XIX International Scientific Conference

# FIS COMMUNICATIONS 2016

in Physical Education, sport and recreation

# Book of Proceedings

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FACULTY OF SPORT AND PHYSICAL EDUCATION
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University of Niš
Faculty of Sport and Physical Education

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*„FIS COMMUNICATIONS 2016"*
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# Book of Proceedings

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# *FOREWORD*

*Faculty of Sport and Physical Education University of Nis in its 45 years long tradition organizes a scientific conference "FIS COMMUNICATIONS". This year we are organizing 19$^{th}$ scientific conference "FIS COMMUNICATIONS 2016". Our profound years long experience in organizing of the conference has contributed to ever increasing high quality of the conference over years.*

*International scientific conference "FIS COMMUNICATIONS 2016" is organized by the Faculty of sport and Physical Education University of Nis under the auspices of the Ministry of Education, Science and Technological Development of the Republic of Serbia.*

*We are proud to announce the key speakers in our plenary sessions as eminent renowned experts in their field of expertise who are coming from the countries taking part in this conference for the first time.*

*This conference can boast submission of 88 full text papers. Upon the review process 70 papers were accepted and approved for the publication.*

*Papers are divided into five sessions depending on the topics investigated as follows:*

*Sport, Team Sport, Physical Education, Physical Exercise and Health, and Interdiciplinary session.*

*Organizers are satisfied with the participation of already renowned researchers and the young, oncoming authors following the thorny path of the scientific investigation, as well. Also a large number of foreign authors and thematic diversity have widen the horizon of the expert and scientific insights, put some new incentive for the cooperation and expression of the new creative efforts.*

*Enclosed you can find the Proceedings of the International scientific conference "FIS COMMUNICATIONS 2016" incorporating all the papers presented at the scientific conference.*

*We would like to express our gratitude to all the participants, especially to the authors of the papers and we expect that all this conference contributes to enhance and further the development of the scientific and expertise thought in the area of sport, physical education and recreation.*

Chair of the Scientific Committee
Saša Pantelić, PhD, prof.

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# Plenary Sesion

# RETURN TO PLAY AFTER MENISCAL INJURY

**Nebojsa Popović**[1]

[1]Aspetar Orthopaedic and Sports Medicine Hospital, Doha, Qatar

UDC 61::796

## SUMMARY

Meniscal tears are common injuries and may result either from acute trauma or by more degenerative processes. Arthroscopic treatment for meniscal injuries is an extremely common orthopaedic procedure in Western countries. Approximately 700 000 arthroscopic partial meniscectomies are performed annually in the USA, at a cost of around US$4 billion. Loss of the meniscus compromises the protective environment of the knee joint and can be regarded as a pre-arthritic condition. Current options for treatment of meniscus injury include: nonoperative treatment, meniscectomy, meniscal repair and meniscus transplantation.

Knowledge of the zones of blood supply as well as age of the patient and tear characteristics, such as tear pattern, tear location and chronicity of the lesion can aid in making treatment decisions. Meniscus repair remains the treatment of choice for unstable tears in the vascular zone. Meniscal repair techniques have advanced significantly since they were first described in 1883 by Sir Thomas Annandale, and are gaining popularity among an increasing number of surgeons. Techniques have evolved from open to semi-open to all-inside arthroscopic repairs. Return to play rates are good in athletic populations, generally occurring around 5 to 6 months postoperatively.

Meniscal allograft transplantation (MAT) is salvage procedure for the patients who have undergone a total meniscectomy and present with joint pain, mild chondral changes, normal joint alignment and a stable knee. Literature suggests athletes may be able to return to training 5 months postoperatively following aMAT procedure.

Recent evidence indicates that supervised exercise therapy should be considered as a primary treatment option for patients with pain and degenerative meniscal tears confirmed by MRI but without radiographic signs of osteoarthritis.

In conclusion, athletes are a challenging population, with high demands on knee function. When treating meniscus injuries we have to take in consideration: meniscectomy offers fast return to play, but with long term risk of OA. Meniscal repair should be prioritised when possible, especially in young athletes. MAT is viable salvage procedure for those who have undergone a meniscectomy, with possible return to sport. Exercise therapy should be considered as a primary treatment option for degenerative meniscal tears in middle-aged patients.

# HOW WILL SPORT SCIENCE SUPPORT ATHLETES IN THE NEXT 10 YEARS?

**Mathew Wilson**[1]

[1]Aspetar Orthopaedic and Sports Medicine Hospital, Doha, Qatar

UDC 796.01

## SUMMARY

Like any human endeavour, sports evolve over time. With 19 world and 60 Olympic records set at Rio 2016, just how far can athletes go? It is clear that science and technology is helping to fuel these improvements in human potential, with sport scientists and engineers providing ever-better equipment made with superior materials, better information about physiological adaptation, nutrition and training optimisation, and improvements in data generation and analytics that help push the limits of athletic capability. This presentation reviews recent developments in sport science support and aims to provide the audience with an insight into the future direction of ethical sport science for the forthcoming decade.

# Sport

# SPECIFICS OF CYCLISTS ALTITUDE TRAINING DURING PREPARATORY PHASE

**Velimira Koleva[1] and Ivan Ivanov[1]**

[1]National Sports Academy "Vasil Levski"-Sofia, Bulgaria

UDC 796.015.6/.7

## SUMMARY

Altitude training is known and widely used in various sports, including cycling for more than sixty years. The applied hypoxic effects to human body and hypoxic training are most often associated with endurance sports to which the road cycling belongs. The transfer of methodological approaches applies to the realization of hypoxic training with focus most often made in the recent past as a training in high-altitude conditions. The written so far gives us reason to suppose that analysis on the problem in a particular sport and discipline, namely, road cycling will allow the forming of a deeper and detailed scientific data.

**Keywords:** altitude, preparatory phase, training, cycling, specifics

## INTRODUCTION

Cycling is a sport with a long lasting history and has different varieties as: cycling on track, road, mountain, etc. In its entity cycling is cyclical movements requiring comprehensive participation of all parts and units of human body.

Success in any cycling discipline is a function of multilateral inherently human activity. For achieving high level results in this sport, cyclists must overcome the increasing competitions at different levels. Nowadays progress in cycling is impossible without creative understanding of best practice and future development of scientific and methodological provision of high qualification cyclists training process management.

Sport activities in substandard altitude conditions is seen by sport specialists as a powerful factor that increases athletes adaptation and puts it to a qualitatively new level which ensures maximum realization in competitions. It also has a long lasting effect on human body functional capacity if this capacity is adequately used during the re-acclimatization period.

Altitude training is known and widely used in various sports, including cycling for more than sixty years. The applied hypoxic effects to human body and hypoxic training are most often associated with endurance sports to which the road cycling belongs. They have different content and different proofs of their positive impact on sport performance.

The transfer of methodological approaches applies to the realization of hypoxic training with focus most often made in the recent past as a training in high-altitude conditions.

The aim of the theoretical research is to reveal the training process in road cycling at altitude training during the preparatory period.

## METHODS

The study was conducted using the following methods: study methodological literature, document analysis, theoretical analysis and synthesis.

## RESULTS

In cycling the altitude training includes three linked parts: preparation for altitude training, altitude training and re-adaptation.

The preparation for altitude training lasts between 7 and 10 days and solves the following tasks:

- slight decrease in training volume, typical for the basic mesocycle;
- gradually increasing the intensity of training loads with slight extending of rest intervals. The aim is to provide greater power to the

neuro-muscular effort, stimulating the internal muscle coordination.

- add more variety in training impact by increasing their contrasting nature; for this purpose, the share of variable-interval irritants increases, which lead to greater mobility of adaptation reactions, typical for altitude training.
- consideration of some morphofunctional and psychological characteristics of cyclists (compensatory capabilities, mindset, motivation to work in tougher conditions, etc.).

The preliminary preparation includes a number of organizational and methodological task including control testing in a specialized set of functional and sport-pedagogical indexes.

Actual altitude training duration varies. During the preparatory period its duration is between 20 and 30 days. The main task of training methodology in actual altitude training is adaptation of training effect in accordance with the already described physiological human body responses in middle altitude. For this purpose, the training work is redistributed in three microcycles with different structure and content. [4]

A) Introductory microcycle – lasting from 3 to 5 days. It is characterized by the so called imbalanced adaptation which is caused by primary effects if increased excitability. They also have “emergency” character with a whole series of negative feelings. During this bioenergetics, psychological and physical discomfort, training sessions should have strictly individual focus. Otherwise, the positive result of altitude training can be questioned. Therefore, the main criterion of training load must be responses of the body to which to adjust the parameters of training loads – speed, resistance, extend, number of repetitions, duration and recovery phases type. It is recommended that these parameters under normal conditions to be under 15-20% of their maximum values. For high qualification cyclists with great experience in altitude training, loads must be carried out adapted to their self-confidence. [7]

B) Transitional stabilizing microcycle with duration 5-8 days. During this period, the cyclists gradually normalizes adaptation reactions which allows increased training loads.

C) Sustainable stabilized microcycle with duration 8-10 days. Here the adaptation changes are stable close to training of external load at the sea level. Sometimes the load cannot exceed the maximum values of the sea level at expense of extending slightly rest intervals.

Training at re-adaptation stage. In cycling it is an integral and essential part of the altitude training. The main task is to restore the normal training regime of cyclists and keep the functional and structural changes of altitude training. This re-adaptive phase of the altitude training during preparatory period has different duration and individual dynamics. The transition takes place smoothly, as it has no part in competitions. Nevertheless, there are some changes in the training program related to the wave nature of re-adaptation process:

- Lowering training volume and keeping intensity of training loads in the first 3-4 days after returning from altitude training camp.
- Decrease of the intensity and increase of the training volume between the 5th and 10th day. Adding variety in the nature of the training resources, giving priority to fartlek and other forms of variable training work.
- gradual increase in the average training intensity, which is generally different for different sports. For speed-strength disciplines this is done at the expense of increased power of neuromuscular effort and slightly extended rest periods. In endurance sports the same purpose is achieved by a slight increase in intensity and shorting the rest periods.
- Switching to higher levels of the special training parameters after the 12th day, conducting control testing, participation in competitions, etc.

Such a strategy during preparation phase of re-adaptation creates favorable conditions for high-performance in the so-called shock and pre-competition mesocycles and microcycles at the end of the preparatory and in the begging of the competition period. [7]

# CONCLUSION

The written so far gives us reason to suppose that analysis on the problem in a particular sport and discipline, namely, road cycling will allow the forming of a deeper and detailed scientific data. On one hand this will allow to make a new rethinking and systematization of achieved so far and on the other hand, on this basis to build and apply in future more effective approach to altitude training related to optimized training process for cyclists.

Training in cycling becomes more and more exact science. Fortunately, this science “of mind and body” does not diminish the joy and satisfaction of sports training sessions in cycling as it gives a new depth and more complete sense to cycling.

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# ASSESSMENT OF LACTATE THRESHOLD FOR CYCLISTS USING PLANTIGRADE TEST BY "STEGMANN" METHOD

**Velimira Koleva[1] and Ivan Ivanov[1]**

[1]National Sports Academy "Vasil Levski"-Sofia, Bulgaria

UDK 796.6/.7:015

## SUMMARY

The aim of the following study is through lactate test to determine the lactate thresholds for cyclists applying "Stegmann" method. Lactate threshold (LT) is intensity of physical exercise, which is associated with significant increase of blood lactate during tests with stepwise increasing loads. 'Stegmann" method is popular with the fact that it allows load to be suspended earlier (lactate levels over 6 mmol/l) compared to other methods. The important thing for cyclists is the produced power in the different heart rate zones and especially around LT.

**Keywords:** test, lactate, intensity, threshold

## INTRODUCTION

Lactate threshold (LT) is intensity of physical exercise, which is associated with significant increase of blood lactate during tests with stepwise increasing loads. The term anaerobic threshold has imposed both in our and international literature. In our study this term will be used often for determining training loads limits. As mark for these limits we will use blood lactate levels.

In a study published in 1981 "Lactate kinetics and individual anaerobic threshold" with authors H. Stegmann, W. Kindermann, A. Schnabel [6] is offered a specific method for determining lactate threshold, which over the years proved its high reliability and informational value. In their approach lactate curve continues during recovery period and plot tangent, to its starting from this point at which lactate concentration in blood during recovery equals its highest values during load period. The method is widely used and enough accurate at varying plantigrade work and recovery duration between steps (where necessary).

The aim of the following study is through lactate test to determine the lactate thresholds for cyclists applying "Stegmann" method.

## METHODS

Contingent of the following study are 6 cyclists (active sportsmen) from Cycling club "NSA Vasil Levski" Sofia aged 16-20 years. Respondents were subjected to one test for determining LT. Tests were conducted with respondents' personal bicycles placed on bike trainer "Tacx Satori". On the back rim of each bicycle we mounted additionally "Sigma" bike computer which traced speed and power. Heart rate was traced with personal heart rate monitors, and lactate samples were monitored with lactate analyzer "Lactate Plus". Bicycle tires were same size 23-622, inflated to 7 bars. The bike trainer was fixed at fourth training load level corresponding approximately to driving on asphalt without slope or wind. Tests were performed with normal motion of around 90-100 round per minute (rpm).

## RESULTS

'Stegmann" method is popular with the fact that it allows load to be suspended earlier (lactate levels over 6 mmol/l) compared to other methods. Studies show that in this case results have a high degree of reliability and makes this test suitable for respondents (not active sportspersons), as well as initial determination of lactate threshold. The test was conducted in the following algorithm:

- Warm up – duration 5 minutes with speed 20 km/h;
- The actual test starts at a speed of 24 km/h with 2 km/h and increase every 1 minute;

- Monitoring heart rate and rpm at the end of every 1 minute;
- Monitoring lactate concentration during the load and during every 3rd minute until it reaches value over 6 mmol/l'
- Passive recovery period and monitoring lactate levels every 3rd minute until it reaches levels lower than the highest during work period.

The data from the test is presented on Figures from 1 to 6.

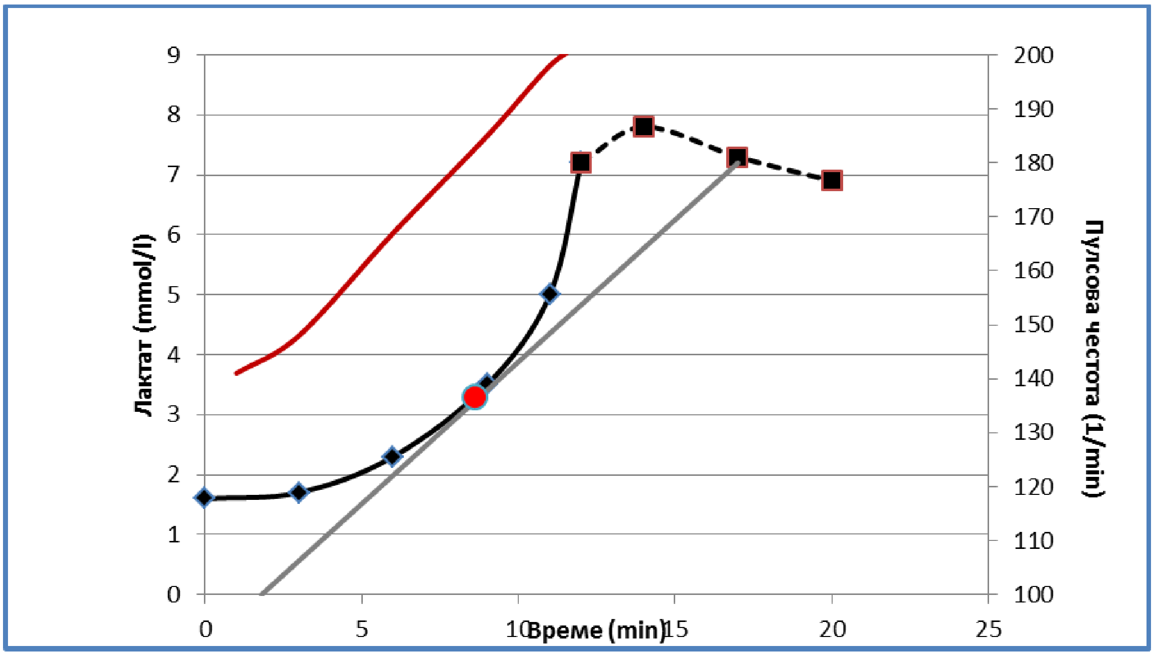


**Figure 1.** Respondent №1 using "Stegmann" method for determining lactate threshold.

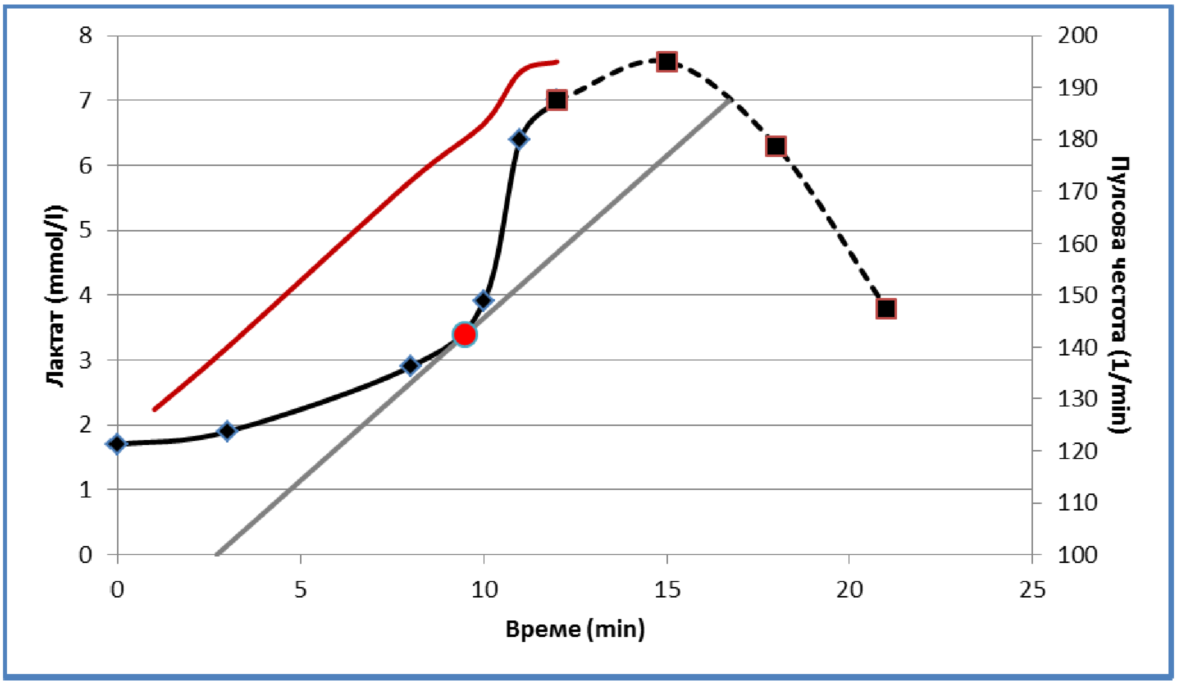


**Figure 2.** Respondent №2 using "Stegmann" method for determining lactate threshold.

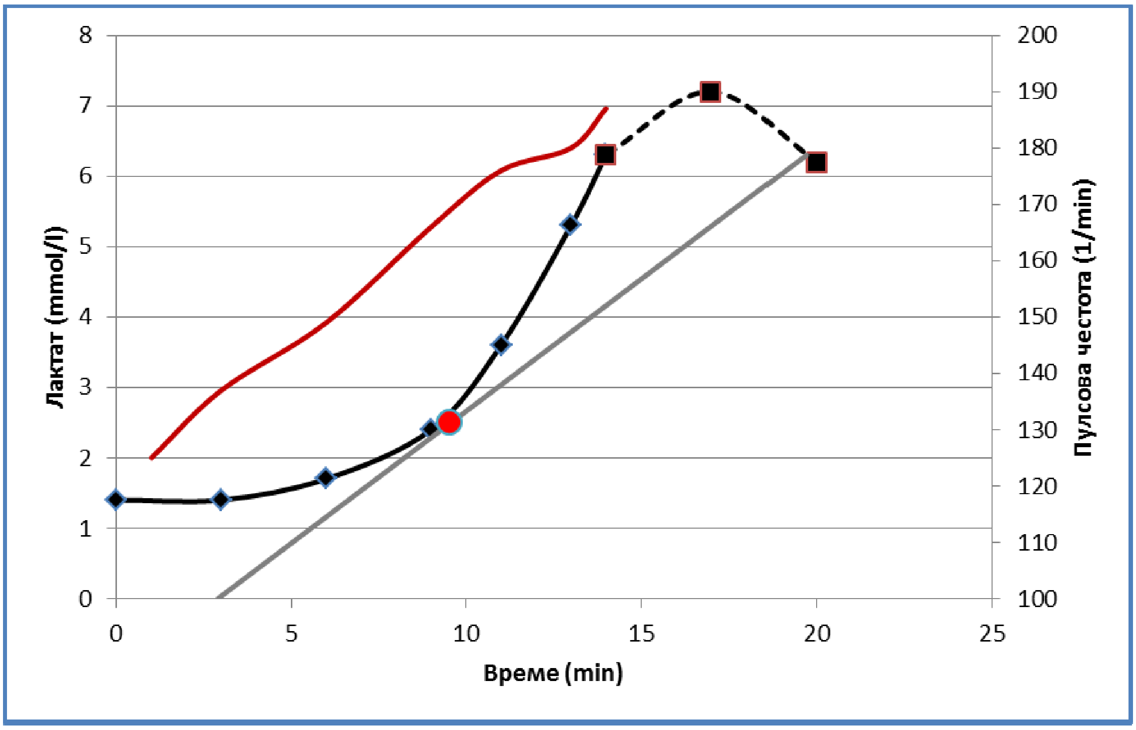


**Figure 3.** Respondent №3 using "Stegmann" method for determining lactate threshold.

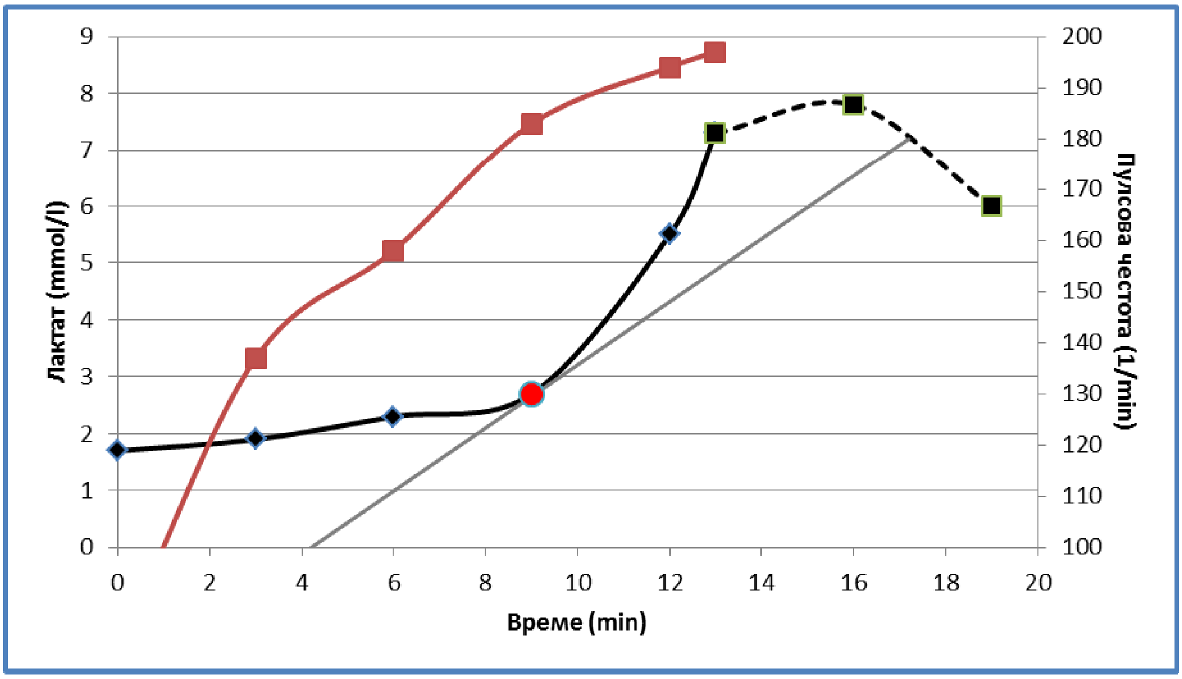


**Figure 4**. Respondent №4 using "Stegmann" method for determining lactate threshold.

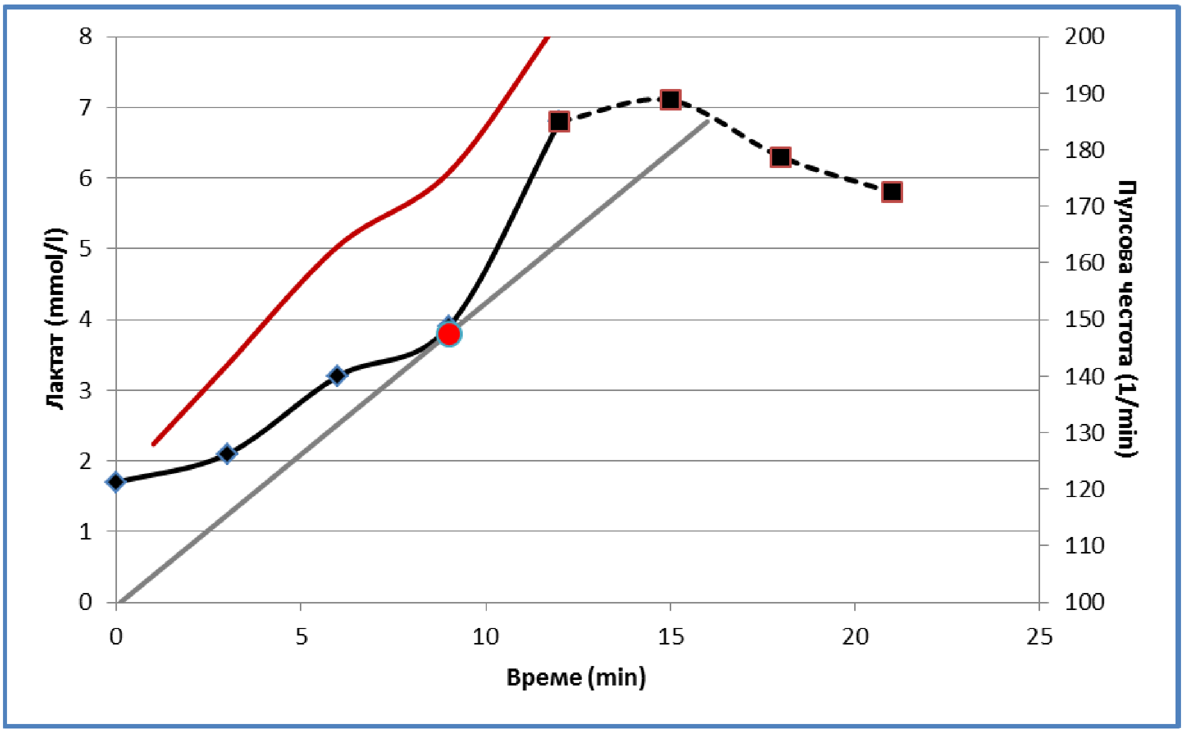


**Figure 5.** Respondent №5 using "Stegmann" method for determining lactate threshold.

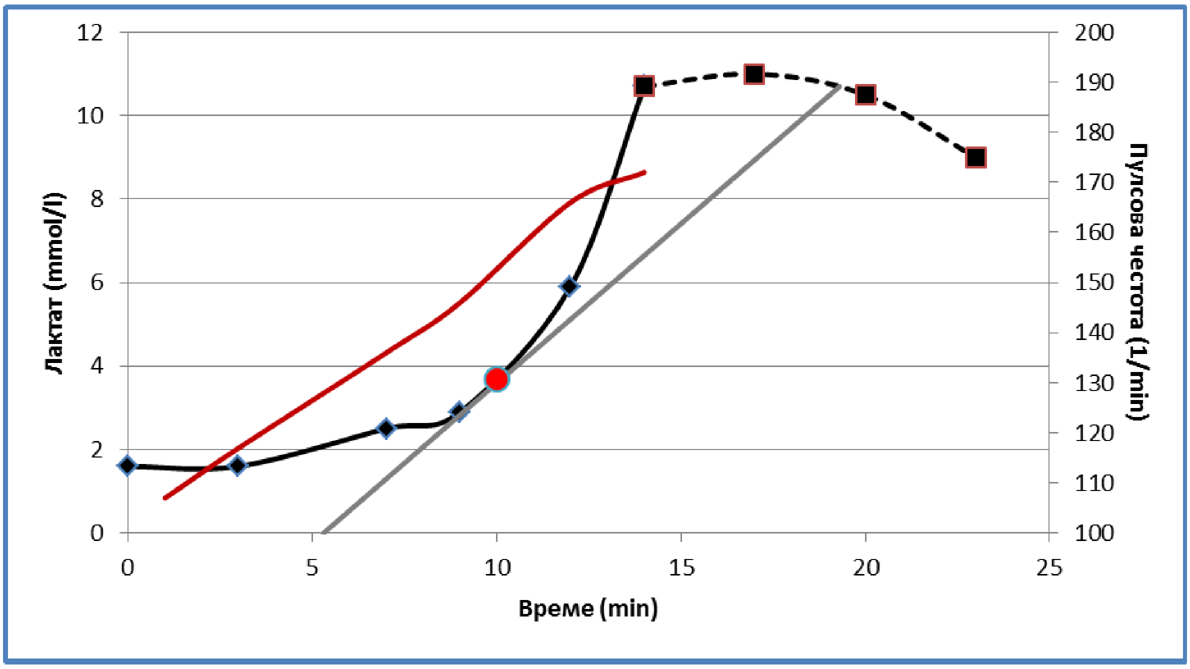


**Figure 6.** Respondent №6 using "Stegmann" method for determining lactate threshold.

## CONCLUSION

We must note that for more advanced cyclists a 20 or even a 30-minute test is too short and the registered average heart rate is slightly higher compared to actual heart rate level of lactate threshold (HRLT – heart rate lactate threshold). Experienced cycled are able to withstand longer the increased acidosis and respectively can continue loads for longer period over the threshold. The important thing for cyclists is the produced power in the different heart rate zones and especially around LT.

Heat rate frequency is quite fickle and not the most accurate indicator of intensity during training. It can be a good reference for training loads with long duration and low intensity. But advanced cyclists need more precise methods for intensity control. Therefore, these power meters and periodic lactate tests become integral part of training process.

During training processes, it may be needed the determined values to be corrected. Upon the initial establishment of training areas and heart rate fluctuations on the real HRLT is recommended to train with lower values. Experience show that cyclists tend to work at higher intensities than necessary at certain times of training.

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# SPECIFICITY OF JUNIOR CYCLISTS TRAINING DURING COMPETITIVE PERIOD

**Ivan Kolev**[1]

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UDC 796.6/.7:373.58

## SUMMARY

The results of the studies allowed us to divide the periods which include a big amount of specialized training. These periods last about 80-90 days. The conducted studies give an additional information about the theory and the methods of the sports trainings. The optimum proportions between the training and the competitive physical energy spending have been established by taking into account the sports calendar, the specific physical preparation and functional condition of the cyclists.

**Keywords:** specifics, macrocycle, mesocycle, microcycle

## INTRODUCTION

The constant improvement of the sports results and the growing competition on a global scale make us constantly improve the system of training. Particularly problematic is the issue with the training of the road cyclists for their participation in European or World junior championships. In comparison to the other cyclic sports for physical endurance – swimming, middle and long-distance running in athletics ,skiing, skating, rowing ,etc., cyclists take part in much more competitions during the year. Depending on the distance and lanshaeft of the competition distance as well as the speed by which it is cycled, the amount, the intensity and the character of training, we need to insure the optimal forming of the social physical preparation.

The studies in that regard of V. Minchenko (1986), S. Erdakov (1997) and others to a great degree deal with the basic issues of the preparation of the cyclists and don't give a full characteristics of the organizational and structural specifics in the making of the training process for the main competitions.

The purpose of this research is the development of a rational structure for the training process in the competition period.

## METHODS

The object of the study is the training process of the higher-qualified junior cyclists

The topic of the study –the specifics of the making of the training process during the special preparation for participation in the main competitions.

Tasks of the study:

1. To determine the optimal parameters of the micro and meso-structure in the stage of special preparation
2. To study the dynamics of the parameters and the functional condition in the special preparation
3. To develop and establish the structure of the training process in the special preparation

Organization of the study- the pedagogical observation and the experimental part of the work was made in stages during the long 2010-2015 period.

During the first stage were studied the training programs of the teams in Burgas, Plovdid, Razgad, Stara Zagora and others.

During the second stage was analyzed the structure of the training and competitive loading used in the preparation for national and international competitions.

In the 3rd stage were analyzed the modern approaches towards the construction of the training process.

# RESULTS

The main task of the competition period is to ensure a stable level of efficient preparation as a grouhd for reaching a high sports form in the main competitions of the year. The results of the studies allowed us to divide the periods which include a big amount of specialized training. These periods last about 80-90 days. By studying the content of the training programs it has been found out that the stage of the special training is regarded as an individual macro cycle consisting of 4 interconnected mesocycles. The duration of the first 2 mesocycles is determined most of all by the number and the type of the competitions for the respective year. We will consider here just a few basic characteristics typical for each of the 4 mesocycles:

First mesocycle - Structurally it is distinguished by a duration of 20-24 days and is characterized by a gradual increase of the intensity of training by a more varied work. It is dominated by exercises for perfection of the glycolytic mechanisms without isolating the aerobic exercises. The number of the training exercises is about 15-18,and the hours are 70-80. The total distance in kilometers is about 2000km,1500 of which are training and 500 competitive.

Second mesocycle - Normally national championships and big regional competitions are held during it. The goal is to achieve the highest possible results. The duration of that mesocycle is about 30 days,18 of which are training days,5 competitive and 7 rest days. The number of the training exercises is about 18-20,and the hours-70-75. The total distance in kilometers is about 2500km,2000 are training and 500 competitive hours. As a whole this period is very tough which makes the competitors lose a considerable amount of their physical and psychological energy.

Third mesocycle - That is a relieving cycle in the competitive period.

The duration of that mesocycle is about 14 days,8-10 of which are training,1-2 are competitive and 3-4 rest days. The number of the training exercises is about 12-14,and the hours-30-35. The total distance in kilometers is about 500-600,500 of which are training and 100 competitive.

The first week has a markedly relieving(recovering) character, immediately after the toughness of the 2nd mesocycle. The number of the training exercises is small to average with moderate intensity. Generally the idea is to keep the aerobic comfort at heart rate of 130-140 beatings/min and a La content up to 3m.mol.l. Complex recovering activities are held.

The second week has a markedly refreshing character. The goal is to activate again the functional systems and the nervous system for the forthcoming major competitions in the year during the 2nd half of the competitive period. Here a special place have 2 types of training exercises:

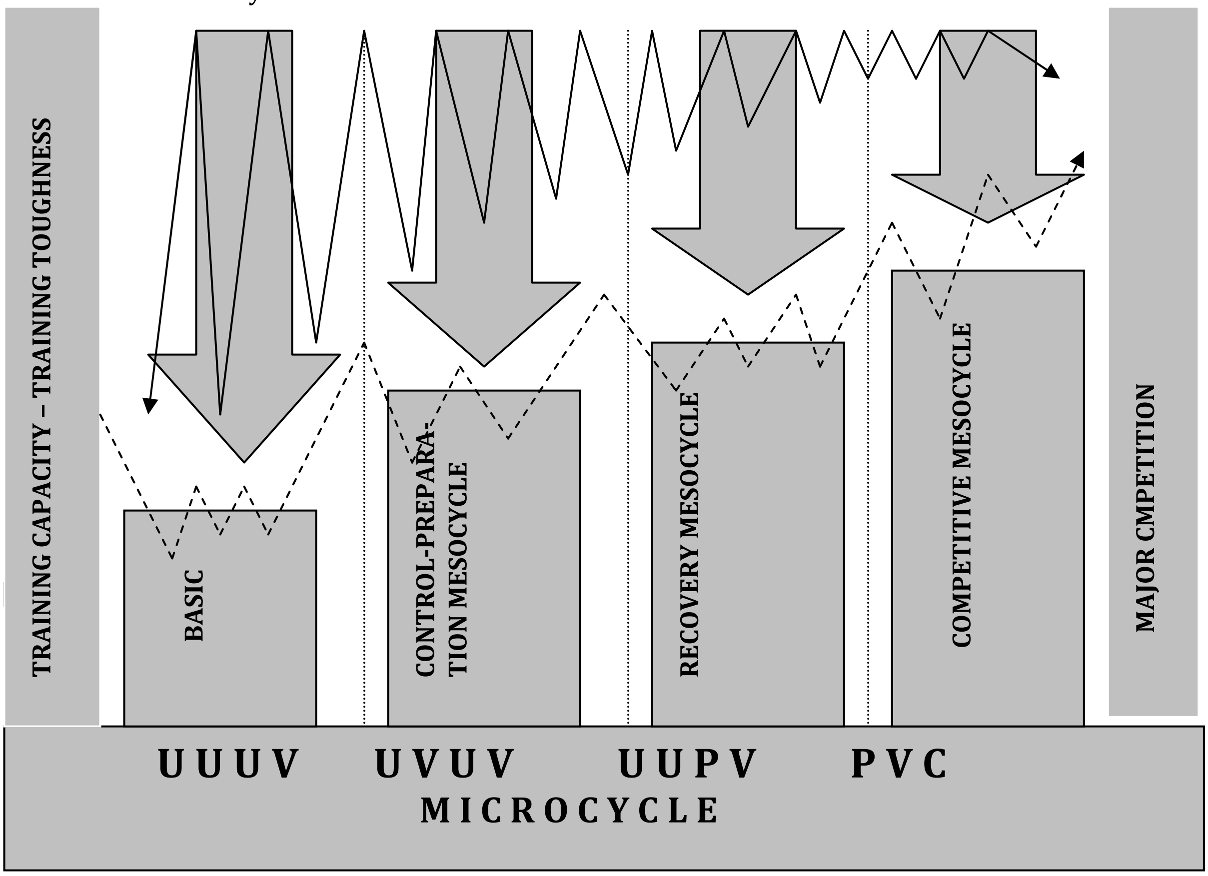
- Training exercise for speed and strength – That is the cycling of a distance of 40-50 km on a varied route. The goal is to maintain a sub maximal intensity. The pulse should be 160-180 heartbeats/min.
- Training exercise for speed endurance.The goal is to maintain high speed of 40-50km. The pulse should be 160-180-190 heartbeats/min. and lactose up to 4-6m.mol/ l. After that trainee exercise are recommended recovering procedures and a greater intake of carbohydrates and vitamin foods.

Fourth mesocycle. During it the major competitions of the year are held-World championships and others. It is desirable that the competitors be in their best of physical fitness. The toughness of training here is greatest for the whole year. A considerable amount of attention is paid to the recovering of the cyclists.

The structure and the content of the special training is represented in the following mesocycles: basic,control-preparational, recovering and competitive (table 1).

The preliminary studies conducted by us during different years showed that the used parameters are an inseparable part of the system of the training of the cyclists. The information about the functional condition of the cyclists allowed us to make timely corrections of the training process and avoid over-tough trainings. During the 2012-2014 period the topic of the studies was the functioning of the cardiovascular systems during competitions: cycling pursuit, one-stage and criteriums. A special attention during the analysis of the cardiovascular system was paid to the separate phases: initial phase, basic work and recovery.

**Table No. 1** Organization of the training process in the stage of special preparation Here-U stands for gradual mesocycle,V-recreation microcycle, P-introducing microcycle, C-competitive microcycle




## CONCLUSION

1. The conducted studies have established that the structure of the training process in the stage of special preparation is characterized by a big amount of tough competitive exercises.

2. The amount of aerobic exercise is 20-25%, of mixed aerobic-anaerobic it is 10-15% and of anaerobic - 5-10%

3. The figures about the pulse (the heartbeats in a minute)give an additional information about the special physical preparation and functional condition of the cyclists.

*Theoretical importance.* The conducted studies give an additional information about the theory and the methods of the sports trainings by providing new methodical conceptions for the making of the training process in the stage of special preparation for the main competition.

*Practical importance.* The suggested methodical instructions about the forming of the special physical preparation can be used in the training process of the preparation of junior road cyclists without the need to change them. The optimum proportions between the training and the competitive physical energy spending have been established by taking into account the sports calendar, the specific physical preparation and functional condition of the cyclists.

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# FUNDAMENTALS OF SELECTION AND ORIENTATION OF BICYCLISTS IN AGE 13-14 YEARS

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UDC 796.6/.7

## SUMMARY

It is proposed that the study selection and orientation of bicyclists in age 13-14 years. This examination is a prerequisite for promoting the development of sport, located at a standstill in recent years. The results obtained can be used in the countries of the region.

**Keywords:** testing, potential contestants, age

## INTRODUCTION

Sports selection is at the top of every science-based and organised sporting activity, a guarantee of future success. The problem of the selection remains the most topical for every kind of sport. In every sport there are a particular group of the most important indicators that the selection is carried out in the course of multiannual training. The selection is an important starting point of training young cyclists and has great importance for the outcome of the preparation. To achieve high sports performance is a necessary finding of sports talent.

To reveal the essence, characteristics and significance of sport orientation, necessary prerequisite was to clarify the relationship and interaction between selection and orientation between the sports and sports orientation. Both processes are inseparable connected to each other, mutually conditioned and placed in front of each other. In the most general terms this is a single process of directed down the correlation between personality and activity between the individual and the sports discipline.

Tests and measurements in the initial stage of sports training are an excellent tool for discovering the makings for one or the other sports variety in the cycling sport.

The main task to solve, standing in the selection and orientation of the young cyclist is that with maximum accuracy to forecast is the young athlete to pass early specialization, so that in the process of sports excellence to him there are real prospects for further development. This is what prompted us to conduct this study.

The purpose of the study is: to explore the fundamentals of selection and orientation of young and promising riders in age 13-14 years.

## METHODS

The subject of the research are possibilities of motor-cyclists boys aged 13-14 years. For the purposes of the study, were separated 7 test, illustrating the anthropometric and motor characteristics of surveyed persons (table 1). The tests provide an opportunity to assess the level of development of basic physical qualities needed for success in the cycling sport – speed, strength, and endurance. They are easy to measure and control, which is a prerequisite for immediate implementation in practice of the professionals and coaches.

**Table No. 1** Tests for the selection of kilometristi included in the study

| №. | Index | Name | Amend. | Accuracy: |
|---|---|---|---|---|
| 1. | **У** | **500 m from the site by bike** | сек | 0,01 |
| 2. | **X1** | **Growth** | см | 1 |
| 3. | **X2** | **Weight** | кг | 1 |
| 4. | **X3** | **100 m flying start with bike** | сек | 0,01 |
| 5. | **X4** | **200 m flying start with bike** | сек | 0,01 |
| 6. | **X5** | **Running 30 m start with low signal** | сек | 0,01 |
| 7. | **X6** | **2 000 m of the site by bike** | сек | 0,01 |

We have grouped them provisionally in the following way:

1. Sport-technical features – У.
2. 2 time anthropometric medical data – X1, X2.
3. Special fast-track opportunities – X3, X4.
4. Speed of the lower limbs – X5.
5. Special gear endurance cyclist – X12.

Object of the study were 13 cyclists aged 13-14 years from the NSA.

For 12 months were conducted two testirani, as follows:

- first test – March. 2015 years.;
- the second test – March. 2016.

# RESULTS

In the table. 2 are listed the results of variacionniâ analysis of the data from the first test. The homogeneity of the sample is as follows:

Highly uniform – in tests У, X1, X2 X3, X4, X5, X12. The homogeneity of the sample is confirmed by the values of coefficients of kurtosis (Es) and asymmetry (As). The distribution of cases across all tests normal, Gausovo.

Not meet the exceptional performance both in sports and technical terms, and in tests, anthropometric indicators and reflecting the physical qualities of the studied individuals.

**Table. No. 2** Variacionen analysis of the data from the first testing

| Test | Xcp. | Mx | S | Ex | Ax | Xмin | Xмax | R | V% |
|---|---|---|---|---|---|---|---|---|---|
| У | **41,08** | **0,83** | **2,80** | **-0,92** | **0,19** | **37,08** | **45,93** | **8,85** | **6,98** |
| X1 | **159,02** | **0,99** | **3,42** | **-0,44** | **-0,51** | **147,0** | **165,0** | **118,0** | **7,63** |
| X2 | **53,43** | **0,68** | **2,61** | **-0,20** | **0,31** | **51,00** | **64,00** | **13,00** | **9,29** |
| X3 | **7,34** | **0,23** | **0,77** | **-0,90** | **0,39** | **6,95** | **8,09** | **1,13** | **7,96** |
| X4 | **13,89** | **0,30** | **0,88** | **-0,70** | **0,65** | **12,67** | **15,84** | **3,17** | **9,01** |
| X5 | **5,07** | **0,09** | **0,18** | **-0,92** | **-0,71** | **4,89** | **5,45** | **0,56** | **9,70** |
| X12 | **157,80** | **2,34** | **7,02** | **-0,90** | **-0,54** | **158,9** | **185,01** | **226,1** | **9,02** |

We find good sports and technical capabilities in the investigated persons (У) – participants in organized sports and pedagogical process, with profiled focus. The scale of the result in the main test (500 м от място – У) within the SEC – 8.85 sounds very much like the values of the waved at the first studied group.

In the table. 3 find the results of variacionniâ analysis of the data from the second test. In it we observe highly homogeneous sample of data

**Table No. 3** Variacionen analysis of the data from the second testing

| Test | Xcp. | Mx | S | Ex | As | Xmin | Xmax | R | V% |
|---|---|---|---|---|---|---|---|---|---|
| У | **39,62** | **0,63** | **2,45** | **-1,02** | **0,20** | **35,86** | **44,03** | **8,17** | **6,18** |
| X1 | **164,53** | **1,12** | **4,32** | **-0,04** | **-0,71** | **155,0** | **170,0** | **15,0** | **2,63** |
| X2 | **57,73** | **0,78** | **3,01** | **-0,30** | **0,01** | **52,00** | **63,00** | **11,0** | **5,22** |
| X3 | **7,03** | **0,08** | **0,31** | **-1,20** | **0,41** | **6,65** | **7,59** | **0,94** | **4,46** |
| X4 | **13,25** | **0,21** | **0,82** | **-0,41** | **0,35** | **11,88** | **14,84** | **2,96** | **6,21** |
| X5 | **4,97** | **0,04** | **0,14** | **-1,12** | **-0,30** | **4,76** | **5,15** | **0,39** | **2,78** |
| X12 | **165,15** | **1,74** | **6,72** | **-0,69** | **-0,44** | **152,95** | **175,0** | **22,1** | **4,07** |

So the relationships give us reason to believe that the test battery is selected and comply with the stated purpose of the study.

## CONCLUSION

It is presented the opportunity for the selection and orientation of bicyclists in age 13-14 years. It is preferable to table proposed regulations apply in the 14-year-old boys, as it has been developed on the basis of final data after conducting a one-year experiment.

The proposed approach can be applied to other sports – with individual and collective character.

The results obtained are carriers as the salient features of the investigated persons and general trends in the development of the age. This makes them applicable to this age in each country.

Certain reservations in this respect may have in the implementation of the results of the research in countries with radically different climate and geographical location where observed some specific manifestations of acceleration in teenagers – an earlier or later maturity.

Eventually the age trends in growth and in the development of physical and sport-technical capacity can serve as a guide in the preparation of the cyclists from examined age in each region.

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# ANALYSIS OF BROKEN RECORDS IN SWIMMING AT THE OLYMPIC GAMES HELD IN RIO IN 2016

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## SUMMARY

Summer Olympics Games in Rio 2016 were the XXXI modern Olympic Games. These sporting events took place at 37 venues in Rio de Janeiro. Swimming has been in the Olympic Games since Athens 1896. Men and women participate in 16 events, including relays and individual competitions in four strokes. The aim of our study is to analyze in details broken records by athletes, nations and continents in recently completed Olympic Games, Rio 2016. The number of broken records on this Olympic Games is: eight World (3 man and 5 woman), 23 Olympic records (7 man and 16 woman), three Africa records (1 man and 2 woman), nine USA records (3 man and 6 woman), three Asia records (3 man), seven Europe records (3 man and 4 woman) and one Oceania record (1 women). The most broken records are performed by women (20 man, 34 woman) from which we can conclude that a woman swimming in the world is in great expansion.

**Keywords:** World record, Olympic record, USA record, Asian record, European record, Oceania record

## INTRODUCTION

The Summer Olympics Games in 2016 were the XXXI modern Olympic Games commonly known as Rio 2016. Rio 2016 is major international multi-sport event held in Rio de Janeiro, Brazil, from 5 August to 21 August 2016. 205 National Olympic Committees took a part in Rio 2016 involve approximately 11,700 athletes who are competing in 42 sport disciplines (www.rio2016.com/en/olympics). These sporting events took place at 32 venues in Rio de Janeiro, plus five football co-host cities: Belo Horizonte, Brasilia, Manaus, Salvador and Sao Paulo. Swimming has been in the Olympic Games since Athens 1896. Men and women participate in 16 events, including relays and individual competitions in four strokes – freestyle, backstroke, breaststroke and butterfly.

Freestyle 50m, 100m, 200m, 400m, 800m (women), and 1,500m (men)
Backstroke 100m and 200m
Breaststroke 100m and 200m
Butterfly 100m and 200m
Individual medley 200m and 400m
Relays 4×100m free, 4×200m free; 4×100m medley

The swimming competition in Rio 2016 was held from 6 to 13 August at the Olympic Aquatics Stadium. FINA rule BL 9.3.6.4 (swimming) determine the qualification procedures for the Swimming competition at the Olympics. Two participants per event and one relay team shall represent each country, and a country may not have more than 26 males and 26 females (52 swimmers) on its team (www.fina.org). Aim of the game was „Swimmers must complete a set distance inside the pool, in some cases using a specific swimming style, in the shortest possible time”.

## METHODS

The aim of our study is to analyze in details broken records by athletes, nations and continents in recently completed Olympic Games, Rio 2016. We investigate Olympic official site, swimrankings database and Wikipedia to collect data of swimming results. The research method implies descriptive method and selection method of data. With descriptive method selected data were analyzed, summarized and included in this study, selection method were selected data from different source that are available in electronic and written form. When searching the databases, the following key words have been used: Olympic Games 2016, Rio 2016, swimming results, broken records.

# RESULTS & DISCUSSION

According to statistics, 47% of swimmers who have qualified for the Olympics is 21 - 25 years old (Figure 1.), 54% were male and 46% were female (Figure 2.). The youngest competitor at these Olympics was thirteen Gaurika Singh from Nepal. The oldest competitor was 37 year old Therese Alshammar from Sweden, which has occurred on his sixth Olympics. In the men's competition the most medals won by American swimmer Michael Phelps (5 gold and 1 silver). In women, the most won Katie Ledecky, from USA, (4 gold and 1 silver). Phelps and Ledecky are now athletes with the most medals at these Olympics. Phelps was still increased balance medals at the Olympics. Now he has 23 gold, 3 silver and 2 bronze medals (www.swimswam.com ; www.swimrankings.net). On the list of most successful medal winners at the Olympics behind Phelps's legendary Mark Spitz (USA) with nine gold, one silver and one bronze. In addition to this success, Phelps became the first Olympian to win four consecutive medals in the individual event, winning the 200m medley. Also, Ryan Lochte (USA) achieved 4 consecutive wins in the 4x200m Freestyle Relay (Athens, Beijing, London and Rio).

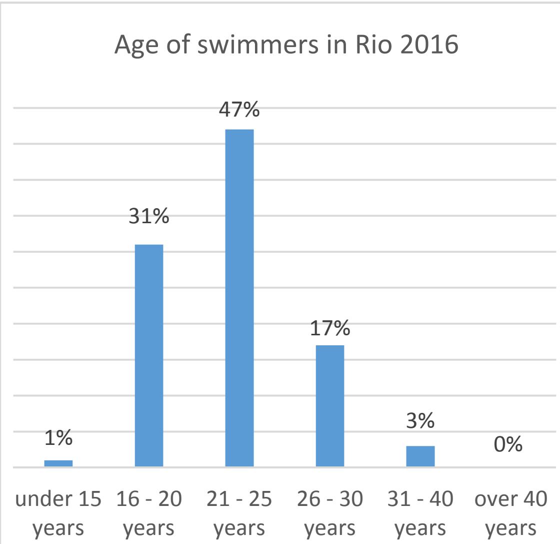


**Figure 1.** Age of swimmers in Rio2016

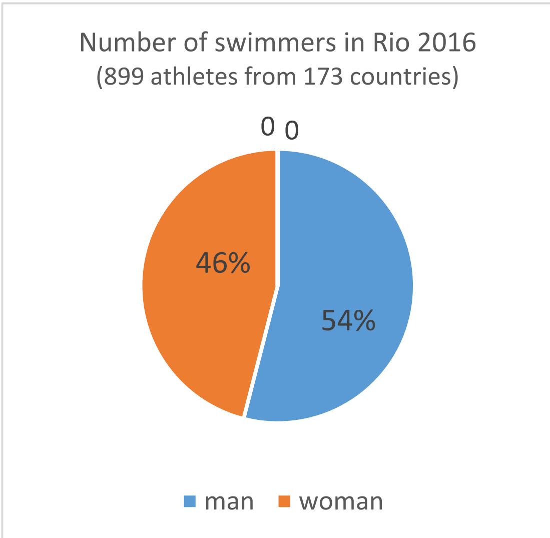


**Figure 2.** Number of swimmers in Rio 2016

Anthony Ervin (USA) became the oldest swimmer, in his 35, who won a gold medal in 50 meter freestyle. Manuel Simone (USA), became the first black woman who won a gold medal at the Olympics in swimming (100m freestyle). Broken records in Rio 2016 are shown in the following table.

**Table 1.** Broken record in Rio 2016

| Record | Event | | Name | NOC Code | Time | Date |
|---|---|---|---|---|---|---|
| World | Women's 100m Butterfly | FINAL | SJOSTROM Sarah | SWE | 55.48 | 7 AUG |
| | Women's 400m Individual Medley | FINAL | HOSSZU Katinka | HUN | 4:26.36 | 6 AUG |
| | Men's 100m Breaststroke | HEAT 6 | PEATY Adam | GBR | 57.55 | 6 AUG |
| | | FINAL | PEATY Adam | GBR | 57.13 | 7 AUG |
| | Women's 4 x 100m Freestyle Relay | FINAL | Australia | AUS | 3:30.65 | 6 AUG |
| | Men's 100m Backstroke (4x100ME) | FINAL | MURPHY Ryan | USA | 51.85 | 13 AUG |
| | Women's 400m Freestyle | FINAL | LEDECKY Katie | USA | 3:56.46 | 7 AUG |
| | Women's 800m Freestyle | FINAL | LEDECKY Katie | USA | 8:04.79 | 12 AUG |
| Olympic | Women's 100m Butterfly | SEMIFINAL 2 | SJOSTROM Sarah | SWE | 55.84 | 6 AUG |
| | | FINAL | SJOSTROM Sarah | SWE | 55.48 | 7 AUG |
| | Women's 400m Individual Medley | FINAL | HOSSZU Katinka | HUN | 4:26.36 | 6 AUG |
| | Men's 100m Breaststroke | HEAT 6 | PEATY Adam | GBR | 57.55 | 6 AUG |
| | | FINAL | PEATY Adam | GBR | 57.13 | 7 AUG |
| | Women's 4 x 100m Freestyle Relay | HEAT 2 | Australia | AUS | 3:32.39 | 6 AUG |
| | | FINAL | Australia | AUS | 3:30.65 | 6 AUG |
| | Women's 100m Breaststroke | FINAL | KING Lilly | USA | 1:04.93 | 8 AUG |
| | Men's 100m Backstroke | FINAL | MURPHY Ryan | USA | 51.97 | 8 AUG |
| | | FINAL (4x100ME) | MURPHY Ryan | USA | 51.85 | 13 AUG |
| | Women's 400m Freestyle | HEAT 4 | LEDECKY Katie | USA | 3:58.71 | 7 AUG |
| | | FINAL | LEDECKY Katie | USA | 3:56.46 | 7 AUG |
| | Women's 200m Individual Medley | HEAT 5 | HOSSZU Katinka | HUN | 2:07.45 | 8 AUG |
| | | FINAL | HOSSZU Katinka | HUN | 2:06.58 | 9 AUG |
| | Men's 200m Breaststroke | SEMIFINAL 1 | WATANABE Ippei | JPN | 2:07.22 | 9 AUG |
| | Women's 100m Freestyle | HEAT 5 | CAMPBELL Cate | AUS | 52.78 | 10 AUG |
| | | SEMIFINAL 2 | CAMPBELL Cate | AUS | 52.71 | 10 AUG |
| | | FINAL | MANUEL Simone | USA | 52.70 | 11 AUG |
| | | FINAL | OLEKSIAK Penny | CAN | 52.70 | 11 AUG |
| | Women's 800m Freestyle | HEAT 4 | LEDECKY Katie | USA | 8:12.86 | 11 AUG |
| | | FINAL | LEDECKY Katie | USA | 8:04.79 | 12 AUG |
| | Men's 100m Butterfly | FINAL | SCHOOLING Joseph | SIN | 50.39 | 12 AUG |
| | Men's 4 x 100m Medley Relay | FINAL | United States of America | USA | 3:27.95 | 13 AUG |
| Africa | Women's 100m Butterfly | HEAT 4 | OSMAN Farida | EGY | 57.83 | 6 AUG |
| | Men's 200m Freestyle | FINAL | le CLOS Chad Guy Bertrand | RSA | 1:45.20 | 8 AUG |
| | Women's 50m Freestyle | HEAT 9 | OSMAN Farida | EGY | 24.91 | 12 AUG |
| USA | Men's 100m Breaststroke | FINAL | MILLER Cody | USA | 58.87 | 7 AUG |
| | Women's 4 x 100m Freestyle Relay | FINAL | United States of America | USA | 3:31.89 | 6 AUG |
| | Men's 100m Backstroke | FINAL (4x100ME) | MURPHY Ryan | USA | 51.85 | 13 AUG |
| | Women's 400m Freestyle | FINAL | LEDECKY Katie | USA | 3:56.46 | 7 AUG |
| | Women's 100m Freestyle | SEMIFINAL 2 | OLEKSIAK Penny | CAN | 52.72 | 10 AUG |
| | | FINAL | MANUEL Simone | USA | 52.70 | 11 AUG |
| | | FINAL | OLEKSIAK Penny | CAN | 52.70 | 11 AUG |
| | Women's 800m Freestyle | FINAL | LEDECKY Katie | USA | 8:04.79 | 12 AUG |
| | Men's 1500m Freestyle | FINAL | JAEGER Connor | USA | 14:39.48 | 13 AUG |
| Asia | Men's 400m Individual Medley | FINAL | HAGINO Kosuke | JPN | 4:06.05 | 6 AUG |
| | Men's 100m Butterfly | SEMIFINAL 2 | SCHOOLING Joseph | SIN | 50.83 | 11 AUG |
| | | FINAL | SCHOOLING Joseph | SIN | 50.39 | 12 AUG |
| Europe | Women's 100m Butterfly | FINAL | SJOSTROM Sarah | SWE | 55.48 | 7 AUG |
| | Women's 400m Individual Medley | HEAT 5 | HOSSZU Katinka | HUN | 4:28.58 | 6 AUG |
| | | FINAL | HOSSZU Katinka | HUN | 4:26.36 | 6 AUG |
| | Men's 100m Breaststroke | HEAT 6 | PEATY Adam | GBR | 57.55 | 6 AUG |
| | | FINAL | PEATY Adam | GBR | 57.13 | 7 AUG |
| | Men's 200m Backstroke | FINAL | RYLOV Evgeny | RUS | 1:53.97 | 11 AUG |
| | Women's 4 x 100m Medley Relay | FINAL | Denmark | DEN | 3:55.01 | 13 AUG |
| Oceania | Women's 4 x 100m Freestyle Relay | FINAL | Australia | AUS | 3:30.65 | 6 AUG |

From this table we can see that the greatest number of broken World records belong to swimmers from Europe (4 WR), one less is broken by swimmers from America and one broken record belong to swimmers from Australia. Most of broken Olympic records belong to American swimmers (9 OR), two less are broken by swimmer from Europe (7 OR), four by Australian swimmers and two by Asia swimmers. Swimmers from Africa broken three Africa records (2 man and 1 woman), swimmers from USA broken nine USA records (3 man and 6 woman), swimmers from Asia broken three Asia records (3man), swimmers from Europe broken seven Europe records (3 man and 4 woman) and one women swimmers from Oceania broken Oceania record (https://en.wikipedia.org/wiki/2016_Summer_Olympics).

# CONCLUSION

We can conclude that the US swimming is most dominant in the 21st century. The US swimming team has been successful in all the Olympics while the just completed Olympic Games are the biggest success of their swim team. Total number of gold medals (16 gold, 8 silver and 9 bronze) is the same as in Sydney in 2000 (16 gold, 9 silver and 6 bronze), but in Rio they won two medals more. A great contribution to American swimming at the Olympic Games since Athens 2004 was Michael Phelps. From that period he hasn't won less than 6 medals. We can also conclude that the biggest number of swimmers, who performed in Rio 2016, is aged 21 to 25 years (47%). The most broken records are performed by women (20 man, 34 woman) from which we can conclude that a woman swimming in the world is in great expansion. A large contribution to the development of women's swimming certainly have Ledecky Katie (USA) with broken two World and four Olympic records, Katinka Hosszu (HUN) with broken one World and three Olympic records, Sarah Sjostrom (SWE) with broken one World and two Olympic records, Cate Campbell (AUS) with broken two Olympic records. In the men's competition is allocated Adam Peaty (GBR) with broken two World and two Olympic records, Ryan Murphy (USA) with broken one World and two Olympic records, Michael Phelps with 5 gold and 1 silver medal. The number of broken records on this Olympic Games is: eight World (3 man and woman 5) and 23 Olympic records (7 man and 16 woman) which is less than in London 2012, where the number of broken World records was nine (3 man and 6 woman) and 25 Olympic records (7 man and woman 18).

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# CURRENT PERSPECTIVES OF DIAGNOSIS AND TREATMENT OF ATHLETES WITH EATING DISORDERS

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## SUMMARY

A unique therapeutic protocol for the treatment of athletes with eating disorders has not yet been agreed upon. However, some new guidelines have been based on the results of treatment in the general population and on the experience of experts who treated female athletes. A treatment of female athletes with eating disorders should be multidisciplinary. The coaches can have a negative role, but can also give valuable information in early detection of eating disorders. Female athletes who are under pressure of the social environment are more prone to eating disorders. An early and timely diagnosis and a promptly instituted treatment are the priority goals in the management of these eating disorders. The progression into more harmful, chronic conditions can thus be prevented. Nutritionist consultations are essential in the prevention of unintentional energy deficiencies.

**Keywords:** eating disorders, female athletes, coaches.

## INTRODUCTION

Eating disorders are rather serious conditions that cause significant health problems and complications. Since eating disorders commonly start and develop insidiously, the symptoms become obvious only after a significant weight loss has already occurred. The symptoms affect all organs and organ-systems in the body and produce long-term and occasionally irreversible consequences. Health-related consequences of eating disorders range widely and involve many bodily systems, and the mortality rate from anorexia nervosa, the most severe of the consequences, is around 6%. Death usually occurs as a secondary, consequential event – as a suicide, or as the result of an electrolyte imbalance and heart rhythm abnormalities (Dosil, 2008).

Early consequences of eating disoders are the depletion of glycogen stores in the muscles, progressive loss of muscle tissue, and dehydration. These make the affected athlete more susceptible to fatigue and musculoskeletal injury due to reduced strength and stamina, as well as the disturbed mental concentration and motor coordination. The resultant electrolyte imbalance can lead to serious heart rhythm disorders. Electrocardiographic abnormalities involve atrial and ventricular arrhythmias, and changes in the heart muscle range from reduced myocardial mass to mitral valve prolapse and pericardial effusion. The patients with *anorexia nervosa* show the signs of bradycardia and hypotension caused by a disturbed balance of the autonomous nervous system. On the other hand, those with *bulimia nervosa* suffer from some serious gastrointestinal problems. Gastrointestinal complications involve reduced bowel motility and chronic constipation. Esophagitis and *Mallory-Weiss* syndrome, enlargement of the parotid glands and dental enamel erosion are the consequences of frequent vomiting (American Psychiatric Association, 1994; American Psychiatric Association, 2013). The endocrine system and thermoregulation are also affected. The examples of endocrine complications are the reduced values of basal metabolism, disturbed cortisol and leptin excretion, electrolyte imbalance, disturbed thyroid function, and disturbed glucose metabolism. A special challenge is the association of type I diabetes with eating disorders (Warren, 2011).

Late consequences of eating disorders have not been fully described and elaborated, but they most certainly involve estrogen deficiency with skeletal demineralization, osteopenia, and premature osteoporosis. We should here also mention a disturbed dynamics of normal growth and development and menstrual dysfunctions. Neurological sequelae involve cortical atrophy due to severe malnutrition, ventricular enlargement, and impairment of cognitive functions (Thompson & Sherman, 2010).

## DIAGNOSIS OF ATHLETES WITH EATING DISORDERS

Diagnosis of eating disorders is very difficult and complex to accomplish, so that even more than half of the cases remain undetected. In the last two decades, many diagnostic procedures have been developed to confirm eating disorders, but the basis of all of them are in fact the questionnaires with targeted questions (Joy, Kussman & Nattiv, 2016). For example, the *Diagnostic Survey of Eating Disorders* (DSED) is an extensive survey aimed to detect anorexia and bulimia; *SCOFF questionnaire* is an excellent tool to detect and identify eating disorders, useful as a screening test despite of its rate of false-positives of 12.5% (Mountjoy, 2015).

The experts from the University of Gothenburg have developed their own *Swedish Version ED Inventory 2* (Nevonen & Broberg, 2001), a questionnaire with 60 questions related to eating disorders according to the DSM-IV (Diagnostic and Statistical Manual of Mental Disoders, 4th edition) criteria (American Psychiatric Association, 1994). The Eating Attitudes Test (EAT) is used to detect the risk of developing an eating disorder and to monitor treatment effectivity. As a specific, sport-related questionnaire, the Survey of Eating Disorders Among Athletes (SEDA) is used. This questionnaire with 33 questions is used to detects eating pathologies in athletes and the contributing factors associated with sports environment. SEDA has been developed and revised several times by sports experts, athletes themselves, and persons with eating disorders; however, since it is rather extensive and its completion is both time and effort-consuming, it is not a very popular survey form for this purpose (Hilibrand, Hammoud, Bishop, Woods, Fredrick & Dodson, 2015).

As the result of strict DSM-IV criteria and complex, time-consuming, extensive, and rather boring questionnaires used to detect eating disorders, many persons with dangerous and harmful eating habits, with a deep physiological and psychological impact, remain undetected. That is why screening methodologies have been recommended, which would offer real benefits to potential high risk individuals. Responses to the questions contained in the form would help experts to detect potential risks and refer such individuals appropriately for further, more elaborate evaluation. Some of the questions have been suggested by the American Family Physicians (Harrington, Jimerson, Haxton & Jimerson, 2015).

A positive response to any of them would indicate a certain degree of risk for the development of an eating disorder and would qualify such responders for further, more extensive assessment (Bratland-Sanda & Sundgot-Borgen, 2013):

- Are you satisfied with your body mass?
- Are you satisfied with your looks?
- Does your social environment (trainers/coaches, parents, fellow players, friends) have objections regarding your looks or body mass?
- Are you currently on any diet or eating plan, a method or exercise program of body mass reduction (preparations: fat burners, diuretics, appetite blockers, laxatives, etc.)?
- Have you been losing weight lately? In what way?
- Have you been dieting during your sports career? How many times?
- Do you ever vomit in order to reduce your body weight?

## TREATMENT OF ATHLETES WITH EATING DISORDERS

A unique therapeutic protocol for the treatment of athletes with eating disorders has not yet been agreed upon (Drinkwater, Loucks, Sherman, Sundgot-Borgen & Thompson, 2005). However, some new guidelines have been based on the results of treatment in the general population and on the experience of experts who treated female athletes. A treatment of female athletes with eating disorders should be multidisciplinary. Family/team doctors, gynecologists, nutritionists, psychologists or psychotherapists should be engaged in the process (with psychiatrists as well in more severe cases). Coaches and parents have to be involved if they produce positive effects upon the patient. The essence of the treatment is to re-establish normal eating habits and to manage other health-related complications, if any (Bratland-Sanda & Sundgot-Borgen, 2013; Harrington, Jimerson, Haxton & Jimerson, 2015).

The importance of prevention of eating disorders has to be stressed, and pre-competition medical assessment, measurement of anthropometric parameters, and well targeted questions by a sports medicine physician can significantly contribute to early detection of these disorders (Radovanović & Ponorac, 2015).

## ROLE OF COACHES IN THE DETECTION OR DEVELOPMENT OF EATING DISORDERS

A large-scale study conducted by *Sherman* and *Thompson* (2005) has supported the importance of social environment when female athletes are concerned and their possible development of eating disorders. The study aimed to establish the precise role of coaches in the development and recognition of eating disorders in female athletes. It was suggested that special attention had to be paid to the recognition of eating disorders in complex sports environments. What has to be addressed are the physical appearance stereotypes, beliefs that leanness is the prerequisite for good results, improvement of physical ability or improvement of one's health.

The question concerning the seriousness of some of the classical characteristics of eating disorders (large meals, use of laxative agents, use of diuretics, fasting/starvation, binging phases, omission of two meals a day, intentionally exhausing physical exercising, multiple body mass/weight measurements, etc.) was answered by coaches in a manner that seven of these could potentially seriously affect the physical ability, but not the health of a female athlete (Zach, Smith-Machin & Hoch, 2011).

Moreover, the similarity of personality traits of a person with eating disorder and a „good athlete" can also contribute to the failure to recognize eating disorders. Several more recent studies have shown that a high percentage of coaches, in a proper or a wrong way, are involved in the assessment and correction of physical appearance or body mass of female athletes. They believe that they are aware of the risks of eating disorders and that they are able to identify them correctly. In addition, in one of the studies, even one third of the coaches stated that they had treated the girls with symptoms of eating disorders. The coaches, in addition to their role in symptom recognition, even tried to treat eating disorders. The issue of the role of coaches in the development of eating disorders was thus rightfully put forward in the study. Regretfully, such inappropriate coaching practice in the routine, everyday training process and wrong guidelines are commonly the factor that precipitates the development of eating disorders or that aggravates the existing subclinical forms of these disorders (Arthur-Cameselle & Baltzell, 2012). It is quite clear that coaches can have a negative role, but can also give valuable information in early detection of eating disorders. Female athletes who are under pressure of the social environment are more prone to eating disorders.

## CONCLUSION

An early and timely diagnosis and a promptly instituted treatment are the priority goals in the management of these eating disorders. The progression into more harmful, chronic conditions can thus be prevented. To our regret, a comprehensive therapeutic protocol to treat the athletes with eating disorders has not yet been formulated. Nutritionist consultations are essential in the prevention of unintentional energy deficiencies, since in sports there is not any strict imperative to monitor (and adjust) energy intake against active energy expenditure.

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# ASSESMENT OF RHYTHMIC GYMNASTICS GROUP CHOREOGRAPHY

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## SUMMARY

This investigation focuses on a metric way of research of newly-constructed test for assessing group rhythmic gymnastics performance, appropriate for male and female, consisted of three parts: body technique, apparatus exchange and variety of formations. The sample consisted of 50 students aged 20 to 23. The results showed that evaluation of rhythmic composition on a segmented scale may be a good assessing instrument after preparing a set of previous instructions about assessment criteria. Since male and female performance did not differ in body techniques but only in apparatus handling, they are encouraged to practice together in coeducational curricula at university level program.

**Keywords:** body technique, apparatus exchange, formation, gender differences

## INTRODUCTION

Rhythmic gymnastics is designed as female sport since Olympics 1984, but practicing with apparatus accompanying with music is commune for both genders nowadays. Gender is an indicator of differences in goal orientation achievement (Hanrahan & Cerin, 2009), sport performance (Davis et al., 2006) and motor learning (Dorfberger, Adi-Japha, & Karni, 2009), but there is no objective reason why rhythmic gymnastics structures cannot be a part of PE curricula equally for both genders, especially in University level. Evaluation of performance in rhythmic gymnastics demands assessment of body technique and handling apparatus simultaneously. Such assessment is even more difficult during group exercising and for proper individual evaluation of mastery of technique videotaping is recommended especially for scientific evaluation (Bozanic & Miletic, 2011). But the problem of objective criteria for evaluation of rhythmic gymnastics body elements and apparatus techniques for both genders still remains. In this investigation a method already presented by Magil and Schoenferder – Zohdi (1996) was applied. Basically, routines were divided into segments and the scoring of each element was based on scores 0, 1, and 2 for performance that were incorrect, partially correct or correct respectively. It is more suitable than evaluation procedures and criteria prescribed by the FIG's (Federation International de Gymnastique) Code of Points in case of both genders. Previous investigations already established that female students dominate in the field of body skill technique, while male students have an advantage in apparatus technique (Bozanic & Miletic, 2011). Gender differences as gender specific performance is the key of designing choreography in which female and male students together, in accordance with their natural differences, could perform spectacular and dynamic group rhythmic compositions.

The aim of the research was (1): to assess some metric characteristics of the test designed for group choreography evaluation; (2): to determine possible differences between genders in performing rhythmic gymnastics group choreography.

## METHODS

### Subjects

Fifty physical education students (31 male and 19 female) aged 20 to 23 participated in the study. All students attended classes of Rhythmic gymnastics for one semester, three times a week and undertook the same program and training load. According to a pre-test questionnaire, male students did not have any prior experience in aesthetic sports and female students were briefly involved in aesthetic activities but not in rhythmic gymnastics programs and apparatus exercising.

## Procedure

Learning program included 5 weeks of body technique and 6 weeks of apparatus technique lessons and then three weeks of mastering group composition with apparatus. Body elements consisted leaps, balances, rotation and apparatus technique consisted skills with rope, ribbon, ball, clubs and hoop. Final group composition had obligatory elements regulated by FIG's Code of Points: body techniques, exchange of apparatus and changes of group formations.

All students were videotaped while performing final group composition. Three independent judges evaluated performance by watching videotaped material. All judges had approximately same experience in practicing rhythmic gymnastics but had different level of education (PhD, M.A. and B.A.). Group rhythmic composition were divided in three parts: body techniques, exchange of apparatus, and formations. In body techniques seven skills were evaluated: three different jumps, two balances and two rotations. In second part, three large and two small apparatus exchange were evaluated as well as original elements. In third part, five different formations were evaluated as well as harmony with music. Finally, first part, body techniques had seven segments, while second and third part, exchange of apparatus and formations had each six segments. Scoring was based on giving scores of 0, 1 or 2 for each segment of the skill in all three parts of the composition. A score 0 was given if the segment was missing from the performance or was not performed correctly, a score 1 if the segment was performed with some mistakes, and a score of 2 if the segment was performed correctly. To establish an overall performance score, the sum of the 7 segments was taken for evaluation of body technique. Thus the final score could range from 0 to 14. The sum of 6 segments was taken to establish overall performance score in apparatus exchange and formation parts where final score could range from 0 to 12.

## Statistical analysis

With the aim of analyzing metric characteristics of the three parts of group rhythmic composition we calculated: descriptive statistic parameters with the aim of analyzing sensitivity: arithmetic mean (Mean), standard deviation (SD), minimum results (MIN), maximum results (MAX) and distribution normality were tested by the Kolmogorov – Smirnov test (KS). The Cronbach alpha coefficient was calculated with the aim of analyzing objectivity of the judges. First main component unit was calculated with the aim of analyzing homogeneity. An independent sample t-test was applied for establishing differences between genders in all three parts of group rhythmic composition.

# RESULTS AND DISCUSSION

According to the results in Table 1 all three parts of group rhythmic choreography (body techniques, exchange of apparatus and formations) have satisfactory sensitivity. KS test didn't deviate significantly from the Gaussian curve on the level of error of 0.05. According to parameter applied to asses objectivity (alpha coefficient), there is certainly a deviation in assessment opinion of what is well done performance. Assessors were well correlated when assessing body techniques, but assessment of apparatus exchange and formations have no satisfactory characteristics of objectivity. Respective correlations between each assessor show that assessors with higher education level have higher, satisfactory correlation while assessing all choreography parts. Assessor with lower education (B.A.) doesn't have satisfactory correlation with other two assessors. Future investigations are necessary to establish if the level of education, age or experience of judges is a limitation factor when assessing performance of group rhythmic gymnastics choreography. Previous investigation (Bavcevic & Miletic, 2015) stated that criteria made on the segmented scale were more acceptable from kinesiometric point of view. Evaluators easier come to the same conclusions because they are focused on parts (segments) of motor structure itself. But in the case of very complex evaluation such as group rhythmic gymnastics choreography, previous instructions about criteria are necessary for better compatibility of judges. Latent dimensions in variables space of the assessors (Table 2) explains 81% of the total variance for body technique and 66 % and 65% of the total variance for apparatus exchange and formations variables. According to the projection of each assessor on latent dimension, it is obvious that the third assessor mostly contributes to lower percentage of total variance for all three parts of the choreography. This is in accordance with previous statement that set of previous instructions about criteria for evaluation group choreography is an important factor for successful evaluation in rhythmic gymnastics.

According to T-test results male students were significantly better in apparatus handling and exchanging than female students.

This investigation confirms that male body and apparatus technique can be judged by the same rules as those that govern the female body and apparatus technique. Better rope technique in favor of male students was already registered by Bozanic & Miletic, 2011 and supported by the development of skills and techniques that play a greater role in the success of an athlete (Di Cagno, et al., 2009).

**Table 1.** Descriptive statistics, *Cronbach alpha* coefficient (ALPHA) and T- test results

| | MEAN±SD | MIN | MAX | ALPHA | T-VALUE | P |
|---|---|---|---|---|---|---|
| BODY TECHNIQUES | 9.23±2.42 | 3.00 | 13.67 | 0.88 | -1.97 | 0.05 |
| APPARATUS EXCHANGE | 8.55±1.43 | 6.00 | 12.00 | 0.71 | -3.65 | 0.00 |
| FORMATIONS | 10.99±0.70 | 9.00 | 12.00 | 0.70 | 0.60 | 0.54 |

**Table 2.** Structure of latent dimension of the three assessors for each part of the choreography

| | body techniques | apparatus exchange | formations |
|---|---|---|---|
| S1 | 0.96 | 0.97 | 0.92 |
| S2 | 0.96 | 0.93 | 0.91 |
| S3 | 0.77 | 0.45 | 0.51 |
| Expl.Var | 2.43 | 1.99 | 1.94 |
| Expl. Totl | 0.81 | 0.66 | 0.65 |

# CONCLUSION

This investigation established that newly-constructed test for assessing group rhythmic gymnastics performance had satisfactory metric characteristics of sensitivity, while objectivity and homogeneity of test must be improved. Preparing a set of previous instructions about criteria for evaluation of group rhythmic gymnastics could improve assessors objectivity. Male students should be encouraged to practice aesthetic activities since their performance does not differ from that of females given the same training. Also, this investigation can contribute better organizing and planning training at university level on coeducational basis.

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# DIFFERENCES BETWEEN CONTRACTILE CHARACTERISTICS OF WRESTLER'S HAND AND CONTROL GROUP OF YOUNG, MODERATELY ACTIVE PEOPLE

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## SUMMARY

Examination of contractile characterists of flexor muscles of the fingers is equally important factor in the functional evaluation of the arm, i.e. the hand, as it is in the purpose of the evaluation of development of physical abilities' levels and preparation of athletes. The function of the hand presents a permanently active field of a scientific research for the purpose of expanding the fundus of knowledge, but of perfecting the procedure of testing and for diagnostical purposes as well.

The aim of this research is the determination of differences in contractile wrestler's hand muscles' abilities and control group of young and moderately physically active male people. For the need of this research, isometric dynamometry and standardized test – hand grip methods have been used. Fifty-nine respondents, aged between 19 and 34 years old have taken part in this research, out of which 28 were wrestlers and 31 were respondents from the control group. For determination of the differences between sets of variables, a multivariate test (MANOVA) was used, whereas for determination of the differences between pairs of single variables, the t test for independent samples was used.

By conducting the analysis, the conclusion that wrestlers have statistically significantly higher level of maximum and explosive strength, but not the endurance when it comes to the force of a hand grip in comparison to the absolute values, but statistically significantly higher explosive force of a hand grip from the aspect of relative values compared to control group has was drawn. Higher level of absolute force does not carry within itself the increase of other muscle characteristics (explosive force and endurance) unless the muscle does not adapt to such kind of activity by specific way of training, whereas the lesser absolute force surely requires less energy requirements and lesser need for the oxygen when it comes to realization of maintaining the hand grip's contractile force on 50 per cent Fmax level for the longest time interval possible.


**Key words**: hand grip, maximum force, explosive force, endurance, wrestlers.

## INTRODUCTION

The hand presents a complex structure of the distal part of the arm, which consists of a large number of bones, muscle, nerve and other structures and has big significance when it comes to function of humans. A large number of bones in the hand are made of many joints, which have different functions based on their shape and mobility. Hand functions are as follows: to provide precise, coordinated, as well as strong movements of object manipulation, such as gripping, hold, touching, moving, feeling etc. (Ilic, 2008). In complex movements of hand and fingers, the coordination of muscle functioning, which are closely related to central nervous system, has a special significance. (Ilic, 2008)

In anybody's everyday activities, gripping is a motoric action that can be observed continually (Fernandes et al., 2014). The first grip appears as a primary reflex since the birth of a child, i.e. as a reflexive response to touch stimulation of the palmar side of the hand (palmary reflex), and the grip can be so powerful that it can hold the weight of the newborn's entire body in a handstand position.(Ilic, 2008). The force of the hand grip is the outcome of the effective folding of all finger joints along with maximum strain that one person can use in normal biocinetic conditions.

Related to that, it is understandable that a large number of research deals with identification of different biomechanic aspects of hand grip force (Hallbeck and McMullin, 1993; Espana-Romero et al, 2010; Massy-Westropp et al., 2011; Fernandes et al., 2014). In the field of anthropometric measurements, hand grip characteristics are often compared and associated with other physical characteristics, with body height, index of body fat and age. (Massy-Westropp et al., 2011; Fernandes et al., 2014). Hallbeck and McMllin (Hallbeck and McMullin, 1993) measured the maximum force of hand grip in different wrist positions and came to the conclusion that decreasing of maximum hand grip force occurs when the angle of the wrist increases. It has been determined that the most adequate protocol for evaluation of the maximum hand grip force is when dynamometer is used where the elbow is in complete extension (Espana-Romero et al, 2010). The analysis of the hand grip in comparison to the age group shows that the hand grip force at both genders reaches its peak in the 4th decade of life, and then gradually decreases (Massy-Westropp et al., 2011). By analyzing the date from the larger number of research, it can be concluded that the examiners usually measure maximum intensity of hand grip force.

Its use in different sporting disciplines, both with recreators and top athletes can be found in a large number of researches (Dopsaj et al., 2009a; Ivanović et al., 2009). Besides that, the hand grip analysis is an important item in the functional evaluation of the arm as well. Characteristic of hand grip force are usually defined as physiological variables that are influenced by numerous factors (Dopsaj et al., 2009a; Dopsaj et al., 2009b).

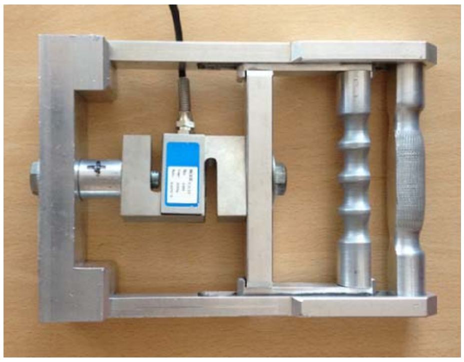
The evaluation of characteristic of hand grip force is a measurement that is simply determined, and that indicates the physical health and muscle function, no matter the scientific research field it is applied in (Dopsaj, 2010). To be precise, a hand grip can be quantified by measuring the achieved characteristics of isometric force that the arm, i.e. hand generates on the dynamometer during the movement or the attempt of the flexion of all fingers into grip motion.

Establishing the big base of data with referential values with healthy population of all ages, with all business profiles, but also different sporting profiles, as well as levels of being well-trained can be useful for further interpretation and mutual comparison of the influence of the way of life, i.e. quality of realized training work. (Dopsaj et al., 2011).

The subject of this research is to assay the contractile characteristic of the hand as the elementary manipulative organ. The aim of the research is determination of the differences in contractile characteristic of the hand (maximum force, maximum explosive force, endurance time at the 50 per cent of the maximum) between wrestlers and moderately active population of healthy and young males. Results obtained in this research can be used for the purposes of further research and their mutual comparisons, as well as for the enhancement of the existing results.

# METHODS

**Photo 1**. – Dynamometer probe with contruction for contractile hand grip characteristics measuring



Compared to the basic physical, i.e. motoric abilities, contractile abilities present the basic ability responsible for movement because without the muscle contraction, there is no movement (in dynamic conditions) or movement attempt (in static conditions). From the aspect of metrology procedures in physical education and sport, i.e. the procedure of analytic procedure and diagnostics of physical ability, muscle force measurement is conducted by the dynamometric method in isometric conditions of straining. A standardized test was used – *Hand grip* using dynamomerer probe (Photo 1)(Dopsaj et al., 2009a; Dopsaj, 2010; Dopsaj et al., 2011; Ivanovic et al., 2009).

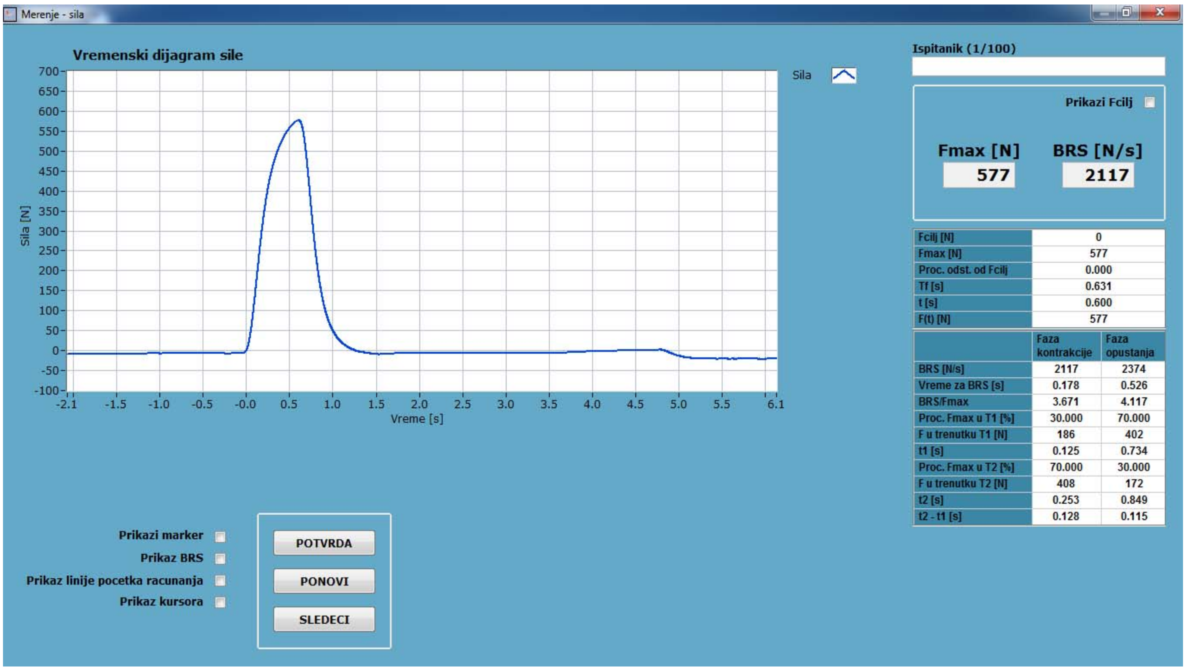
## Sample of respondents

The sample included 59 male respondents, aged from 19 to 34, 28 of which were wrestlers (average age 24.4±5.5 years, body height – BH = 179.5±6.2 cm, body weight – BW = 84.6±15.4 kg, BMI = 26.1±3.6 kg/m$^2$) and 31 were young and moderately active males (age 24.6±4.4 years, body height – BH = 183±5.7 cm, body weight – BW = 81.9±11.4 kg, body mass index – BMI = 24.4±2.7 kg/m$^2$). In the conducted research, all respondents reported their right hand as a dominant one. The sample included wrestlers from Belgrade and Sabac, whereas students and economically active population chosen by the method of sampling by chance make the control group. All respondents were familiar with the testing conditions and voluntarily took part in the research. The research was realized in accordance with conditions „Declaration of Helsinki for recommendations guiding physicians in biomedical research involving human subjects“ – (http://www.cirp.org/library/ethics/helsinki/), and with approval and consent of Ethics Commission of Faculty of Sport and Physical Education, University of Belgrade.

## Testing procedure

For the need of this research all respondents were tested on the following extended arm position or slightly flexed and placed in the position of slight abduction, for the sake of unification and standardization of the results (Dopsaj et al., 2011). The testing procedure was the following – after the individual 3-minute general warm-up (shaping and stretching exercises), every respondents was explained the testing procedure. Then, every respondent tried the hand grip twice (both with left and right arm) for the sake of the specific warm-up. After a one-minute break, the respondents took the test using the following protocol – they first realized two alternating attempts of the maximum hand grip muscle force measuring of both hands on the preparatory sign of the measurer (the respondent himself chose which arm to do the test first with) in order to determine the level of 100 percent given contractile ability (Photo 2).

**Photo 2.** – Determining the maximum force value and RFD




A pause between every attempt of testing of one arm lasted for at least 1 minute. For every respondent, force value for each hand at the level of 50 per cent of maximum was calculated. In continuation of the procedure, after a three-minute rest, the measuring of capacity of manifesting the force given was approached (endurance of isometric muscle force manifest), i.e. the time interval during which the respondents were able to maintain the given level of force at 50 per cent from maximum was measured (Photo 3). The respondents' task was to, by looking at the display that was showing the force, maintain the given level by hand gripping the construction of the dynamometric probe holder. At the same time, the examiner measured the endurance time and controlled the display that was showing the force in the created software (Photo 3), corrected the respondent in regards to the level of force realization and verbally stimulated the respondent to withstand the given motoric task for the longest interval of time possible. In the moment when the respondent could not realize the given force anymore, i.e. when the level of force would drop below 45 per cent of maximum, the test attempt would be stopped and software would note the total time of the endurance in the given range. After a break of at least 3 minutes, the same test was realized using the other hand, and after a break of at least 10 minutes, the endurance test was repeated for both hands. After the testing was finished, the values of better attempts entered the data process.

**Photo 3**. – Endurance of isometric muscle force manifest


## Variables

The examines (measured) space is defined in comparison to three basic aspects of muscle force dimension when it comes to motoric tasks – hand grip and that: the aspect of maximum muscle force (expressed in N), explosive force (expressed in N/s) and time aspect of manifesting the given per cent of the force (expressed in seconds)

In the research, the following variables were used:

1. Sum of absolute values of maximum hand grip muscle force of left and right arm – Fmax L+R abs., expressed in Newtons (N);
2. Sum of absolute values of maximum level of explosive force – RFDmax L+R abs. (rate of force development) of hand grip of left and right arm, expressed in Newtons per second (N/s),
3. Sum of absolute values of time of maintaining the hand grip muscle force at 50% of maximum of left and right arm - tF50%max L+R abs, which is expressed in seconds (s).
4. Sum of relative values of maximum hand grip muscle force of left and right arm– Fmax L+R rel., expressed in Newtons per kilogram of body weight (N/kg);
5. Sum of relative values of maximum level of explosive force – RFDmax L+R rel. (rate of force development) of hand grip of left and right arm, expressed in Newtons per seconds per kilogram of body ((N/s)/kg),
6. Sum of relative values of time of maintaining the hand grip muscle force at 50% of maximum of left and right arm - tF50%max L+R rel., which is expressed in seconds per kilogram of body weight (s/kg).

## Statistical analysis

All results were first analyzed by applying the basic descriptive statistic method, where the following was calculated: measures of central tendency (middle value of the variable) and measures of dispersion (standard deviation – SD), range limit (minimum – Min and maximum – Max), as well as the variation coefficient. Regularity of individual variable distribution was tested using the nonparametric Kolmogorov-Smimov test. General differences between groups and tested variables were determined by MANOVO, whereas significant differences of every variable tested individually were determined using independent t test. All statistical analysis were carried out with the help of the software package SPSS 19.0, while the limit of 95 per cent probability, for the value $p < 0.05$ was used for the level of statistic significance.

# RESULTS

In Tables 1 and 2, a descriptive statistic of all variables for both tested groups is shown, where a slightly larger middle value of all variables with wrestlers, except in absolute and relativized time for endurance at 50 per cent of maximum force achieved is clearly seen

**Table 1.** – Descriptive statistic of variables with absolute values of both groups.

| Variables | Groups | N | Mean | Std. Err. | Std. Dev. | Min. | Max. | 95% Confidence Interval for Mean Lower Bound | 95% Confidence Interval for Mean Upper Bound |
|---|---|---|---|---|---|---|---|---|---|
| Fmax L+R abs. | Wrestlers | 28 | 1154.4 | 33.5 | 177.4 | 865 | 1654 | 1085.6 | 1223.1 |
| | Moderately active | 31 | 1030.8 | 23.4 | 130.4 | 679 | 1240 | 982.9 | 1078.6 |
| RFDmax L+R abs. | Wrestlers | 28 | 5197.6 | 255.8 | 1353.3 | 3053 | 7665 | 4672.8 | 5722.4 |
| | Moderately active | 31 | 4040.4 | 201.7 | 1123.0 | 2270 | 7346 | 3628.5 | 4452.4 |
| t50% L+R abs. | Wrestlers | 28 | 101.50 | 6.57 | 34.75 | 27.29 | 188.01 | 88.03 | 114.98 |
| | Moderately active | 31 | 107.86 | 5.67 | 31.56 | 41.92 | 179.71 | 96.28 | 119.43 |

**Table 2.** – Descriptive statistic of variables with relative values of both groups.

| Variables | Groups | N | Mean | Std. Err. | Std. Dev. | Min. | Max. | 95% Confidence Interval for Mean Lower Bound | 95% Confidence Interval for Mean Upper Bound |
|---|---|---|---|---|---|---|---|---|---|
| Fmax L+R rel. | Wrestlers | 28 | 13.80 | 0.33 | 1.76 | 9.68 | 17.71 | 13.12 | 14.48 |
| | Moderately active | 31 | 12.95 | 0.31 | 1.71 | 9.81 | 16.04 | 12.33 | 13.58 |
| RFDmax L+R rel. | Wrestlers | 28 | 61.76 | 2.74 | 14.50 | 40.17 | 91.19 | 56.14 | 67.38 |
| | Moderately active | 31 | 50.53 | 2.33 | 13.00 | 32.09 | 84.44 | 45.76 | 55.30 |
| tF50% L+R rel. | Wrestlers | 28 | 1.22 | 0.08 | 0.42 | 0.35 | 1.85 | 1.06 | 1.39 |
| | Moderately active | 31 | 1.37 | 0.08 | 0.44 | 0.47 | 2.25 | 1.21 | 1.53 |

**Table 3.** – Normality of data distribution of all variables for both groups

| Groups | Variables | Fmax L+R abs. | RFDmax L+R abs. | tF50% L+R abs. | Fmax L+R rel. | RFDmax L+R rel. | tF50% L+R rel. |
|---|---|---|---|---|---|---|---|
| Wrestlers | Kolmogorov-Smirnov Z | 0.524 | 0.591 | 0.484 | 0.950 | 0.821 | 0.952 |
| | Asymp. Sig. (2-tailed) | 0.946 | 0.876 | 0.973 | 0.327 | 0.510 | 0.324 |
| Moderately active | Kolmogorov-Smirnov Z | 0.726 | 1.319 | 0.776 | 0.550 | 1.055 | 0.681 |
| | Asymp. Sig. (2-tailed) | 0.668 | 0.062 | 0.583 | 0.923 | 0.216 | 0.743 |

Proper distribution of individual variables of both groups is shown in Table 3.

In the following two tables, MANOVO test results are shown, by which a difference between three variables (Fmax, RFDmax, tF50%max) with absolute values of both groups (Table 4), but relativized variables in both tested groups (Table 5) was determined.

**Table 4.** –Determination of significance existence on general group level in variables with absolute values.

| Multivariate Tests | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Value | F | Hypothesis df | Error df | Sig. | Partial Eta Squared | Noncent. Parameter | Observed Powerb |
| Wilks' lambda | 0.789 | 4.912 | 3 | 55 | **0.004** | 0.211 | 14.737 | 0.889 |

**Table 5.** – Determination of significance existence on general group level in variables with relative values.

| Multivariate Tests | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Value | F | Hypothesis df | Error df | Sig. | Partial Eta Squared | Noncent. Parameter | Observed Powerb |
| Wilks' lambda | 0.819 | 4.065 | 3 | 55 | **0.011** | 0.181 | 12.195 | 0.818 |

In Tables 6 and 7, variables in which a statistically significant difference between tested variables in function of tested groups was determined are precisely shown.

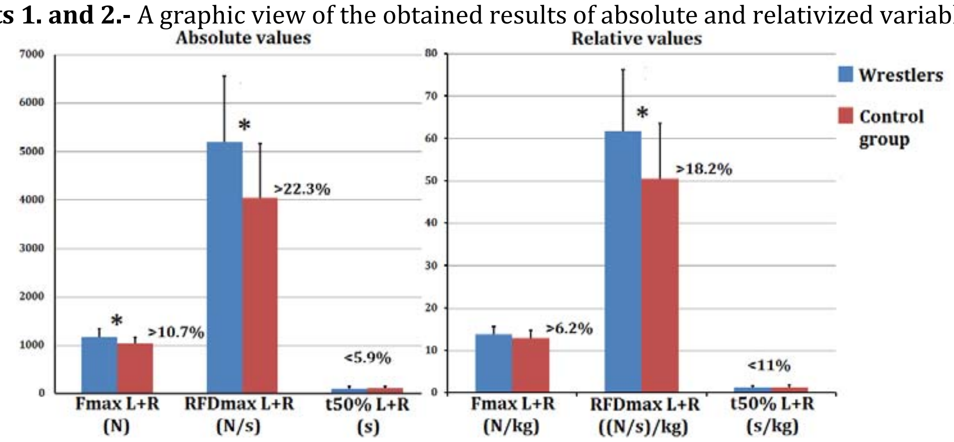
**Table 6.** – t test results of variables with absolute values.

| Independent Samples Test | | | | | |
|---|---|---|---|---|---|
| | t-test for Equality of Means | | | | |
| Variables | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference |
| Fmax L+R abs. | 3.069 | 57 | **0.003** | 123.58 | 40.27 |
| RFDmax L+R abs | 3.587 | 57 | **0.001** | 1157.19 | 322.63 |
| tF50% L+R abs. | -0.736 | 57 | 0.465 | -6.35 | 8.63 |

**Table 7.** – t test results with relative values.

| Independent Samples Test | | | | | |
|---|---|---|---|---|---|
| | t-test for Equality of Means | | | | |
| Variables | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference |
| Fmax L+R rel. | 1.869 | 57 | 0.067 | 0.84 | 0.45 |
| RFDmax L+R rel. | 3.136 | 57 | **0.003** | 11.23 | 3.58 |
| tF50% L+R rel. | -1.303 | 57 | 0.198 | -0.15 | 0.11 |

**Charts 1. and 2.-** A graphic view of the obtained results of absolute and relativized variables.



# DISCSSION

The examination of hand's muscle flexor contractile characteristics in evaluation of level of development of physical abilities function, in evaluation of wrestler's preparedness function, as well as examination of motoric hand grip task, present a permanently topical field of a scientific research for the purpose of expending the fundus of knowledge, but for the purpose of perfecting testing procedures, in both diagnostic and professional purposes. (Dopsaj, 2010). Hand grip characteristics can be relatively predicted because they are directly linked to morphological structure, training, shape, health condition and physiological state in the time of testing (Fernandes et al., 2014). Unlike the hand grip force, the explosiveness and endurance are abilities which cannot be predicted based on anthropometric measurements. The ability to create big force doesn't necessarily mean that that force is able to be maintained in longer time interval (Dopsaj et al., 2011). The explosiveness presents ability of manifesting the force in the shortest time period possible, i.e. the fastest possible, and endurance means the ability of doing the task with possible or in advance given intensity in a certain time interval without reduction of efficiency.

The aim of this research is to determine the differences in contractile characteristic of wrestler's hand and control group of young moderately active people. When it comes to wrestlers group, the sum of average values of maximum hand grip force of both left and right hand was 1154.4±177.4 N, which is very similar to the previous research in which wrestlers were tested (Garcia-Palares et al., 2011; Ratamess et al., 2012). By comparing the results of control group, we can see that somewhat lower result of summary value of maximum force of both left and right hand 1030.8±130.4 N, which presents the difference of 123.6 N or 10.7%. Also, the values of summary maximum wrestlers' explosiveness are significantly bigger compared to control group, and for as much as 1157.2 N/s or 22.3%. But it also should be noted that the summary time of endurance force is at 50% Fmax of both left and right hand, more when it comes to moderately active people than when it comes to wrestlers, for 6.36 s or 5.9% (Table 1).

In the following Table, relativized values of previously stated variables compared to body weight have been shown (Table 2). That way, the tested group of wrestlers develops an average maximum force 13.8±1.8 N per kilogram of body weight, whereas the control group develops 12.95±1.71 N/kg, i.e. 6.2% less. Somewhat bigger difference between groups appears in specific muscle characteristics, whereby the maximum explosive force with wrestlers is 61.76±14.5 N/s per kilogram of body weight , and with economically active population 50.5±13 N/s per kilogram of body weight, which presents 11.26 N/s/kg difference or 18.2%. The last relativized variable has bigger values in favor of the control group which on average realizes 1.37±0.44 s/kg body weight, and wrestler realize 1.22±0.42 s/kg body weight, where the difference is 0.15 s/kg or 11%.

When it comes to normality of tested variables' division, in Table 3 we can be assured that the distribution is regular in all variables.

In order to determine whether the mentioned difference between tested groups is statistically significant in both absolute and relativized variables, a multivariate test was applied (Table 4 and 5). Statistically significant difference between groups appears in both cases observed and that on the level $p = 0.004$ and $p = 0.011$.

By applying the t test, it was determined between which absolute or relativized variables a significant difference exists, therefore the groups differ on general level (Table 6 and 7). Significant difference between groups appears in Fmax abs. variables on level $p = 0.003$ , RFDmax abs. on level $p = 0.001$, and RFDmax rel. on level $p = 0.003$, but also Fmax rel. on the borderline of statistical difference on level $p = 0.067$.

Wrestlers had a bigger maximum hand grip force value than the control group of respondents due to bigger body weight which is attributed to the mass that represents a bigger muscle contractile potential, and as a cause to the adequate training process, whereas the control group showed bigger endurance. The reason for why the control group showed bigger endurance can be the lower absolute force. The lower absolute force includes smaller energetic requirement and less need for oxygen (Dopsaj et al., 2011). The given fact is probably the reason for determined paradox where the results showed that the control group had higher level of endurance, i.e. time interval of maintaining the hand grip force on the same level of contraction intensity compared to the tested sample of wrestlers (Chart 1 and 2). Absolute and relativized endurance data variable at 50% Fmax, represent interesting news in the diagnostic sense. This information is interesting because the respondents from the control group, are moderately engaged in physical activity, whereas the other tested group is actively engaged in wrestling. Wrestling includes all physical characteristics on the maximum level, but the hand grip alone does not appear as a primary element of a certain training or competitive process in wrestling, but it wriggles as a secondary element, i.e. various grips for the opponent throws, or weight grip during strength trainings, all of these are the moments that do not last long time-wise. Based on those facts, we can justify the obtained results, i.e. conclude that with the absence of endurance training for the tested muscle group (hand and forearm muscles), we cannot expect their progress in the mentioned muscle characteristic of the tested group of wrestlers.

Also a possible explanation for lower level of measured force endurance with wrestlers can be the time and place of testing of this group, who were mostly tested before their training activity in the club, that way they were not motivated enough to give their maximum during the testing process. Also, it is possible that, to a certain extent, the culminating effect of training in terms of fatigue influenced the results during the endurance of hand grip testing, i.e. that the wrestlers were in a certain culminating fatigue phase, which is why they achieved worse results compared to control group when it comes to endurance test. In the researches to come, it is certainly necessary to confirm or refute results that are obtained this way.

# CONCLUSION

Based on the results obtained with this test, we can draw the following conclusions. The group of wrestlers developed the ability of fast maximum and explosive force reach due to a specific way of training, and in wrestling hall, but also during the strength trainings in gym. That is supported by the results of the work, where the statistically significant difference between tested groups appears in variable RFDmax as the absolute value on the level $p = 0.001$, but as relativized value on the level $p = 0.003$ as well. Also, we can draw as a conclusion that the average absolute maximum force of the wrestler bigger than moderately trained population on the significance level $p = 0.003$, but the relativized value of maximum force that has larger values when it comes to wrestlers than it does when it comes to control group should be noted, but the statistic significance is on the borderline $p = 0.067$. As far as time variable of maintaining the hand grip muscle force at 50 per cent Fmax is concerned, it didn't show a significant difference between groups in both absolute or relativized case, and besides that the results showed that control group had higher level of endurance, i.e. the time interval of maintaining the hand grip, both as the average absolute value and relativized value.

When it comes to limitation of the study, the next research should be realized on significantly larger number of respondents, whom the final model indicator from the aspect of measured contractile ability will be defined on by using the same measuring process and procedure

# ACKNOWLEDGEMENT

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# MORFO-MOTOR PROFILE OF HIGH JUMPERS

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## SUMMARY

The aim of this study was to review and summarizing published studies to determine which morphological characteristics and motor abilities are characterized by high jumpers that can or has already achieved significant results in this athletic discipline. Based on the obtained information morfo-motor profile of hihg jumpers is constructed.

By analysis and synthesis of research it could be concluded that there is a strong connection between the morphological characteristics and motor abilities with the result in the high jump. Regarding the morphological characteristics, the best predispositions for achieving significant results have high athletes with the lowest weight-height index and a low percentage of body fat, and those who have a strong skeleton with a larger volume of the shoulder and femur and medium musculature (circumference of upper arm, thigh and calf). Longer limbs are advantage in raising the center of gravity, which is the essence of the high jump. Being tall, allows high jumpers take-off from higher starting positions of center of gravity. There is also no significant difference concerning morphological characteristics in male and female high jumpers. The most common components in male high jumpers are endomorph and ectomorph, and in elite male high jumpers are ectomorph and mesomorph. The most common components in female high jumpers and elite female high jumpers are endomorph and ectomorph. Considering motor abilities of high jumpers, high jumpers should have extremely high levels of explosive strength and speed, very high level of maximum force of attempted movements and general strength, and a relatively high level of coordination. It must also possess a high level of relative explosive strength and flexibility, and the presence of good muscle coordination is relevant too. Particularly important is the horizontal and vertical velocity while performing a high jump.

**Keywords:** morphological characteristics, motor abilities, high jump

## INTRODUCTION

The great importance of athletics, and the increasing demands that are within the framework of athletic training setting athletes, pointing researchers and other sports educators to devote themselves to scientific research on the relations of the anthropological area and results in different athletic disciplines, by which they can determine the anthropologicalareo of athletes of different quality levels. Within the anthropology status of athletes, morphological characteristics and motor abilities occupy a significant place. That is why the special attention in training work for development of these dimensions is given. Morphological characteristics are important for success in some athletic branches, in other their influence is very small or negligible. Motor abilities participate in the realization of all the movements of athletes and provide strong, quick and long-term performance of motor tasks. For this reason reserches constantly carry out researches in relations between morphological characteristics and motor abilities with situational-motor abilities of athletes. (Stanković, 2006)

Fosbery flopp technique was first introduced by American jumper Dick Fosbery 1968 at the Olympic Games in Mexico and since then it has been almost irreplaceable. Unlike other jumps, this technique is based on a different biomechanical basis. Jumper jumps with his back turned to the bar in the transverse position of the body. That kind of position is suitable for the transmission of related parts of the body over the bar by applying a compensatory effect. Transverse jump over the bar affects the speed increase of the horizontal passing of the body over the bar and successfully raising the highest point of the trajectory of the body center of gravity. This technique is structured from four phases: a run-up, take-off, flight and landing. (Stanković, D., & Raković, 2010)

The aim of this study is to review and summarizing published studies to determine which morphological characteristics and motor abilities are characterized by high jumpers that can or has already achieved significant results in this athletic discipline. Based on the obtained information morfo-motor profile of hihg jumpers will be constructed.

# METHODS

For Collecting previous research on the morpho-motor profile of high jumpers Google academic electronic database is searched. We used all the appropriate papers published in the period from 1980 to 2016.

When searching the databases the following keywords were used: Fosbury flop, high jump, high jumper, morphology, antrophometry, somatotype, motor abilities, motor skils. Found abstracts and full text were then read and analyzed.

In order to study be accepted for the final analysis it had to meet the criteria that in research exists systematic measurement of morphological characteristics and motor abilities and that on the basis of the measured and derived measures in the process and in accordance with the methodology of scientific research a conclusion on the morphological characteristics and motor skills of research subjects was made. Conducted researches are on the subjects of both sexes.

Methods used in this paper are: the method of analysis, the method of comparison and the descriptive method.

Collecting research on keywords identified over 1000 works of which are excluded studies that did not satisfy the search criteria based on titles, duplicate papers and abstracts. After analysis of the remaining studies, those in which there was no systematic collection of anthropometric and motor measurements and data were excluded.

# RESULTS AND DISCUSSION

In the majority of authors results indicate a high correlation of the morphological characteristics with the result in high jump (Khosla & Mcbroom, 1985; Čoh & Novak, 1999; Stanković, 2006; Ivković, 2008; Milenković, 2009; Abraham, 2010; Shafeeq et al., 2010; Singh et al., 2010; Bratić et al., 2012; Laffaye, 2012; Singh et al., 2012; KaurTiwana, 2013).

The situation is similar when we consider results of correlation of motor abilities and the high jump result. (Kraemer & Newton, 1994; Branković et al., 1995; Gehri, 1998; Raković i Stanković, 2005; Stanković, 2006; Ivković, 2008; Milenković, 2009; Stanković, 2011)

Milanovic (1980) confirms that result in high jump undoubtedly depends on longitudinal dimensionality of the skeleton of jumpers, high level of relative explosive strength and flexibility. It is obvious that high jumpers who are superior in the height in general and especially at the level of the overall center of gravity of the body in compared to the other, as well as those jumpers in which the central and peripheral neuromuscular elements responsible for the intensity of the excitation operate at a higher level, are more likely to achieve better results in the high jump.

Khosla & Mcbroom (1985) conducted a investigation in which, among the data that were collected for women finalists of the Olympic Games in the various disciplines in 1972. and 1976., the female high jumpers were taken into account. What is noticed is that best placed Olympian have average height 176.2 ± 3.3 cm, average weight 63.9 ± 3.3 kg, BMI = 2.056 ± 0.078 g / cm$^2$ and age 22.6 ± 3.8 years wherein the first-placed jumpers were highest with the lowest weight- height ratio.

Kraemer & Newton (1994) in the context of the key moments in the improvement of vertical take-off stated that vertical take-off is a complex multijoint movement that requires muscle coordination that most improves the development of specific skills. Considering that the quality performance of the vertical take-off is one of the key elements for the successful execution of a hihg jump up, there is the reasonable assumption that in order to effectively perform high jump requires good muscular coordination.

Brankovic et al. (1995), this paper are shown structure of the leading elements of the anthropological characteristics of athletes. Considering motor abilities of high jumpers with a score of significance +5 are marked explosive power and speed of alternative movements, +4 maximum force attempted movements and overall strength, while coordination is estimated to +3, flexibility and precision to +2, with and balance of +1. None of motor ability is negatively evaluated.

Geri et al. (1998) concluded that the experimental program consisting of jumps in depth and standing high jumps increase the average height of the jump. The study group, which is in an experimental program conducted in-depth jumps increased the average height of jump 113.61%, and the study group that performed standing high jumps has increased the average height of the jump 106.83%.

Čoh & Novak (1999) have obtained results that showed relatively narrow profiling of morphological space (small variability), but with a still relatively large variance in the area of variable body height. This variable is not a crucial factor for achieving top results nor in women neither men. Some morphological features are indirect functional basis for biomechanically optimal structure of movement. Based on the correlation matrix it is not possible to establish a statistically significant correlation between morphological measures and results in the high jump.

Raković & Stanković (2005)concluded that the predictor set of tests for evaluation of explosive strength has a statistically significant correlation with the result in the high jump. However, based on the results of individual regression coefficients and their significance, it can be noted that a statistically significant correlation with the criterion variable has only foot taping test.

Stanković (2006) concluded that there is a significant correlation between morphological characteristics and motor abilities with the result in the high jump. The applied motor tests on the result in high jump significantly influenced the assessment tests for speed, explosive strength type vertical jumping ability, flexibility and agility.

Ivkovic (2008) got the the results of the regression analysis showed that the set of morphological and motor variables has a statistically significant effect on all individual criterion variables at the level of 0.00, except motor variables of explosive strength of upper extremities.

Singh et al. (2010) found that good high jumpers have a significantly higher body height, body weight, body mass index, lower limb length and the length of the upper extremity in comparison to bad high jumpers. Good high jumpers also had a significantly greater volume of the upper arm, thigh and calf, shoulder and femur diameter, clean body weight and mesomorphic component in relation to the worse high jumpers. Worse high jumpers in relation to the good have a higher percentage of body fat and endomorph component.

Milenkovic (2009) got the results of canonical correlation analysis that showed that the morphological characteristics, motor and functional abilities, have a statistically significant effect on the results of the program content of physical education in athletics (high jump, long jump, shot put and sprinting) for pupils in primary school.

In the following two researchs Shafeeq, Abraham, & Raphael (2010) and Abraham (2010), the results of measurements of specific components of somatic types show a tendency of growth. Note: according to Ballreich and Kuhlau (1986) increase in the value of the height of high jumpers for 0.1 m resulting in an increased jump height of +0.07 m. Average somatic type of hihg jumpers is 3,4-3,7-4,2. Observed group of male high jumpers falls into the category of mesomorph and ectomorph - mesomorphic component significantly dominates (55%), while ectomorphic component is represented with 33%. It should also be noted that the observed dominance of ectomorph components is 51% in the last two periods of measurement.

Laffaye (2011) has noted that both sexes perfotmed high jump on the same way. Also, the long lower limbs are not undisputed advantage and that different body morphology may be effective in jump. In this way can be linked anthropometric measures and performance in high jump.

Stanković (2011) found that there is a statistical connection between strengt as a predictor with the high jump results.

Bratić et al. (2012) were, by using regression analysis came to the conclusion that there is a statistically significant effect on the anthropometric characteristics of horizontal and vertical jump in boys and girls.

Singh, Yadav & Yadav (2012) have come to the conclusion that the average endomorphic components in high jumpers is low because they need greater height and explosive power at take-off, and the body weight, in fact, was no advantage to achieve significant results. Also, mesomorphic component of high jumpers is small because they have longer limbs. Longer limbs, upper and lower, are advantage in raising the center of gravity, which is the essence of the high jump. As the component with the highest value stands out the ectomorph component. High jumpers need less weight and higher center of gravity, with the least possible use of leg strength, in order to raise their center of mass on the the highest possible level and thus achieve better performance in the high jump.

KaurTiwana (2013) came to the conclusion that, on the basis of three categories of jumpers, generally speaking, the female high jumpers have greater body hight with the longest torso and the largest range of hands, with the smollest body weight, and with less muscle on the thighs, calves and upper arm. They also have a mean value of diameter of the shoulder bone, wrist and ankle joint. Body mass index (18.39), and Ponderal index (22.38) is the smallest among the observed categories of jumpers. The height-weight ratio shows that female high jumpers have the lowest weight in relation to height. When considering the body structure, it was concluded that the female high jumper have medium percentage of body fat, but almost the same body density as jumpers of other categories. When analyzing somatotype, average female high jumpers are endomorph ectomorph. This shows that they have a thin and slim type of body structure.

# CONCLUSION

Based on all the above and by analysis and synthesis of research it could be concluded that there is a strong connection between the morphological characteristics and motor abilities with the result in the high jump.

Regarding the morphological characteristics, the best predispositions for achieving significant results have high athletes with the lowest weight-height index and a low percentage of body fat, and those who have a strong skeleton with a larger volume of the shoulder and femur and medium musculature (circumference of upper arm, thigh and calf). Longer limbs are advantage in raising the center of gravity, which is the essence of the high jump. Being tall, allows high jumpers take-off from higher starting positions of center of gravity. There is also no significant difference concerning morphological characteristics in male and female high jumpers. The most common components in male high jumpers are endomorph and ectomorph, and in elite male high jumpers are ectomorph and mesomorph. The most common components in female high jumpers and elite female high jumpers are endomorph and ectomorph.

Considering motor abilities of high jumpers, high jumpers should have extremely high levels of explosive strength and speed, very high level of maximum force of attempted movements and general strength, and a relatively high level of coordination. It must also possess a high level of relative explosive strength and flexibility, and the presence of good muscle coordination is relevant too. Particularly important is the horizontal and vertical velocity while performing a high jump.

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# QUALITY OF JUDGING ON THE BALANCE BEAM AT THE EUROPEAN CHAMPIONSHIP 2014

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## SUMMARY

The aim of our research was to analyze the reliability and validity of judges' E scores and artistry deductions on the balance beam in the qualifying competition (C - I) of the 2014 European Championship in senior (n=89) competition. The following reliability and validity statistics were then calculated: Interclass Correlation Coefficient (ICC), Cronbach's alpha, Kendall coefficient of concordance W and repeated measures ANOVA. All data were analyzed using SPSS 20. The most of the results are satisfying, but correlations between judges for the artistry deductions are smaller than .90 so we can report that the quality of judging artistry was on the lower level comparing to the E score. The results of our investigation showed the need for better definition of the artistry deductions during the next Olympic cycle. Some of the authors suggested that computerized systems for the artistic gymnastics judging should be tested in order to reduce differences between judges.

**Keywords:** Artistic gymnastics, Reliability, Validity

## INTRODUCTION

Balance beam is one of the most difficult apparatus in the Woman's Artistic Gymnastics. In defining exercises and skills on this apparatus it can be noticed that a large number of skills were taking over from the floor, but an important fact is that the construction of the apparatus is dictating the technique of execution. Gymnasts perform elements on the limited support area: 10 cm width, 1.25 m height and 5 m length, so balance is one of the most important skills for success and high level execution (Hars et al., 2005).

Exercising on the balance beam includes maintaining balance in different positions with legs and arms supports, movements, transitions and gymnastics elements on the balance beam, and also mount and dismount of the balance beam. During maintaining positions, optimal angles of the body segments and tonus of the muscles are very important in order to resist external forces. Position of hands and feet can also be a factor of success in secure and stabile performing and landing.

During complex, highly valued elements, gymnasts' body is moving by mechanisms associated with the laws of displacement of a body in space. Keeping the direction of movement is crucial because of the characteristics of the balance beam. Small body compensatory movements are necessary in order to maintain balance and bring the center of gravity of the body above the support. If these movements are accompanied by additional movements of arms, legs, torso or the whole body, in order to prevent the fall off the devices, they will be sanctioned by the judges of the E (Execution) panel (FIG, 2013-2016).

Over time the balance beam has undergone various changes from the original to the bench today - a modern balance beam. The balance beam has a stand and an aluminum center. The upper surface is specially treated elastic and padded leatherette, which prevents slippage (Sands, 2000). These changes are affected by the elasticity of the balance beam, and they enabled realization of complex elements, as well as the safety in exercising and reduced number of injuries. It is essential that gymnasts have good explosive power of legs to perform elements with control. Plyometrics and progressive training helps developping explosive power and speed of the leg muscles in gymnasts (Mohamed, 2010).

According to the regulations of the International Gymnastics Federation (Code of Points, 2013-2016) evaluating of the composition on the balance beam begins with the take-off from the board or the mat. Exercise duration is 90 seconds and the end of the exercise is when the gymnast touches the mat after dismount. Ten seconds before the end of the time for exercise "gong" warns gymnasts. The deduction for overtime of the exercise is 0.10 points. After the fall off the devices gymnast has ten seconds to continue the exercise or the exercise is considered completed. This time is not included in the total duration of the exercise.

The content of the composition of the beam is evaluated by D - panel (Difficulty Value), consisting of the difficulty value of the exercises (maximum 5 acro and minimum 3 dance elements), specific requirements and the connections value. Difficulty value - DV consists of eight heaviest elements, including dismount. These values should include acrobatic elements with or without hand support and leaps, jumps, turns, "endurance" and "wave" body elements from a Code of points - table of elements.

The value of every requirement is 0.50 points and all except dismount must be performed on the balance beam. The value of the connection (CV) can be obtained only for direct connections between the elements, according to the formulas in the Code.

On the European Championship, The FIG Technical Committee is evaluating the quality of judging by evaluating E judges, calculating the difference between the final score (average score of middle 3 judges, after rejection minimal and maximal E score) and the individual judges' score. Judging system in gymnastics is influenced by several factors. One of the factors emphasize on difficulty and acrobatics association with the risk of injury. Moreover, increasing number of judges involved in judging could influence the reliability of scores. Accordingly, the researchers have been recently looking to the bias, reliability and validity of judging. Therefore, the aim of our research was to analyze the reliability and validity of judges' E scores and artistry deductions on the balance beam in the qualifying senior competition (C - I) of the 2014 European Championship.

## METHODS

Judges' E scores were obtained from the official book of results. There were five E judges and two references judges giving E score and Artistry deduction. Senior gymnasts (n=89) performed in the qualification on the balance beam. For each set of analysis we calculated statistics for the E score and Artistry item (individual judge) and scale (final E score on the competition) scores. The following reliability and validity statistics were then calculated: Interclass Correlation Coefficient (ICC), Cronbach's alpha, Kendall coefficient of concordance W (Leskošek, Čuk, Karácsony, Pajek, & Bučar, 2010). Differences in mean E scores between judges were tested using repeated measures ANOVA. All data were analyzed using SPSS 20.

## RESULTS

In the Table 1 are the results of the descriptive statistics of all judges' scores. Mean E scores are normally distributed. Distributional statistics (mean and standard deviation) were calculated for raw E scores for every judge, but on the competition the minimal and maximal E score were thrown out and here we have mean score from three judges. Reference judge ER1 and ER2 have one mean score ER and only when we have big deviations between judges, then ER score inputs to calculation of the score. We put all judges into consideration in order to examine their scores, and not final score.

**Table 1**. Descriptive Statistics seniors

| | Mean | SD | Skew. | Kurt. | Corrected Item-Total Correlation | Cronbach's Alpha if Item Deleted |
|---|---|---|---|---|---|---|
| 1 | 7.01 | 1.07 | -.665 | .003 | .926 | .982 |
| 2 | 7.09 | 1.22 | -.963 | .716 | .936 | .981 |
| 3 | 6.96 | 1.07 | -.292 | -.210 | .749 | .988 |
| 4 | 7.16 | 1.05 | -.631 | -.296 | .852 | .984 |
| 5 | 7.15 | 1.13 | -.840 | .492 | .963 | .980 |
| 6 | 7.04 | 1.12 | -.870 | .323 | .939 | .981 |
| 7 | 7.07 | 1.19 | -.759 | .166 | .950 | .981 |
| 1 | .2562 | .08 | -.135 | -.285 | .793 | .926 |
| 2 | .2303 | .15 | .233 | -.817 | .836 | .917 |
| 3 | .3438 | .13 | .516 | 1.558 | .667 | .932 |
| 4 | .1854 | .14 | .138 | -1.052 | .836 | .916 |
| 5 | .3157 | .11 | .015 | -.386 | .802 | .919 |
| 6 | .2551 | .11 | -.301 | -.113 | .793 | .921 |
| 7 | .3876 | .14 | -.198 | -.492 | .851 | .914 |

Table 2 shows correlations between judges' scores and Table 3 between the artistry deduction. The most of the results are satisfying, but we have smaller correlation values from .90. This score was thrown out from the calculation and didn't affect the final score at the competition, but it is important for our analysis. Correlations between judges for the artistry deductions are smaller than .90 so we can report that the quality of judging artistry was on the lower level comparing to the E score. In the Table 4 there is the result of reliability analysis. Reliability of judges scores (Cronbach's Alpha>0.90) are on the satisfying level.

**Table 2. Correlations between scores**

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| .933** | | | | | |
| .814** | .837** | | | | |
| .888** | .908** | .798** | | | |
| .953** | .958** | .857** | .902** | | |
| .942** | .926** | .849** | .898** | .960** | |
| .948** | .952** | .839** | .907** | .964** | .952** |

**. Correlation is significant at the 0.01 level (2-tailed).

**Table 3. Correlations between artistry**

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| .698** | | | | | |
| .479** | .600** | | | | |
| .746** | .743** | .633** | | | |
| .704** | .741** | .550** | .717** | | |
| .666** | .693** | .636** | .698** | .680** | |
| .784** | .792** | .582** | .752** | .737** | .712** |

**. Correlation is significant at the 0.01 level (2-tailed).

**Table 4. Reliability and validity measures for the balance beam E scores and artistry deductions**

| | Cronbach's Alpha | $ICC_{averege}$ | $ICC_{single}$ | Kendall's W | ANOVA F |
|---|---|---|---|---|---|
| **E scores** | .985 | .985 | .903 | .040* | 3.677 |
| **Artistry deductions** | .931 | .931 | .660 | .040* | 84.218 |

# DISCUSSION WITH CONCLUSION

There are numerous objective and subjective factors for these differences e.g. the number of competitors in a session, judges' seat positions and view angle to the gymnast, and the judges' experience. At the moment as there is only sum of deductions presented in the judges' score it would be advisable if E judges could be evaluated according to what deduction was taken in time of gymnast's exercise (Leskošek et al., 2010). Subjectivity of judging artistry, especially confidence, personal style and uniqueness of the gymnasts, but also insufficient variation in rhythm and tempo in movements, influenced the shown results correlations between the judges.

There have been numerous investigations about gymnastics judging so far (Bučar, Čuk, Pajek, Karacsony, & Leskošek, 2012; P. M. Bučar, 2015; Dallas & Kirialanis, 2010; Leskoŝek, Cuk, Pajek, Forbes, & Bucar-Pajek, 2012; Leskošek, Čuk, Karácsony, Pajek, & Bučar, 2010; Massidda & Calò, 2012; Pajek, Cuk, Pajek, Kovač, & Leskošek, 2013; Plessner, 1999). Continuous monitoring of the quality of judging (incorporating reliability and validity) is a necessity in order to achieve reliable and objective judging (Pajek et al., 2013). Leskošek et al. (2010) define reliability as achieving the same results with several measurements of the same subject under identical conditions. A special case of reliability, called inter-rater reliability or objectivity is defined as achieving the same results from different persons who evaluate the same performance. This later aspect of reliability is especially important in gymnastics. As most of the reliability measures are based on inter-item correlations, they could not detect validity of judging, i.e. if there is any systematical bias in judging, e.g. systematical under- or overestimation of particular judge or competitors of certain nationalities. Reliability of judges scores on European Championship (Cronbach's Alpha>0.90) are on the satisfying level, similar to results of the earlier studies (Bučar et al., 2012; Bučar, 2015; Leskošek et al., 2010).

Pajek et al. (2013) published the first comparative report of reliability and validity of judging at two major gymnastics events of different levels. Overall, for the European championship the indices of consistency are satisfactory. Except for the vault and floor all around finals and floor apparatus finals Cronbach's alpha is above 0.95, minima of item total correlations are above 0.8, and the ICC of average scores and Armor's theta coefficients are at or above 0.95, which are all good values.

The latest regulations of the International Gymnastics Federation (Code of Points, 2013-2016) emphasizes the importance of composition and artistry during exercise on the beam. The most difficult elements of acrobatics should be balanced with elements of choreography in order to create a continuous flow of unique abilities, style and personality of gymnasts during exercise. Break and pauses between the length of the beam must not be longer than one second, and it is necessary to move sideways, close to the beam and throw entire apparatus, to give the creativity in choreography. Judging on the balance beam became very difficult with inclusion of separated dedications for exercise and artistry. In the beginning of the cycle, coaches didn't pay attention on this part of the presentation, so artistry deductions were very high. E panel judges can deduct faults for Artistry of Performance that includes: confidence, personal style and uniqueness; Insufficient variation in rhythm and tempo in movements; Performance of the entire exercise as a series of disconnected elements and movements; Lack of creativity of movements and transitions; Lack of directional changes (forward, backward, sideward); Insufficient use of entire apparatus; Mount not from the table of elements and one-sided use of elements.

The results of our investigation showed the need for better definition of the artistry deductions during the next Olympic cycle. Some of the authors suggested that computerized systems for the artistic gymnastics judging should be tested in order to reduce differences between judges (Bučar et al., 2012), but artistry is the part of the score on the balance beam and the floor where is human perception is necessary.

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# DIFFERENCES AND TREND CHANGES OF THE MAXIMUM HAND GRIP FORCE IN SELECTED KARATE MALE IN FUNCTION OF AGE: A PILOT STUDY[1]

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## SUMMARY

The hand grip test is relatively simple and doesn't demand efforts characteristics for other motor tests. Beside the fact that hand grip force do not has direct influence on karate competitive achievement, it could be the indicator of athletes condition. The goal of this work was to model developmental trends in contractile characteristics in terms of the maximum force of the flexor muscles of the fingers on the basis of data from the hand grip test collected in a sample of male karate athletes recruited from the Republic of Serbia's male karate training system. The sample consisted of 66 male participants organized into age categories: *senior*, *junior*, *cadet*, *hope* and *pioneer*. The contractile properties of hand grip muscle force were indexed using maximal muscle force for the right, the left and summarized the right and the left hand. Trends in variables as a function of age were defined using linear regression and by mathematical modeling method using dependency functions. There is a statistically significant difference between all observed groups in all Fmax variables, while there were no differences between *hopes* and *cadets*, and *cadets* and *juniors* also. Trend of increase in maximal right, left and summary value of left and right hand grip force in function of different age groups – selected group of R Serbia karate athletes, is 83.78 N, 80.71 N and 164.49 N in every age category in regard to absolute level of expressed force, respectively. The defined model in this study can be accepted as statistically reliably and on the level of initial testing. Future studies in this area should be directed on accessing of karate training effects in regard to trends of basic and specific abilities changing.

**Keywords:** karate, hand grip force, age group, regression model, prediction

## INTRODUCTION

The hand grip test is relatively simple and doesn't demand efforts characteristics for other motor tests. The hand grip test has been used to evaluate the contractile characteristics of muscles related to relationship between the players (Koley et al. 2011; Dopsaj et al. 2011), age, sex or fitness level (Bohannon, 2001; Dopsaj et al. 2009; Ivanović et al. 2009) or to the type of sport (Dopsaj et al. 2009; Ivanović et al. 2009; Carrasco et al. 2010; Koley et al. 2011, 2012; Taghread, 2013). It was established that hand grip force in children and adolescents could be used to track biological development and evaluate total body muscle (Bohannon, 2001; Kadir et al. 2005; Wind et al. 2010). Training and competition plan, which is intended to ensure that athletes achieves top results within their period of optimal biological development, is crucial for success career (Ford et al. 2011). Additionally, it is necessary to describe the development of each sub-system on which top sport results are dependent, such as morphology, organic systems – energy and contractile components – as well as the development of important general and specific skills, psychological characteristics, etc. (Milišić, 2007).

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Describing relevant characteristics and defining mathematical models of their development to facilitate monitoring is an important task for sports science (Zaciorski, 1982).

Nowadays, karate is one of the most widespread individual martial sport (Koropanovski et al. 2011), which will be implemented on Olympic Games in Tokyo 2020. Main characteristic of karate techniques are fast, explosive movements with priority on controled force realisation in regard to opponent competitor. The requirements of karate imply controlled time and space movements stoping. High-level performance and top sports results in karate are conditioned by not only superior technical performance or exceptional motor and functional abilities but also by mental stability and favorable anthropometrics (Amusa and Onyewadume, 2001; Jukic et al. 2012). However, recent studies imply on more relations between maximal strength (i.e. force) and success in karate (Roschel et al. 2009; Loturco et al. 2014). Also, it was established that daily karate practice did not result in bilateral asymmetry of either lower or upper extremities, which earlier had been associated with the increased risk of injuries (Scattone-Silva et al. 2012).

In the recent studies there were no explorations of trend changes between karate athletes of different ages. Beside the fact that hand grip force do not has direct influence on karate competitive achievement, it could be the indicator of athletes condition (Svantesson et al. 2009). The goal of this work was to model developmental trends in contractile characteristics in terms of the maximum force of the flexor muscles of the fingers on the basis of data from the hand grip test collected in a sample of male karate athletes recruited from the Republic of Serbia's male karate training system.

## METHODS

Measurements were carried out during field testing, applying a dynamometric method and a standardized procedure for the hand grip test (Dopsaj et al. 2009; Ivanović and Dopsaj 2012). The research was conducted in accordance with the guidelines for physicians carrying out biomedical research involving human subjects set out in the Declaration of Helsinki (http://www.cirp.org/library/ethics/helsinki/) as was approved by the Ethics Committee of the Faculty of Sport and Physical Education, University of Belgrade.

### Subjects

The sample consisted of 66 male participants organized into age categories as follows: 11 *senior* athletes (age = 21.7 ± 3.3, body height (BH) = 182.0 ± 6.4 cm, Body mass (BM) = 81.4 ± 9.6 kg, Body mass index (BMI) = 24.51 ± 2.11 kg/$m^2$), 11 *junior* athletes (16-18 years, age = 16.7 ± 0.8, BH = 180.4 ± 6.9 cm, BM = 73.3 ± 7.8 kg, BMI = 22.48 ± 1.73 kg/$m^2$), 9 *cadet* athletes (14-16 years, age = 14.6 ± 0.7, BH = 174.0 ± 7.6 cm, BM = 66.2 ± 14.2 kg, BMI = 21.66 ± 3.35 kg/$m^2$), 14 *hope* athletes (12-14 years, age = 12.9 ± 0.7, BH = 169.9 ± 6.9 cm, BM = 58.6 ± 9.2 kg, BMI = 20.25 ± 2.71 kg/$m^2$), and 21 *pioneer* athletes (10-12 years, age = 10.9 ± 0.9, BH = 151.9 ± 9.0 cm, BM = 39.9 ± 6.1 kg, BMI = 17.25 ± 1.67 kg/$m^2$). All participants were active karate athletes who compete in national teams or participated in national training camps for talented athletes in 2016.

### Testing Procedure

Field testing was carried out by the same examiners, using the same procedure during preparations and camps for the selection of national teams in 2016, in the Republic of Serbia. All testing was performed after a standard warm-up period of at least 15 minutes. After the warm-up each participant performed two trial hand grips with each hand, alternating between hands, in order to familiarize himself with the procedure. Measurements were taken following the procedure described above after a break of 3 to 5 minutes (Ivanović and Dopsaj 2012).

The contractile properties of hand grip muscle force were assessed using three variables (the absolute maximum muscle force):

- Maximum muscle force for the right hand grip (FmaxR), expressed in Newtons (N);
- Maximum muscle force for the left hand grip (FmaxL), expressed in Newtons (N);
- Maximum muscle force summarized the right and the left hand grip (FmaxSUM), expressed in Newtons (N);

### Statistical analysis

Basic descriptive statistics for all variables was calculated: measures of central tendency (mean, MEAN) and measures of dispersion (standard deviation, SD). Multiple variance analysis (MANOVA) was used to assess differences between dependent variables as a function of age group, the Bonferroni criterion was applied to pairwise comparisons between groups. Trends in variables as a function of age were defined using linear regression and by mathematical modeling method using dependency functions (Hair et al. 1998). Statistical analysis was carried out using the software package Excel 2003 (Microsoft®Office Excel 2003) and SPSS Win 19.0.

# RESULTS

Results of the descriptive statistical parameters are shown in Table 1.

**Table 1.** Descriptive statistics of variables according to age categories

| | PIONEERS | HOPES | CADETS | JUNIORS | SENIORS |
|---|---|---|---|---|---|
| BH | 151.95 ± 9.00 | 169.86 ± 6.89 | 174.00 ± 7.58 | 180.45 ± 6.89 | 182.09 ± 6.39 |
| BM | 39.95 ± 6.08 | 58.57 ± 9.20 | 66.17 ± 14.18 | 73.27 ± 7.79 | 81.45 ± 9.65 |
| FmaxL | 174.29 ± 35.55 | 266.50 ± 56.82 | 329.89 ± 80.42 | 409.73 ± 59.15 | 505.73 ± 96.05 |
| FmaxR | 189.14 ± 41.74 | 284.86 ± 53.95 | 370.44 ± 94.89 | 432.55 ± 72.25 | 531.36 ± 106.74 |
| FmaxSUM | 363.43 ± 74.36 | 551.36 ± 107.32 | 700.33 ± 169.73 | 842.27 ± 120.60 | 1037.09 ± 198.27 |

**Table 2.** MANOVA results for Fmax on general level

| Effect | | Value | F | Hypothesis df | Error df | Sig. |
|---|---|---|---|---|---|---|
| Groups | Wilks' Lambda | .196 | 18.881 | 8.000 | 120.000 | .000 |

**Table 3.** MANOVA results for Fmax on partial level

| Source | Dependent Variable | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| Groups | FmaxL | 947625.325 | 4 | 236906.331 | 58.687 | .000 |
| | FmaxR | 1021391.810 | 4 | 255347.953 | 50.111 | .000 |
| | FmaxSUM | 3933528.870 | 4 | 983382.218 | 58.274 | .000 |

Multivariate analysis of variance (MANOVA) examined the state of the difference among the Age groups in relation to FmaxL, FmaxR and FmaxSUM (Table 2).

On Tabeli 3 the results of MANOVA are shown on partila level.

In regard of Bonferroni test results for FmaxL, FmaxR and FmaxSUM, the proper statistically significant differences between all observed groups was established. Additionally, there is a statistically significant difference between all observed groups in all Fmax variables, while there were no differences between *hopes* and *cadets*, and *cadets* and *juniors* also.

In Tables 4 and 5 the regression models with equitation's of specifications for all Fmax variables are shown in regard to two predictive models: belonging prediction to age group (1 – *pioneers*; 2 – *hopes*; 3 – *cadets*; 4 – *juniors*; 5 – *seniors*) on the basis of known value of explored hand grip variable (Table 4); and prediction of achieved result (FmaxL, FmaxR and FmaxSUM) on the basis of known results of age group belonging (Table 5). The results of regression depending on the FmaxL, FmaxR and FmaxSUM test in relation to the values of Groups are shown in Graph 1-3.

**Table 4.** Regression models and prediction group models for analyzed variables for Fmax

**Regression Model Summary**

| Model | R | $R^2$ | Adj. $R^2$ | S.E.E. | ANOVA F | ANOVA p | Prediction model |
|---|---|---|---|---|---|---|---|
| FmaxR | .874 [a] | 0.764 | 0.76 | 0.731 | 207 | 0 | Group = -0.373 + (FmaxSUM * 0.009) |
| FmaxL | .889 [a] | 0.791 | 0.788 | 0.688 | 242.3 | 0 | Group = -0.382 + (FmaxSUM * 0.010) |
| FmaxSUM | .889[a] | 0.79 | 0.787 | 0.689 | 241.4 | 0 | Group = -0.430 + (FmaxSUM * 0.005) |

a. Predictors: (Constant), FmaxR, FmaxL, FmaxSUM

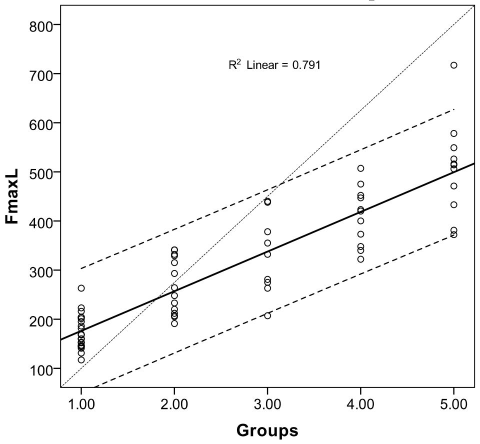
**Table 5.** Regression models and achieved result prediction models (FmaxL, FmaxR, FmaxSUM) based on age group affiliation

**Regression Model Summary**

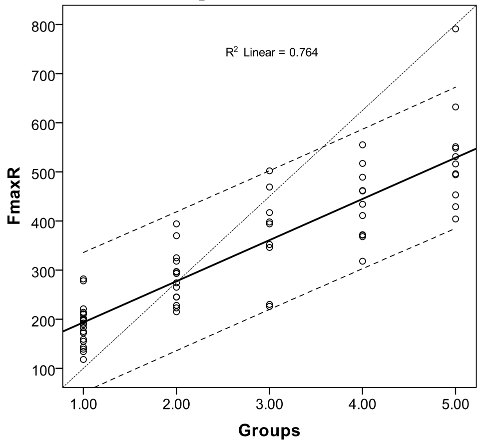
| Model | R | $R^2$ | Adj. $R^2$ | S.E.E. | ANOVA | | Prediction model |
|---|---|---|---|---|---|---|---|
| | | | | | F | p | |
| FmaxR | .874 [a] | 0.764 | 0.76 | 70.11 | 207 | 0 | FmaxR = 109.630 + (Group * 83.780) |
| FmaxL | .889 [a] | 0.791 | 0.788 | 62.43 | 242.3 | 0 | FmaxL = 95.545 + (Group * 80.709) |
| FmaxSUM | .889 [a] | 0.79 | 0.787 | 127.48 | 241.4 | 0 | FmaxSUM = 205.175 + (Group * 164.488) |

a. Predictors: (Constant), Group

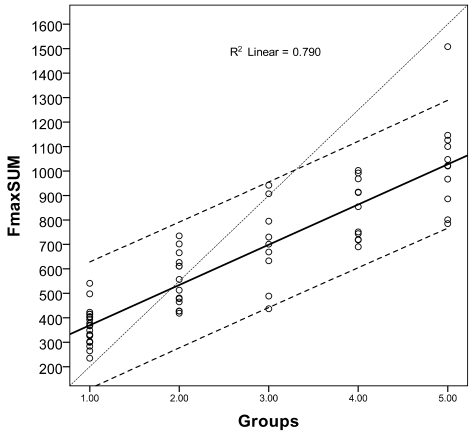
**Graph 1.** Regression model of the relation between the FmaxL test and Groups




**Graph 2.** Regression model of the relation between the FmaxR test and Groups




**Graph 3.** Regression model of the relation between the FmaxSUM test and Groups




# DISCUSSION

Optimal functioning of the hand in daily activities requires a preserved range of motion in all joints of the upper limbs, muscle strength and a fully functional grip. Maximal hand grip force is correlated with variables representing the morphological structure of the body, the balance between the types of muscle fibres, characteristics of the skeleton and bone tissue and fitness status (Bohannon 2001; Koley et al. 2011; Wind et al. 2010).

The results of the recent studies of maximal hand grip force indicate on greater differences in regard to tested samples. In the study of Fallahi and Jadidian (2011) which was implemented on athletes from sports where hand grip is important for competition performance, maximal dominant hand grip (DH) was 48.15 ± 7.98 kg, while maximal non-dominant hand grip (NDH) was 45.64 ± 7.21 kg. In regard to this results, the *senior's* in our study achieved higher level of the maximal hand grip force (DH 52.13 kg, NDH 49.61 kg). Also, *senior* karate athletes expressed better results than basketball (DH 48.25 ±

5.42; NDH 43.84 ± 6.39), volleyball (DH 45.67 ± 7.08 kg; NDH 42.33 ± 7.64 kg), badminton (DH 50.71 ± 10.23 kg; NDH 43.32 ± 8.45 kg) and handball players (DH 48.60 ± 9.91 kg; NDH 45.20 ± 8.60 kg) (Kaplan 2016). On the other hand, our *senior* karate athletes achieved lower results then Serbia top level athletes who achieved FmaxR 632 ± 125.67 N and FmaxL 591 ± 118.91 N (Ivanovic et al. 2009), ice hockey players (FmaxR 614 N, FmaxL 563 N) and sailors (FmaxR 680 N, FmaxL 655 N) (Svantesson et al. 2009), as well as elite Italian amateur boxers with hand-grip strength of 58.2 ± 6.9 kg (Guidetti et al. 2002). Similar results were found in soccer players (FmaxR 529 N, FmaxL 479 N) (Svantesson et al. 2009). If we consider that the maximal hand grip muscle force in young, physically active men is the reference (Dopsaj et al. 2007), our results indicate that our *senior* karate respondents have achieved between 25-30 percentile for the right hand grip maximal force and between 2.5-5 percentiles for the left hand grip maximal force of the reference value.

In younger age categories, there are only a few studies with maximal hand grip force exploration. *Junior* and *cadet* karate athletes expressed better results than intercollegiate cricket male players in the age group 17, 18 and 19 years, DH 33.57 ± 6.62 kg, 33.77 ± 6.73 kg and 37.70 ± 5.16 kg; NDH 32.40 ± 6.77 kg, 31.96 ± 6.22 kg and 37.21 ± 5.16 kg, respectively (Sathya et al. 2016). Also, *pioneer*, *hope* and *cadet* karate athletes showed slightly better results than 11, 13, 15 and 17 years boys in India who achieved FmaxR 16.62 ± 3.13 kg, 18.4 ± 3.87 kg, 33.6 ± 5.52 kg, 38.11 ± 3.42 kg, and FmaxL 15.56 ± 2.92 kg, 17.77 ± 3.86 kg, 30.9 ± 5.05 kg, 36.28 ± 3.51 kg, respectively (Koley et al. 2007). Karate athletes in *hope* category age showed similar results for DH as male table tennis athletes DH (27.94 kg vs. 27.1 ± 5.1 kg) and slightly better results for NDH (26.14 kg vs. 22.4 ± 4.1 kg) (Carrasco et al. 2010).

As expected, the statistical significant increase in force variables maximal hand grip force was found (Table 2 and 3). The increase of contractile characteristics is effect of chronological and biological development (Koley and Melton, 2010), but there is also the effect of training process. For the control and planning of training process, it is necessary to determine standards in regard of top level results achieving (Milišić 2007). Trend of increase in maximal right hand grip force in function of different age groups – selected group of R Serbia karate athletes, is 83.78 N in every age category in regard to absolute level of expressed force. Trend of increase in maximal left hand grip force in function of different age groups – selected group of R Serbia karate athletes, is 80.71 N in every age category in regard to absolute level of expressed force. Trend of increase in summary value of maximal left and right hand grip force in function of different age groups – selected group of R Serbia karate athletes, is 164.49 N in every age category in regard to absolute level of expressed force.

In this way the cybernetic controlled model of the studied contractile characteristics of hand grip was established in regard to actual model of ability measured in selected group of R Serbia karate athletes. With the fact that this kind of testing is easy to perform, hand grip can be highly recommended as a measuring tool for assessing overall performance (Svantesson et al. 2009). Our results can be used to improve training programs, taking into account the developmental phase of the athletes.

## CONCLUSION

On the basis of the defined model, for the variables FmaxL, FmaR and FmaxSUM, it can be concluded:

- Trend of increase in maximal right hand grip force in function of different age groups – selected group of R Serbia karate athletes, is 83.78 N in every age category in regard to absolute level of expressed force;
- Trend of increase in maximal left hand grip force in function of different age groups – selected group of R Serbia karate athletes, is 80.71 N in every age category in regard to absolute level of expressed force;
- Trend of increase in summary value of maximal left and right hand grip force in function of different age groups – selected group of R Serbia karate athletes, is 164.49 N in every age category in regard to absolute level of expressed force.

At the moment, there are no dates about differences in changes trends between athletes and normal population. There are any recent studies which investigate influence of systematic long year training in karate on the changes in increasing levels of measured hand grip force. Therefore the defined model in this study can be accepted as statistically reliably and on the level of initial testing. Future studies in this area should be directed on accessing of karate training effects in regard to trends of basic and specific abilities changing.

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# DIFFERENCES IN THE LEVEL OF COGNITIVE ABILITIES AMONG ATHLETES WHO PREFER DIFFERENT SPORTS GAMES

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## SUMMARY

The research was conducted on a sample of 200 male respondents, ages 16 to 19 years who prefer different sports games (football, volleyball, handball and basketball). The research was conducted in order to identify statistically significant differences in the level of cognitive abilities between athletes who prefer different sports games. The KOG-3 battery that was applied for the assessment of the cognitive abilities is designed to measure the level of general cognitive abilities and it consists of the three following tests: IT-1 test for assessing the efficiency of the perceptual processor, AL-4 test for assessing the efficiency of the serial processor and the S-1 test for assessing the efficiency of the parallel processor, with an aim of determining statistically significant differences between athletes of different sports orientation.

The results of the discriminant analysis of the cognitive variables showed that the tested athletes are statically significantly different in relation to their preferred sports game.

**Keywords:** Athletes, cognitive abilities, differences

## INTRODUCTION

Cognitive abilities include the abilities that enable reception, processing and the transmission of information, which is achieved through the contact of an individual with its surroundings. With observing the analyzed parameters of the cognitive abilities of handball, volleyball, basketball and football players using the Guttman $\lambda 6$ measure, we noticed that only one latent dimension which marks the entire space of the three cognitive tests was separated. Communalities of the examined variables for assessing the efficiency, of the input processors i.e. the perceptual reasoning IT-1, of the serial processor i.e. symbolic reasoning AL-4, and of the parallel processors i.e. detecting relations and correlates of S-1, are relatively high and can be considered satisfactory in all of the tested athletes. It can be stated that the new scientific findings enrich the technology and the methodology of trainings of top athletes on a daily basis. New methods of training as well as the recoveries from previous training loads in order to endure the new loads easier and to make the effects more optimal, are being invented. On the basis of optimal readiness more modern technical skills and tactical variants in some sports fields, can be built on, especially in team sports such as: handball, basketball, football, volleyball and others. Sports games require large strains to be made by the athletes and besides the strain requirements they also influence the development of characteristics of the constitution, functional motor skills (Bala, 2003). A successful athlete is distinguished by strength, speed, explosiveness, agility and adroitness in all of the situations of the game, as on the ground as well as during the jump; he/she must be precise in passing the ball and shooting at the goal; in the end he/she should have an excellent overview of the game. The subject of this research are athletes of different sport orientation that are divided into four sub-samples (handball, basketball, football and volleyball) ages 16 to 19 years and their cognitive abilities. The research had an aim of determining the differences in the level of cognitive abilities among athletes who prefer different sports games (handball, basketball, football and volleyball). Different types of skills have different stressing of the need for perceptual processes, cognitive decisions and motor control (Holding, 1989). In a large number of researches which are correspondent with this research, a correlation was demonstrated between specific motor skills, primarily coordination, the speed of performing complex motor tasks and balance, and general and perceptual factor of cognitive abilities (Ismail, 1976, 1976a, 1976b, Kurelić, Momirović, Stojanović, M. Sturm, Radojević, Viskić-Štalec, 1975).

# METHODS

## The sample of respondents

This research includes a sample of 200 male respondents, ages 16 to 19 years that are athletes and who prefer different sports games. The sample was divided into four sub-samples in accordance with the type of sport disciplines, namely: handball players - 50, basketball players - 50, football players - 50 and volleyball players - 50.

## The sample of measuring instruments

In this paper, *The Momirovic et al model of cognitive abilities* was used, within which intelligence was operationally defined as the efficiency of the system for processing information in situations when an intelligent reaction is needed and which is implemented using seven functional units of the system for the processing of information, namely:

The receptor system,

The processor for decoding, structuring and searching the input information,

Units for short-term memory,

Units for long-term memory,

The processor for serial (successive) analysis of the information,

The processor for parallel (simultaneous) analysis of the information,

The central processor, which basic function is programming, regulating and controlling the work of other processors and integrating the results of the work of those processors.

KOG-3 battery is designed to measure the level of general cognitive abilities, and it is comprised of the three following tests:

1. IT-1 Test for assessing the efficiency of the perceptual processor,
2. AL-4 Test for assessing the efficiency of the serial processor and
3. S-1 Test for assessing the efficiency of the parallel processor.

## Statistical data processing

For the purposes of this research and in order of determining differences among athletes in different sports disciplines, a modified method of canonical discriminant analysis in Mahalanobis space was applied using the SPSS 17 statistical package.

# RESULTS

The variables for assessing the cognitive abilities were chosen in a way that covered the dimensions that were obtained on the basis of a research carried out on the test sample with similar characteristics. In this case, the measuring instruments that represent the operationalization of the theoretical constructs were fully adapted for application on the examined population. In order to cover the basic cognitive abilities in a representative way, measuring instruments IT-1, AL-4 and S-1 were selected in accordance with the cybernetic model of cognitive information processing (Wolf, Momirović and Džamonja, 1992) and the cybernetic model of conative regulators (Momirović, Wolf and Džamonja, 1992).

**Table 1.** Discriminant analysis of cognitive variables

| Funct. | Type characteristics | % variance | Cumulative | Canon R | Wilks' Lambda | χ2 | df | Sig. |
|---|---|---|---|---|---|---|---|---|
| 1 | .014 | 82.1 | 82.1 | .32 | .08 | 14.31 | 9 | .05 |
| 2 | .003 | 17.8 | 99.8 | .05 | .99 | .59 | 4 | .09 |
| 3 | .000 | .2 | 100.0 | .00 | 1.00 | .00 | 1 | .89 |

**Table 2.** Structure of the cognitive variables

| | FUN 1 |
|---|---|
| IT-1 | .64 |
| AL-4 | -.05 |
| S-1 | .58 |

## DISCUSSION

The results of the discriminant analysis of cognitive variables showed that the tested athletes are statically significantly different in relation to the preferred sports discipline. Analyzing the values in Table 1 it can be concluded that there is a high level of coherence of the results between the four groups of athletes and the registered indicators. Only one discriminant dimension with characteristic roots (.014) and a canonical correlation (.32) was isolated. The aforementioned points out to the significance of the discriminant function and it is the main indicator of the quantitative and qualitative structure. The significance of differences between groups was presented using the Wilks's lambda distribution while the significance of canonical correlation was tested with Bartlett' s X test which amounted to (14.31).

By analyzing the Table 2, we noticed that the first discriminant function separates the athletes on the basis of the IT-1 test which is intended for accessing the perceptual identification and discrimination in the basic subject of measurement. The results obtained in the aforementioned manner support the research presumptions of Rushall 1970, Bushna i Agarwala 1978, Bayios 2007, and others which dealt with the possibility of athletes being differentiated according to their cognitive abilities and personality traits, on the basis of their success in sports and not on the type of sport they are active in.

## CONCLUSION

The research was conducted in order to determine the structure of the anthropological dimensions at athletes who train football, basketball, handball and volleyball and to determine their specificities and differences. 50 football players, 50 basketball players, 50 handball players and 50 volleyball players were tested for the purpose of determining the structure of the dealt anthropological dimension; 200 athletes in total. The factor structure of intellectual abilities was analyzed on the basis of all the information provided by the matrix of significant principal components. On the basis of Momirovic B6 criteria, two latent dimensions which mark the entire space of the three cognitive tests were isolated with about 64.48% of the common variance. The previously mentioned can be accepted as satisfactory for this type of research. Communalities of the variables are relatively high and can be regarded as satisfactory, except for the test S-1 which was used for accessing the efficiency of parallel processors i.e. the ability of perceiving relations and correlations. IT-1, the variable for accessing the perceptual abilities has the strongest correlation with the isolated cognitive dimension.

The results of the discriminant analysis of the cognitive variables showed that the tested athletes are statically significantly different in relation to the preferred sports game.

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# THE EFFECTS OF VIBRATORY TRAINING ON ANTHROPOMETRIC CHARACTERISTICS

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## SUMMARY

The aim of this research was to determine the effects of vibratory training with Flexi-bar over a period of 10 weeks on the changes in anthropometric characteristics. The participants in this study consisted of third year students of Faculty of Sport and Physical Education, University of Niš. The entire sample was distributed into two groups, the experimental and control group. The experimental group (n=15) consisted of participants who took part in a specially programmed training program with Flexi-bar. The measurment of anthropometric characteristics included circular dimensionality of the body and skinfolds. The univariate analysis of covariance (ANCOVA) and multivariate analysis of covariance (MANCOVA) were used to determine the effects of the experimental program. The results of the research indicate that the experimental program partially had an effect on change in anthropometric characteristics, but there are statistically significant changes in only one variable.

**Keywords:** *Flexi-bar*, upper extremities, lower extremities, skinfolds, , circular dimensionality of the body

## INTRODUCTION

The first application of vibrating stimulus in medicine was recorded back in the nineteenth century when Doctor John Harvey Kellogg was using a vibrating chairs and platforms to treat headaches and pain in the lower back. (Calvert, 2002). The experimental work of doctor Biermann in East Germany showed how cyclical vibrations affected condition of joints and if it improved that condition (Biermann, 1960). The first implementation of vibratory muscle stimulus in training athletes was recorded some fifty years ago, but the attention of scientific sport public was drawn to it twenty years ago. The later researches classified this type of training as training for developing muscle strength with combined muscle contractions. (Radovanović & Ignjatović, 2009). This type of training was used in the former Soviet Union to prevent negative impact of antigravity with astronauts, but later they applied it as training system for the Olympic Games athletes. (Golecki et al, 2012).

Human response to vibrating exercises has been linked to increased EMG activity of muscles, with muscle spindle causing increased muscle activation. (Matthew, Stephen, David & Walter, 2005; Issurin & Tenenbaum, 1999). The vibrating training causes functional and structural changes. (Marković & Gregov, 2005). There is additional activation only in the muscles that were previously contracted, so changes can be seen at very specific muscle groups. The whole body or just its parts could be stimulated. The most visible effects are in the parts of the body closest to the source of vibration. (Babajić, Bradić, Pojskić, Kovačević & Abazović, 2013).

A Flexi-bar is an exercising requisite for vibration training that produces a vibration frequency of 4.6 Hz which is transmitted through the grips on the whole body. ( Flexi-Sports, Bislez, Stroud, United Kingdom, 514g weight, 1520 mm length ). Doing exercises with these props stimulates the change of strength parameters (Kassenböhmer, 2005; Živković, Herodek, Bubanj, Živković, & Đošić, 2014), and muscle stimulating is the best during submaximal trainings. The studies have shown that the muscles of the upper extremities have the greatest electromyographic activity (Amin, Mileva, Kadr & Bowtell, 2006), but the activation of abdominal muscles is bigger by doing exercises with additional vibratory stimulus. (Kim, So, Bae & Lee, 2014). This exercise program is a step forward in strengthening the effectiveness of this region of the body (Hurley, 2007).

The aim of this study was to determine the effects of vibrating training with Flexi-bar over a period of ten weeks on the changes in anthropometric characteristics.

# METHODS

## Subjects

The overall sample of participants in this study consisted of the third year students of the Faculty of Sport and Physical Education of the University of Niš. 30 participants took part in this study and they were all males aged 21 ± 6 moths, and were divided into two sub-samples. The experimental group (n=15) was made up of participants who were included in a specially programmed Flexi-bar training. The control group (n=15) was made up of participants who only took part in regular daily physical activities at the Faculty of Sport and Physical Education.

## Procedure

The measuring of anthropometric characteristics included a circular dimensionality and skin folds. The circular dimensionality included: upper arm circumference, lower arm circumference, upper leg circumference, and lower leg circumference. Skin folds measurements covered: upper arm skin fold, lower arm skin fold, upper leg skin folds, lower leg skin fold (using an anthropometer, as according to Martin). The participants voluntarily agreed to participate in the study, which was carried out in accordance with the Helsinki Declaration.

The experimental program lasted for a period of ten weeks. The experimental group participants had trainings twice a week lasting for a period of 60 minutes. The experimental program was designed by the authors of this research who adhered to the recommendations of renowned authors who did research on this topic and manufacturer of Flexi-bar. (Zatsiorsky, Kraemer, 2009; Verkoshansky, 2006; Bompa, 2006; Thibaudeau, 2007). A set of exercises had three exercises for the upper extremities and three exercises for lower extremities. The intensity of the exercise was determined by the weight of the participant.

## Statistical analysis

Repeated Measures ANOVA was used to find differences between initial and final measurements. A univariate analysis of covariance (ANCOVA) was applied to determine effects of experimental program for each group's variables and a multivariate analysis of covariance *MANCOVA for comparing groups in general.* The statistical significance was determined at the p<0,05 level. All of the data were processed using the SPSS 11.0 (SPSS, Chicago, IL) statistical package.

# RESULTS

The descriptive statistical indicators for each group (experimental and control group) participants at the initial and final measuring are shown in table 1. Apart from these results this table shows values of Kolmogorov-Smirnov test which analyzes the normality of distribution.

**Table 1.** Descriptive analysis

| Variable(unit) | Measurement | Experimental group | | | Control group | | |
|---|---|---|---|---|---|---|---|
| | | Mean | SD | P | Mean | SD | P |
| Upper arm skinfold(mm) | Initial | 7,67 | 2,69 | ,454 | 11,09 | 6,73 | ,322 |
| | Final | 8,11 | 2,41 | ,834 | 8,27 | 3,93 | ,758 |
| Lower arm skinfold(mm) | Initial | 5,92 | 3,20 | ,160 | 5,43 | 2,15 | ,362 |
| | Final | 5,75 | 1,00 | ,834 | 5,67 | 2,23 | ,860 |
| Upper leg skinfold(mm) | Initial | 11,41 | 4,02 | ,879 | 12,44 | 8,17 | ,284 |
| | Final | 10,75 | 4,01 | ,997 | 11,31 | 6,14 | ,844 |
| Lower leg skinfold(mm) | Initial | 11,04 | 4,27 | ,903 | 10,97 | 3,64 | ,870 |
| | Final | 11,08 | 2,79 | ,914 | 10,16 | 3,43 | ,696 |
| Upper arm circumference(cm) | Initial | 29,61 | 2,56 | ,987 | 29,75 | 1,83 | ,953 |
| | Final | 30,09 | 2,29 | ,963 | 29,66 | 1,93 | ,948 |
| Lower arm circumference(cm) | Initial | 26,19 | 1,34 | ,992 | 26,46 | 1,21 | ,685 |
| | Final | 26,59 | 1,12 | ,993 | 26,43 | 1,29 | ,980 |
| Upper leg circumference(cm) | Initial | 53,37 | 2,37 | ,851 | 53,52 | 2,58 | ,879 |
| | Final | 55,48 | 2,77 | ,960 | 53,49 | 2,58 | 1,000 |
| Lower leg circumference(cm) | Initial | 36,26 | 2,03 | ,907 | 37,19 | 2,31 | ,788 |
| | Final | 36,43 | 1,55 | ,446 | 38,07 | 4,27 | ,386 |

The results of the Kolmogorov-Smirnov test enable the use of parametric tests for further data processing, while the values of descriptive statistics provide pieces of information about the arithmetic mean and standard deviation.

The intergroup differences between the values of anthropometric characteristics during the initial and final measurements were tested by univariate analysis of variance for repeated measures

(*Repeated Measures ANOVA*). The results of the experimental and control group are shown in table 2.

**Table2.** The results of univariate analysis of variance for repeated measures

| Variable (unit) | Experimental group | | Control gropu | |
|---|---|---|---|---|
| | Wilks' Lambda | Sig. | Wilks' Lambda | Sig. |
| Upper arm skinfold (mm) | 0,96 | ,449 | 0,84 | ,128 |
| Lower arm skinfold (mm) | 1,00 | ,802 | 0,93 | ,320 |
| Upper leg skinfold (mm) | 0,90 | ,242 | 0,92 | ,277 |
| Lower leg skinfold (mm) | 1,00 | ,951 | 0,79 | ,072 |
| Upper arm circumference (cm) | 0,85 | ,143 | 0,99 | ,658 |
| Lower arm circumference (cm) | 0,77 | ,058 | 1,00 | ,830 |
| Upper leg circumference (cm) | 0,40 | **,000** | 1,00 | ,914 |
| Lower leg circumference (cm) | 0,95 | ,398 | 0,90 | ,227 |

Based on the statistical significance, it can be determined that a difference between the initial and final measuring can be determined among the participants of the experimental group in terms upper leg circumference variable skinfolds (sig=0,000). If the descriptive statistics is observed it can be concluded that the value of this variable is increased. The obtained results indicate that there are no statistically significant differences in other variables among participants of experimental and control groups.

The effects of the experimental program on values of anthropometric characteristics were examined by the multivariate analysis of covariance (*MANCOVA*). The results are shown in table 3.

**Table3.** The results of the multivariate analysis of covariance

| Variable | F | Hypothesis df | Error df | Sig. |
|---|---|---|---|---|
| **Experimental program** | ,486 | 1,719[a] | 8,000 | 13,000 |

The obtained results of the multivariate analysis of covariance (*MANCOVA*) that was used to examine effects of experimental program on anthropometric characteristics among participants of experimental group ($n$=15) and control group($n$=15) indicate that there are no statistically significant effects (13,00) on changing the observed variables among the experimental and control groups.

The experimental program had no statistically significant effects on the changes in the studied variables if groups are generally compared.

The effects of the experimental program on the individual values of anthropometric characteristics were studied using the univariate analysis of covariance (ANCOVA). The results are shown in table 4.

**Table 4.** The results of the univariate analysis of covariance

| Variable (unit) | F | Sig. |
|---|---|---|
| Upper arm skinfold (mm) | 0,24 | ,625 |
| Lower arm skinfold (mm) | 0,09 | ,768 |
| Upper leg skinfold (mm) | 0,03 | ,861 |
| Lower leg skinfold (mm) | 2,06 | ,163 |
| Upper arm circumference (cm) | 2,39 | ,134 |
| Lower arm circumference (cm) | 3,00 | ,095 |
| Upper leg circumference (cm) | 14,99 | **,001** |
| Lower leg circumference (cm) | 0,52 | ,476 |

The results of the univariate analysis of covariance (*ANCOVA*) for testing experimental program on values of anthropometric characteristics among experimental ($n$=15) and control group ($n$=15) participants are shown in the table. The only statistically significant change was seen in the upper leg circumference variable (sig=0,001). The special vibrating training had a statistically significant effect on one of the studied values of anthropometric characteristics.

## DISCUSSION

The results of the multivariate analysis of covariance (*MANCOVA*) indicate that experimental program had no statistically significant effects on studied values of anthropometric characteristics (table 3), if variables are generally observed. The univariate analysis of covariance (ANCOVA) was used to examine the effects of experimental program on individual anthropometric characteristics values. The obtained results of the univariate analysis of covariance (ANCOVA) indicated that the experimental program had statistically significant effect only on one studied variable, upper leg circumference. (table4). Similar results got Roelants, Delecluse, Goris & Verschueren (2004) who examined the effects of vibrating training during a period of 24 weeks. There were no statistically significant changes in the thickness of skin folds after the experiment was over. Milanese, Piscitelli, Zenti, Moghetti, Sandri, & Zancanaro (2013) examined effects of short vibrating training on anthropometry and body structure and they concluded that vibrating training makes obese women's body structure better.

The results of this study suggest that vibrating training has no expected effects, except on the upper leg circumference. Based on the previous researches, the obtained results can be justified by the strength of the frequency because the most effective muscle activation is caused by the frequency range of 30-50 Hz, and smaller amplitudes may be insufficient to cause muscle reaction. The effects also depend on the method of applying vibration and if practitioners are professional athletes or amateurs. (Luo, McNamara & Moran, 2005).

## CONCLUSION

The significance of this study is seen in the examination of the effects of vibration training on anthropometric characteristics change. The obtained results indicate that the usage of this experimental treatment affects circular dimensionality change (upper leg volume) and gives useful information about neuro-muscular system reply when it is exposed to vibratory stimulation. The effects of vibration training are studied numerous times, but there are still not many papers that deal with Flexi-bar as a requisite within the vibration training. All of that gives an opportunity for future researches. The practical contribution of this research is to provide guidance in improving vibration training especially in the sphere of anthropometric characteristics changes.

## ACKNOWLEDGMENT

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# EFFECT OF 8 WEEK PLYOMETRIC TRAINING ON CONTRACTILE PARAMETERS IN FIVE SKELETAL MUSCLES

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## SUMMARY

The aim of the present study was to examine whether an improvement in jumping performance following 8 weeks of plyometric training (PT) runs in parallel with changes in lower-limb skeletal muscle contractile properties. Using non-invasive tensiomyography (TMG), we assessed contraction time (Tc) and the maximal amplitude of radial displacement (Dm) in 20 subjects (50% males; age 22.4±4.7 years of age, randomly divided in PT group (N=10; PLYO) and a control group (N=10; CTRL). PLYO group performed 8 weeks of PT. TMG was measured in five leg skeletal muscles: vastus lateralis (VL), biceps femoris (BF), tibialis anterior (TA), gastrocnemius medialis (GM) and lateralis (GL). Additionally, we evaluated countermovement jump (CMJ) height improvement on a ground force plate. Assessments were repeated before and after PT. After 8-weeks of PT, CMJ height increased by 12.2% in PLYO (p=.015), but not in CRTL. Tc, which is related to myosin heavy chain type I (MHC-1) proportion, decreased in VL (-8.7%; p<.001), BF (-26.7%; p=.032), TA (-32.9%; p=.004), GL (-25.8%; p=.044), but not significantly in GM (-8.1%; p=.158). The estimated VL MHC-1 proportion decreased by -8.2% (p=.041). Dm, inversely related to muscle tone, decreased in BF (-26.5%; p=.032), GM (-14.9%; p=.017), GL (-31.5%; p=.017), but not significantly in TA (-16.8%; p=.113) and VL (-6.0%; p=.654). Following PT, jumping performance increased, that was paralleled by decreased Tc and increased muscle tone (decreased Dm). Additionally, contractile properties adaptations were muscle specific that is important for future studies. It seems that adjustments were dose dependent, being higher in muscles with lower habitual load.

**Keywords:** tensiomyography; contractile properties; muscle-tendon stiffness; jumping

## INTRODUCTION

Although systematic plyometric training (PT) training is universally accepted among athletes as a method to improve jumping performance (Blazevich et al., 2003; Marković, et al., 2007; Pellegrino et al., 2016), only a limited number of investigations have examined the alterations in single muscle fiber composition and kinetics following PT (Malisoux et al 2006; Pellegrino et al., 2016). For example, Malisoux et al. (2006) showed that PT enhances the adaptation of cross-bridge kinetics that translates into changes of whole muscle function, including an increase in jumping performance by 12%. Alternatively, recent randomized controlled trial of Pellegrino et al. (2016) demonstrated that 6-weeks of PT training did not change jumping performance or myosin-heavy-chain (MHC) isoform proportion. The aforementioned studies have demonstrated that the adaptation of cross-bridge kinetics at single fiber level originate exclusively from biopsy findings on vastus lateralis (VL) muscle following 6-8 weeks of PT, while physiological pathways responsible for adaptation in the whole lower limb muscles have still not been documented in the literature. Invasiveness of procedures and non-selectiveness of non-invasive procedures used to determine single muscle contractile properties were recently overcome by the development of tensiomyography (TMG), which may provide additional insight into the contractile capacity of skeletal muscle. However, the applicability of TMG to follow the adaptation of contractile properties to systematic athletic training in more than one muscle to remains unknown. Thus, the aim of the present study is to examine whether an improvement in jumping performance following 8 weeks of PT runs in parallel with changes in skeletal muscle contractile properties. We hypothesized that 8 weeks PT would decrease in contraction time (Tc) and maximal amplitude of radial displacement (Dm); however, both adjustments were hypothesized as being larger in non-postural than postural leg muscles.

# METHODS

## Subjects

In a randomized controlled trial, 20 subjects (50% males; average age 22.4 ± 4.7 years; ranged from 20-40 years old, body mass index 24.4 ± 2.2 kg/m2) were randomly recruited from students of Applied kinesiology study programme. After providing informed consent, subjects were randomly assigned to an experimental group (N=10; PLYO) and a control group (N=10, CTRL). Subjects did not have any history of musculoskeletal injuries according to their medical chart, and were not taking medication during the study.

## Procedure

PT was applied only in PLYO for eight weeks and in three weekly sessions, as proposed by Markovič et al. (2007). Each session consisted of a 15-minute structured warm-up (jogging, dynamic stretching, warm-up jumps) and 20-30 minutes of jumping exercises. In order to increase the accuracy of the results of the study, all individuals participated in a one week familiarization period before the study began. The CTRL was instructed to maintain regular activities and to avoid any additional systematic, vigorous athletic training or high-intensity power training throughout the duration of the study, so the only difference between PLYO and CTRL was in PT. All tests were assessed a week before and a week after the 8-week PT period.

**TMG assessment**

TMG was used to assess skeletal muscle contractile properties in VL, biceps femoris (BF), gastrocnemius medialis (GM), gastrocnemius lateralis (GL), and tibialis anterior (TA). All measurements were performed isometrically in relaxed pre-defined positions: for VL, in a supine position with the knee angle set at 30 deg. flexion (where 0 deg represents the extended joint); for BF, in a prone position with the knee angle set at 5 deg. flexion; for TA and both the gastrocnemius muscle, in a supine and prone position respectively, with the ankle in neutral position as previously reported in the literature (Pišot et al., 2008; Šimunič et al., 2011; Tous-Fajardo et al., 2010).

**Vertical Jump tests**

Countermovement jumping (CMJ) performance was evaluated following the TMG assessment. After a supervised 15 minute warm-up protocol involving a 5-minute step test, five minutes of whole-body dynamic stretching and five minutes of jumping drills CMJ performance was assessed using force plate (HE600X600, AMTI, Watertown, MA, USA). Subjects performed 2-3 warm-up CMJs, followed by three maximal CMJs, where the CMJ with the highest jump was taken for further analysis. A jumping height was calculated from force impulse.

## Statistical analysis

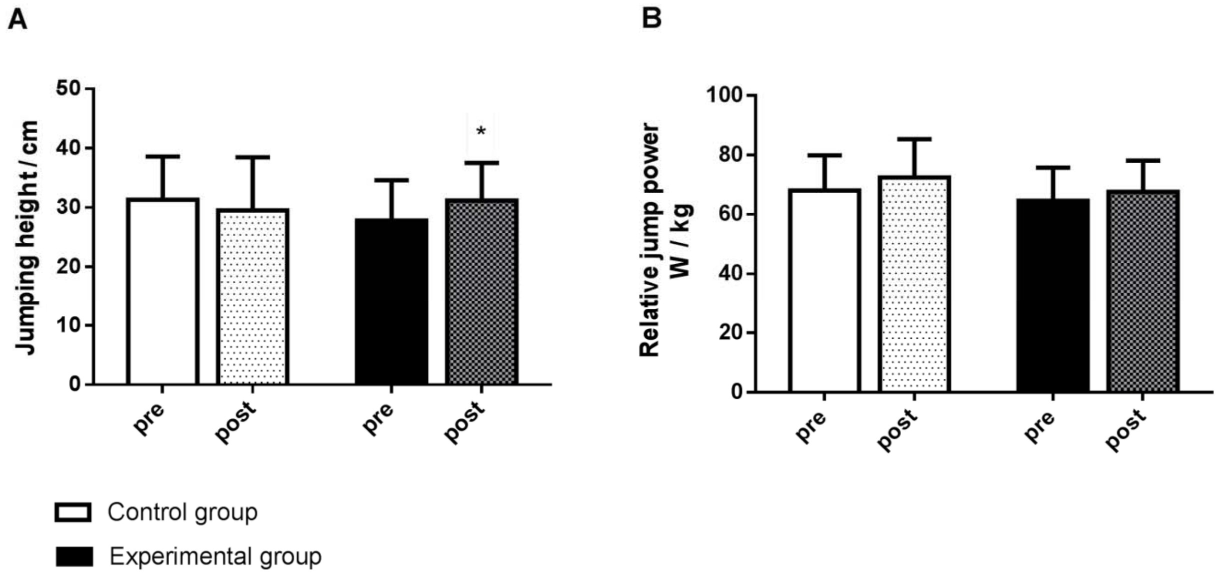
All data are presented with mean ± standard deviation. Normality was confirmed using the Shapiro-Wilk test. The main effects were analyzed using a mixed general linear model (GLM), taking into account the groups (CTRL, PLYO) and time (baseline and final assessment) as within and between factors, respectively. After determining the interaction effect, secondary analysis was used to determine the time effect in both groups. Statistical significance was accepted at p-values <.05 for the main effects and p-values <.10 for the interaction effect.

# RESULTS

All subjects successfully completed all study procedures. A significant interaction (time x group) effect was found for CMJ height ($p = .018$; $\eta 2 = .275$), where an increase was only significant in PLYO group for 12.2% ($p = .015$; $\eta 2 = .498$; Figure 1). Although CMJ height improved, the relative CMJ power did not ($p = .716$). Main time and interaction effects (time x group) were significant in Tc for all observed muscles (except in GL), whereas in the PLYO group, Tc decreased as follows (Figure 2): in VL by -8.7% (time effect: $p<.001$; $\eta 2 = .790$; time x group effect: $p=.013$; $\eta 2 = .299$), in BF by -26.7% (time effect: $p=.032$; $\eta 2 = .418$; time x group effect: $p=.052$; $\eta 2 = .194$), in TA by -32.9% (time effect: $p=.004$; $\eta 2 = .621$; time x group effect: $p=.076$; $\eta 2 = .164$), and in GL by -25.8% (time effect: $p=.044$; $\eta 2 = .321$; time x group effect: $P=.069$; $\eta 2 = .172$). In GM, non-significant Tc decreased by -8.1% (time effect: $p=.158$; time x group effect: $P=.179$). Main time and interaction effects (time x group) were significant in Dm for most observed muscles (except in GL), whereas in the PLYO group, Dm decreased as follows (Figure 3): in BF by -26.5% (time effect: $p=.032$; $\eta 2 = .418$; time x group effect: $p=.015$; $\eta 2 = .286$), in GM by -14.9% (time effect: $p=.017$; $\eta 2 = .485$; time x group effect: $p=.016$; $\eta 2 = .283$), and in GL by -31.5% (time effect: $p=.017$; $\eta 2 = .484$; time x group effect: $p=.086$; $\eta 2 = .155$). On the other hand, recorded decreases were not significant in VL and TA: for VL, there was a decrease of -6.0% (time effect: $p=.654$; time x group effect: $P=.209$), and in TA of -16.8% (time effect: $p=.113$; time x group effect: $p=.853$). Following an estimation of MHC-1 proportion

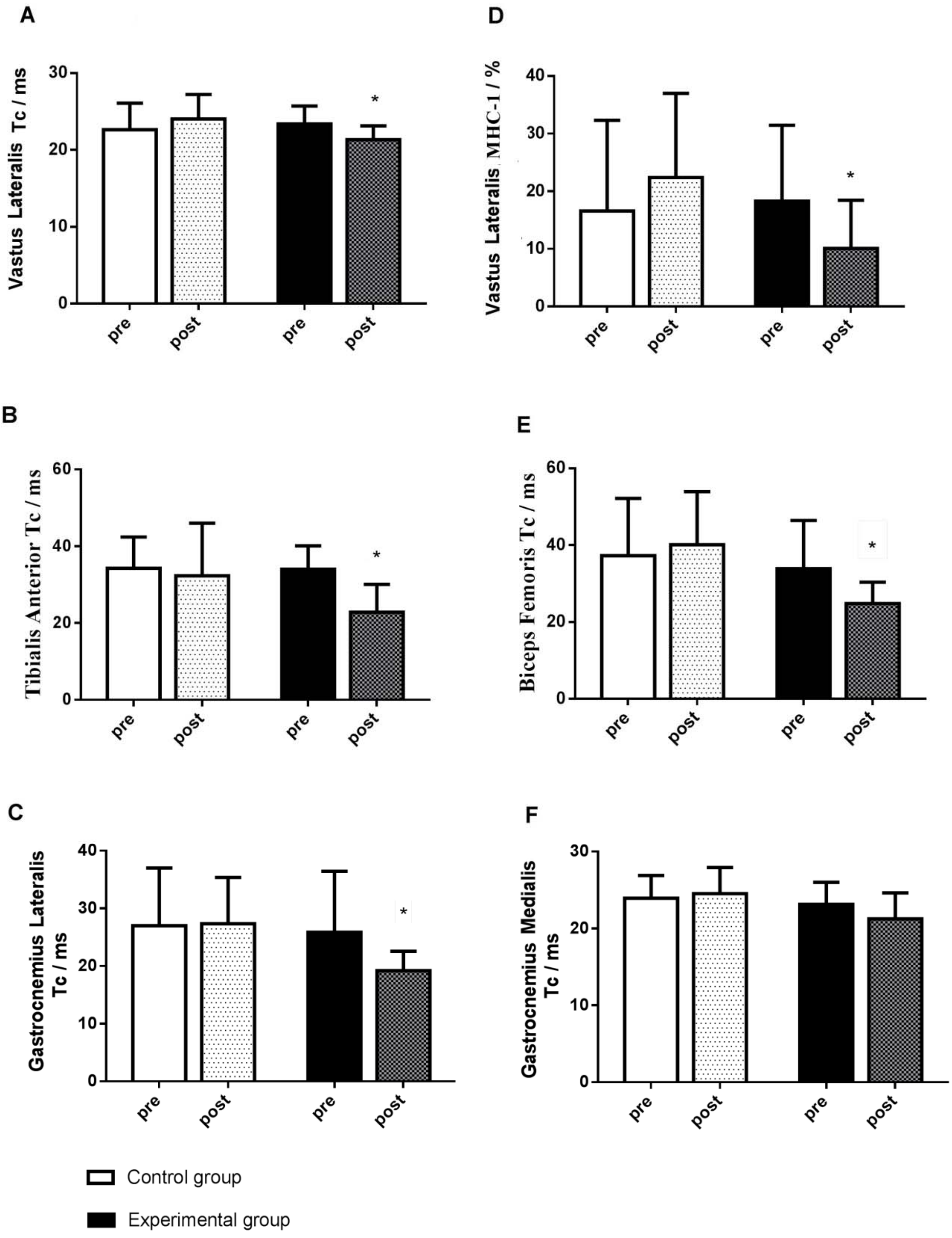
(Equation 1) for VL, a significant time and interaction effect (time x group) was found, where in the PLYO group, MHC-1 proportion decreased by -8.2% (time effect: $p = .041$; $\eta 2 = .387$; time x group effect: $p = .028$; $\eta 2 = .242$).

**Figure 1**. Baseline and final relative jumping power and height for both groups



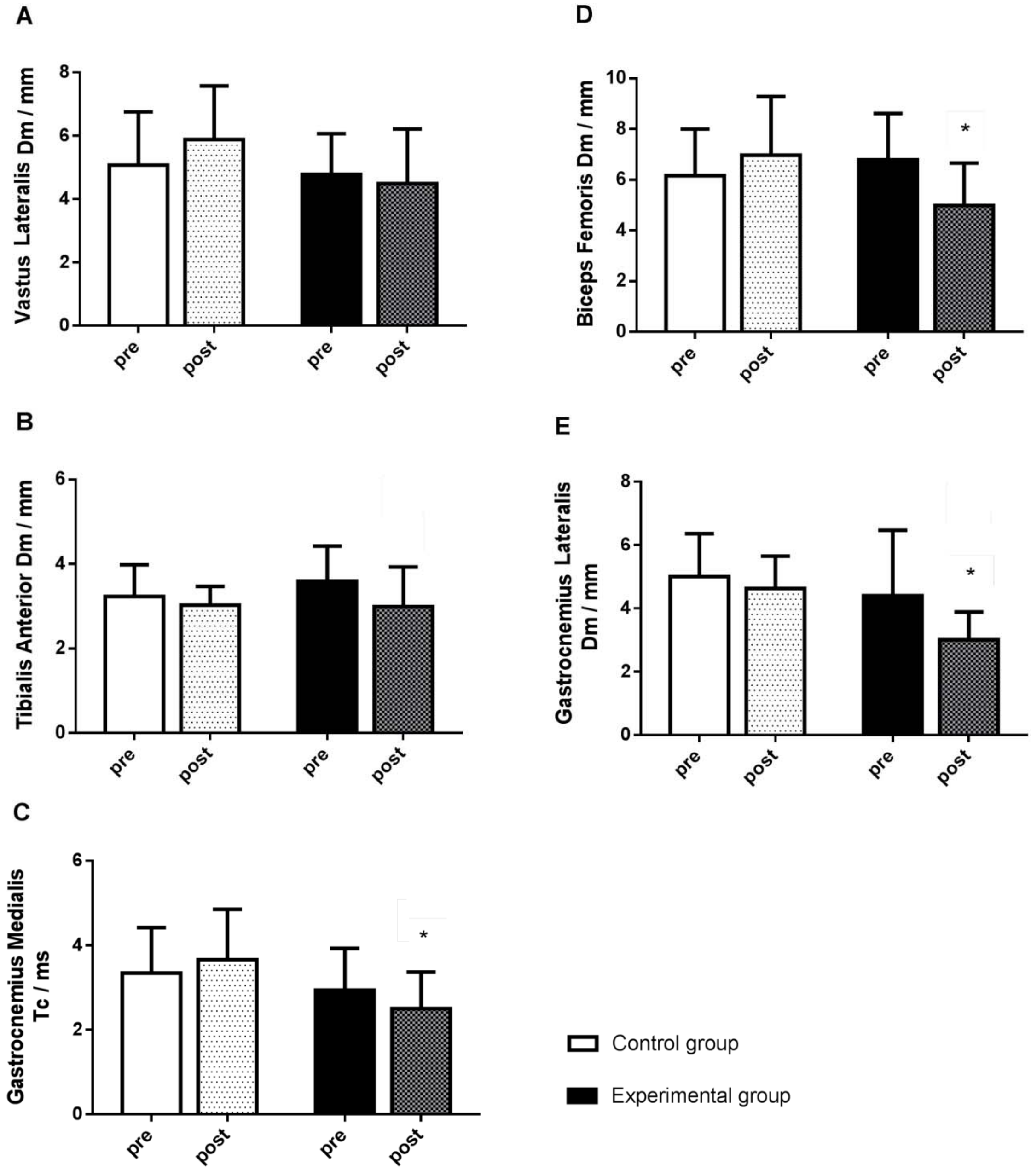

**different from CTRL at p<0.05*

**Figure 2.** Baseline and final contraction time (Tc) and vastus lateralis myosin heavy chain-1 proportion (MHC-1) for both groups




*different from CTRL at p<0.05

**Figure 3.** Baseline and final maximal amplitude of radial belly displacement (Dm) for both groups.




*different from CTRL at p<0.05

## DISCUSSION

V This study results were previously published in larger study report (Zubac and Šimunič, in press). For the purpose of this report, only limited data are presented. Using the 8-week PT protocol, as proposed by Marković et al. (2007), this study instrumented improvement in CMJ height by 12.2% in PLYO, but not in CRTL groups. The increase in jumping height for the PLYO group matched previous research results reported in the literature (Malisoux et al., 2006), as also documented in meta-analytic review that reported an increase of 8.7% with moderate-to-large effect size (0.88) in CMJ height after 4–24 weeks of PT (Marković, 2007).

Namely, Tc values extracted from TMG decreased in all five lower-limbs skeletal muscles observed in

PLYO group, and were translated into ~12 % CMJ height increase. The multiple linear regression model of estimating MHC-1 proportion from three contractile parameters (Td, Tc, and Tr), as proposed by Šimunič et al. (2011), indicates that in the VL muscle, the MHC-1 proportion decreased in the PLYO group by -8.2%, but not in the CTRL group. Importantly, we noted more dramatic decreases in Tc: for BF, -26.7%; TA, -32.9%; and GL, -25.9%, indicating even a higher type II/type I proportion change.

In this study, Dm decreased in the PLYO group in all muscles; however, significant in BF, GL, and GM muscles: -26.5%, -31.5%, and 31.8%, respectively, and non-significant in VL (-6.0%) and TA (-16.8%). Presumably, alterations in muscle stiffness could be modulated via changes in the visco-elastic properties of intramuscular and tendon connective tissue (Pišot et al. 2008). This new architecture might impact Dm either way, depending on the new initial sarcomere length, due to an increase in the fascicle length and/or more direct muscle fibre thickening and oscillation transfer in the transversal plane (to the TMG sensor) of muscle contraction. However, results obtained in the present study relate to previous findings, where generalization was only possible regarding the VL muscle. On the other hand, we contributed significantly to existing knowledge concerning other muscles.

# CONCLUSION

The study is the first to evaluate longitudinal adaptations of skeletal muscles in causal sport training research design using simple, non-invasive and selective TMG. Our findings confirm muscle specific adaptations following 8 weeks of PT that was paralleled by increase in jumping performance. Specifically, contraction time, previously related to myosin heavy chain I proportion, decreases more in non-postural (TA: -32.9%, and BF: -26.7%) than in postural (VL: -8.7%, and GL: -25.9%) and more in distal than in proximal muscles. Furthermore, Tensiomyographic amplitude, previously negatively related to muscle tone, decreases more in muscles with lower habitual load (e.g., BF, TA and GL).

# ACKNOWLEDGEMENTS

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# VERTICAL JUMP PERFORMANCE AND POWER ASSESSEMENT OF GREEK JUNIOR NATIONAL LEVEL JUDO ATHLETES

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## SUMMARY

Muscular strength and power are essential parameters for judo performance. Vertical jumping tests are commonly used to evaluate lower limb strength and power, but biased results occure in the literature about vertical jump performance and power output when judokas are examined. The aim of the present study was to assess vertical jump performance and the power output of junior judo athletes when a countermovement and/or an arm swing is enabled to the jumping technique. Twelve male junior national level judo athletes (age = 17.3 ± 1.9 yrs; height = 1.70 ± 0.11 m; mass = 69.7 ± 18.2 kg) volunteered to participate in the present study. Vertical jumps from a stationary squatting starting position (SQJ), with a countermovement (CMJ), with a countermovement and an arm swing (CMJf) and after dropping from 40 cm (DJ40) were executed on an AMTI force plate. Repeated measures ANOVA revealed that vertical jump performance was significantly ($p < .05$) increased in CMJ and CMJf compared to SQJ and DJ40. However, no differences ($p > .05$) were revealed concerning power output normalized to body mass. Average jump height gain due to the countermovement was 20.5%, while the respective gain due to the neuromuscular coordination imposed by the arm swing was 14.1%. It was concluded that the tested biomechanical parameters across the vertical jump tests in the examined judo athletes were not in agreement with the trend reported in the literature, especially in the case of the combined use of an countermovement and an arm swing.

**Keywords:** martial arts, biomechanical analysis, force parameters, fitness training

## INTRODUCTION

Besides mastering the needed skills and to implement optimally the desired tactics, an advanced level of physical fitness and physical condition is required for judo athletes in order to achieve success in competitions (Franchini, Del Vecchio, Matsushigue, & Artioli, 2011). Thus, it is of interest for researchers to investigate various strength and/or neuromuscular power variables included in test batteries in order to examine athletic performance and the effectiveness of training (Boguszewska, Boguszewski, & Buśko, 2010; Drid et al., 2015; Drid, Trivić, & Tabakov, 2012; Fukuda et al., 2013; Lachlan, Haff, Kelly, & Beckman, 2016; Papacosta, Gleeson, & Nassis, 2013; Sertić, Segedi, & Milanović, 2006).

The ability to perform complex motor tasks of a speed-explosive type was found to be an important factor for judo performance (Sertić, Sterkowicz, & Vuleta, 2009). Thus, plyometric exercises that potentiate the stretch-shortening cycle (SSC) are recommended to be included in judokas' training programs, aiming for increasing performance in judo matches through strength and power development (Lahart & Robertson, 2010). The SSC is evident in the vertical countermovement jump (CMJ), resulting in a greater jumping height compared to the squat jump (SQJ) which is executed from a stationary squatting starting position (Bobbert & Casius, 2005). CMJ height is further increased when an arm swing (CMJf) is used (Richter, Rapple, Kurz, & Schwameder, 2012). The SSC is also potentiated with the execution of a drop jump (Komi & Nicol, 2011). The SQJ is believed to evaluate the concentric muscular function, whereas the difference concerning jump height between SQJ and CMJ reflects the gain earned by SSC and the respective difference between CMJ and CMJf represents the neuromuscular coordination (NMC) of lower and upper limbs (Bosco, 1992).

Based on that above, vertical jumping tests have been widely used as a mean to assess performance and lower limb muscle power of judo athletes and to provide information about their physical condition (Franchini et al., 2011; Torres-Luque, Hernández-García, Escobar-Molina, Garatachea, & Nikolaidis, 2016). For example, previous research revealed that during a tournament or training with consecutive judo contests, athletes exhibited a decrease of muscle power of the lower limb muscles as estimated by the CMJ performance (Detanico, Dal Pupo, Franchini, & dos Santos, 2015; Serrano-Huete et al., 2016). Research also revealed that experienced judokas perform better in the CMJ than novice (Zaggelidis & Lazaridis, 2013). However, despite differences concerning the CMJ height, power output was found not to differ between adolescent and young adult or senior judokas (Buśko, 2015; Monteiro, Massuça, García, Carratala & Proença, 2011). Additionally, CMJ parameters were not found to be deferent between elite and international level judo athletes (Monteiro, Massuça, García-García, & Calvo-Rico, 2014). This leads to the conclusion that vertical jumping performance in judokas and the associated neuromuscular power variables constitute an issue requiring additional research, with additional concern for analyzing developing athletes.

The aim of the study was to evaluate the vertical jump performance and the power output of junior judo athletes when a countermovement and an arm swing are enabled in the jumping technique, using as criteria the SQJ. In detail, it examined the use of SSC and the effectiveness of the arm-swing and it was hypothesized that the examined parameters across the vertical jump tests will be identical to the trend described in the literature.

# METHODS

## Subjects

Twelve male junior national level judo athletes (age = 17.3 ± 1.9 yrs; height = 1.70 ± 0.11 m; mass = 69.7 ± 18.2 kg [range: 45.3 – 102.1]; mean ± standard deviation, respectively) volunteered to participate in the present study. Inclusion in the study required a recent participation to an official national level judo tournament and the absence of a recent injury. Informed consent was obtained from the athletes in order to participate in the study, which was conducted according to the 2000 revision of the Declaration of Helsinki for the use of human subjects and was approved by the Institutional Research Committee Board.

## Procedure

The vertical jump tests were executed in a randomized order with a minimum 60-second interval in order to avoid fatigue following a typical warm-up that included 10 min cycling on an 817E Monark Exercise Cycle (Exercise AB, Vansbro, Sweden) and 10 min non-static stretching exercises. The instruction was to "*jump as high and as fast as possible*".

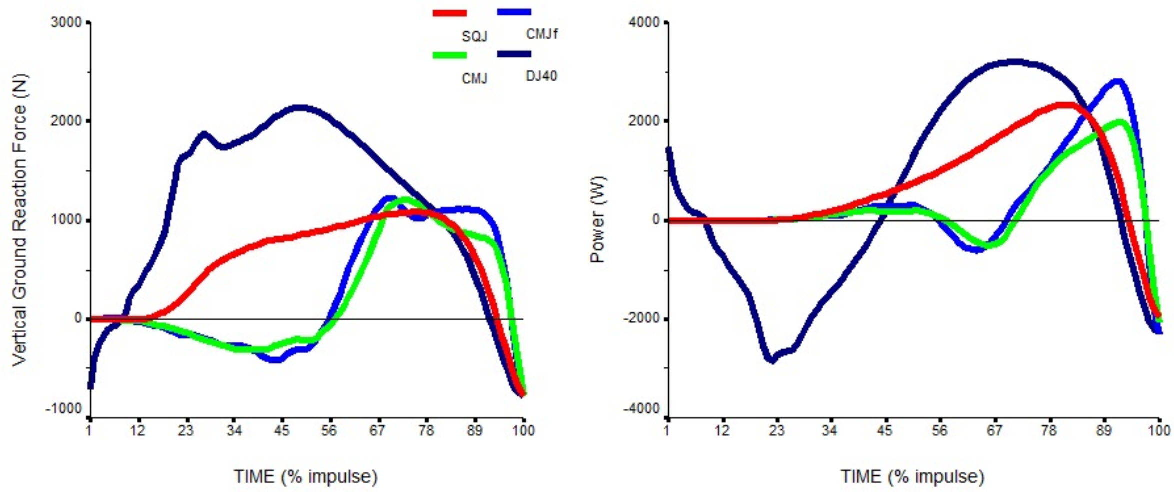


**Figure 1.** Representational time-history curves of the vertical GRF (left) and power output (right) for the vertical jump tests.

At the starting position for the execution of the SQJ, the arms were placed on the hips, the feet were in full contact with the force-plate and the knee joint was in an approximate 90° angle. The avoidance of a countermovement was check as described by Panoutsakopoulos, Papachatzis and Kollias (2014). When performing the CMJ, participants were requested to keep their arms on the hips throughout the jump, flight and landing. As for the CMJf, the arms were initially hanging freely at the side of the body and then swung backwards and forwards during the propulsion phase. As for the execution of the drop jump from 40 cm (DJ 40), participants were instructed in: to fall instead of jump off the raised platform and to keep the arms at the trunk during execution. The raised platform was adjusted in order for the landings to occur at the center of the force plate. No limitations were set concerning the magnitude of the knee flexion during the countermovement.

All jumping tests were executed barefooted on an AMTI mod. OR6-5-1 force plate (AMTI, Newton, MA) connected on line with a Pentium II PC in which recordings were stored after being converted to digital using a PC-LabCard PCL-812PG (Advantech Co, Taiwan) 12 bit analogue-to-digital converter. Data acquisition was set to a nominal sampling frequency of 1000 Hz (Figure 1). The signal was digitally smoothed using a 2nd order low-pass Butterworth filter, with cut-off frequency set at 8 Hz. Each participant executed three attempts in each testing condition, but only the best jump (creteria: jump height) was selected for further analysis. The jump height (Hjump) was calculated as the outcome of the BCM vertical take-off velocity that was computed after the integration of the vertical component of the recorded ground reaction forces (GRF). The maximum rate of force development (RFD) was extracted as the peak value of the first time derivative of the recorded vertical GRF. Peak body power output (P) was the peak value of the multiplication product of the vertical GRF by the vertical BCM velocity during the propulsive phase. BCM displacement (Sdown) from the initial starting position to the instant of the lowest BCM position (i.e. the downward phase of the propulsion) and from there up (Sup) until the take-off (i.e. the upward phase of the propulsion) was extracted through integration of the vertical BCM velocity. Temporal parameters such as the total duration of the impulse (T) and the time to achieve maximum GRF (TF) were also examined. The SSC gain in vertical jump performance was calculated as [(CMJ-SJ) × 100]/CMJ, while NMC was calculated as [(CMJf-CMJ) × 100]/CMJf.

## Statistical analysis

A repeated measures ANOVA with Bonferroni adjustments was run in order to test the hypothesis of the study using the SPSS 10.0.1 software (SPSS Inc., Chicago, Il.). The level of statistical significance was set at a = .05.

# RESULTS

Hjump was significantly increased when a countermovement and a combined countermovement and arm swing was used compared to the SQJ (Table 1). It is also noted that the duration of executing the above mentioned jumps was significantly larger.

**Table 1.** Mean ± standard deviation of the kinetic parameters of the vertical jump tests (n = 12).

| PARAMETER | SQJ | | | CMJ | | | CMJf | | | DJ40 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hjump (m) | 0.220 | ± | 0.041 | 0.260 | ± | $0.042^{a}$ | 0.290 | ± | $0.039^{a}$ | 0.201 | ± | $0.051^{b,c}$ |
| T (ms) | 467.3 | ± | 69.2 | 677.0 | ± | $152.2^{a}$ | 641.0 | ± | $87.5^{a}$ | 537.7 | ± | $116.0^{c}$ |
| F (N/kg) | 2.21 | ± | 0.15 | 2.72 | ± | $0.40^{a}$ | 2.47 | ± | 0.34 | 2.96 | ± | $0.53^{a}$ |
| TF (ms) | 296.4 | ± | 106.9 | 317.1 | ± | 163.1 | 375.2 | ± | 94.9 | 196.3 | ± | $89.9^{a,c}$ |
| RFD (kN/s) | 9.3 | ± | 4.2 | 11.8 | ± | 4.5 | 9.3 | ± | 3.3 | 43.2 | ± | $22.4^{a,b,c}$ |
| P (W/kg) | 23.0 | ± | 3.9 | 21.4 | ± | 5.1 | 27.6 | ± | 5.9 | 28.3 | ± | 4.1 |
| Sdown (m) | | | | -0.386 | ± | 0.098 | -0.334 | ± | 0.082 | -0.455 | ± | $0.124^{c}$ |
| Sup (m) | 0.437 | ± | 0.067 | 0.567 | ± | $0.095^{a}$ | 0.575 | ± | $0.073^{a}$ | 0.437 | ± | $0.101^{b,c}$ |

$^{a}$: p < .05 compared to SQJ; $^{b}$: p < .05 compared to CMJ; $^{c}$: p < .05 compared to CMJf

However, relative force output was significantly increased but not when an arm swing was involved. In the case of parameters expressing explosive strength properties, TF and RFD were significantly favorable in DJ40. The power output normalized to body mass was not significantly different across the testing conditions. The effects of the SSC and the arm swing on jumping performance using as reference the Hjump recorded for the SQJ are presented in

Figure 2. SSC gain was 20.5 ± 22.3 %, whereas NMC was 14.1 ± 13.7%.

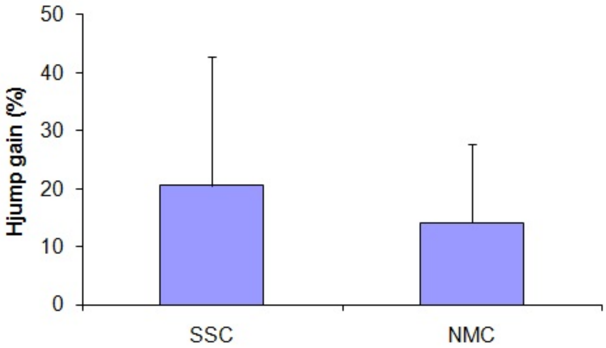


**Figure 2.** Gains in Hjump due to the countermovement (SSC) and the arm swing (NMC).

# DISCUSSION

The results of the present study revealed that junior Greek national level judo athletes increased their Hjump when a countermovement and a combined countermovement and arm swing was used compared to the SQJ (Table 1). Additionally, TF and RFD values revealed that explosive strength properties are evident in DJ40. However, power output was not differentiated in the examined vertical jump tests.

The greater Hjump of the CMJ compared to SQJ has been attributed to the SSC, which increase the lower limb muscle's active state (Bobbert & Casius, 2005). A similar co-activation of the thigh muscles during the execution of vertical jumps and selected judo techniques has been reported for experience judokas (Zaggelidis & Lazaridis, 2013). This could explain the observed trend for enhancing strength parameters at the CMJ compared to the SQJ. The gain due to SSC extracted in the present study was almost double than reported in the past (Chaouachi et al., 2009; Zaggelidis, Lazaridis, Malkogiorgos, & Mavrovouniotis, 2012).

In the case the increased Hjump at the CMJf, research suggested that the arm swing is associated to larger force application, power production and work output compared to CMJ (Cheng, Wang, Chen, Wu, & Chiu, 2008). However, this was not observed in the present study. Power output, although larger in CMJf and DJ40, was not significantly different across the vertical jump tests, as no differences concerning normalized power output between SQJ and CMJ were found for judokas in the past (Chaouachi et al., 2009). This is not in agreement with previous research examining power production at vertical jumps (Kollias, Panoutsakopoulos, & Papaiakovou, 2004). This finding could provide explanation why NMC was inferior compared to SSC gain. Furthermore, it has been suggested that the optimisation of coordination between the eccentric and concentric phases of muscle action is not the primary determinant of performance of Judo athletes (Monteiro et al., 2011). Based on this, the large variability of SSC and NMC can be interpreted.

Research findings on vertical jumping performance of judo athletes highlight some additional factors that might set limitations when interpreting the results of the present study. Firstly, vertical jump parameters were found to be different through pre-competition training (Buśko & Nowak, 2008; Fukuda et al., 2013). Thus, the period of testing seems to be a factor influencing vertical jumping parameters. Secondly, experience in the sport was found to influence the parameters associated with jumping performance (Zaggelidis & Lazaridis, 2013). Thirdly, elite junior judo athletes were found to modify SQJ and CMJ performance after an intervention for weight loss (Koral & Dosseville, 2009). This should also be taken into consideration when judo athletes are examined. Finally, increased body mass was found to be negatively correlated to body mass (Detanico, Budal Arins, Dal Pupo, & Dos Santos, 2012). In the present study, participants were competing in various weight categories. More accurate results might be extracted when examining judokas from the same weight category. In general, vertical jumping performance was in reasonable agreement to previous finding concerning Greek judo athletes (Zaggelidis et al., 2012). Nevertheless, future research should address the above issues.

# CONCLUSION

It was concluded that the tested biomechanical parameters across the vertical jump tests in the examined judo athletes were not in agreement with the trend reported in the literature, especially in the case of the use of an arm swing. Nevertheless, it is believed that the findings of this study will increase knowledge and understanding of vertical jump performance and power output and thus to inform future coaching practice for judo athletes.

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# THE DIFFERENCES IN THE DEFORMITIES OF THE SPINAL COLUMN BETWEEN JUDOISTS AND NON-ATHLETES AT THEIR PRIMARY SCHOOL AGE

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## SUMMARY

The goal of this research was to determine the differences in the deformities of the spinal column between boy judoists and the ones who do not practise sports at their primary school age. The total number of examinees consisted of 42 boys, aged 7 and 8, which was divided into two subsamples. The first was made of judoists (N=26) PJSC "Kinezis" from Niš, and the second was made of students (N=21) of PS "Vožd Karađorđe" from Niš. In order to measure the curve and determine the deformity of the spinal column, the instrument called "spinal mouse" was used to estimate 5 variables:kyphosis, lordosis, kypho-lordosis, scoliosis, and flat back. Data processing was done using the statistics programe SPSS 20. The $X^2$ test for independent samples and result frequency was used to analyze the data. The results of the research showed that a large number of children included in the research had some of the deformities (at least one) in connection with the spinal column (kyphosis, lordosis and flat back) (78,7%), and a small number of children with a proper body posture (21,3%). Based on the $X^2$ test it was determined that there are no statisticly significant differences between judoists and non-athletes in any of the variables. In the conclusion, it is stated that an adjusted programe of physical education, paired with a well planned training of a sports collective and better education of parents, whose role is very significant, should provide much more positive results in forming a proper postural position in children.

**Keywords:** Deformities, young judoists, pupil

## INTRODUCTION

Man's period of evolution from semi-straight position all the way to completely standing up lasted for thousands of years. This process represented a hard and constant battle of the organism against the enormous gravitational torque (Živković, 2009). Man's adjusting to the upright position, however, still has not finished, and that is confirmed by the obvious tendencies towards bad posture. The difficulties occur when the internal forces (especially muscular) can not get in balance with the outside forces in every situation, especially the force of gravity, and as a result there is body instability, disorders and falls. Such a negative tendency can be removed, or significantly lowered by preserving muscular strength (Hodžić, Gerdijan, Mikić and Katanić, 2010). As an active part of the moving aparatus, the muscles have the biggest role in forming and maintaining a proper posture. Too great or onesided presure on the muscles, as well as weekness of the above mentioned can lead to creation of various body deformities (Sabo, 2006). Hodžić and his coworkers (2010) noticed that even though the problem of postural disorder in school children had been obvious for a long time, the level of professional relationship towards the above mentioned had not improved enough to influence postural disorders and the overall growth and development more addequatly.

Physical innactivity leads to atrophy and a reduced muscular tone, which results in forming postular disorders. They start to appear on the spinal column due to bad posture, sitting, innactivity, but as a result there is often deformity of feet in way of a lowered arch. Primary changes in the spinal column are usually shown in muscles first, and it is considered an easier functional state, after that on the ligaments and bone system, which is considered structural or statical, or fixed deformity (Babjak, 1984; Živković, 2009). Those changes can be observed through a sagital plane – kyphosis and lordosis, and a frontal plane – scoliosis.

Kyphotic bad posture or kyphosis is a postural disorder located on the active and passive elements of the spinal column. Basic characteristic of kyphotic bad posture is seen in a specified curve in the chest thoracic part, where the convexity of the curve is turned towards the back (Milenković, 2007).

Lordosis is a curve of the spinal column where the convexity is turned towards the front. These curves are present in the neck and side area (Živković, 2009).

Kypho-lordosis is a body deformity where, looking from a sagital plane, it came to the appearance of a curve outside physiological boundaries in the thoracal and lumbal area (Živković, 2009).

Scoliosis, or scoliotic bad posture, represents a lateral deviation of the spinal column which is seen in the frontal plane. Depending on the number of vertebras that are affected, it is divided into – partial and total scoliosis. Total scoliosis is a deformity which has affected the full length of a spinal column. It can be to left or right, and if only one side is afffected then it is called total left (right) scoliosis (Milenković, 2007).

Flat back represents a lack of physiological curves in the spinal column. It is not considered to be a real deformity and therefore the correction of the above mentioned is the easiest (Živković, 2009).

If there are no deformities, it points out to a proper postural postural position and by that it means that there is a habbit of an unforced upright position, posture while walking, sitting and doing other activities. With a proper posture, the body profile forms a natural physiological curve of the spinal column with a moderate neck lordosis, chest kyphosis and side lordosis. Head position is with a look forward, shoulders slightly pulled back, thorax is slightly forward, arms straight by the sides, stomach pulled in, knees straight, and the pelvis is set at a 60º angle (Bajrić, Lolić, Perić and Kovačević, 2012). This position can be seen less and less among younger population. Each year the number of children with a deformity increases (Sabo, 2008; Slavni, Kovačević and Žikić, 2005). The main cause of that is hypokinesis which intensifies from the moment we start to walk untill we start school (Simov, Minić and Stojanović, 2011), which helps the start of postural disorders that most frequently start in the period of primary and secondary school. It is at that very period that due to lessened physical activity caused by the urban way of life and practice of inadequate excercise at physical education classes, muscular insufficiency and weakening of the spinal column muscles start, which causes bad posture and postural disorders (Bogdanović, 2008). That is why it is of the outmost importance to start with the exercise which mobilise the whole locomotor system (Živković, 2009), because if we do not register bad posture in time, in time structural or statical deformites could develop, which are harder to correct with specific exercise (Milošević, Obradović, 2008).

Each pedagogue should be able to recognize improper posture in a child so that it can timely be reacted to in an adequate way. Postural deformities localized on the spinal column at preschool and primary school age are corrected using specific exerise, proper sitting and proper posture while walking and working, doing physical activities such as swimming, gymnastics, athletics and other sports. With a correct choice of exercise and a constant practice with younger children, we can prevent, remove functional deformity, but also soften the postural disorder (Beganović and Bešković, 2012).

The goal of this research was to determine the differences between the deformities of the spinal column between boy judoists and non-athletic boys at a primary school age.

# METHODS

Total sample of examinees in this study was made of 42 boys, aged 7 and 8, which was divided into two subsamples. The first was made of judoists (N=26) PJSC "Kinezis" from Niš, and the second was made of students (N=21) of PS "Vožd Karađorđe" from Niš. The examinees of PJSC "Kinezis" were in their treining process for at least 6 months, unlike the students of PS "Vožd Karađorđe" who were not members of a sports collective. All of the examinees, their parents, teachers and trainers were familiar with the goal of the research, after which the parents gave written permision for their children to be the part of the research.

In order to measure the curve and determine eventual deformites of the spinal column, an instrument called "spinal mouse" was used to evaluate 5 variables: kyphosis, lordosis, scoliosis and flat back. Data processing was done using the statistics programe SPSS 20. The $X^2$ test for independent samples and result frequency was used to analyze the data.

# RESULTS

**Table 1 –** Result frequency of examinee's postural status

| Type of bad posture | Sport status | Bad posture | Good posture |
|---|---|---|---|
| **Kyphosis** | Judoists | 2 (7,7%) | 24 (92,3%) |
| | Non-athletes | 3 (14,3%) | 18 (85,7%) |
| | **Total** | **5 (10,6%)** | **42 (89,4%)** |
| **Lordosis** | Judoists | / | 26 (100%) |
| | Non-athletes | / | 21 (100%) |
| | **Total** | / | **47 (100%)** |
| **Scoliosis** | Judoists | 10 (38,5%) | 16 (61,5%) |
| | Non-athletes | 8 (38,1%) | 13 (61,9%) |
| | **Total** | **18 (38,3%)** | **29 (61,7%)** |
| **Kypho-lordosis** | Judoists | / | 26 (100%) |
| | Non-athletes | / | 21 (100%) |
| | **Total** | / | **47 (100%)** |
| **Flat back** | Judoists | 13 (50,0%) | 13 (50,0%) |
| | Non-athletes | 13 (61,9%) | 8 (38,1%) |
| | **Total** | **26 (55,3%)** | **21 (44,7%)** |
| **Total (at least one disorder)** | Judoists | 20 (76,9%) | 6 (23,1%) |
| | Non-athletes | 17 (81,0%) | 4 (19,0%) |
| | **Total** | **37 (78,7%)** | **10 (21,3%)** |

**Table 2 –** Ratio between sports activity / inactivity and bad posture (at least one disorder)

| Sports status | Bad posture (at least one disorder) | | Continuity Correction | | |
|---|---|---|---|---|---|
| | Лоше држање тела | Нормално држање тела | $X^2$ | p | fi |
| Judoists | 20 (76,9%) | 6 (23,1%) | 0,000 | 1,000 | 0,049 |
| Non-athletes | 17 (81,0%) | 4 (19,0%) | | | |
| Total | 37 (78,7%) | 10 (21,3%) | | | |

Results of Table 1 show that lordotic bad posture, as well as kypho-lordosis, is not found in the examinees who took part in our research. Therefore, in further research, those variables were not processed.

Result of the $X^2$ independence test in Table 2 (with the continuity correction according to Yates (Pallant, 2011)) did not show a significant connection between sports activity / inactivity and bad posture (at least one disorder) $X^2$ (n=47)=0,000; p=1,000; fi=0,049. That means that the percentage of children with bad posture (at least one disorder), and train judo (76,9%) does not differ significantly from the percentage of children with bad posture and do not do sports (81%).

**Table 3 –** Ratio between sports activity / inactivity and kyphotic bad posture

| Sports status | Kyphosis | | Continuity Correction | | |
|---|---|---|---|---|---|
| | With kyphotic bad posture | No kyphotic bad posture | $X^2$ | p | fi |
| Judoists | 2 (7,7%) | 24 (92,3%) | 0,0 64 | 0,8 00 | ,10 6 |
| Non-athletes | 3 (14,3%) | 18 (85,7%) | | | |
| Total | 5 (10,6%) | 42 (89,4%) | | | |

**Table 4 –** Ratio between sports activity / inactivity and scoliotic bad posture

| Sports status | Scoliosis | | Continuity Correction | | |
|---|---|---|---|---|---|
| | With scoliotic bad posture | No scoliotic bad posture | $X^2$ | p | fi |
| Judoists | 10 (38,5%) | 16 (61,5%) | 0,0 00 | 1,0 00 | 0,0 04 |
| Non-athletes | 8 (38,1%) | 13 (61,9%) | | | |
| Total | 18 (38,3%) | 29 (61,7%) | | | |

Result of the $X^2$ independence test in Table 3 (with the continuity correction according to Yates (Pallant, 2011)) did not show a significant connection between sports activity / inactivity and kyphotic bad posture (at least one disorder) $X^2$ (n=47)=0,064; p=0,800; fi=0,106. That means that the percentage of children with kyphotic bad posture, and train judo (7,7%) does not statistically differ significantly from the percentage of children with kyphotic bad posture and do not do sports (14,3%).

Result of the $X^2$ independence test in Table 4 (with the continuity correction according to Yates (Pallant, 2011)) did not show a significant connection between sports activity / inactivity and scoliotic bad posture $X^2$ (n=47)=0,000; p=1,000; fi=0,004. That means that the percentage of children with scoliotic bad posture, and train judo (38,5%) does not statistically differ significantly from the percentage of children with scoliotic bad posture and do not do sports (38,1%).

**Table 5** – Ratio between sports activity / inactivity and bad posture – flat back

| Sports status | Flat back | | Continuity Correction | | |
|---|---|---|---|---|---|
| | With flat back | No flat back | $X^2$ | p | fi |
| Judoists | 13 (50,0%) | 13 (50,0%) | 0,272 | 0,602 | 0,119 |
| Non-athletes | 13 (61,9%) | 8 (38,1%) | | | |
| Total | 26 (55,3%) | 21 (44,7%) | | | |

Result of the $X^2$ independence test in Table 5 (with the continuity correction according to Yates (Pallant, 2011)) did not show a significant connection between sports activity / inactivity and scoliotic bad posture – flat back $X^2$ (n=47)=0,272; p=0,602; fi=0,119. That means that the percentage of children with bad posture – flat back, that train judo (50%) does not statistically differ significantly from the percentage of children with bad posture – flat back and do not do sports (61,9%).

## DISCUSSION

Study results have shown that a large number of children involved in our research have some of deformities (at least one) related to spinal column (kyphosis, lordosis and flat back) (78.7%), and a small number have a proper body posture (21.3%). Romanov, Stupar, Medjedović and Brkin (2014) came to similar results in their research called ''Postural status of pre-school children at the territory of Novi Sad.'' Results showed that 70% of the total number of the examined (423 boys and girls) have a bad posture. The most frequent of all the deformities is lordosis (approximately 40% of both sexes), and the least frequent one kyphotic bad posture (7.51% with boys and 6.19% with girls). However, in difference to this study, in our work the most frequent postural disorder is flat back (55.3%), then scoliosis (38.3%) and finally kyphosis (10.6%). An interesting piece of information is that lordotic bad posture was not recorded in any of the examinees in contrast to the research of Romanov and associates (2014), in which that problem was the most frequent.

In case of a kyphotic bad posture, statistically significant difference between the subsamples of judoists and non-athletes was not recorded, but somewhat better results were shown by the judoists with which a 7.7% kyphosis was visible, while in the case of non-athletes it was present with 14.3%. Significantly larger sample of the examinees (810 boys and girls) was in the study of Djoković, Medjedović and Smiljanić (2011) where similar results were obtained in comparison to our research. They had studied the quality of physical education teaching on postural status and nutritional status in an elementary school, and kyphotic bad posture with boys (N=406) was measured with 14.1% in the third grade i.e. 14.9% in the sixth grade. They had also concluded that lordotic bad posture had been present in the least, and that the most serious problem they quoted was scoliosis which was recorded with 29.7% of the third grade students, while with the sixth grade students it was a bit lower, 24.9% to be precise, which indicated a tendency of this deformity reduction during children's growth and development and while practising physical education. In our study, scoliotic bad posture was recorded with 39.1% of the judoists and 39.5% with the first grade students of elementary school. These data, but the results of other researches (Djoković, Medjedovićand Smiljanić, 2011; Milenković, Stojanović, 2005) indicate the presence of a high percentage of this spinal column deformity with pre-school and junior school male population. In the research of Milenković and Stojanović (2005) it was concluded that practising sports at the junior school age did not influence the recovery and prevention of a scoliotic bad posture. Out of the total number of the elementary school third grade examinees even 585 had scoliosis, 54% of the fourth grade students, while the largest number of children with scoliotic bad posture was observed with the fifth grade students (68%). We have to emphasise that a period of practising sports was not specified. A lot of attention should be paid to a training structure in any sport. When talking about the so called asymmetrical sports, there are contradictory opinions among researchers who dealt with influence of such activities on the posture. Sabo (2006) concluded that one–sided muscle loading may bring about deformities, while Cottini and Di Salvo (20039 indicate that practising such sports (for example tennis) does not make scoliosis progress (Cottini & Di Salvo, 2003 according to Stošić, 2009).

One of the rare researches (Dačević and Jovović, 2013) which dealt with a similar topic of comparing judoists' and non-athletes' postural status in the adolescence period, did not give expected results. Actually, statistically significant differences between these two groups were not recorded, which is the case with our research too. However, the sample of examinees in our study was much younger, therefore we cannot compare them in total for that reason. It can be assumed that such results are the consequence of an insufficient judoists' training process. It is undisputable that at the junior school age it is desirable to practise as many versatile physical activities as possible (Djurašković, 2002) which have a positive effect on a child's proper development, but a longer time period is probably needed for correcting bad posture, which can be a consequence of endogenic factors too, which represents a more difficult form and greater efforts in their corrrection, but egsogenic as well, which are far easier to correct and recover (Demeši-Drljan and Milkov), 2012).

## CONCLUSION

Summing up all the results, we see that the biggest problem is flat back, which is the easiest deformity on a spinal column that is, as we have already pointed out, the fastest and the easiest to correct. A concerning data is that, in our and in above mentioned studies, there is a great prevalence of scoliotic bad posture with children. Kyphosis is present in a much smaller extent, while lordotic bad posture was not observed in the whole of the examinee sample, nor kypho-lordotic bad posture. Statistically significant differences were not recorded between the judoists group and the non-athletes group in any variable which indicated the spinal column deformity or a bad posture. A discouraging piece of information is that only 21.3%, which makes almost a fifth of examinees, has a proper posture, while in case of others there is at least one noticeable spinal column deformity.

We have to mention that the sample of judoists in this study , represents the non-competitive part of PJSC "Kinezis" and they are also a part of "judo school", where as a priority we highlight the development of basic motoric abilities and strengthening of a child's musculature to prevent deformities and remove them as well as build a proper posture, and at a smaller scale we work on teaching the very basic judo techniques, so the expected results are not also satisfying. However, the gained values point towards the fact that in order to remove a spinal column deformity,a longer period of continuous practice, made of correct and optimally practiced exercises is needed, as well as a larger number, scale and maybe the intensity of training on a weekly level. Of course, it is not enough only to direct full attention only to certain sports collective, it is also necessary and very important to correct the teaching plan and programe of physical education in pre-school and primary school institutions. Gojković (2009) concluded that one year's programe of physical education did not have a significant influence on the students' posture, which shows physical education classes are inadequately based.

Out of everything mentioned, the overall conclusion is that corrected programe of physical education, together with a well planned training of a certain sports collective and better education of parents, whose role is very important, should give much more positive results in forming a proper postural position in children.

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# DIFFERENCE IN PHYSICAL FITNESS OF JUDOKA AFTER PREPARATION PERIOD

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## SUMMARY

Background: Judo is Olympic sport with high physical and technical/tactical demands. assesment of training outcomes is necessery if competition success is expected. Objective: The purpose of this study was to evaluate the state of sport specific physical fitness of judokas before and after six week preparation period. Methods: the research was realized on a sample of of 15 members of the University judo and sambo club Kinezis from Niš, who compete in Serbian National league (the highest rank of the national competition). The examines were competitors with minimum 5 years of judo training, average age 22.4±4.5 years. The physical fitness was assessed by using the Special judo fitness test (SJFT). Results: There was an improvement in the SJFT results (from 13.49 to 13.08) but student t-test for dependent samples didn't show that they are statistically (p=0.062). Conclusion: Authors recommend the training program used in the study. In addition, they recommend Special judo fitness test for assessment of judokas current condition of physical fitness.

**Keywords:** special judo fitness test, judo training.

## INTRODUCTION

Judo ih high-intensity combat sport which is characterized with efforts of ~30s and pauses of ~10s during the regular 5min fight period (Miarka et al., 2012). In sport fight aim is to throw your opponent on the back with force and speed or to utilize some of the control techniques during the ground fight (Bala & Drid, 2010). Judokas use all three metabolisms: anaerobic alactic system in powerful actions during the application of the technique in tachi waza (standing fight), anaerobic lactic system for high-intensity actions that lasts longer (e.g., grip fighting or ground fighting) and aerobic system for the recovery processes between high-intensity actions and matches (Franchini, Artioli, & Brito, 2013).

Training prescription must consider these demands in order to prepare athlete for the competition. It is important to emphasize that lower-body is responsible for short-term high-intensity actions (during technique executions), while upper-body muscle groups are activated in strength-endurance and power actions (Franchini, Artioli, & Brito, 2013). With these in mind coach should approach to creating of successful training periodization. Basic model of periodization is consisted of three periods: a Preparation period, a Competition period and a Transition period. Each training phase contains physical, technical, tactical and psychological preparations. In high level of proficiency it is important to produce an effective interaction among these preparations (Blumenstein, Lidor, & Tenenbaum, 2005).

Usually, the most important competition of the year is scheduled in the final part of the competition period. In Judo, experience has led to the use of a so-called "double periodization" with to cycles of preparation-competition period followed by one transition period (Gil'ad, 1999). In that case the first preparation period is longer compared to second. It comes after transition period and demands more time in order to prepare the competitor for the upcoming season.

Variety of field and laboratory test are being used in order to gain insight into athletes physical condition which surely is of great importance for achieving good results in the competition. In our opinion, the best way is to conduct the tests that include some sport specific movements in the procedure. Most widely used and evaluated test in judo is Special judo fitness test (Sterkowicz, 1995). This test correlate with aerobic and anaerobic metabolism (Detanico, Dal Pupo, Franchini, dos Santos, 2012; Sterkowicz, Zuchowicz, Kubica, 1999). Also, it can divide elite form non-elite judokas (Franchini, Takito, Kiss, & Strerkowicz, 2005), and it is recommended for optimal control of the training process in judo (Boguzewska, Boguzewski, Busko, 2010, Sterkowicz-Przybycien, & Fukuda, 2014; Stamenković, Milošević, Cvetković, 2015).

Aim of the research was to evaluate the state of sport specific physical fitness of judokas before and after six week preparation period. For that purpose differences in the conducted Special judo fitness test (SJFT) will be established.

# METHODS

## Sample

The sample was consisted of 15 male members of the University judo and sambo club Kinezis from Niš, who compete in Serbian National league (the highest rank of the national competition). The examines were informed in advance about test protocol and they agreed voluntary to participate. The examines were cadet, junior and senior competitors, aged 16-29 years (mean 22.4±4.5), without injures in the moment of testing. All competitors had minimum 5 years of judo training, and had brown (1. kyu) or black belt (1. dan or above). Weight of the competitors was in range from 61kg up to 94kg (mean 74.7±10.1kg). 24 hours before begging of testing competitors were free of training and didn't have injures which can affect of the results of testing.

## Special judo fitness test

For the purpose of the test one fighting area is required (tatami). Beside the judoka which is performing the test, two more judokas from the same weight category and approximately same height are participating in the test. They stand in line with 6 meters between them. In the middle is the respondent, and to its both sides, at a distance of 3 meters, are two other judokas (Figure 1).

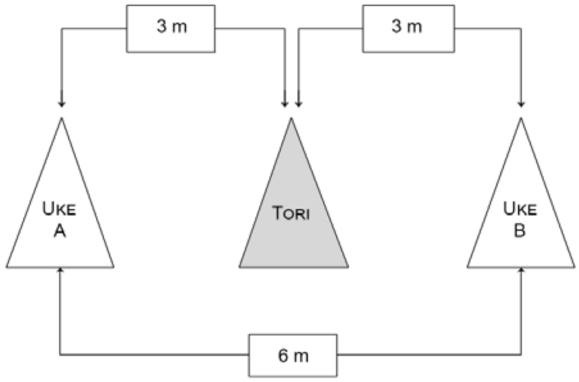


**Figure 1.** Positions in Special judo fitness test

At the command "hajime" the person being tested starts at throwing Ipon Seoi Nage (Figure 2), at maximum speed, both athletes, one at a time, who are standing at the ends with the overall distance of 6 meters. The test is carried out in three series. The first lasts 15 seconds, while the second and third last 30 seconds. Between two seires there is a break of 10 seconds. The respondent is all the time wearing a heart rate monitor to measure the heart rate. It is measured immediately after the performed test and also after a minute break.

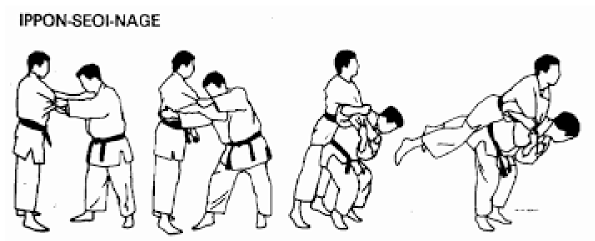


**Figure 2.** Ippon seoi nage

The result of SJFT is presented by index of SJFT. To calculate the index, the following formula is used:

**Index = HR after the test + HR 1min after the test/N**

where N represents the total number of performed throws.

Franchini, del Vecchio, & Sterkowicz (2009) have made the classificatory norms for male competitors which include the total number of throws, heart rate and index of SJFT (Table 1). The lower result of the SJFT index means that judoka is in better state of physical fitness.

**Table 1.** Special judo fitness test classificatory table

| Classification | Variable | | | |
|---|---|---|---|---|
| | Total number of throws | HR after the test | HR 1min after the test | Index |
| Excellent | ≥29 | ≤173 | ≤143 | ≤11,73 |
| Good | 27-28 | 144-161 | 144-161 | 11,74-13,03 |
| Average | 26 | 162-165 | 162-165 | 13,04-13,94 |
| Bad | 25 | 166-174 | 166-174 | 13,95-14,84 |
| Very bad | ≤24 | ≥175 | ≥175 | ≥14,84 |
| **HR – heart rate** | | | | |

## Procedure

Both measures (initial and final) were taken at the same time. Prior to test the 15 minutes warm up was conducted. It included running at medium pace, elementary exercises and uchi komi. The measurement was conducted by experts from the area of sport sciences.

## Preparation training program

Training program lasted for six week. The variety of physical, technical, tactical means was used. Judokas had 10 training sessions per week. In first three week (table 2) the focus was on running, resistance and technical training. In second part of the preparation period (table 3) focus was on running, endurance, technical and tactical training. It includes three training sessions with randori (judo fight simulation)

**Table 2.** Training schedule (week 1, 2 and 3)

| Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday |
|---|---|---|---|---|---|---|
| Running Resistance training for upper extremities | Resistance training for lower extremities, and shoulder region | Running Resistance training for upper extremities | Training for agility and cooorditnation | Resistance training for lower extremities, and shoulder region | Running Swimming Sauna | Rest |
| Technical training (leg techniques) | Technical training (ne waza techniques) | Technical training (seoi techniques) | Rest | Technical & tactical training (ne waza randori) | Rest | |

**Table 3.** Training schedule (week 4,5 and 6)

| Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday |
|---|---|---|---|---|---|---|
| Running Endurance training for upper extremities | Running Endurance training for lower extremities, and shoulder region | Running Endurance training for upper extremities | Training for agility and cooorditnation | Running Endurance training for lower extremities, and shoulder region | Running Swimming Sauna | Rest |
| Technical training (practicing technique in different kind of movement strategy) | Technical training (ne waza randori) | Technical & tactical training (tachi waza randori) | Rest | Technical & tactical training (tachi waza randori with transition to ne waza) | Rest | |

## Data Analysis

Statistical analysis was carried out using statistical software package SPSS version 21.0 (IBM SPSS 21.0). Descriptive statistics of mean and standard deviation were used to examine the data. Student t-test for dependent sample was used to compare the results from initial and final test of SJFT. P-value < 0.05 was considered to be statistically significant.

## RESULTS

The research was realized on a sample of 15 highly selected judo athletes average age 22,4±4,5 years. In Table 4 are shown the characteristics of the sample (the values of the arithmetic means, standard deviations, minimum and maximum).

**Table 4.** Descriptive Statistics

Descriptive Statistics

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Weight | 15 | 61.00 | 94.00 | 74.7733 | 10.12969 |
| Age | 15 | 16.00 | 29.00 | 22.4000 | 4.45293 |
| Valid N (listwise) | 15 | | | | |

In Figure 3 the frequencies of the results of the SJFT on the start of the preparation period are shown. Judoka with the best results had an index of 11.38, while the poorest result was 16.82 (mean 13.49±1.52). According to classification of Franchini, del Vecchio, & Sterkowicz (2009) two judokas had excellent condition of physical fitness and five judokas had the results which is estimated as good. Satisfying result had two members of UJSK Kinezis (average score). Four judokas came in bad condition, while very bad physical fitness condition had two competitors. After successfully completing the preparatory training period, another SJFT was conducted in orther to check the differneces. Frequencies of these results are shown in Figure 4. Mean result was 13.08±1.29. On the second SJFT two judokas remain in the excellent state of physical fitness, good results had six judokas, an average one, bad five, and very bad one judoka of UJSK Kinezis.

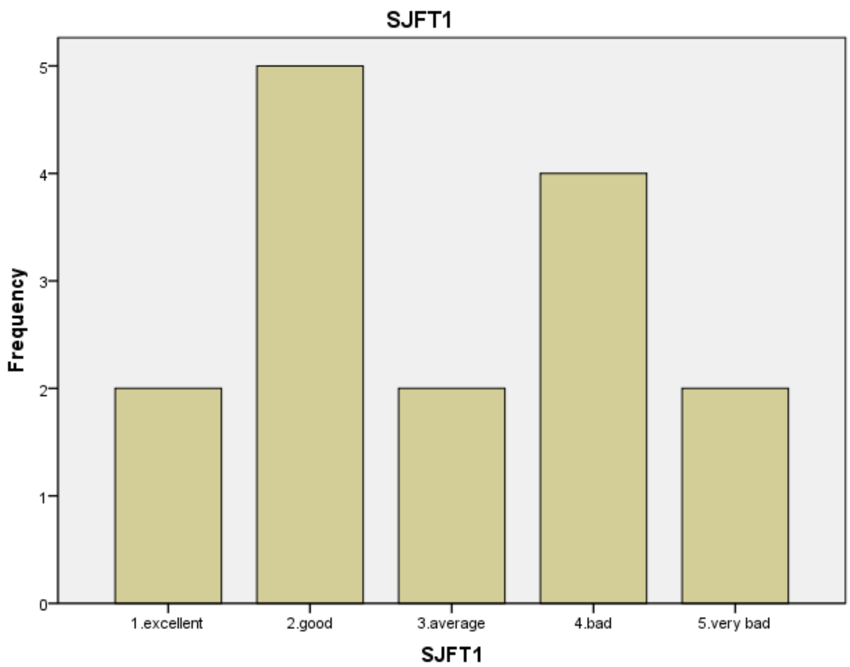


**Figure 3**. Frequencies of SJFT result on initial test

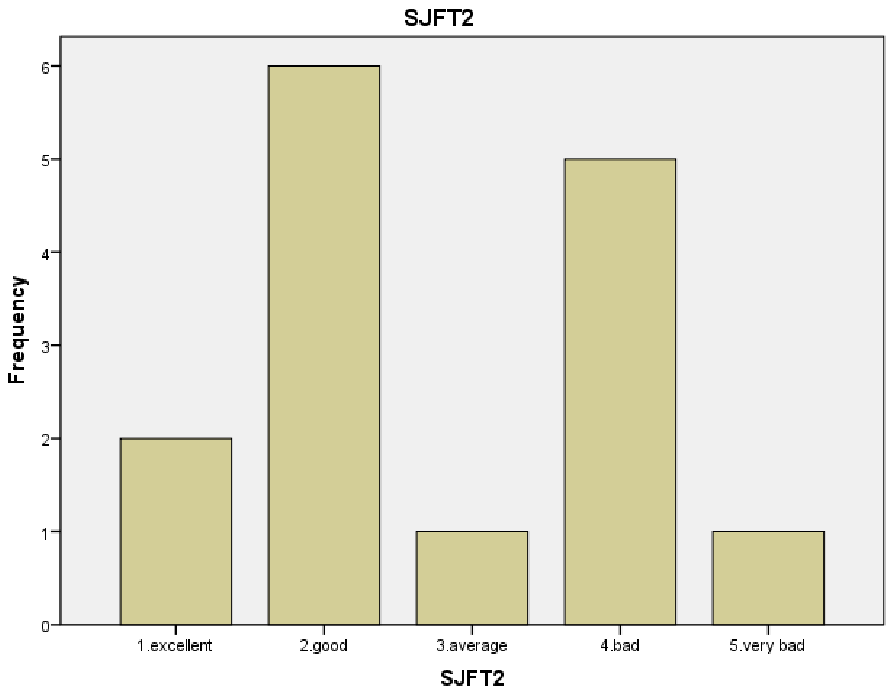


**Figure 4.** Frequencies of SJFT result on final test

Results of student t-test for dependent samples are shown in tables 5,6, and 7. As we can see from table 7 there are no statistically significant differences between the results of initial and final test (p=0.062).

**Table 5. Paired Samples Statistics**

| | | Mean | N | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Pair 1 | Initial | 13.4933 | 15 | 1.52334 | .39332 |
| | Final | 13.0753 | 15 | 1.29390 | .33408 |

**Table 6.** Paired Samples Correlations

| | N | Correlation | Sig. |
|---|---|---|---|
| Pair 1 Initial & Final | 15 | .852 | .000 |

**Table 7.** Paired Samples Test

| | Paired Differences | | | | | t | df | Sig. (2-tailed) |
|---|---|---|---|---|---|---|---|---|
| | | | | 95% Confidence Interval of the Difference | | | | |
| | Mean | Std. Deviation | Std. Error Mean | Lower | Upper | | | |
| Pair 1 Initial - Final | .41800 | .79837 | .20614 | -.02412 | .86012 | 2.028 | 14 | .062 |

## DISCUSSION

The aim of this research was to determine the difference in result of SJFT before and after preparation training program. The results of SJFT at the initial measure indicate the condition of the Club competitors after the transition period. The lowest result was 16.82 which is classified as very bad, and the best was 11:38 which is a excellent result. The average value of the result was 13:49±1:52. These results are expected because, although the result is homogeneous, there is variation within the sample results. At the beginning of preparation period judo players come after a transitional period which is characterized by low number of trainings with no high loads in general. Also, in this period the strict control of the player's activity is not possible. In addition, the test included players from different weight category, age and competitive success. Overall, nearly half of examines had scores rated as excellent or good. Compared with top Brazilian judokas who achieved an average score of 12.53±11.1 (Franchini, Takito, Kiss, Sterkowicz, 2005) we can say that the competitors of judo club Kinezis were in good condition of the physical fitness prior to start of the preparation period.

The result of the second SJFT, made after the completion of the training program, was 13.08±1.29. According to classification this is also average result, but it is very close to be classified as good (up 13.04 - good, from 13.04 - average, see table 1) (Franchini, Del Vecchio, Sterkowicz, 2009). Although the result of t-test showed no statistically significant difference (it was close to be significant because p = 0.062), we can say that the state of physical fitness of judokas is better than at the beginning of the preliminary period. Four judokas have achieved significantly better result, nine players held the same level in rank, and two had a significantly worse result compared to the initial test. As previously mentioned, a top Brazilian judo players, winners of international medals had average resultof 12.53, while the Brazilian judo players who do not compete at the international level had results 14.16 (Franchini, Takito, Kiss, Sterkowicz, 2005). SJFT is very sensitive tool and little fluctuations could mean significantly different result. As it can been seen in the Figure 5, improvement is achieved. In elite and subelite athletes even small improvements could mean the differences between winning and losing.

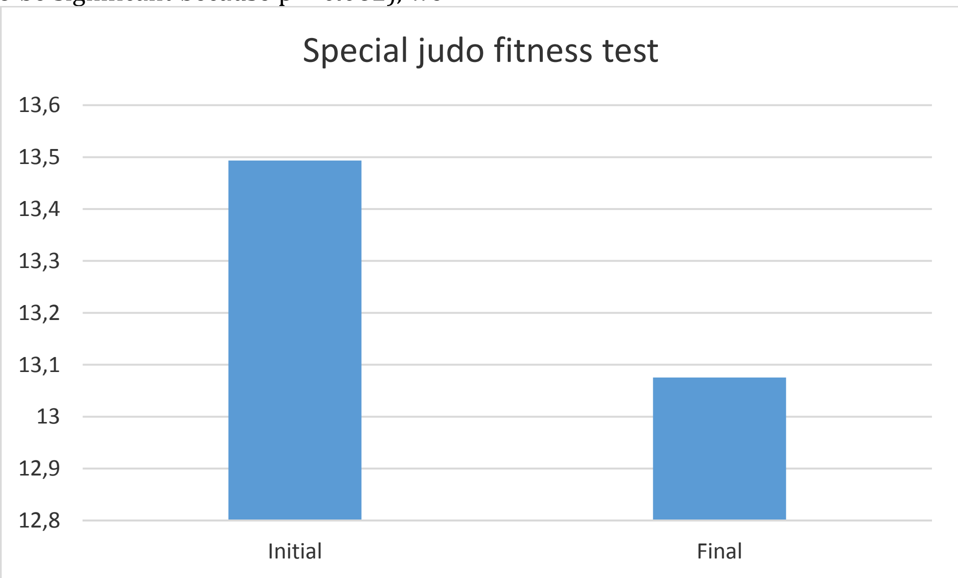


**Figure 5.** Special judo fitness test

To confirm the results, further researches are necessary, particularly through experimental and interventional studies. In short, the results indicate that there is a relation between the level of the cardiorespiratory fitness and blood pressure and likely the change in cardiorespiratory fitness is related with blood pressure for adolescents.

## CONCLUSION

In this research the positive but still insignificant difference is determined between the state of physical fitness of judoka prior and after preparation training cycle. Follow up of athletes condition throughout the season remains one of the most important coach's task. Authors recommend Special judo fitness test, the cheap and reliable tool for assessment of judokas current condition of physical fitness.

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# EFFECTS OF BASIC TRAINING MODEL ON THE DEVELOPMENT OF ANTHROPOLOGICAL DIMENSIONS OF YOUTH KARATE PRACTITIONERS

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572.85.053.81

## SUMMARY

The sample consisted of 46 high school students, aged 15 to 16 years, who in addition to regular physical education classes, were included in the training process of Banja Luka region karate clubs. The overall sample was divided into two subgroups. The first sub-group of 22 subjects made up the experimental group. This included karate practitioners involved in the training process for the development of anthropological characteristics by basic training. The other 24 subjects, underwent a training process in karate clubs and made up the control group. This group included karate practitioners who implemented the plan and program for the development of anthropological characteristics and increasing the level of technical and tactical skills. The work of both groups lasted for four hours per week over a period of two months. To assess the explosive strength the following tests were applied: standing long jump (ref.as MSDM), standing triple jump (ref.as MTRS) and standing five jump (ref.as MPTS). Repetitive strength was evaluated by tests: trunk lift for 30 sec. (ref.as MD30), mixed chin-ups (ref.as MMZG) and squats (ref.as MČUČ). Segmentary speed was estimated by hand tapping (ref.as MTAP), foot tapping (ref.as MTAN) and foot tapping off the wall (ref.as MTPZ). The aim of this study was to determine the effects of a basic training model on the development of motor skills for karate practitioners of the experimental group. The covariance analysis found that the subjects of the experimental group significantly differ (P = .000-Level) in the level of motor skills compared to the control group on the final measure. It can be concluded that the differences arose under the influence of appropriate means of physical exercises, methods and loads to which experimental group subjects were exposed to.

**Keywords:** basic training model, karate players, repetitive strength, explosive strength, segmentary speed, analysis of covariance.

## INTRODUCTION

Karate is becoming increasingly popular due to the simple structure of motor skills that positively influence the adaptive characteristics of the organism by the increased level of working capacity. In addition, in karate, practical determination of the intensity and scope of the intensity of the load has positive influence on medical prevention and health of subjects.

For the above reasons, the application for optimal development of abilities and characteristics that are set in the training process of karate practitioners are significantly increased. According to some researchers (Babin, 1985, Sertic, 2004, Cesari & Bertucci, 2008; Sterkowicz & Franchini, 2009) it contributed by increasing the application of scientific methods for more efficient procedures in formulating methodical training process in accordance with individual abilities and characteristics of athletes.

Karate fighting competition, by the complexity of technical and tactical tasks, belongs to the group of polystructural acyclic sports. The main characteristic of karate fighting is mobility of great intensity and duration with a maximum speed of movement. Speed is a major factor of solving both technical and tactical tasks of fighting sports, with the use of dynamic-explosive, high static strength and flexibility of the body. Karate fighting takes place in the aerobic-anaerobic work of submaximal intensity

(Al-Kubati, Fisher & Novakova, 2007; Kovac, 2008; Vidranski et al , 2007).

The movement dynamics of the karate fight is particularly emphasized in both actions of attack and defense. While static situation is almost nonexistent, one appearing only in maintaining stances that Karate athletes use to concentrate the attack and counter-attack. Karate exercises, in terms of structural and biomechanical specificity, place high demands on the development of many anthropological characteristics of the practitioner.

To successfully analyze the effects of the training, it is important to satisfactorily resolve the issues of programming and control of the training process and selection of methodological procedures that are appropriate to the problem under study.

The aim of this study was to determine the effects of the basic training model on the development of motor skills of karate practitioners from the experimental group.

# METHODS

## Subjects

The sample comprised of 46 karate athletes aged 16 to 17 years, who were, in addition to regular physical education classes, covered by the training process in the karate clubs of the Banja Luka region. The overall sample was divided into two subgroups.

The first sub-group consisted of 22 subjects covered by the training process in karate clubs (experimental group). This include karate practitioners included in the training process for the development of anthropological characteristics using the basic training model.

The second sub-group consisted of 24 subjects covered by the training process in karate clubs (control group). This include karate practitioners who completed an existing plan and program for the development of anthropological characteristics and increase their level of technical and tactical skills in their home clubs. Work in both groups lasted for two months, four hours per week.

## Procedure

Before the start of training process and after its completion in both groups, nine tests were applied to the tests for motor abilities: explosive strength, repetitive strength and segmentary speed.

The tests applied to assess the explosive strength were: standing long jump (ref.as MSDM), standing triple jump (ref.as MTRS) and standing five jump (ref. as MPTS). Repetitive strength was evaluated by the following tests: trunk lifting for 30 seconds (ref.as MD30), mixed chin-ups (ref. as MMZG) and squats (ref.as MČUČ). To assess segment speed, the following tests were applied: hand tapping (MTAP), foot tapping (MTAN) and foot taping off the wall (ref.as MTPZ). The tests were selected based on guidelines and recommendations Kurelić and al. (1975).

The basic training of the karate practitioners of the experimental group was focused on the development of strength, speed, endurance, coordination, agility, precision and balance. Efficient motor exercises were applied to create the fundamentals necessary for the effective implementation of the training loads and working methods, aimed at the development of basic motor abilities.

The main goal of the basic training was to achieve a high speed level of performing complex motor tasks to achieve the efficiency of rapid execution of complex arms and legs motions that would enable rapid movement of stance change, strokes and blocks. Exercises for raising the functional capacity of various organs and systems in the body were also applied in order to improve neuromuscular coordination, increase the ability to carry heavier loads and training capabilities for efficient recovery.

The research into the efficiency of the training process in the control group in their karate schools, was determined on the basis of the realization of the existing curriculum for the development of anthropological characteristics and increases in technical and tactical skills levels.

## Statistical analysis

Processing of the obtained motor tests data was performed by multivariate analysis and covariance.

# RESULTS

**Table 1**. Multivariate analysis of covariance between the experimental and control groups in motor skills in the final test with the neutralization of the difference in the initial testing.

| Wilks' Lambda | F | df 1 | df 2 | P-level |
|---|---|---|---|---|
| .574 | 9.52 | 6 | 46 | .000** |

Legend: the value of Bertlets test (Wilks' Lambda) Ra F-approximation (F) and the significance level (P-level)

Table 1 shows the multivariate analysis of covariance, which determines the realized effects of experimental treatments on the development of motor skills of the experimental compared to the control group on the final test with the neutralization of the recorded differences in the initial testing.

There are statistically significant differences at the multivariate level between the experimental and control groups at a significance level greater than .01 (P-level = .000). That is confirmed by the value of Wilks' Lambda test (.574) and F-test (9.52). The existing differences occur under the influence of experimental treatment of basic training model, which effectively acted on the development of motor skills of the experimental group.

**Table 2.** Univariate analysis of covariance between the experimental and control groups in motor skills in the final test with the neutralization of the difference in the initial testing.

| Motoric skills tests | Groups | N | Mean | F-ration | P-Level |
|---|---|---|---|---|---|
| MDTK | EK | 22 | 19.30 | 5.72 | .000** |
| | KO | 24 | 16.60 | | |
| MMZG | EK | 22 | 15.40 | 5.38 | .000** |
| | KO | 24 | 11.90 | | |
| MČUČ | EK | 22 | 22.80 | 6.52 | .000** |
| | KO | 24 | 16.10 | | |
| MDPK | EK | 22 | 40.30 | 5.64 | .000** |
| | KO | 24 | 32.20 | | |
| MŠPA | EK | 22 | 149.50 | 3.52 | .035* |
| | KO | 24 | 142.60 | | |
| MISP | EK | 22 | 74.20 | 6.38 | .000** |
| | KO | 24 | 83.50 | | |
| MOKV | EK | 22 | 12.40 | 5.42 | .000** |
| | KO | 24 | 16.80 | | |
| MKOP | EK | 22 | 12.00 | 5.58 | .000** |
| | KO | 24 | 18.60 | | |
| MOTL | EK | 22 | 29.40 | 2.92 | .062 |
| | KO | 24 | 33.20 | | |

Legend: arithmetic mean of the experimental group (Mean EK), the arithmetic mean of the control group (Mean KO), the value of F-test (F-relationship) and the level of significance (P-Level)

Table 2 shows the univariate analysis of covariance between the experimental and control group in evaluation tests of motor abilities on the final test with the neutralization and fragmentation results in the initial test. On the bases of the coefficients F-relations and their significance (P-Level), it can be stated that the seven motor tests determined a statistically significant effect on the confidence level of 99%. In the test (ref.as MŠPA), the difference was statistically significant at the .05.level. The result of the test of coordination (MOTL.062) showed a difference that was not statistically significant at the .01 level.

# DISCUSSION AND CONCLUSION

The applied model of basic training on development of anthropological characteristics in the experimental period, contributed to the positive transformation of the tested motor abilities in the experimental group of karate practitioners (Table 1 and 2). There was certainly a contribution from the proper implementation of organizational forms and methods for the realization of more complex structures of motor exercises. Special attention in basic training of karate practitioners was focused on the correct positioning of the body (arms work, hips directing, knees and feet) and development of a sense of awareness of the position and the center of gravity of the body.

The dosage of loads had a gradual and progressive character in the intensity of the burden to increase the activity of the central and peripheral nervous system in order to achieve the speed of nerve impulses transmission for the activation of the major number of motor units and launch of cardio-respiratory system to ensure oxygen transport and aerobic energy process (Sertić, 2004).

The justification of the obtained results is confirmed by a large number of researchers (Kurelic et al, 1975; Mori et al, 2002, Kules & Muratagić, 1993; Arlov, 1993; Kuleš & Muratagić, 1994; Milanović, 2007; Duraković, 2008).

The applied diagnostic measuring instruments of the abilities and qualities at the initial and final measurement can contribute to the proper d selection and training of potential candidates for karate practice.

The results obtained regarding the experimental models of basic training have a wide applicative value for better technical and scientific training of trainers in the development of their own experimental models in the development of anthropological characteristics of karate practitioners, which will contribute to achieving better training results.

The research conducted is an original contribution to science, a significant contribution to advancing design of methodical work, especially in the appropriateness and effectiveness of the applied model of basic training on the transformation processes of motor skills of karate practitioners and secondary school students.

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# Team Sport

# RELATIONS BETWEEN SOMATOTYPE AND PARAMETRES OF SITUATIONAL EFFICIENCY IN TOP JUNIOR MALE BASKETBALL PLAYERS

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## SUMMARY

The purpose of this research was to establish and explain the importance and characteristics of the relationship between somatotype and situational efficiency of top junior basketball players in five playing positions. A significant connection between somatotypes and percentage of two point shots as well as three point shots has been defined in the point guard position. Further on, the somatotype of the shooting guard position players show that there is only one significant regression indicating situational efficiency which is the connection with rebound. The somatotype of players in forward position shows one significant connection with indicators of situational efficiency in predicting blocked shots. Constitutional type of players in position of forward centre indicates, as in the previous two playing positions, one significant multiple regression analysis in which the connection between somatotype and the number of assists has been established. When it comes to somatotypes of players in centre position, the results show there is no significant connection with any variables of situational efficiency.

**Keywords:** basketball, player type, top juniors, somatotype, situational efficiency.

## INTRODUCTION

In basketball, morphological characteristics significantly influence the determining of the position and the role of playing in a certain player (Trninić et al., 2002). Morphological characteristics in the interaction with other dimensions forming an anthropological status of a certain player determine performance and sport achievement (Trninić et al., 1999). Based on morphological structure, in any player we can establish percentage of ectomorphic (leptosomatic), mesomorphic (athletic) and endomorphic (pycnic) constitution (Jeličić, 2006). According to this, ectomorphy in a basketball player's body constitution suggests an expert trainer and a player in the process of sport preparation the necessity of selective hypertrophy (e.g. the increase of active muscle mass quantity, changing of the proportion between slow and fast muscle fibres). On the other hand, if the level of endomorphy is raised in a certain type of player, it is necessary to direct the process of sport preparation towards adipose tissue reduction. In junior players, growth is followed not only by quantitative, but also by qualitative changes which reflect in morphological maturity linked to the functional maturity of players. Further on, body constitution is an important component of his level of training (e.g. body mass, body height, mesomorphy).

Data concerning the state of morphological characteristics of basketball players during the sport preparation are useful for assessment on various levels: training, anthropological status, the potential of a certain player even with regard to normative and model values for a certain age (Jeličić et al., 2002). At the same time, it is important to stress that model characteristics are marked by achieved results in basic and specific anthropological dimensions of the athletes at a certain age (Jeličić, 2006). In addition to what we have already stated, in standard and derived indicators of situational efficiency obtained by assessing, we also reveal profiles for situational efficiency in a certain type of a player (Trninić, 2006). Further on, the final sport specialisation of players for certain positions in the game is done during transition from junior to the senior selection which is crucial in the development of a certain player's career (Trninić, 1995). In contemporary basketball game, the structure of morphological characteristics and situational efficiency parameters make foundation for comparative analyses of players and teams (Trninić et al., 1999). What we just stated asks for the optimization of the morphological structure of a certain type of player and stimulation of the development of the total actual player's quality. The research analyses reveal that morphological status differs players by positions and is connected to the situational efficiency (Jeličić et al., 2002; Jeličić, 2006). The purpose of this paper is to establish the connection between somatotype and situational efficiency of players in the position of the point guard, shooting guard, forward, forward centre and centre.

# METHODS

## Subjects

The research was done on the sample of 108 top junior basketball players who participated in 19th European junior championship held in 2002 in Zadar who played minimally 8 minutes per match on average and in more than 3 matches, and they were selected from 11 teams who played 46 games. According to the data from the official tournament applications, the players were divided in 5 groups based on their playing positions: 22 players dominantly playing in positions 1 (point guard), 20 players playing in positions 2 (shooting guard), 26 player playing in position 3 (forwards), 19 players playing in positions 4 (forward centre) and 21 players playing in position 5 (centres). The average age of the players was 17.8 (± 0,7σ). All the subjects voluntarily took part in measuring based on the approval by FIBA (Federation Internationale de Basketball Amateur).

## Procedure

*The sample of variables to assess morphological characteristics in basketball players*. Altogether we measured 10 morphological variables used further on to calculate somatotype values on the measured sample of basketball players. Variables have been measured according to the protocol described by Medved et al. in 1987, and according to Mišigoj Duraković et al. in 1995: VISINA – body height, MASA – body mass, AKNTRI – upper arm skinfold, triceps, AKNLEĐ – back skinfold, AKNSIL – supraspinale skinfold, ADLAKT – elbow diameter, ADKOLJ – knee diameter, AONADL – upper arm circumference, AOPOT – lower leg circumference, AKNPOTK – lower leg skinfold. The sample of morphological variables was presented by somatotype measures: ENDO - endomorphic body constitution component by Heath-Carter method, ECTO – ectomorphic body constitution component by Heath-Carter method, MESO – mesomorphic body constitution component by Heath-Carter method, (according to Ross W. D., M. J. Marfell-Jones, 1990).

*The sample of variables to assess situational efficiency in basketball players.* Variables in this set were obtained on the European junior basketball championship matches held in Zadar in 2002. In total, we analysed 13 variables to assess situational efficiency in players and 3 which were deduced (for the purpose of this paper we used ten variables to assess situational efficiency) as it follows: SUT1_US – 1 point field goal made; SUT1_NE – 1 point field goal attempted; SUT2_US – 2 points field goal made; SUT2_NE – 2 points field goal attempted; SUT3_US – 3 points field goal made; SUT3_NE – 3 points field goal attempted; SKOK-NAP – offensive rebound; SKOK_OBR – defensive rebound; OSLOP – steals; ASIST – assists; BLOK - blocks; IZLOP – turnovers; OSOB – personal fouls and SB% - free throws percentage (SBUS*$(SBUS+SBNE)^{-1}$); S2% - 2 points field goal percentage (S2US*$(S2US+S2NE)^{-1}$); and S3% - 3 points field goal percentage (S3US*$(S3US+S3NE)^{-1}$).

## Statistical analysis

The connection between somatotype and situational efficiency of a player in the position of point guard, shooting guard, forward, forward centre and centre has been determined by regression analysis. The results were processed by Statistica ver. 11 software package.

# RESULTS

**Table 1.** Multiple regression connections between somatotype variables (predictors) and situational efficiency indicators in players in the position of the point and shooting guard, forward, forward centre and centre

| | %SUT1 | %SUT2 | %SUT3 | SKOB | SKNA | ASIST | OSLOP | IZLOP | OSOB | BLOK |
|---|---|---|---|---|---|---|---|---|---|---|
| | POINT GUARD | | | | | | | | | |
| R | 0,52 | 0,59 | 0,55 | 0,40 | 0,38 | 0,32 | 0,28 | 0,45 | 0,50 | 0,42 |
| Rsq | 0,27 | 0,35 | 0,30 | 0,16 | 0,14 | 0,10 | 0,08 | 0,20 | 0,25 | 0,18 |
| P | 0,06 | **0,02** | **0,03** | 0,24 | 0,28 | 0,46 | 0,58 | 0,14 | 0,07 | 0,20 |
| | SHOOTING GUARD | | | | | | | | | |
| R | 0,28 | 0,31 | 0,53 | 0,45 | 0,57 | 0,16 | 0,37 | 0,27 | 0,25 | 0,29 |
| Rsq | 0,08 | 0,10 | 0,28 | 0,20 | 0,32 | 0,03 | 0,14 | 0,07 | 0,06 | 0,08 |
| P | 0,65 | 0,53 | 0,07 | 0,19 | **0,04** | 0,90 | 0,37 | 0,66 | 0,72 | 0,60 |
| | FORWARD | | | | | | | | | |
| R | 0,19 | 0,49 | 0,44 | 0,31 | 0,29 | 0,22 | 0,31 | 0,47 | 0,41 | 0,51 |
| Rsq | 0,04 | 0,24 | 0,19 | 0,10 | 0,08 | 0,05 | 0,10 | 0,22 | 0,17 | 0,26 |
| P | 0,81 | 0,07 | 0,14 | 0,44 | 0,53 | 0,71 | 0,45 | 0,09 | 0,18 | **0,04** |
| | FORWARD CENTRE | | | | | | | | | |
| R | 0,31 | 0,27 | 0,32 | 0,41 | 0,26 | 0,54 | 0,26 | 0,26 | 0,27 | 0,28 |
| Rsq | 0,10 | 0,07 | 0,10 | 0,17 | 0,07 | 0,29 | 0,07 | 0,07 | 0,07 | 0,08 |
| P | 0,47 | 0,61 | 0,45 | 0,22 | 0,65 | **0,04** | 0,63 | 0,65 | 0,60 | 0,62 |
| | CENTRE | | | | | | | | | |
| R | 0,27 | 0,37 | 0,32 | 0,38 | 0,51 | 0,50 | 0,30 | 0,32 | 0,24 | 0,39 |
| Rsq | 0,07 | 0,14 | 0,10 | 0,14 | 0,26 | 0,25 | 0,09 | 0,10 | 0,06 | 0,15 |
| P | 0,68 | 0,42 | 0,45 | 0,40 | 0,13 | 0,13 | 0,60 | 0,57 | 0,76 | 0,36 |

*Legend: %SUT1 – free throws percentage, %SUT2 – 2 points field goal percentage, %SUT3 – 3 points field goal percentage, SKOB – defensive rebound; SKNA – offensive rebound, ASIST – assist, OSLOP – steals, IZLOP – turnovers, OSOB – personal fouls, BLOK -blocks; R – connection coefficient, Rsq – determination coefficient, P – significant differences coefficient.*

**Table 2.** Relations between somatotype variables (predictors) and the indicators of those situational efficiency variables where there is a significant connection.

| | POINT GUARD | | | SHOOTING GUARD | | | FORWARD | | | FORWARD CENTRE | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | END | MEZ | EKT | END | MEZ | EKT | END | MEZ | EKT | END | MEZ | EKT |
| %SUT1 | | | | | | | | | | | | |
| %SUT2 | -0,42 | -0,37 | -0,93 | | | | | | | | | |
| %SUT3 | -0,18 | 0,32 | 0,50 | | | | | | | | | |
| SKOB | | | | | | | | | | | | |
| SKNA | | | | -0,09 | -0,44 | -0,76 | | | | | | |
| ASIST | | | | | | | | | | -0,85 | -0,44 | -0,99 |
| OSLOP | | | | | | | | | | | | |
| IZLOP | | | | | | | | | | | | |
| OSOB | | | | | | | | | | | | |
| BLOK | | | | | | | -0,34 | -0,37 | 0,01 | | | |

*Legend: %SUT1 – free throws percentage, %SUT2 – 2 points field goal percentage, %SUT3 – 3 points field goal percentage, SKOB – defensive rebound, SKNA – offensive rebound, ASIST – assist, OSLOP – steals, IZLOP – turnovers, OSOB – personal fouls, BLOK - blocks; , ENDO – endomorph, MEZO – mesomorph, EKTO – ectomorph.*

# DISCUSSION

Point guard. It is evident there is a certain connection between somatotype characteristics and situational efficiency in top junior basketball players playing in the position of point guard. Table 1 reveals significant connection between somatotype characteristics and 2 points shot percentage (35% of the explained variance) and between somatotype characteristics and 3 points shot percentage (30% of variability). In 2 points shots, there is a connection between ectomorphic component and the 2 points shot percentage where a marked ectomorphic component involves a lower 2 points shot percentage (table 2). This can be explained by the fact that one of the roles of point guards is to initiate 1 to 1 game and "break" the first defending line and from these actions they create their own shooting ( most frequently at the free-throw line height , but also in breakthroughs ending with placing the ball in the basket). It is rather evident that ectomorphic types of players playing in the position of the point guard (especially in junior players), are less athletic types (less marked muscularity and aggressiveness and taking less risk in the game) and therefore they find it harder to fulfil the given roles and assignments characteristic for this position and thus having a higher 2 points shot percentage. On the other hand, in 3 points shot percentage, there is a reverse connection, i.e. a marked ectomorphic component which includes better efficiency in 3 points shooting. This most certainly happens since players in position one, who have a marked ectomorphic body constitution, i.e. less marked athleticism, find it much more difficult to shoot from a contact ( they exhaust themselves more before reaching this situation) than shooting for 3 points after just one dribbling. Thus, on one hand, they have weaker muscularity (regardless of the fact they both need to put in the same effort), and on the other, a taller player finds it easier to shoot over the defence from the outside than a shorter one does (especially when guarded by a shorter player). Further on, due to weaker efficiency in breaking the first defence line, they mostly move outside the 6.75m line which gives them more opportunities to shoot from these distances. This improves their coordination, i.e. they form habits which finally, with a large number of repetitions and the compensation of weaknesses in breakthrough playing, enable larger efficiency in 3 points shots.

*Shooting guard.* The connection between somatotype characteristics and situational efficiency variables is evident in players in the position of shooting guard. Out of ten multiple regressions, only one has reached statistical significance and that is the one with established connection between somatotype and offensive rebound. 32% of variability has been explained. It involves the connection between mesomorphic and ectomorphic component and offensive rebound. In other words, shooting guards with more marked mesomorphic and ectomorphic component perform less offensive rebounds. This must happen due to the dominant influence of psychological skills where the number of offensive rebounds is determined by e.g. the players' concentration and motivation or the consistency putting in some effort in the game.

*Forward.* The results of multiple regression analyses (table 1) reveal connection between somatotype characteristics and ten situational efficiency variables for players primarily playing in the position of forward. Even in this case, there is only one significant regression analysis and that is the one determining the connection between somatotype and blocked shots in players in the forward position. There is a negative influence of endomorphic and mesomorphic component on block. In other words, players with more marked endomorphic and mesomorphic component have less efficiency in blocked shots (26% of explained variance). This may be explained by the fact that players with primarily ectomorphic type have long levers and are more agile at the same time (faster in reaction from both motor and cognitive aspect), which allows them more efficiency in blocked shots. This is partially one of the basic goals for players in the forward position which are also manifested in stopping aggressive breakthroughs and shots made by the opposing offense players. Shorter players are *handicapped* due to shorter levers, i.e. short body height and thus have less opportunities to be in the zone of higher results in the mentioned parameter.

*Forward centre.* By further inspection of table 1, we can focus on the series results of multiple regression analysis which reveal connection between somatotype and situational efficiency indicators in players in the position of forward centre. Even in this case, there is only one significant multiple regression analyses and this is the one revealing connection between somatotype and the number of assists in players in the position of forward centre. This involves 29% of the explained variability of criterion variable. Table 2 reveals that players with more marked endomorphic component and more stressed ectomorphic component, primarily playing in the position of forward centre, have a smaller number of accomplished assists. It is known for a fact that in contemporary basketball forward centre in interaction with the point guard form the main shaft in the attacking phase which is manifested in assists, i.e. in playmaking of their fellow players. In this case, forwards have a larger number of assists. This may be interpreted in a way that taller and "fatter" (stronger players) can more easily handle the situation themselves most frequently playing under the basket (by scoring or by a foul) since they are superior (in their dominant strength). Shorter players, however, cannot handle the situation themselves in playing one to one so they turn to playmaking. This primarily goes for shorter, but faster players in this position who, once being in advantage, force defence to help and thus create an opportunity to assist. In addition to this, according to LeUnes (2008), apart from the fact that mesomorphic types are marked by stressed muscularity and an athletic look, they react on outside stimuli with aggression, by taking the risk and by leading which can also be reflected on a larger number of their assists.

*Centre.* Table 1 shows regression analysis establishing the connection between somatotype and situational efficiency for the players in the position of centre. As it is evident, none of the multiple regression analysis is significant and in the centre position there is no significant influence of somatotype characteristics on the situational efficiency of players. It is quite evident that some pieces of information are lost due to this large number of subjects grouped in five positions. However, what is even more likely is that extremely ectomorphic players, for instance, need more time to mature psychologically, but also to adopt their skills. Thus, e.g. a player 215 cm tall should be capable of having more blocked shots than a player who is 202cm tall and plays in the same position. However, at junior age they are equal since, e.g. a taller centre accomplishes a certain number defensive rebounds based on his height, while the shorter one does it due to his skill, maturity, experience. On the other hand, somatotype characteristics at this age may not be playing a significant role, but timing, correct setting up for defensive rebound etc.

At the end of discussion, it is necessary to stress the importance of separating typical from untypical players in basketball (Bird, Jordan, Magic; Bouges, Barkley...) in all positions from the aspect of total potential and /or complete actual quality in playing due to the fact there is a large number of players who were average in some elements of the basketball game, but extremely quality in other. For instance, a player may have a weak shot, but this can be compensated by the strength of will, by a winning mentality and self-confidence and playmaking intelligence. Moreover, a lack of a short player can be compensated by speed, explosive power, agility, mental and physical toughness and precision (M. Bouges). Thus, in modern basketball, players should not be assessed merely by their partial potential (functional-motor abilities and anthropometrical characteristics, in this case somatotype and variables to assess situational efficiency), but also by their specific psychosocial characteristics (Trninić et al., 2010), since these characteristics affect successful task accomplishment in the game in the situation of training and competing stress. Thus it is necessary to understand the differences between partial and total potential in basketball players and the differences between the structure of the total situational effect (partial successfulness in the game – based on the statistical notes of the final actions in the game) and the structure of the total actual quality of players (total successfulness in the game) for certain positions in the game (Trninić et al., 1999; Trninić and Dizdar, 2000; Trninić et al., 2002; Dizdar, 2002).

## CONCLUSION

The obtained results can be applied in the selection of junior players since they are based on referent values (the results in somatotype characteristics and standard and derived indicators of situational efficiency) which characterize elite junior players. Namely, with relation to referent values, it is possible to detect which players fulfil the conditions of top basketball. Further on, research results on somatotype conditioning of situational efficiency help the expert trainers to understand that technical, cognitive and emotional skills of players are conditions necessary to use body constitution of certain player types and the whole team. At the same time, the obtained results on situational efficiency and somatotype characteristics of certain player types enable an expert trainer to assess partial efficiency in the game (situational efficiency indicators) and partial potential (somatotype status) in forming the team. The given results an expert trainer and a scientist-practitioner can use in assessing the performance of certain player types and the whole team, in establishing the state of integral preparation, i.e. partially of their sport form level.

Practical implications of research results are therefore manifested in revealing, recognizing, developing and selecting players. Furthermore, the given indicators enable expert trainers to programme individualized and specific training which include shaping of desirable somatotype characteristics with regard to a certain position in the game. That kind of approach enables to stimulate the development of the optimal morphological characteristics manifested through desirable somatotype players' characteristics with relation to their position in the game.

Considering future research directions, it is necessary to connect ideographic methodological approach directed towards finding unique characteristics of elite players in a certain position in the game which can be done by analysing a top player with a nomothetic research approach directed towards establishing mutual, complete features of anthropological characteristics in certain positions in the game. In this way, we can obtain results which focus on anthropological sets of top players in a certain position as well as revealing specific characteristics of a certain elite player (case study). Based on this, traditional kinesiological science deals with modelling the so-called ideal basketball type (point guard, shooting guard, forward, forward centre and centre), and unjustifiably ignores the studies of untypical players who are, from the point of view of basketball, particularly important since they enable many teams a turnover in the game and frequently top sport achievement which was proved right in practice a number of times.

Finally, in accordance with everything stated, we must conclude with the fact it is not necessary, neither in theory, nor in practice to determine a position and a role in playing of a certain player or his efficiency by exclusively following morphological characteristics, i.e. in this case, the somatotype of top junior basketball players or, for instance, motor-functional abilities. Thus, the selection of players must not be based only on the given morphological-motor potential and situational efficiency indicators since integral sport preparation in players, as well as their personal characteristics and cognitive potential give numerous possibilities to compensate for the relevant characteristics in a certain position in the game. In this context, we should mention that tests results can significantly contribute to a more quality programming and players' potential assessment control, a specific condition part of the training, technical-tactical and psychosocial, e.g. in top junior basketball players. Any further researches must include different modalities of a training process and their effects to be able to assess the final efficiency of basketball players in the game more completely.

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# MORPHOLOGICAL PROFILE OF TOP FUTSAL PLAYERS

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## SUMMARY

The aim of the research was to analyse morphological profile of top futsal players and to establish differences in anthropometrical measures between players in defense and offense. The sample of subjects involved 12 players from Croatian futsal national team. The sample of variables included 11 anthropometrical measures. The average chronological age of the subjects was 25.3, the average value of body height was 181.2 cm and average body mass was 80.7 kg. The subjects were divided in two groups: defensive and offensive players. To establish the differences between top defensive and offensive futsal players, we applied the Mann Whitney non-parametrical test. We established the morphological profile of top Croatian futsal players. The presented results reveal there are no significant differences between defensive and offensive players in Croatian futsal national team in none of the 11 measured anthropometrical variables. The absence of differences between defensive and offensive players is expected considering the character of this dynamic sport game. Therefore, the further researches of this type should analyse a larger number of top futsal national teams measured at the same time and place, by the same measuring instruments to confirm the obtained results even of a large sample which would be helpful for trainers in the selection of players.

**Keywords:** anthropometrical characteristics, futsal, Mann Whitney, non-parametrical test.

## INTRODUCTION

Futsal is a team sport game, multi-structured and made of mutually connected cyclical and acyclical movements with and without the ball, in accordance with the official futsal rules (FIFA, UEFA) and biomechanical rules. The allowed ways of moving, as well as tactical, meaningful combinations are manifested in handling situations in the game. Specific structural and functional characteristics make a difference between futsal and other team sports (Gorostiaga et al., 2009; Šamija et al., 2010; Erceg et al., 2013; Burdukiewicz et al.. 2014; Galy et al., 2015). Specific morphological body constitution of players is the integral part of the mentioned characteristic differences which means it is connected with the quality of the game and the competition result (Jeličić, 2006).

Regarding the movement structure and situational structure, modern futsal is one of more complex team games dominated by fast transitions from one action to another. Taken into account that the total activity of players during the game takes place in a relatively small court in the shape of a rectangle (25-42 metres long and 15-20 metres wide), where the substitutes of players are done each in their own half of the court, and that the goalkeeper must not pass the ball to a player closer to him than six metres, one can understand the development of the dynamics and variability of this complex team sport game. Regarding the development of futsal, many authors consider that each team should optimally have polyvalent and swingman players, but also players specialised for certain roles in the game. Such approach towards creating a futsal team demands a particular and careful selection of players from the point of view of functional division of players considering their morphological characteristics such as longitudinal dimensionality of the skeleton or a relatively larger percentage of muscle mass (Orhan et al., 2010; Jovanović et al., 2011).

The efficiency of handling situations in the game both in defense and offense depends on a number of factors, but the most important are the following ones: quality (team and individual) of the players in a team, the quality of teamwork (the reciprocity of helping in the game) within the selected game tactic model, but also individual and team quality of the opponents and their countertactic. According to Dežman (1999), game tactic model is the selection of tactic systems of the game, combinations and formations of movement in defense and offense which must fit the characteristics of certain players and the team as well. Game tactic model must be selected in a way that the integral potential of the team is maximally used, which is, to a great extent, based on morphological-anthropometric characteristics of the whole team regarding the contribution of relative proportions of physical components in sport performance – for instance, body height of a player partially determines his positions and roles in the game (e.g. pivot in the offense receiving the ball while turned with his back towards the goal, if he is taller and more voluminous, it is harder for him to take the same ball unlike a smaller player or the last player in the defense line, who should also be taller, but more movable at the same time. In this way, one determines the other). Furthermore, adequate height in players is another precondition for effective creation of players with polyvalent technique, tactic and playing which gives trainers opportunities for different variants, i.e. combinations of transition and set up playing in defense and offense with low conception risk during adjustment on geometry of the opponent's game (Trninić, 1996). With relation to this, some of the best world futsal players had marked body height values with relation to the first league futsal seniors average (e.g. a Brazilian – Schumaher (187/85), who was a polyvalent player. He was the last player in the defense line, but he was also the best scorer (compared to some of the best offensive players). Even other morphological characteristics are more or less connected to successful performances in the game. Thus a developed muscularity of legs, trunk, arms and shoulder belt enables players to quality fulfil different defense and offense assignments (low body centre of gravity in basic defense and offense posture, the power of kicking with left and right leg, body blockage, sprint efficiency and other). Larger quantities of adipose tissue will, on the other hand, obstruct the realization of motor assignments in futsal (Hofman and Hofman, 1980; Gorostiaga et al., 2009; Trabelsi et al., 2014). Thus, it is evident that certain studies define significant differences between efficient and less efficient athletes based on changeable dimensions of morphological body constitution, so one may expect that by changing morphological status, we may improve sport performance as well.

From all the stated facts, we may assume that the morphological structure of futsal players partially determines the variance of the total efficiency in futsal. Thus the aim of this research was to analyse the morphological profile of top futsal players and to determine differences in anthropometrical measures between players in defense and offense in elite futsal players, the members of Croatian national team (average age – 25.3).

# METHODS

## Subjects

The research was done on the sample of 12 elite Croatian futsal players aged 25.3 on average, average height 182.1 cm and average body mass 80.7 kg. The subjects were divided in two groups in accordance with players' positions: defensive players (N=6), offensive players (N=6). The analysed team is considered to be a top one since it was measured immediately before the beginning of the qualification tournament where they have won the participation at the European championship where they have won the fifth place. Further on, the analysed sample of subjects in approximately ten official matches played at the European championships during this period were tied or they even won against the European champions and vice-champions (Spain, Italy, Ukraine).

## Procedure

We have measured eleven anthropometrical measures: body height, body mass, elbow width, knee width, upper arm circumference – flexed, thigh circumference, triceps skinfold, subscapular skinfold, abdominal skinfold, calf skinfold, supraspinale skinfold.

Variables were measured according to the protocol described by Medved et al. (1987), Ross and Marfell-Jones (1990), Mišigoj Duraković et al. (1995) and Norton et al. (2000). Measuring was done on the athletes' dominant extremities, which is in accordance with the previous studies in this area (Medved et al., 1987; Ross and Marfell-Jones, 1990; Norton et al., 2000). In this way, we get an insight into the model characteristics of futsal players since practice affects extremities dominantly used by a player. Measures were taken three times in each of the subjects and we finally marked the middle value of the results obtained for a certain variable.

## Statistical analysis

We measured descriptive statistical indicators of morphological-anthropometrical variables by which we determined and explained the morphological constitution of members of the Croatian futsal national team separately for defensive and offensive players. Furthermore, to establish the differences between defensive and offensive players, we used the Mann Whitney non-parametrical test. The data were analysed by Statistica programme, ver. 11.00.

# RESULTS

**Table 1.** Descriptive statistics and Mann Whitney nonparametrical test between defensive and offensive players

| | Defense | | Offense | | Mann Whitney test | |
|---|---|---|---|---|---|---|
| | Mean | SD | AS | SD | Z-value | p |
| Body height (cm) | 182.50 | 47.64 | 181.66 | 40.33 | 0.00 | 1.00 |
| Body mass (kg) | 80.83 | 79.35 | 80.50 | 54.68 | 0.00 | 1.00 |
| Elbow width (cm) | 7.15 | 2.17 | 7.16 | 4.37 | 0.24 | 0.81 |
| Knee width (cm) | 10.28 | 4.17 | 10.28 | 2.64 | 0.08 | 0.94 |
| Upperarm CF – flexed (cm) | 32.00 | 15.79 | 32.15 | 28.16 | -0.64 | 0.52 |
| Thigh CF (cm) | 39.43 | 12.40 | 40.05 | 22.15 | -0.32 | 0.75 |
| Triceps SF | 7.83 | 27.80 | 6.00 | 15.95 | 1.68 | 0.09 |
| Subscapular SF (mm) | 9.33 | 23.11 | 9.90 | 23.17 | -0.08 | 0.94 |
| Abdominal SF (mm) | 13.82 | 51.89 | 10.86 | 51.97 | 1.52 | 0.13 |
| Calf SF (mm) | 5.95 | 19.16 | 5.92 | 12.70 | 0.16 | 0.87 |
| Supraspinale SF (mm) | 8.16 | 33.18 | 7.45 | 32.48 | 0.40 | 0.69 |

*LEGEND: CF – circumference; SF – skinfold*

# DISCUSSION

The main goal of this study was to determine the morphological profile of top Croatian futsal players and to show if there is a significant difference in the measured variables between defensive and offensive players. Thus the average height values of the Croatian national team members are 4.94 cm higher than the average height values of futsal players in the First Croatian futsal league. Both of them have taken part in at least 80% of the matches and played minimally 15 minutes in each of them (league/national team). Body mass of the Croatian national team members compared to the players in the First Croatian futsal league is, proportional to the body height, higher in relation to the league players for 10.31 kg (Jovanović et al., 2011). Compared to elite league futsal players in other countries, there are almost identical differences in the given variables which can be ascribed to morphological-anthropometrical characteristics of a certain population (Kondrič et al., 2012; Trabelsi et al., 2014; Galy et al., 2015). Players of the Croatian national futsal selection compared to elite senior football players have almost identical morphological characteristics (Gil, S. M. et al., 2007; Gorostiaga et al., 2009; Orhan et al., 2010; Plunčević et al., 2014). The obtained equalities in the given characteristics between Croatian futsal players and football players may be explained by the fact that most of the Croatian futsal players started with football and "switched" to futsal in junior selection. On the other hand, in leading futsal organizations (countries) such as Spain, Italy, Portugal, Brazil and Russia, children are directed towards futsal since they are ten. Furthermore, the study has revealed there are no statistically significant differences in the given sample in any of the 11 measured morphological-anthropometrical parameters between defensive and offensive players, which is partially in accordance with previous studies in football (Matković et al., 2003; Orhan et al., 2010). Namely, regarding a relatively small area between defense and offense, trainers and players in modern futsal both strive towards players playing in all of the positions. Here we should point out that in this treated sample there are problems such as the lack of a larger number of polyvalent players which partially limits the continuity of achieving top results (one part of players is about 30% better in defense, and the other part of them is about 30% better in offense). However, the higher the competition level gets, the smaller the differences in the quality of playing in defensive and offensive players are both in league futsal and on the level of national teams. Thus any future studies should corroborate the obtained results by the results of morphological characteristics of other top European national teams, measured, if possible, at the same time and place (e.g. before the beginning of the European championship; Erčulj, 1998; Jeličić et al., 2002). The stated facts also depend on the defensive and offensive systems used during a match (e.g. 4:0, 3:1 or 2:2 since someone, although not frequently, plays with two pivots in offense).

# CONCLUSION

Since morphological set in certain sports (futsal) changes with time, it needs to be followed continually, so that data on these changes could have some useful value in practice. In accordance with this, the obtained values may present certain morphological-anthropometrical norms which could be used by trainers in the selection of top futsal players as their part of partial potential. Further on, the hypothesis on the non-existence of differences between defensive and offensive players in morphological-anthropometrical variables in top Croatian futsal national team members is completely legitimate and acceptable regarding the characteristics of futsal. With regard to this, a larger sample of subjects and by involving other variables (technical-tactic preparation of players, psychological characteristics, condition and theoretical preparation) could likely significantly determine a larger part of efficiency variance in futsal as well as potential model value of players for certain positions in the game, but also for creation of players with polyvalent technical-tactic and playing which many countries lack in, especially the ones with a smaller playing base.

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# DIFFERENCES BETWEEN PLAYERS OF DIFFERENT RANKS OF COMPETITION IN THE SPECIFIC MOTOR SKILLS

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## SUMMARY

Soccer is one of the most widely played and complex sports in the world, where players need technical, tactical, and physical skills to succeed. Soccer is an anaerobic-aerobic sport with alternating phases of high loads such as sprints, quick change of direction, jumping, and sudden stops. Football is characterized by a continuous course of activities with intermittent intensity of a game and a very low success ratio (the number of achieved goals) according to a possession of a ball. Research indicates that performance in soccer depends on various physical qualities and skills including tactical and technical skills as the two most import factors affecting performance in soccer. Solving some specific tasks in a football game is closely associated with the corresponding structural trends, and with the specific motor skills. The aim of research was to determine differences in specific motoric between football players with different levels of competition. The sample of research were 252 football players from second and thrid division. The sample of the variables represented eighteen tests of specific motoric devided in six groups. Results noted that there was a major area of discrimination in specific motor respondents between players II and III in the league

**Keywords:** specific-motor skills, different rank of competition

## INTRODUCTION

Soccer is one of the most widely played and complex sports in the world, where players need technical, tactical, and physical skills to succeed (Joksimović et al., 2009). Soccer is an anaerobic-aerobic sport with alternating phases of high loads such as sprints, quick change of direction, jumping, and sudden stops. Football is characterized by a continuous course of activities with intermittent intensity of a game and a very low success ratio (the number of achieved goals) according to a possession of a ball (Reilly et al., 1993). Research indicates that performance in soccer depends on various physical qualities and skills including tactical and technical skills as the two most import factors affecting performance in soccer (Bangsbo, 1993; Reilly, Bangsbo, & Franks, 2000). Some exposure to games skills is necessary at an early age, since Elliott et al., (1980) reported that movement and muscle activity patterns in young soccer players were evident by age 11 years. The period of life before adolescence is critical for the acquisition by young soccer players of many physical and technical features. During the course of prepubertal development, running speed, resistance and strength improve (Armstrong & Welsman, 2001; Beunen et al., 2002). Research on talented young athletes often focuses on comparisons between youth and professional players and players classified by competitive level or expertise at a certain stage of development (Reilly, Williams, Nevill & Franks, 2000). Other studies not only support this assumption but also claim that physical capabilities such as strength and running speed must be well developed to reach a high performance level in soccer (Hoff, 2005; Little & Williams, 2005). During a soccer match, lower body power is important for executing different activities as stopping and changing running speed as well as direction (Hoff & Helgerud, 2004; Thorlund, 2009).

Achieving high sport achievements is conditioned by a number of objective and subjective factor. Among these factors are very important specific characteristics of psychosomatic status of players, or the appropriate anthropological characteristics, but also their timely guidance to the sport, the correct selection and properly organized training. Particular importance is the understanding of factors that influence the achievement of high sports achievements in the football game, and the coefficients of participation of each of them in the prediction of these accomplishments. In other words, the determination of these factors can be taken as a dominant problem that must be resolved if we want to provide quality and efficient planning of sports activities with the players and rational management of the transformation process, which will be directed to work on the development of determinants achievements in the football game. It is known that a transformation process of players will be effective only if its aim is explicitly defined in terms of the desired quality characteristics or dimensions responsible for achievement in the game, if in the process include people who have abilities and traits that are the determinants of achievement and determine whether there are differences in specific - motor, cognitive and conative dimensions depending on the playing positions within the team, with the players of different ranks of competition. It follows, therefore, that the high sports results in football can be achieved only if all the components of the sport and the training process, starting with orientation and selection of subjects, application of training content, objective and rigorous control of training effects, be implemented on the basis of scientific knowledge and modern scientific developments in general. This is because the load in the training process, as well as other factors training process in modern football, reached such limits that can not be applied to any other basis other than scientific. Otherwise, the increased loads and other requirements related to the intensification of sports - training process can cause adverse effects.

Solving some specific tasks in a football game is closely associated with the corresponding structural trends, and with the specific motor skills, which should be primarily emphasized the assessment of the time - space relationships which the player must synchronize and find an adequate solution to the situation.

# METHODS

## Subjects

The sample of research were 252 football players from the Greek football league (126 players from second division and 126 players from the third division), conferred by the position in the football field at the 5 sub samples: goalkeepers (36), central defender players (60), the full back players (48), midfielders (60) and forwards (48).

## Procedure

Each participant will have to meet pre-defined conditions, to enter the sample: to regularly attend training sessions, that the respondents voluntarily attended training in the football club. All the players had more than 3 years of experience that the participants are healthy, participants do not have physical defects, morphological aberrations damaged locomotor apparatus, and they do not possess greater pathophysiological abnormalities. The players were fully-informed of all the experimental procedures. All tests were performed on an outdoor grass pitch. Each player performed a standardized 15-minute warm-up consisting of general movements and dynamic and static stretching. After the general warm-up, the players performed all required test. The sample of the variables represented eightteen tests of specific motoric devided in six groups.

- Three tests for the assessment of precision of target: Elevation precision kicking the ball while running from a distance of: 15 meters (horizontal objective) (PR1), 20 meters (horizontal objective) (PR2) and 15 meters (vertical objective) (PR3).
- Three test for assessing ball handling: kicking a rolling ball against the wall – by foot (BR1), kicking a ball into the wall from the air after being ball touch the ground - by foot (BR2) and kicking rejected balls against the wall head (BR3).
- Three tests to predict the speed of ball driblling: on a half-circle (BV1), with changing direction (BV2), on 20 meters distance (BV3).
- Three tests to assess the strength of kicking the balls as far as participant can: kick the ball by right foot (SUD1), kick the ball by left foot (Sul2), kick the ball by head (SUG3).
- Three agility test: running on a half-circle (AG1), running with the change of direction (AG2), curve running on 20 m high start (AG3).
- Three coordination Tests: juggling balls alternately with both feet (KO1), juggling the ball with better foot (KO2), juggling the ball with head (KO3).

## Statistical analysis

All results have been analyzed in the statistical program Statistics 7.0 for Windows. For all variables basic parameters of the descriptive statistics were calculated: the minimum score (Min), maximum score (Max), mean (Mean), standard deviation (Std. deviation). To determine a statistically significant difference between the groups for each variable was used a T - test, where for the statistical significant difference the value of the significance level to 0.05 ($p \leq 0.05$) was taken. Differences in the multivariate and univariate level was assessed using the canonical - discriminant analysis were assessed differences in the investigated areas and different ranges of competitions.

# RESULTS

**Table 1.** Multivariate difference between II and III league in the space of specific motor

| | Eigen- value | Canonical - R | Wilks' - Lambda | Chi-Sqr. | df | p |
|---|---|---|---|---|---|---|
| **0** | 0.979809 | 0.703492 | 0.505099 | 164.6031 | 18 | **0.0000** |

**Table 2.** Structure of examined variables

| Variable | Root 1 | Variable | Root 1 | Variable | Root 1 |
|---|---|---|---|---|---|
| **PR1** | -0.147454 | **BV1** | 0.158753 | **AG1** | 0.221003 |
| **PR2** | -0.143477 | **BV2** | 0.117587 | **AG2** | 0.347259 |
| **PR3** | -0.126498 | **BV3** | 0.222168 | **AG3** | 0.381726 |
| **BR1** | -0.369673 | **SUD1** | -0.100416 | **KO1** | -0.087063 |
| **BR2** | -0.288571 | **SUL2** | -0.024612 | **KO2** | -0.090407 |
| **BR3** | -0.328901 | **SUG3** | -0.073698 | **KO3** | -0.131091 |

**Table 3.** Univariate differences between II and III league in the space of specific motor

| Varb | L | N | Mean | SD | F | p |
|---|---|---|---|---|---|---|
| **PR1** | II | 126 | 10.02 | 1.467 | 5.32593 | **0.021828** |
| | III | 126 | 9.59 | 1.535 | | |
| **PR2** | II | 126 | 9.56 | 1.622 | 5.04247 | **0.025607** |
| | III | 126 | 9.13 | 1.399 | | |
| **PR3** | II | 126 | 10.32 | 1.792 | 3.91964 | **0.048822** |
| | III | 126 | 9.90 | 1.574 | | |
| **BR1** | II | 126 | 25.74 | 2.184 | 33.47473 | **0.000000** |
| | III | 126 | 24.17 | 2.127 | | |
| **BR2** | II | 126 | 16.66 | 1.894 | 20.39798 | **0.000010** |
| | III | 126 | 15.48 | 2.248 | | |
| **BR3** | II | 126 | 23.09 | 2.090 | 26.49790 | **0.000001** |
| | III | 126 | 21.70 | 2.192 | | |
| **BV1** | II | 126 | 13.15 | 1.121 | 6.17338 | **0.013624** |
| | III | 126 | 13.50 | 1.146 | | |
| **BV2** | II | 126 | 9.93 | 1.018 | 3.38691 | 0.066901 |
| | III | 126 | 10.18 | 1.062 | | |
| **BV3** | II | 126 | 3.73 | 0.249 | 12.09055 | **0.000597** |
| | III | 126 | 3.84 | 0.262 | | |

| Varb | L | N | Mean | SD | F | p |
|---|---|---|---|---|---|---|
| **SUD1** | II | 126 | 55.82 | 6.343 | 2.46993 | 0.117308 |
| | III | 126 | 54.55 | 6.419 | | |
| **SUL2** | II | 126 | 44.06 | 6.408 | 0.14839 | 0.700410 |
| | III | 126 | 43.74 | 6.672 | | |
| **SUG3** | II | 126 | 15.89 | 1.780 | 1.33045 | 0.249827 |
| | III | 126 | 15.61 | 1.962 | | |
| **AG1** | II | 126 | 7.42 | 0.584 | 11.96405 | **0.000637** |
| | III | 126 | 7.69 | 0.586 | | |
| **AG2** | II | 126 | 6.45 | 0.356 | 29.53851 | **0.000000** |
| | III | 126 | 6.72 | 0.433 | | |
| **AG3** | II | 126 | 3.20 | 0.188 | 35.69316 | **0.000000** |
| | III | 126 | 3.34 | 0.185 | | |
| **KO1** | II | 126 | 67.34 | 13.061 | 1.85675 | 0.174227 |
| | III | 126 | 65.13 | 12.640 | | |
| **KO2** | II | 126 | 47.92 | 10.797 | 2.00210 | 0.158326 |
| | III | 126 | 46.02 | 10.482 | | |
| **KO3** | II | 126 | 24.44 | 4.994 | 4.20946 | **0.041241** |
| | III | 126 | 23.17 | 4.830 | | |

Based on the results in Table 1 it can be noted that there was a major area of discrimination in specific motor respondents between players II and III in the league ($p = 0.0000$). The canonical correlation coefficient (R = 0.70 Canonical) indicates that significant canonical functions is explained with 70%. Statistical significance of discrimination which represents the sum of the square of the correlation coefficient in size to the entire set of variables is very high and is explained by Chi-Sqr test and is (164.60).

Structure of examined variables (Table 2) indicates the existence of a significant discrimination function whose contribution hierarchically belongs primarily BR1, BR2 and BR3 in favor of the II league, and AG3, AG2 and AG1 in favor of III league. Thus, a significant contribution to the separation, belongs to next tests: handling ball tests (kicking a rolling ball against the wall by foot, kicking a ball into the wall from the air after being ball touch the ground by foot and kicking rejected balls against the wall head) and have a high contribution to the hierarchical division II; and tests for assessing agility (curve running on 20 m high start, running with a change of direction and run by a half-circle) are hierarchically high contribution to the III league. However, we can conclude that the credit for the distinction of the league belong II which is a significant contribution to the separation contributed 12 of the 18 tests.

By analyzing Table 3, in which are shown the univariate differences between II and III league in the space of specific motor abilities, it can be noted that there are statistically significant differences in all three tests for the precision assessment of target (PR1, PR2 and PR3), then all three tests for ball handling assessment (BR1, BR2 and BR3), two tests for assessing of handling the ball (BV1 and BV3), all three tests for agility assessing (AG1, AG2 and AG3) and one test for the evaluation of coordination (KO3), all in favor of II league. The remaining 6 tests did not show statistically significant differences.

# DISCUSSION

The results of this research coincide with the results of research Di Salvo, Baron, Tschan, Calderon, Bachl & Pigozzi (2007), as well as with research Dey, Kar & Debray (2010), that investigations were carried out on a total of 150 male players two-tier competition, and the sample of respondents is divided according to the position in the game the following subsamples: 23 past, 44 central and outer side's central defenders, 48 midfielders and 35 attackers. The level of specific motor skills that have players who play for the first federal football league of India, is higher than the levels that have players who play for lower league football India. The results coincide with the results of the survey Davis, Brewer & Atkin, (1992), that investigations were carried out on a total of 135 male players from the two-tier competition, and the sample of respondents is divided according to the position in the game the following subsamples: 13 past, 22 foreign-backs 24 central fullbacks, 35 midfielders and 41 attackers, as well as with the results of Gil, S., Gil, M., Ruiz, & Irazusta Irazusta (2007), that investigations were carried out on a total of 241 male players from the two-tier competition, and sample of respondents is divided according to the position in the game the following subsamples: 29 past, 77 external and central backs, 79 midfielders and 56 attackers.

# CONCLUSION

Based on these results, in accordance with the set goal, it can be concluded that there are significant differences in the space of specific motor abilities in football players of different ranges of competitions,

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# EVALUATION OF PROPRIOCEPTION AFTER BOSSU PROGRAM IN ADOLESCENT FEMALE VOLLEYBALL PRAYERS

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## SUMMARY

The aim of this study was to examine the effect of bossu program on developing proprioception. It was used the star excursion balance test because of its big reliability from 0.89 to 0.94. Twenty - four (N=24) female national volleyball team u19 players were participated in this study, but only eighteen (N18) based the inclusion criteria. It was used paired - simple t-test for analyze the results. Results indicated that there was a significant difference within the pre and post test results ($p \leq 0.05$). It was suggested that application of bossu program may improve significantly the proprioception and the postural control in young volleyball players.

**Keywords:** SEBT, star excursion balance test, proprioception, postural control, bossu

## INTRODUCTION

Proprioception provides the basis for knowing where our limbs are in space and is comprised of both static (joint/limb position sense) and dynamic (kinesthetic movement sense) components. (Goble, Lewis et al. 2005). In the production of coordinated movement, proprioceptive feedback has been found to be critical in controlling muscle interaction torques and the timing of limb segments during multi-joint movement (Goble, Lewis et al. 2005). Given this importance the good proprioception is important for promoting dynamic joint and functional stability in daily living activities and in sport (Zouita, Majdoub et al. 2013). It is well established that the control of upright posture depends on sensory information from proprioceptive (Fitzpatrick & McCloskey, 1994). The advantage of assessing dynamic postural control is that additional demands of proprioception, range of motion and strength are required along with the ability to remain upright and steady. Numerous tests have been developed to assess dynamic postural control, but very few tests that truly stress the dynamic balance capabilities of the tested population ( Gribble & Hertel, 2003). The SEBT (star excursion balance test) is designed to challenge posture during multiple reaching tasks and the reliability of the test is pretty high (Hertel, Miller et al., 2000; Kinzey, & Armstrong, 1998) as well as sensitivity (Miller, 2001; Olmsted, Carcia et al., 2002). Intra-tester reliability has been reported to range from 0.84 to 0.87 and test retest reliability from 0.89 to 0.93 (Plisky et al., 2006). It has been proven that SEBT is a reliable and valid test for assessing dynamic postural control (Hertel, Miller et al., 2000, Olmsted, Carcia et al., 2002).

## METHODS

### Subjects

Twenty four female players of Bulgarian national team under 19 take part in our experiment. Descriptive data of the participants is presented in Table 1. The Inclusion criteria were: national team players under 19, no history of lower extremity surgery or fracture, no lower extremity injury in the previous month and no concussions or head injuries. The including criteria for examination group was passed from eighteen of twenty four players.

**Table 1.** Means and Standard deviations summary

| **Means and Standard Deviations Summary Statistics for Participants** | | | |
|---|---|---|---|
| | *Age* | *Height* | *Leg length* |
| **Female (n = 18** | *18± 1* | *189± 7* | *85± 6* |

## Procedure

The measure was made in the distance from the anterior superior iliac spine to the center of the ipsilateral medial malleolus ( Sabharwal & Kumar, 2008). The reach directions for the test were adjust with applying three tape strips of 1 m measures to the floor, one orientated to anterior (A) and two aligned at 135 degree to this in the PM (posteriomedial) and PL (posteriolateral) directions (Fitzgerald et al. 2010; Plisky, Rauh et al.2006). The order of the reach directions was randomized for each participant and kept constant across all 3 trials (Doherty & Bleakley, 2016). Participants placed their foot of the tested limb in the center of the SEBT lines and aligned it with the anterior facing tape (fig 1). Participants were instructed to reach along each of the tape measures with the opposite limb as far as possible with light touch on the flour with the distal part of the foot and return to the middle of the "star", while keeping the test limb foot on the floor and their hands on their pelvis. (Fullam, Caulfield et al. 2014). All trials were conducted barefoot to eliminate additional balance and stability gained from shoes (Gribble & Hertel, 2004). Three practice trials were performed in each direction. The order of the direction of reach was randomized for each participant (Robinson & Gribble, 2008). was considered unsuccessful if the subject (a) lost balance or failed to maintain unilateral stance, (b) shifted weight onto the reach foot when touching the measuring tape, (c) failed to perform a controlled return of the reach foot to the starting position prior to reaching another direction, (d) did not maintain heel contact between the stance limb and floor, (e) did not maintain hands on the pelvis, (f) moved or lifted the stance foot, or (g) failed to touch the measuring tape. If the trial was deemed unsuccessful, it was discarded and repeated until a successful trial was performed (Delahunt, Chawke et al. 2013; Coughlan et al., 2012).

Fig 1. SEBT test

All participants participated in the bossu program before every volleyball practice during the european championship preparation camps for the period of 01. 06.2016 to 31.08.2016. Bossu which was set up in the experiment was ENERGETICS Balance Ball, INTERSPORT International Corporation. Before the first training session, the setup and training procedure was demonstrated to each participant by a physical therapist . The program was made before every afternoon ball practice (average 5 times in a week) and was supervised from the team physiotherapist (table 2).

**Table 2.** Bossu proprioception program.

| Bossu proprioception program | | |
|---|---|---|
| Exercise №1 | Player stays still on one leg on the bossu for one minute | 1 min. X 2 sets for leg |
| Exercise №2 | Partisipant stays on one leg over the bossu and perform with the other leg tuoches anterior, posterior, left, right aterolatera, anteromeial, posterolateral, posteromedial directions of the boss ("star"). | 2 sets for leg |
| Exercise № 3 | Half of participants stay over the bossu on one leg on the side line and on the opposite side line are the another half of the participants. Each couple throw the ball and catch it always wit two arms. | 2 X 20 throws |

## Statistical analysis

Because leg length was found to be the most highly correlated factor, and leg length and height were highly correlated, excursion distances were normalized to the participant's leg length for further analysis. The Reach distances from 3 trials in each direction were averaged Normalization was performed by dividing each excursion distance by a participant's leg length, and then by multiplying by 100. Normalized values can thus be viewed as a percentage of excursions distance in relation to a participant's leg length. (Gribble, F, Hertel, J, 2003). To examine any significant differences between pre and post measurements for the 3 reach directions, the paired-sample t-Test was used. SPSS (V19) was used to perform all statistical procedure. Finally using the normalized scores we determine 6 different dependent values : anterior, posterolateral, and posteromedial reach distance with left and right leg.

## RESULTS

For all 18 female subjects were successfully completed the 3 montes experiment. All "p" values are under .05 witch means that all improvements in the results have significantly difference.

**Table 3.** Comparison of results of SEBT test.

| Comparison of results of SEBT test | | | |
|---|---|---|---|
| Right leg | t - value | p - value < .05 | Mean |
| Anterior | 2,32 | 0,01 | 5.56 |
| Posterolateral | 1,8 | 0,04 | 7.49 |
| Posteromedial | 1,75 | 0,04 | 6.94 |
| Left leg | | | |
| Anterior | 2,1 | 0,02 | 5,34 |
| Posterolateral | 1,8 | 0,4 | 7.28 |
| Posteromedial | 1,8 | 0,04 | 6.61 |

Baseline statistical characteristics of the volleyball players are shown in Table 3. The reach distances in percent, normalized to limb length for the 3 reach directions, and normalized composite reach are presented in Table 4.

For all players, anterior reach distance differences are improved with 6% for left and right directions with is the smallest improvement compare to the other two test directions. For all players the average value of improvement for posterolateral and posteromedial reach for the right leg is 7%. In the left leg reach the improvement in the data is bigger, 9% for posterolateral reach and 7% for posteromedial.

There is big difference in percentage between posterolateral and posteromedial reaches. In the pre test results posterolateral are with 13% bigger with the right leg and left leg. It is interesting that after the improvement the difference between left posterolateral and posteromedial are maintained 13% for the right leg. In the left leg the pre test differences again are 13 % and after the post test there're 15% difference between the two directions. Also it is interesting that the smallest values pre and post testing and also the smallest improvement are in anterior reach direction.

# DISCUSSION

The purpose of this study was the determination if the bossu program will significantly improve proprioception and indirectly the postural control of under 19 national team female players. Our research indicates that the increasing of reach distance for all 3 movements is due to improved proprioception and postural control which allows better feed-back process from the proprioceptors and regulation of motor control through reflex pathways, which lets the better maintaining of posture and the regulation of movement (Lephart, S, FU, F, 2000).

The bigger percentage in pre and post assessment in the posterolateral movements compared with the another two movements maybe is due to sport specific movements in volleyball and that many times is needed lateral or posterolateral step movement.

**Table 4.** The average result from SEBT in percents

| The average results from SEBT in percents | | | |
|---|---|---|---|
| | anterior | posterolateral | posteromedial |
| Right Pre | 90% | 107% | 94% |
| Right Post | 96% | 114% | 101% |
| Left Pre | 88% | 104% | 91% |
| Left Post | 94% | 113% | 98% |

Anterior reach results are with smallest value compared to the another 2 reach distance which may be due to lack of mobility in dorsiflexion in the ankle joint or limitations in the quadriceps eccentric control. In the future experiments it can be add passive range of motion examination and also dynamic ROM examination during SEBT performance.

The maintaining the differences between left and right leg and between anterior and posterolateral reach in the percentage pre and post examination may be due to selection of the bossu exercises, which was selected to affect proprioception in many different positions of the legs and body.

With improving proprioception and reach distance in SEBT the risk of injury is decreased. SEBT reach distance less than 89.6% of limb length is indication for risk of injuries. If the result are over that 89,6% the participants ate categorized as not at risk (Ness, B, Taylor, A, et al. 2015). The average reach percent in our study is 99%.

# CONCLUSION

The present study was conducted to evaluate the effect of bossu program on the proprioception and the postural control of young volleyball players. Proprioception was measured with SEBT before and after the 3 mont period of application the bossu program. The results of the study indicated that there is a significant difference in the proprioception after the applied program. The improved levels of proprioception is also big factor of injury prevention.Therefore, the bossu exercise program can be recommended without limitations as a helpful instrument for improving proprioception and postural control for adolescent volleyball players.

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# BODY COMPOSITION AND AEROBIC POWER INTERDEPENDENCE IN FEMALE SOCCER PLAYERS

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## SUMMAR

Purpose of the study was to evaluate a relationship between body composition and aerobic fitness parameters in female soccer players. In total, fourteen soccer players participated in the study. Each individual performed a continuous running test modified according to the Taylor protocol. Test was performed on motor driven treadmill in laboratory conditions using gas analyzer. Body composition assessment was done using Soehnle weight scale and measurement of four specific skinfolds. Pearson product moment correlation (*r*) was used to statistically estimate the relationship. Results are suggesting small to moderate relationship between parameters emphasizing correlation of $VO_2max$ with body fat ($r = -0.47$) and muscle mass percentage ($r = 0.43$). Maximal heart rate negatively correlated with BMI ($r = -0.47$) and BMR ($r = -0.48$). From the results obtained it can be concluded that high aerobic capacity was negatively affected by excess of adipose tissue and low percentage of muscle mass. Training regime should be conceived to prevent muscle mass decay and to maintain optimal level of body fat, which generally contributes towards excellent aerobic fitness.

**Keywords:** lean mass, fat tissue, $VO_2max$, soccer, endurance

## INTRODUCTION

Soccer is one of the most popular ball games in the world, and with game given attractiveness and unpredictability it entices great number of spectators. It is assessed (FIFA) that the total number of active female participants exceeds 23 million. Female soccer is highly demanding intermittent activity, with noted major variability in skill performance, agility, repeated sprint ability and aerobic function between players. (Davis & Brewer, 1993; Krustrup, Mohr, Ellingsgaard, & Bangsbo, 2005). Physiological and physical demands of the game have evolved, from the time when the total distance covered was similar compared to male soccer cohorts (Davis & Brewer, 1993), to major distinctions in the level of game intensity (Mohr, Krustrup, & Bangsbo, 2002). Several studies (Juric, Sporis, & MIHACIC, 2007; Sedano, Vaeyens, Philippaerts, Redondo, & Cuadrado, 2009; Silvestre, West, Maresh, & Kraemer, 2006; Vescovi, Brown, & Murray, 2006; Wells & Reilly, 2013) have evaluated variety of physiological and anthropometric data for the purpose of determining differences between players' positon. Authors concluded that in order to achieve competitive peak, an optimal anthropometric and functional ability is mandatory, with few genetically predisposed exceptions.

Aerobic power is related to training status (Krustrup et al., 2005). Aerobic power is presented by maximal oxygen consumption or $VO_2max$. However, training status – performance related issue represents a recurring question for practitioners. Correspondingly, investigations find that soccer high intensity activity was highly related to $VO_2max$ ($r=0.81$). Maximal oxygen intake is estimated using field based fitness tests or in laboratory controlled conditions which have proved to be the most accurate. Aerobic function is mainly restricted by heart functional ability (heart rate - HR), oxygen pulse (O2/HR), maximal ventilation (VE) and blood lactate saturation ($La^+$) (Burtscher, Nachbauer, Baumgartl, & Philadelphy, 1996). Elite female players have $VO_2max$ of 47.1 to 57.6 ml/kg/min (Davis & Brewer, 1993) for direct and 43.4–56.8 ml/kg/min for indirect measurements.

Excessive adipose tissue is commonly not related to fit athletes, and can blemish sport performance. Footballers have mesomorph body build, generally with low body fat and moderate musculosity with body adaptations in accordance with physical criteria and energy demands of the position played.

(Parks & Read, 1997). Aerobic exercise and HIT activity, similar to those in soccer, may improve insulin sensitivity and "burn fat" which results in decrease of the body fat mass and change in body composition (Lamarche et al., 1992; Little et al., 2011). Davis (1993) reported that female soccer players were composed of 19.7-22% of body fat. A study of Sedano et al., (2009) noted similar body fat contained (20-24.6%) along with 39.1-43.2% of muscle mass. By examining results of mentioned studies, body fat and total weight ranges between 9.3-24.6% and 50.7-70 kg, respectively.

Relation of body composition in regards to aerobic functional ability was not fully investigated nor explained. It is unknown how the long term soccer playing affects body composition in female athletes, or what are the expected body adaptations. Energy expenditure, beside energy intake, is main factor which determines body fat level. High aerobic power can provide with constant energy supply, predominantly using non- saturated blood fats in oxidation process. This directly affects body composition. It is evident that aerobic power is one of the key components for achieving maximal soccer performance (Krustrup et al., 2005). Based on the previous, aim of this study was to provide with information, which could be used to asses optimal body composition features, providing the practitioners with directions towards the best aerobic power output. We assume that small to moderate relationship is to be presented.

# METHODS

## Subjects

Fourteen experienced female football players (age = 22.7±4.4 years; height = 165.4 ± 6.6 cm; body mass = 55.3 ± 7.8 kg) participated in study. Subjects trained approximately 10 h per week. All subjects previously underwent a medical examination and were declared healthy. Participants were subjected to continuous running test (CT) and body composition assessment. All of them were members of state champion's football club and 60% played periodically for the senior national team. The study was approved by the Faculty of Sport and Physical Education, University of Sarajevo. Participants signed a written consent form which guarantied their possibility to withdraw at any time, according to the regulations of Ethic Committee.

## Procedure

Subjects underwent continuous running (CT) exercise test modified according to the Taylor protocol (Taylor, Buskirk, & Henschel, 1955). Test was performed using motor driven treadmill (Cosmed, Rome, Italy). Test started at speed of 7 km/h with an increase of 1 km/h per minute. Gas exchange was analyzed using automated breath-by-breath respiratory system (K4b2, Cosmed). All cardiorespiratory data (including $VO_2$max $VCO_2$, tidal volume and VE) was averaged across 5 s time intervals. Maximal $O_2$ consumption obtained from 20 seconds presented maximal oxygen uptake ($VO_2$max). Heart rate at $VO_2$ peak represented maximal heart rate (HRmax). Running velocity reached at $VO_2$peak was test end speed (VCT). Aerobic threshold was manually determined at point of $CO_2$ dispersion. Speed (VAT), heart rate (HRAT) and oxygen consumption at aerobic threshold ($VO_2$AT) were included in the study as aerobic fitness variables.

Body composition was estimated using digital weight scale (Order - 800100, Soehnle Professional GmbH Co. KG) and skinfolds measured at four sites – biceps, triceps, subscapular and supra-iliac measured with caliper (Durnin & Womersley, 1974). Procedure was done early in the morning prior to the CT. Harpenden skinfold caliper (Brook, 1971) was used for accurate skinfold measurement. Body weight (BW - kg), Muscle mass (MM%), fat tissue (FT%), body mass index (BMI – kg/m$^2$) and basal metabolic rate (BMR - kcal) featured standard results of the measurement and all were included in the study.

## Statistical analysis

Statistical software package (SPSS 23, IBM Corp.) was used for result analysis. Normality of data distribution was tested using Kolmogorov – Smirnov test. Pearson product-moment correlation ($r$) was used for determining relations between aerobic functionality and body composition parameters. Correlations of <0.3, 0.4-0.6, 0.61-0.85, >0.86 were declared as small, moderate, high and almost perfect. Data are presented as Mean and standard deviations (Mean ± SD) if otherwise not stated. Results are presented as raw data and as charts.

# RESULTS

Results from the K-S test suggested normal data distribution for all body composition and CT output measures. Maximal oxygen consumption averaged 39.9 ± 5.8 ml/kg/min. Subjects had 19.1 ± 3 percentage of body fat and 41.1 ± 2.7 percent of muscle mass. Correlations observed (Table 2) ranged from 0.01 (HRAT and body height) until -0.48 (basal metabolic rate and maximal heart rate.) Maximal oxygen consumption ($VO_2$max) moderately correlated with players age (*$r=0.44$, $p<0.001$*) and muscle mass percentage (*r=0.43, p<0.001*), while similar correlation has been observed between $O_2$ consumption at anaerobic threshold and percentage of muscle mass (*r=0.42, p<0.001 – Figure 2*). Moderately negative relationships of -0.48,-0.47 and -0.47 were observed for HRmax with BMR (Figure 4), HRmax with BMI (Figure 3) and $VO_2$max with fat tissue percentage (Figure 1).

***Table 1** Values of body composition and Continuous running test*

| Sample characteristics | | CT performance | |
|---|---|---|---|
| Age<br>years | 22.7±4.4 | $VO_2$max<br>ml/kg/min | 39.9 ±5.8 |
| Height<br>cm | 165.4 ±6.6 | VCT<br>km/h | 12.9 ±1.4 |
| Body mass<br>kg | 55.3 ±7.8 | $VO_2$AT<br>ml/kg/min | 26.2 ±6.9 |
| Fat tissue<br>% | 19.1 ±3 | VAT<br>km/h | 8.4 ±1.9 |
| Muscle mass<br>% | 41.1 ±2.7 | HRAT<br>b.p.m | 151 ±14.1 |
| Body Mass Index<br>kg/m$^2$ | 19.5 ±1.7 | HRmax<br>b.p.m | 185.9 ±6.1 |
| Basal Metabolic Rate<br>kcal | 1651 ±112.1 | | |

*Mean ± SD*

***Table 2** Correlation matrix for body composition (BC) parameters and continuous running test (CT) performance*

| | $VO_2$max | VCT | VO2AT | VAT | HRAT | HRmax |
|---|---|---|---|---|---|---|
| Age | **0.44** | 0.39 | 0.07 | -0.17 | -0.02 | 0.1 |
| Height | 0.09 | 0.05 | -0.18 | -0.06 | - | 0.02 |
| BM | -0.16 | -0.19 | -0.34 | -0.25 | -0.09 | -0.31 |
| FT% | **-0.47** | -0.08 | -0.36 | -0.12 | - | 0.16 |
| MM% | **0.43** | 0.14 | **0.42** | 0.23 | 0.06 | - |
| BMI | -0.32 | -0.34 | -0.29 | -0.24 | -0.1 | **-0.47** |
| BMR | 0.03 | -0.23 | -0.25 | -0.26 | -0.19 | **-0.48** |

**Figure 1** Relationship for FT% and VO2max

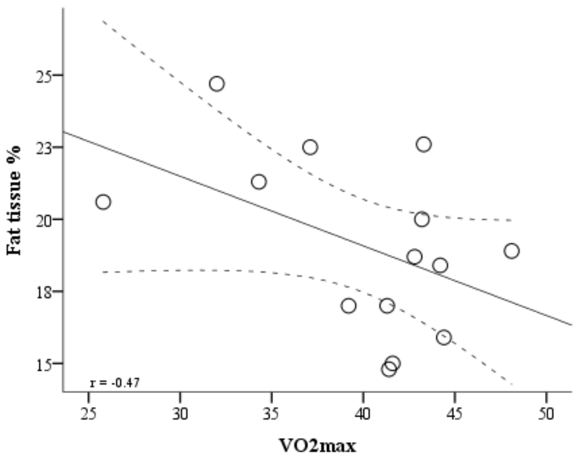



**Figure 2** Relationship for MM% and VO2AT

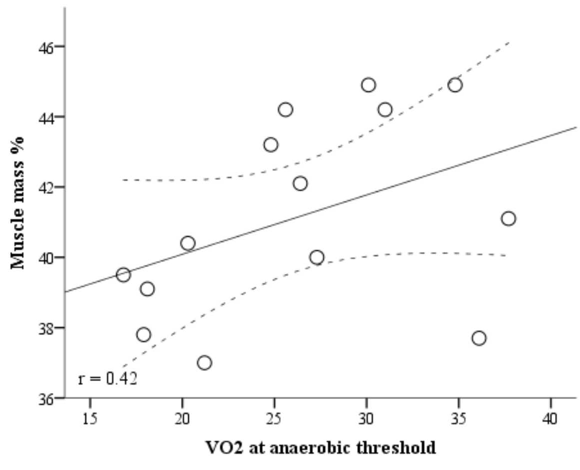


**Figure 3** Relationship for BMI and HRmax

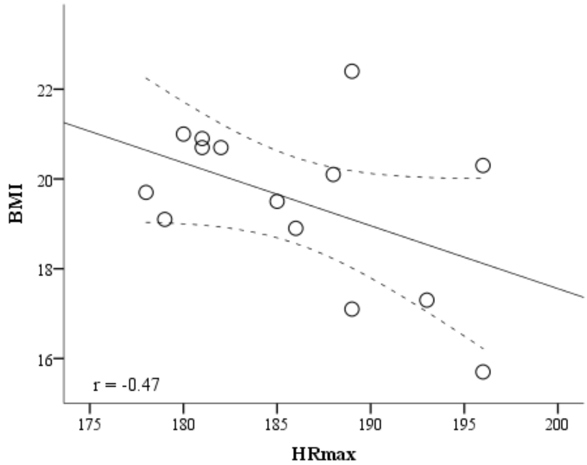
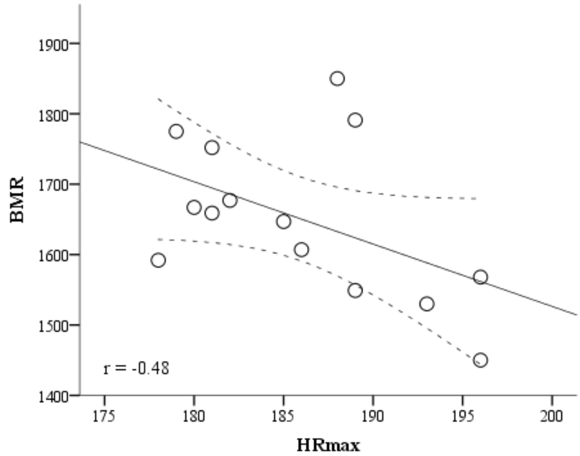



**Figure 4** Relationship for BMR and HRmax




# DISCUSSION

Data obtained can be taken as valid and objective. Results are suggesting that small to moderate relationship between observed body composition components and aerobic power exists. No single correlation suggested high depended relationship for all the parameters observed. Significantly positive transfer to maximal oxygen consumption was seen in players with higher muscle mass percentage and lower total body fat percentage. Maximal heart rate during CT was related to the BMI and BMR.

The most important finding of the present study was data for profiling Bosnia female soccer players. Mainly, regarding the body composition, players had similar features like indicated in previous studies (Davis & Brewer, 1993; Juric et al., 2007; Krustrup et al., 2005), with slightly lower average body mass when compared from results of study Nikolaidis (2014). However it is worth knowing that players' physical performance (CT) varied individually, and we are assuming that it is mainly related to training status rather than BC. In overall 14 subjects, the collected average value was around 39 ml/kg/min of peak oxygen consumption. The value obtained is lower than compared to the previous findings. Maximal speed reached during CT was 12.9 ± 1.4 km/h, while speed at anaerobic threshold was 8.4 km/h with range of 7-12 kmh/h. Maximal heart rate and heart rate at anaerobic threshold was 185.9 ± 6.1 and 151 ± 14.1 beats per minute.

Relatively high range of maximal oxygen consumption was observed (25 - 48 ml/kg/min). Since heart rate and $VO_2max$ highly correlate it can be concluded that aerobic loading for this cohort might not be equally distributed by individuals, especially since similar physical demands in match, usually above 80% of maximal heart rate (Mohr et al., 2002), are presented.

A positive correlation (*r=0.43*) between increased muscle mass and higher aerobic output was notable. The sample of female collegiate Miller et al. (2007) followed the changes in aerobic capacity and body composition before, during and after the season. A significant drop in $VO_2max$ and increase of body fat were observed prior to and after the competitive season. Authors conclude that drop in muscle mass was related to the decrease in aerobic fitness which supports our finding. Muscle mass correlates with $O_2$ consumption at anaerobic threshold as well (*r=0.42*). Oxidative lipid „burnout" happens in muscles which in addition emphasize the importance for optimal muscle mass maintaining.

An inverted dependence of maximal oxygen capacity and fat tissue percentage further supports previously stated. Heavier players with larger percent of body fat tend to have lower $VO_2max$ (Vanderburgh & Katch, 1996). It remains unclear wheatear the low fat percentage is caused by higher $VO_2max$ (training induced) and increased rate of lipid oxidation (Blaize, Potteiger, Claytor, & Noe, 2014), or that higher aerobic power output ($VO_2max$) originates in genetical predisposition for low body fat. This also implies the time at which lipids start to oxidize more rapidly.

HRmax at exhaustion negatively correlated to body mass index. The higher the BMI was, maximal pulse was lower. Similar dependence was observed for BMR and HRmax. Recent study (Nikolaidis, 2014) showed that BMI and fat free mass moderately correlates with aerobic power output during $PWC_{170}$ test

Further researching should be targeted towards sport specific demands in soccer. A standardized oxygen consumption (CR) must be taken into account. CR is normally expressed as oxygen consumption ($V^{\cdot}\ O_2$) at a standardized workload or volume of $O_2$ per meter when running. CR can provide with adequate information which can lead to a more effective training process. Localization of the body fat should be taken into account since it can influence the lipid oxidation.

## CONCLUSION

Aerobic power is related to soccer performance including high intensity efforts, total distance covered and ability to maintain energy demands during the game. Study has showed that female soccer players in Bosnia and Herzegovina tend to have similar body composition like that described in previous studies. However, it is obvious that the results vary individually, and that players were slightly underweighted with the same fat percentage. This means that they have lower absolute muscle mass. $VO_2max$ measured was lower in comparison to early published data. Study results showed that muscle mass and fat mass were related to $VO_2max$. Body fat mass should be reduced as much as possible. Muscle mass contributes towards better aerobic output in female soccer players. Optimal level of muscle mass is essential, and resistance training should be performed regularly. Practitioners and coaches should prescribe a training regime in order to improve and maintain optimal level of muscle mass and low body fat.

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# DIFFERENCE IN PHYSICAL PERFORMANCE AND BODY COMPOSITION IN FEMALE COMPETITIVE VOLLEYBALL SETTERS

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## SUMMARY

The purpose of this study was to determine the difference in physical performance and body composition in female competitive volleyball setters. Ninety female volleyball players participated in this study. Players were members of Volleyball clubs in three different levels. Players performed assessments of body composition and vertical jump. Significant difference was found in all variables except for BMI which had no significant differences at the 0.05 level. This study has confirmed that body composition and jumping ability could discriminate players in different level of play in female volleyball.

**Keywords:** training, competitive players, power, morphological characteristics

## INTRODUCTION

Elite male volleyball players have been reported to perform 250 to 300 high-power activities during a 5-game match (Hasegawa et al., 2002). Of these activities, the attack and block situations represent 45% of total actions of the game and are also responsible for 80% of the points obtained within international matches (Voigt & Vetter, 2003).

In addition to technical and tactical skills, muscular power is one of the most important factors that give a clear advantage for successful participation during volleyball competitions (Marques, Van den Tillaar, Vescovi, & Gonzalez-Badillo, 2008). It is believed that to improve their volleyball performance, players must arrange specific volleyball conditioning with some additional resistance and sprint and agility training (Scates & Linn, 2003). During the preseason, coaches usually implement a conditioning and training routine in attempt to maximally prepare their athletes for the upcoming competitive season. Accordingly, a number of studies have investigated the effects of different training methods at off-season (Gabbett & Georgieff, 2007), preseason (Sheppard et al., 2008), or during the competitive season in volleyball (Bloomfield, Polman, O'Donoghue, & McNaughton, 2007; Moir, Button, Glaister, & Stone, 2004; Stanganelli, Dourado, Oncken, Mancan, & da Costa, 2008).

Thissen-Milder & Mayhew (1991) showed that selected physiological and anthropometric characteristics could discriminate successfully among freshman, junior varsity, and varsity volleyball teams and starting and non-starting players. However, few data are available about female volleyball players and their abilities in volleyball. Moreover, to our knowledge, no previous study has examined the difference of physical characteristics and body composition in female volleyball setters concerning the level of players. In addition, it is unclear whether

Having in mind that season is very long and there is little time for preparation, there is a need for training in team sports to provide advantages in terms of time-efficiency, motivation, and training compliance (Gamble, 2007). Therefore, the purpose of this study was to determine the difference in physical performance and body composition in female competitive volleyball setters.

## METHODS

### Subjects

Ninety female volleyball players participated in this study. Players were members of Volleyball clubs in three different levels. Descriptive characteristics are presented in Table 1. Each player had at least 6 years of training experience, corresponding to 2 hour training sessions, and at least 1 competition per week.

## Procedure

Each athlete performed a standardized 15 minute warm-up consisting of general movements and dynamic and static stretching. After the general warm-up, players performed assessments of vertical jump.

**Table 1**. Descriptive statistics in three different levels

| | N | Mean | SD | Minimum | Maximum |
|---|---|---|---|---|---|
| First league | 29 | 19.86 | 3.11 | 14 | 26 |
| Professional | 37 | 23.27 | 4.51 | 16 | 34 |
| Top level | 24 | 26.87 | 4.43 | 19 | 34 |
| Total | 90 | 23.13 | 4.86 | 14 | 34 |

Players underwent physical tests assessments in an indoor stadium. During the test air temperature ranged from 22°C to 25°C. It began at 10 am and finished by 1 pm. Standard anthropometry (height, standing reach height, body mass) and lower-body muscular power (vertical jump and spike jump), were the physical tests selected. Players were instructed not to be involved in strenuous exercise for at least 48 hours before the fitness testing session and consume their normal pre-training diet before the testing session. None of the subjects were injured 6 months before the initial testing as well as during the training program. There was no supplement addition regarding the nutrition of players. In addition, subjects were not taking exogenous anabolic-androgenic steroids and other drugs that might be expected to affect physical performance or hormonal balance during this study. Measurements were taken on Monday morning because the athletes had rested during the weekend. The testing session began with anthropometric measurements. Players were then instructed to assess the lower-body muscular power (block jump, spike jump). Subjects performed 3 trials for muscular power tests, with a recovery of approximately 3 minutes between trials. Players were encouraged to perform static stretching between trials.

Body height and body weight were measured according to the instructions of the International Biological Program–IBP (Weiner & Lourie, 1969). The body height was measured with a GPM anthropometer (Siber & Hegner, Zurich, Switzerland ) to the nearest 0.1 cm. Body weight was obtained by TANITA BC 540 (TANITA Corp., Arlington Heights, IL) to the nearest 0.1kg.

Body mass index was calculated by formula: BMI=Body mass (kg) / (Heighy (m))2. Percentage of body fat (Bfat%) was calculated by formula: Adult body fat % = (1.20 x BMI) + (0.23 x Age) - (10.8 x gender) - 5.4 (Deurenberg et al., 1991).

## Spike and block jump performances

For the standing reach, while wearing their normal volleyball footwear, players were requested to stand with their feet flat on the ground, extend their arm and hand, and mark the standing reach height while standing 90° to a wall. Players were encouraged to fully extend their dominant arm to displace the highest vane possible to determine their maximum standing reach height. The measurement of the standing reach height allowed for a calculation of the relative jump heights on each of the jumping tasks (absolute jump height (cm) – standing reach height (cm) = relative jump height) (Sheppard et al, 2009).

Spike and block jump performances for volleyball players depend heavily on the height at which these skills are performed above the net and are determined by not only the capacity of the athlete to raise vertically his center of gravity, but also his stature and standing reach. In this particular case, specific tests would provide a further understanding of the training-induced adaptation. For the Spike jump, the standing reach was determined as the maximal distance between the fingertip of the attack hand and the ground, while standing 90° to a wall. The Spike jump was measured from a running lead (2- or 3-step approach) by using a basketball backboard marked with lines 1 cm apart with a 1-

minute rest interval between them. For the Block jump, the standing reach was determined as the maximal distance between fingertips of the block hands and the ground, while facing the wall. The Block jump jumps started from a standing position with the hands at shoulder level and arms raised from the start position without extra swing. All tests used the same observer who was situated on a volleyball referee stand placed 2 m from the backboard. Both jumps were recorded as the best of the 3 attempts (Stanganelli, et al, 2008).

# RESULTS

Table 2 shows the differences between the groups at the univariate level. The table shows that there are significant differences in all variables except for BMI which had no significant differences at the 0.05 level.

**Table 2.** Difference between groups

| | | Sum of Squares | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Body height | Between Groups | 421.438 | 210.719 | 7.491 | .001* |
| Body weight | Between Groups | 282.559 | 141.279 | 4.372 | .016* |
| BMI | Between Groups | 2.621 | 1.311 | .450 | .639 |
| Fat% | Between Groups | 90.301 | 45.150 | 6.194 | .003* |
| Block jump | Between Groups | 15898.361 | 7949.181 | 43.521 | .000* |
| Spike jump | Between Groups | 4626.999 | 2313.499 | 11.753 | .000* |

**Table 3.** Post-hoc Tukey test

| | (I) groups | (J) groups | Mean Difference (I-J) | Std. Error | Sig. |
|---|---|---|---|---|---|
| Height | first | professional | -3.925* | 1.315 | **.010** |
| | | Top level | -5.318* | 1.464 | **.001** |
| | professional | first | 3.925* | 1.315 | **.010** |
| | | Top level | -1.393 | 1.390 | .578 |
| | Top level | first | 5.318* | 1.464 | **.001** |
| | | professional | 1.393 | 1.390 | .578 |
| Body mass | first | professional | -2.492 | 1.410 | .187 |
| | | Top level | -4.609* | 1.569 | **.012** |
| | professional | first | 2.492 | 1.410 | .187 |
| | | Top level | -2.117 | 1.490 | .335 |
| | Top level | first | 4.609* | 1.569 | **.012** |
| | | professional | 2.117 | 1.490 | .335 |
| BMI | first | professional | .1520 | .4232 | .931 |
| | | Top level | -.2720 | .4708 | .832 |
| | professional | first | -.1520 | .4232 | .931 |
| | | Top level | -.4240 | .4472 | .611 |
| | Top level | first | .2720 | .4708 | .832 |
| | | professional | .4240 | .4472 | .611 |
| Fat % | first | professional | -.43967 | .66959 | .789 |
| | | Top level | -2.47182* | .74503 | **.004** |
| | professional | first | .43967 | .66959 | .789 |
| | | Top level | -2.03215* | .70762 | **.014** |
| | Top level | first | 2.47182* | .74503 | **.004** |
| | | professional | 2.03215* | .70762 | **.014** |
| Block jump | first | professional | -9.458* | 3.352 | **.016** |
| | | Top level | -33.950* | 3.729 | **.000** |
| | professional | first | 9.458* | 3.352 | **.016** |
| | | Top level | -24.492* | 3.542 | **.000** |
| | Top level | first | 33.950* | 3.729 | **.000** |
| | | professional | 24.492* | 3.542 | **.000** |
| Spike jump | first | professional | -11.600* | 3.480 | **.004** |
| | | Top level | -18.276* | 3.872 | **.000** |
| | professional | first | 11.600* | 3.480 | **.004** |
| | | Top level | -6.676 | 3.677 | .171 |
| | Top level | first | 18.276* | 3.872 | **.000** |
| | | professional | 6.676 | 3.677 | .171 |

*. The mean difference is significant at the 0.05 level.

The greatest differences were found in tests Block jump and Spike jump where the differences were in the level of significance of 0.01.

According to post hoc test (Table 3), there is significant difference between first league and top level volleyball setters in almost all variables accept for BMI. Difference between professional and top level setters was found for body height, fat% and block jump. Other variables showed no statistical differences between groups.

# DISCUSSION

The aim of this study was to determine the difference in physical performance and body composition in female competitive volleyball setters. We have found significant differences between setters of different level. The difference was obvious in almost all variables between first league setters and top level setters. However, difference between professional and top level setters was found in for body height, fat% and block jump ($p<0.05$).

Smith, Roberts & Watson (1992) compared physical, physiological, and performance characteristics of national-level and college-level volleyball players and found significantly higher block and spike jumps, 20-m speed, and VO2max in the national-level players. Palao, Santos & Ureña (2004) have found a significant difference in male volleyball players between team levels for the skills of spiking and blocking. In females, a significant difference in the performance of the spike in level 1 teams was found. In addition, Milić, Nešić, Trajković & Radenković (2012) found statistically significant differences in volleyball accuracy tests between the volleyball players from the First and Second League which was not the case for effectiveness, where significant differences were not found. Our results were similar with those found in aforementioned authors. Grgantov, Katić & Janković (2006) have stated that the elementary technique of all volleyball elements is important for competition success and have indicated that the mastering of the technique of volleyball elements is a longstanding process that should be paid due attention in all age groups. However, this study has confirmed that body composition and jumping ability could discriminate players in different level of play in female volleyball. The importance of body fat and jumping ability at different competition levels could be confirmed with this kind of research.

# CONCLUSION

Setters have the main role in the team. Methodology of setters'training is one of the most difficult type of training. The efficiency of the training depends on resources of CNS. Setters always have problem drills where the problem must be solved in a short time,in the front row,in quite complex combinations of attack and defence.It is insisted in each drill on the correctness of the technique of lifting. All the structures (kinematic,dynamic,rhythmic) are adjusted to the situation during the training,which simulate match situations. Great variability in structure of lifting and elements of the situation requires a lot of effort for the setter,other players and the coach. The setter has to find his own way of lifting,because only in this case he activates intelectual functions of the nervous system. Setters who base their lifting on copying a successful setter,will never overcome roll model's skills.

Setting is an action used both in attack and defence (some authors define it as a synthesis between attack and defence),so every setting is unique and unrepeatable. There rises a question of possibility of shaping a reasonable training methodology which is common for training model of a seetter.

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# DIFFERENCES BETWEEN PLAYERS OF DIFFERENT RANKS OF COMPETITION IN THE COGNITIVE ABILITIES

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## SUMMARY

The specific contribution of psychological abilites for success in sport has been the subject of numerous previous studies. Athletes are constantly expected to perform under high tension. For this reason it is not surprising that psychological characteristics as personality are often influence the differences and the separation of those who are highly successful athletes from those who are less successful in some sport. The aim of this research is to determine differences between players of different ranks of competition in the cognitive abilities. For that purpose, only part of the battery SVPN - 1 without V - verbal factors, have been implemented.Based on these results it can be concluded that there aren't significant differences in the cognitive abilities between football players of different ranges of competitions.

**Keywords:** cognitive abilities, different rank of competition

## INTRODUCTION

Cognitive abilities are human abilities that enable the reception, transmission and processing of information, which is realized in contact with the environment. They really are the basis of thoughts, conscious activities and without them it would not be possible to analyze sports scores, control and manage all other operations in the thought process of training work. Success in sports is determined by a number of factors, among which an important role morphological, motor, physiological and psychological factors. The specific contribution of psychological abilites for success in sport has been the subject of numerous previous studies (Araki, K., Mintah, J. K., Mack, M. G., Huddleston, S., Larson, L. & Jacobs, K, 2006; Janssen, I., Dostaler, S., Boyce, W. F. & Pickett, W., 2007; Pallesen, S., Nordhus, I. H., Carlstedt, B., Thayer, J. F. & Johnsen, T. B. 2006; Steinar, S., Arne, E. & Roald, B. 2007). Athletes are constantly expected to perform under high tension. For this reason it is not surprising that psychological characteristics as personality are often influence the differences and the separation of those who are highly successful athletes from those who are less successful in some sport (Morris, 2000). Earlier researches show a strong relation between the psychological characteristics and sport performance (Morgan and Pollock, 1977; Morgan, 1979; May, J. R., Veach, T. L., Reed, M. W. & Griffey, M.S. 1985). There are also attempts to identify the content that is associated with motivation, self-esteem, control anxiety, mental preparation, team empathy and concentration (Mahoney, M. J., Gabriel, T. J., & Perkins, T. S. 1987). It has been established that the fear and anxiety can negatively affect the success of athletes, while the psychological factor confidence is positively associated with performance athletes (Cartoni, A. C., Minganti, C. & Zelli, A. 2005). There is a much larger number of studies dealing with the influence of psychological factors on performance in elite athletes (Chroni, S., 1997; Reuter, J. M. & Short, S. E. 2005; Short, S. E., Reuter, J. M., Brandt, J., Short, M. W. & Kontos, A. P., 2004; Stevens, M. J., Lane, A. M., 2001). Williams & Franks (1998) cite that a potential indicator for football talent including anthropometric, physiological, cognitive and psychosocial variable. Lanc (1972), whose research with title “Relation function tests and tactical skills in sports games”, wanted to establish the kind of relations that certain factors of cognitive abilities (measured test SVPN-1 represented by four variables) and the success achieved by the students from Zagreb, in overcoming tactical tasks in some sports fields (football, handball, basketball and volleyball). Examinees were I and II year of faculty. The results indicate, in most cases, that tactical skills in individual sports games do not depend on the level of development of individual primary cognitive functions. However, a significant value on the correlation was obtained between the battery of tests (cognitive ability) SVPN-1 and tactical skills in soccer. Thus the results tell us that there is a correlation factor of intelligence and tactical ability of certain sports games. In addition to this, the author concludes that the correlation is significant but not high enough to be able to assume that the general factor of intelligence main predictor of success in some sports games. The aim of this research is to determine differences between players of different ranks of competition in the cognitive abilities.

# METHODS

## Subjects

The sample of research were 252 football players from the Greek football league (126 players from second division and 126 players from the third division), conferred by the position in the football field at the 5 sub samples: goalkeepers (36), central defender players (60), the full back players (48), midfielders (60) and forwards (48).

Procedure

Each participant will have to meet pre-defined conditions, to enter the sample: to regularly attend training sessions, that the respondents voluntarily attended training in the football club. All the players had more than 3 years of experience that the participants are healthy, participants do not have physical defects, morphological aberrations damaged locomotor apparatus, and they do not possess greater pathophysiological abnormalities. The players were fully-informed of all the experimental procedures. All these tests from the SVNP – 1 battery of tests, are performed in group, and the time of testing is limited. The sample of the variables represented three cognitive abilities tests. For the area of cognitive abilities, one factor and educational test will be applied to one factor and educational. For that purpose, only part of the battery SVPN - 1 without V - verbal factors (Momirović & Horga, 1982), have been implemented.

- Specialisation test - This test assesses the visual factor of specializing. Using this factor can be evaluated the ability of representing spatial relations, which plays an important role in a football game;
- Perception Test - This test assesses the primary factor perception and visually establishes the essential characteristics of the perceptual field. It is located on the border of physiological and psychological capabilities.
- Numerical test - This test assesses numerical factor, i.e. the ability of fast computing and manipulating numbers. This capability is important in the sport due to the programming and quantitative attitude in the records of planning and measurement.

## Statistical analysis

All results have been analyzed in the statistical program Statistics 7.0 for Windows. For all variables basic parameters of the descriptive statistics were calculated: the minimum score (Min), maximum score (Max), mean (Mean), standard deviation (Std. deviation). To determine a statistically significant difference between the groups for each variable was used a T - test, where for the statistical significant difference the value of the significance level to 0.05 ($p \le 0.05$) was taken. Differences in the multivariate and univariate level was assessed using the canonical - discriminant analysis were assessed differences in the investigated areas and different ranges of competitions.

# RESULTS

**Table 1.** Multivariate difference between II and III league in the cognitive abilities

| | Eigen- - value | Canonical - R | Wilks' - Lambda | Chi-Sqr. | df | p |
|---|---|---|---|---|---|---|
| 0 | 0.006659 | 0.081332 | 0.993385 | 1.649272 | 3 | 0.648270 |

Based on the results in Table 1, it can be noted that it has not been established significant discrimination in the area of cognitive abilities between players II and III in the league (p = 0.648270). The canonical correlation coefficient (Canonical R = 0.08 indicates that significant canonical functions is explained with 8%. Statistical significance of discrimination which represents the sum of the square of the correlation coefficient in size to the entire set of variables is very high and is explained by Chi-Sqr test and is (1.65). Structure of examined variables (Table 2) indicates the existence of one significant discrimination function, whose contribution hierarchically primarily belongs to numerical test, then the specialisation test and at the end the perception test. By analyzing Table 3, in which are shown the univariate differences between II and III league in the cognitive abilities, it can be noted that there are not statistically significant differences in all three tests.

**Table 2.** Structure of examined variables

| Variable | Root 1 |
|---|---|
| SPA | 0.470674 |
| PER | -0.338646 |
| NUM | 0.620190 |

**Table 3.** Univariate differences between II and III league in the cognitive abilities

| Variable | L | N | Mean | SD | F | p |
|---|---|---|---|---|---|---|
| SPA | II | 126 | 18.14 | 3.167 | 0.368797 | 0.544212 |
| | III | 126 | 17.90 | 3.264 | | |
| PER | II | 126 | 17.59 | 6.893 | 0.190915 | 0.662533 |
| | III | 126 | 17.97 | 6.948 | | |
| NUM | II | 126 | 14.93 | 4.770 | 0.640320 | 0.424355 |
| | III | 126 | 14.45 | 4.676 | | |

# DISCUSSION

In this research we didn't found differences between players of different ranks of competition in the cognitive abilities, so this confirms some earlier research in which the authors came to the same or similar results (Ismail & Gruber 1971, Petrić 1994).

The relation between motor and cognitive abilities indicate that there is a significant positive relationship between coordination and less in balance, and the general factor of intelligence (Ismail & Gruber, 1967; Momirović, Horga & Bosnar, 1982).

This research confirm research that Sekereš (1967) performed using SVPN-1 tests to check intelligence. Based on the results, he came to the conclusion that intelligence affects performance in a football game, or that the coefficient of correlation statistically significant at 5 percent.

# CONCLUSION

Based on these results it can be concluded that there aren't significant differences in the cognitive abilities between football players of different ranges of competitions.

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# CHARACTERISTICS OF THE DEVELOPMENT OF THE EXPLOSIVE STRENGHT AND AGILITY IN YOUNG BASKETBALL

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## SUMMARY

Basketball is a sport that consists of short but very intense activities, interrupted by longer or shorter periods of passive or active rest, during which the basketball player recovers. Vertical jumps, which require an appropriate level of explosive strength are of great importance for success in basketball and are manifested in situations such as jump shot and jump towards the ball. Agility is a motor ability which is also important for basketball. Motor structures of this type are very common in the game because, due to changes of the situations, the players are required to start quickly, to run fast and change the direction, as well as to stop quickly. The **aim** of this study was to determine the differences in the explosive strength and agility between younger pioneers, pioneers, cadets and juniors and identify where that difference is greatest, in order to recognize the period when the development of the mentioned skills is greatest. The sample in this study consisted of 89 basketball players of basketball clubs: YBC "Constantine" from Nis, YBC "Junior" from Nis and BC "Mašinac" from Kraljevo. The respondents were of various ages: younger pioneers (n = 21), pioneers (n = 27), cadets (n = 22) and juniors (n = 19). The respondents were in the basketball training process for at least three years. For the assessment of the explosive leg power of the basketball players, two tests were used: jump from the squat (Squat jump) - SJ and jump from the squat with the preparation (Countermovement Jump) - CMJ. To assess the agility of the basketball players, two tests were used: Agility T Test - ATT and Hexagon Agility Test - HAT. The data analysis was performed with the help of One-factor analysis of variance - ANOVA. The results showed that there were significant differences in the tested abilities between younger pioneers and pioneers, as well as between the pioneers and cadets, but not between cadets and juniors. The results also show that the development of the mentioned capabilities is largest in the transition from the pioneer in the cadet age.

**Key words**: explosive leg strength, young basketball players, agility, sensitive stages, development.

## INTRODUCTION

Basketball is a sport that consists of short but very intense activities, interrupted by longer or shorter periods of passive or active rest, during which the basketball player recovers (Jakovljević, Karalejić, Pajić & Mandić, 2011). These activities are of explosive character such as: short sprints, quick stops and accelerations, changes of direction, different jumps, throwing and passing the ball (Nikolić, Kocić, Berić & Jezdimirović, 2015). The explosive strength is an extremely important motor skill for dealing with basketball (Lehnert, Hůlka, Malý, Fohler & Zahálka, 2013; Zhang, 2013). "*The ability of muscles to manifest significant strain in minimal time is characterized by the explosive strength*" (Verhošanski, 1979, 24). "*The maximum value for power or strength that a specific muscle or muscle group can develop in the shortest period of time is referred to as an **explosive force** or **explosive strength***" (Radovanović, 2009, 201). The explosive strength is genetically determined about 80% (Jovanović, 1999; Stojiljković, 2003). Vertical jumps, which require an appropriate level of explosive strength (Bober, Rutkowska-Kucharski, Pietraszewski & Lesiecki, 2006), are of great importance for success in basketball (Nedeljković, 2004; Bobbert, 1990), and are manifested in situations such as jump shot and jump towards the ball (Manojlović & Erčulj, 2013). One basketball game includes an average of 46 ± 12 rebounds for each player, with or without eccentric-concentric phase (Castagna, Chaouachi, Rampinini, Chamari & Impellizzeri, 2009; Pavlović, Nikolić, Zivković & Berić, 2013). Jump is the only element of basketball techniques with whose execution players just cannot overdo it (Wissel, 2011). Another motor skill which is very important for basketball is agility (Jovanović, 1999; Lehnert, Hůlka, Malý, Fohler & Zahálka, 2013; Nikolić, Kocić, Berić & Jezdimirović, 2015). Motor structures of this type are very common in the game because, due to changes of the situation, players are required to start quickly, to run fast and change the direction, as well as to stop quickly (Jovanović, 1999). Possession of optimal agility reduces the possibility of injury, has influence on the improvement of sport achievements and neutralizing the opponents, or avoiding of opponents by using body deception. The term "agility" is not easy to explain because it represents the synthesis of almost all physical abilities of athletes (Verstegen & Marčelo, 2010). It is defined by motor tasks composed of fast running with frequent changes of direction (Jovanović, 1999). The ability of quick stops and changes of direction is an obvious example of physical ability that provides the conversion of classic speed into specific speed in almost all sports (Kremer & Gomez, 2010). Some authors define it as "a quick coordination", because it involves movement structures in which there is a rapid moving of body in space, while the primary motor task is structuring movements (Jovanović, 1999). In this study, the subjects were young basketball players, adolescents. Adolescence is defined as a period that begins at the age between 11 and 13, is characterized by the development of secondary sexual characteristics, and lasts until 18-20 years. In this period there are intensive physical, psychological, emotional and personal changes (Kuzman, 2009). The development of motor skills should be in function of sensible phases. Sensible phases are periods of time particularly suitable for learning, but also as particularly vulnerable phases for professional insufficient or incorrect methodical procedures. If we respect the sensitive phase and apply adequate training operators for the development of precise motor skills, there is a possibility to develop them to the maximum. In doing so, of course, it includes the concept of an individual maximum of each individual who is genetically determined. This approach creates a quality basis and conditions for further development of specific motor skills as well as technical and tactical skills (Kocić & Berić, 2015). In the formation of basic and specific motor abilities, it is important to pay attention that the load, the contents and modalities of work are in line with the basic biological and sport principles of the development of young athletes (Badža & Sudar, 2011).

The **subject** of this study is the explosive strength and agility of young basketball players. The **aim** of this study was to determine the difference in explosive strength and agility between the young pioneers, pioneers, cadets and juniors and identify where the difference is greatest.

# MATERIALS AND METHODS

## Sample of the respondents

Sample of the respondents in this study consisted of 89 basketball players of the basketball clubs: YBC "Constantine" from Nis, YBC "Junior" from Nis and BC "Sloga" from Kraljevo. The respondents were of different ages: young pioneers (n = 21), pioneers (n = 27), cadets (n = 22) and juniors (n = 19). The respondents were in the training basketball program for at least three years. None of them had been subjected to special training programs for the development of motor skills in the past, but only to technical and tactical training of basketball. The respondents, the specialists in the field of sports, parents and the administration of clubs were aware of the way and rules of testing and the parents and the administration of clubs approved that the data obtained by testing could be used for scientific purposes.The basic characteristics of the respondents are given in Table 1.

**Table 1** The basic characteristics of the respondents

| Age | N | Age of the respondent | Body height (average) | Body mass (average) |
|---|---|---|---|---|
| Juniors | 19 | 17-18 | 184,55cm | 78,19kg |
| Cadets | 22 | 15-16 | 183,36cm | 72,95kg |
| Pioneers | 27 | 13-14 | 171,35cm | 59,66kg |
| Younger pioneers | 21 | 11-12 | 156,61cm | 48,07kg |
| Total | 89 | 11-18 | 173,66cm | 64,17kg |

## Sample of the measuring instruments

For the assessment of the *explosive leg power* of basketball players, two tests were used:

1. *Squat jump* - SJ and
2. *Countermovement Jump* - CMJ.

The parameter of the explosive leg power which was obtained by the device *Optojump*, and which was statistically processed, was the jump height (in cm).

To assess *agility* of the basketball players, two tests were used:

1. *Agility T Test - ATT;*
2. *Hexagon Agility Test - HAT.*

The parameter obtained by agility tests is the time for performing the task (1/10 sec). The measuring instrument was a stopwatch.

All the listed measuring instruments for assessment of the explosive leg strength and agility were taken from the site Topend Sports: http://www.topendsports.com/testing/tests/index.htm.

## Statistical analysis

Data analysis was performed by the program for statistics SPSS 20, namely: Kolmogorov-Smirnov test for determining the normality of distribution, one-factor analysis of variance (ANOVA) to determine the differences between groups, subsequent comparisons by Tukey test for determining the differences between each pair of groups, descriptive statistics- frequency for obtaining relevant data, relevant to this research.

# RESULTS

**Table 2** Kolmogorov-Smirnov test

| Variables | Statistic | df | Sig. |
|---|---|---|---|
| SJ | ,094 | 72 | ,189 |
| CMJ | ,087 | 72 | ,200* |
| ATT | ,134 | 72 | **,003** |
| HAT | ,093 | 72 | ,200* |

**Table 3** One-factor analysis of variance (ANOVA)

| Variables | Age | N | Mean | Std. Deviation | F | p | Eta Squared |
|---|---|---|---|---|---|---|---|
| SJ | Juniors | 12 | 32,60 | 6,91757 | 32,365 | **0,00** | 0,567 |
| | Cadets | 21 | 29,01 | 4,86815 | | | |
| | Pioneers | 24 | 21,36 | 4,50313 | | | |
| | Young pioneers | 21 | 18,02 | 3,91713 | | | |
| CMJ | Juniors | 12 | 37,97 | 6,29073 | 49,503 | **0,00** | 0,670 |
| | Cadets | 21 | 33,18 | 6,26862 | | | |
| | Pioneers | 23 | 23,70 | 4,25478 | | | |
| | Young pioneers | 21 | 18,57 | 4,12276 | | | |
| ATT | Juniors | 19 | 9,82 | ,77369 | 53,222 | **0,00** | 0,653 |
| | Cadets | 22 | 10,21 | 1,02184 | | | |
| | Pioneers | 27 | 13,62 | 2,17330 | | | |
| | Young pioneers | 21 | 15,01 | 1,80303 | | | |
| HAT | Juniors | 19 | 12,89 | 1,92384 | 38,313 | **0,00** | 0,593 |
| | Cadets | 19 | 11,99 | 1,98333 | | | |
| | Pioneers | 24 | 16,52 | 1,67973 | | | |
| | Young pioneers | 21 | 20,38 | 4,51277 | | | |

Legend: **N** - number of respondents; **Mean** - mean; **Std. Deviation** - average deviation from the mean; **F** - variance between groups divided by the variance within groups; **p** - level of significance; **Eta Squared** - size of the impact (differences between groups); **Note** - The level of significance for this study was p <0.05.

Based on the results shown in Table 2, one of the four variables violates the assumption of normality of distribution (Sig. <0.05). It is quite usual for large samples (Pallant, 2011).

In Table 3, One-factor analysis of variance (ANOVA) shows that there is a statistically significant difference between the groups at the variable **SJ** (F=32.365, p=0.000). Based on Eta Squared=0.567, the difference between groups is **large**. According to Kohen, 0.01 is little impact (small difference), 0.06-medium impact (difference), 0.14 and more-a large impact (difference) (Pallant, 2011). Also, a statistically significant difference between the examined groups exists in **CMJ** variables (F=49.503, p=0.000). Based on Eta Squared=0.670, the difference between groups is **large**. A statistically significant difference between the examined groups exists in variable **ATT** (F=53.222, p=0.000) and **HAT** (F=38.313, p=0.000), and based on Eta Squared=0.653, respectively Eta Squared=0.593, the difference between groups is **large**.

Considering the fact that the difference in Table 3 for all variables is statistically significant, we started subsequent tests to determine the significance of the differences between each pair of the groups which we found important for this survey.

**Table 4** Subsequent comparisons by Tukey test

| Variables | Age | Mean | Mean Difference (I-J) | p | Eta Squared |
|---|---|---|---|---|---|
| SJ | Juniors | 32,60 | 3,59048 | 0,188 | / |
| | Cadets | 29,01 | | | |
| | **Cadets** | 29,01 | 7,65119* | **0,000** | 0,411 |
| | **Pioneers** | 21,36 | | | |
| | Pioneers | 21,36 | 3,33452 | 0,112 | / |
| | Young pioneers | 18,02 | | | |
| CMJ | Juniors | 37,97 | 4,78571 | 0,060 | / |
| | Cadets | 33,18 | | | |
| | **Cadets** | 33,18 | 9,47660* | **0,000** | 0,454 |
| | **Pioneers** | 23,70 | | | |
| | **Pioneers** | 23,70 | 5,13292* | **0,008** | 0,281 |
| | **Young pioneers** | 18,57 | | | |
| ATT | Juniors | 9,82 | - 0,38758 | 0,868 | / |
| | Cadets | 10,21 | | | |
| | **Cadets** | 10,21 | - 3,41581* | **0,000** | 0,494 |
| | **Pioneers** | 13,62 | | | |
| | **Pioneers** | 13,62 | -1,38270* | **0,021** | 0,107 |
| | **Young pioneers** | 15,01 | | | |
| HAT | Juniors | 12,89 | 0,90737 | 0,746 | / |
| | Cadets | 11,99 | | | |
| | **Cadets** | 11,99 | -4,52436* | **0,000** | 0,615 |
| | **Pioneers** | 16,52 | | | |
| | **Pioneers** | 16,52 | -3,86935* | **0,000** | 0,262 |
| | **Young pioneers** | 20,38 | | | |

Legend: **Mean Difference (I-J)** - the difference between the mean values of the group; **Mean** - mean; **p** - level of significance; **Eta Squared** - size of the impact (differences between groups).

In Table 4, the subsequent tests for multiple comparisons show that there is a statistically significant difference between the *pioneers* and *cadets* at the variable **SJ** (p=0.00), and based on the mean value (Mean), we can see that the cadets (Mean=29.01) achieved better results than the pioneers (Mean=21.36). Based on Eta Squared=0.411, the difference between groups is **large.** It is interesting that among *juniors* and *cadets*, as well as between the *pioneers* and *younger pioneers*, there is no significant difference in the mentioned variable.

A statistically significant difference between the *pioneers* and *cadets* there is at the variable **CMJ** (p=0.000), and based on the mean value (Mean), we can see that the cadets (Mean=33.18) achieved better results than the pioneers (Mean=23.70). Based on Eta Squared=0.454, the difference between groups is **large.** There is also a significant difference in the variable **CMJ** between *younger pioneers* and *pioneers* (p=0.008), and based on the mean value (Mean), we can see that the pioneers (Mean=23.70) achieved better results than younger pioneers (Mean=18.57). Based on Eta Squared=0.281, the difference between groups is **large.** As with the variable SJ, there is no significant difference between *cadets* and *juniors* at this variable.

The findings further indicate that a statistically significant difference between the *pioneers* and *cadets* exists in the variable **ATT** (p=0.000), and based on the mean value (Mean), we can see that the cadets (Mean=10.21) achieved better results than the pioneers (Mean=13,62). Based on Eta Squared=0.494, the difference between groups is **large**. Significant differences in the variable **ATT** also exists between *younger pioneers* and *pioneers* (p=0.021), and based on the mean value (Mean), we can see that the pioneers (Mean=13.62) achieved better results than younger pioneers (Mean=15.01). Based on Eta Squared=0.107, the difference between the groups is **median.** As with previous variables, at this one there is no significant difference between the *cadets* and *juniors*.

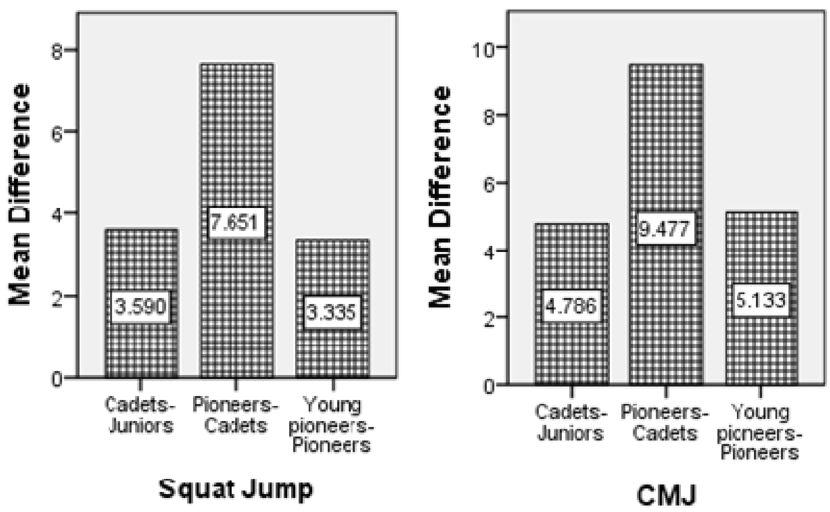
With the variable **HAT,** there is also a statistically significant difference between the *pioneers* and *cadets* (p = 0.000), and based on the mean value (Mean), we can see that the cadets (Mean=11.99) achieved better results than the pioneers (Mean=16.52). Based on Eta Squared=0.615, the difference between groups is **large**. A significant difference in the variable **HAT** exists also between *younger pioneers* and *pioneers* (p=0.000), and based on the mean value (Mean), we can see that the pioneers (Mean=16.52) achieved better results than younger pioneers (Mean=20.38). Based on Eta

Squared=0.262, the difference between groups is **large**.

# DISCUSSION

The results of this study showed that on the test for assessing the explosive strength **SJ,** *cadets* achieved significantly better results than the *pioneers*, and this difference was **large** (Eta Squared = 0.411). It is interesting that on this test there was no significant difference between the *cadets* and *juniors*, as well as the *younger pioneers* and *pioneers*. Based on these results, we can conclude that the development of explosive strength, which means reaching the maximum values of the same only through the concentric muscle contraction (without previous stretching-eccentric contraction), is largest in the transition from the *pioneer* in the *cadet* age. On **CMJ** test, the *cadets* also achieved significantly better results than the *pioneers*, but on this test *pioneers* achieved significantly better results than *younger pioneers*. In both cases the difference is **great**, but on the basis of Eta Squared we can see that the difference is greater between the *pioneers* and *cadets* (Eta Squared = 0.454) than between *younger pioneers* and *pioneers* (Eta Squared = 0.281). On this test also there is no significant difference between the *cadets* and *juniors*. Based on these results, we can conclude that the development of the explosive leg strength, which means reaching the maximum values of the same through eccentric-concentric muscle contraction, is also largest in the transition period from the *pioneer* in the *cadet* age. On Chart 1 and 2 with the help of indicator Mean difference, which shows the difference between the mean values of the groups, we can see the aforementioned relations.

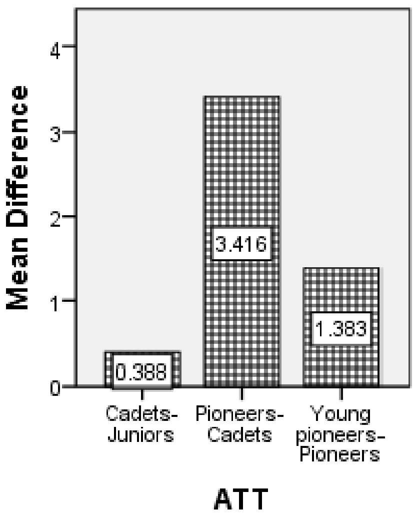
**Chart 1 and 2** Ratio of the difference between the mean values of the groups for SJ and CMJ

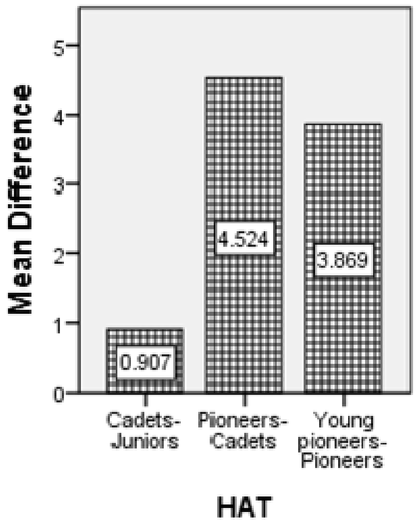



Considering the fact that the explosive strength depends on the development of muscle mass, but also on maturing of neuromuscular units, actually on the developing coordination, as well as that the explosive leg strength grows rapidly to 14 and 17 years of age and then gradually begins declining until the old age (Bala, 1991), it is clear why we get results which show that the greatest development of the explosive leg strength is between the *pioneer* and *cadet* age (13-16 years). This period is characterized by the growth and development with the changes taking place in the context of the completion of the sexual maturity, there is an intense development of skeletal, the ossification process is nearing its completion, musculature increases its weight and power (Đurašković, 2002). The motor behavior of children depends on their biological growth and development. The different levels of growth of bones, muscles, ligaments and organs, as well as the development of organ systems, are in close conjunctions with the physiological functions of the whole organism, all of which affect the motor behavior (Bala, 1991). The development of the explosive strength in the subjects of this study is the result of the biological growth and development and technical-tactical basketball training. The respondents would probably achieve better results if, in addition to the tactical and technical training, they also had specific training to develop power and explosive strength. However, what this study shows is that the development of the explosive leg strength after the cadet level (in the junior age) will not be continued under the influence of biological growth and development in the combination with the basketball technical-tactical training, and that it is necessary to include other stimuli in the form of a specific training for the development of the explosive leg strength. The ideal would be to include such a training even earlier, at the stage of sensibility, in order to raise the level of this development and keep it for a longer time, and later postpone the period of the decline of corresponding basic motor skills, in this case the explosive leg strength. According to Bala (1991) the development of the explosive strength requires work, particularly in the period from 4 to 10 years of age, and later even more, in the period from 12 to 16 years. Boys of the mentioned age represent a very important age category in basketball because after the junior age, they start preparing for the transition to the senior age. An important feature of this age is that the motor skills of players are at a relatively high level, but there is also the possibility of adaptation and progress in all of these abilities (Ilić & Janković, 2014). Coaches and athletes should know that the development of the explosive strength represents the last step in the sport development (Donald Ču, 2010). Some of the training methods that can be used to develop the explosive leg strength of junior player age are: complex training, plyometric training, SAQ training and so on. Complex training is founded by Russian and Bulgarian trainers and involves a combination of large and small loads within a workout. Among the coaches there is an opinion that the simultaneous mastering of large external loads (ex. a weight) and small loads (ex. body mass), would produce a better neuromuscular adaptation (Kukrić, Karalejić, Petrović & Jakovljević, 2009). In recent years, science has confirmed the assumption of trainers and in research work came to the conclusion that the complex training could lead to large effects of training (Cheng, Lin & Lin, 2003; Santos & Janeiro, 2008; Kukrić, Karalejić, Jakovljević, Petrović & Mandić, 2012 ; Roden, Lambson & DeBeliso, 2014). Plyometrics is a popular training method that is widespread among athletes in order to develop the ability to counteract the force of gravity (Jamurtas at al., 2000). A large number of studies have confirmed that plyometrics can improve the explosive power of the lower extremities (Khlifa at al., 2010; Shallaby, 2010; Wee, Mudah & Tan, 2011). SAQ training is considered to be a method of training (speed, agility, explosiveness) that includes progressive exercises to develop skills so that athletes should be more adept at higher speeds and with greater precision (Polman, Bloomfield & Edwards, 2009). The research shows that this training can give good results with basketball players (Prasad & Subramainiam, 2014; Ademović, 2015).

The results further showed that on the test of agility **ATT,** the *cadets* achieved significantly better results than the *pioneers*, and *pioneers* significantly better results than *young pioneers*. In the first case the difference is **large** (Eta Squared=0.494), and in the other is **medium** (Eta Squared=0.107). On this test also there is no significant difference between the *cadets* and *juniors*. On the test **HAT** *cadets* also achieved significantly better results than the *pioneers*, and *pioneers* than the *young pioneers.* In both cases the difference is **great**, but on the basis of Eta Squared we can see that the difference is greater between the *pioneers* and *cadets* (Eta Squared=0.615) than between *young pioneers* and *pioneers* (Eta Squared=0.262). On this test there is also no significant difference between the *cadets* and *juniors*. Based on these results, we can conclude that the development of agility is largest in the transition period from the *pioneer* to the *cadet* age. In Chart 3 and 4 with the help of indicator Mean difference which shows the difference between the mean values of the groups, we can see the aforementioned relations.

**Chart 3 and 4** Ratio of the differences between the mean values of the groups for ATT and HAT



The development of agility in the subjects of this study is the result of biological growth and development, as well as technical-tactical basketball training. Since most of the tasks in basketball are performed on a relatively small area, insisting all the time on the speed of realization of complete structure of the movement, it is assumed that the results of the tests of agility are significantly affected by the ability to develop the maximum force. This is especially important, because in the majority of the tasks it is necessary to master a relatively large force of inertia in the moments of change of direction (Kocić, 2007). For this reason, we believe that the development of agility is largest during the period of transition from the pioneer age to the cadet age, for the same reason as in the case of developing the explosive leg strength. Specifically, we believe that the biological growth and development in these years contribute significantly to the development of the explosive leg strength and agility combined with technical-tactical training. When the biological growth and development slows after the cadet age, there is also a slower progress of the mentioned skills, so in addition to technical-tactical basketball training it is necessary to use some more specific training stimulus to continue progression.

## CONCLUSION

The results of this study showed that the development of the explosive strength and agility is largest in the transition from the *pioneer* in the *cadet* age, slightly lower then when crossing from *young pioneer* age in the *pioneer* age, and very small, statistically insignificant, when crossing from the *cadet to junior* age. This development has been influenced by the biological growth and development and basketball, tactic-technical training. It is expected that, with the biological growth and development, in conjunction with the basketball training techniques and tactics, the explosive leg strength and the agility of basketball players develop. However, it is interesting that the development of the mentioned abilities declined during the period of transition from *cadet* to *junior* age. Probably in that period, the biological growth and development slowed down and it slowed the development of the measured abilities. Therefore, in this period it is important, in addition to technical and tactical basketball training, to include some more specific training methods to continue the progression. Although basketball technical - tactical training contributed to the development of the explosive leg strength and agility, in this study we did not determine how big role such training had. Probably the development of the explosive leg strength and agility would even be greater if in the phases of sensitivity the specific training methods to develop these skills were used, which of course would be in line with the basic biological and sport principles of the development of young athletes.

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# INFLUENCE OF MOTOR SKILLS ON SITUATIONAL SUCCESS IN HANDBALL

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## SUMMARY

The aim of this paper is to discover certain information related to the impact of motor characteristics on the success in situational plays in handball, based on the data from collected research. The analysis of 14 studies, in which the aim was to test the basic and specific motor activities of men's and women's handball players, as well as non-athletes with basic knowledge of handball (university students) of different ages, brought to the conclusion that the examined parameters have a great impact on the success in situational plays in the game of handball. During the effective implementation of a basic technical element in handball – the shot, explosive power and precision have the biggest role. This data can be of great use to coaches in planning and programming of the training process, but also in selection of young handball players. Motor characteristics, agility and explosive leg strength are the most important factors in completing defensive tasks. However, these characteristics cannot be taken as decisive parameters for the selection of players separately. It is necessary to develop a complete motor status of players, with greater emphasis on motor characteristics that prevail in solving situational tasks of the game.

**Keyword*s:*** motor characteristics, handball, shot speed, player positions

## INTRODUCTION

In the basics of every sport, there is antagonism that encourages players to improve themselves and their athletic shape in order to achieve better results and obtain victories at competitions. There are many factors that influence the efficiency of the competitors and the end result. Dominance of an individual is, to a large extent, reflected in the development of his motor characteristics compared to others, and the more developed they are, a player is in a more superior position.

Handball is a team sport played with a ball, in which two teams play against each other with seven players on the court. The aim of this game is to score more goals than the opponent within a time period of 60 minutes. The ball is passed with hands during the game, which, in modern handball, takes place in indoor conditions.

Improving the form of a handball player can be conducted in different ways, but a growing number of researchers believes that the fastest way to achieve the desired results is through situational training because the conditions are similar to the in-game conditions. In order for the player to respond to the tasks of the competition, he/she needs to be well-prepared in the context of motor skills.

Motor skills are considered to be the abilities of an individual that participate in solving motor tasks and enable successful movements, regardless of whether they were acquired by training or not. It is increasingly noted that motor skills are manifested in a variety of very complex tasks. There are discoveries that the basis of motor skills consists of simple, but also very complex integral movements. The relationship between the conditions of neuromuscular system, the movement apparatus and other bodily functions (analog physiological, biochemical, cognitive and conative mechanisms) may have different impacts on the behavior of the body and its effectiveness (Malacko & Rađo, 2004).

The current level of scientific knowledge makes it possible to note that motor skills are manifested in a certain way, during different tasks. Factorial approach to the research of motor space eventually led to relevant information that confirm that there are several motor skills (factors), which led to questions about the structure of motor abilities, that is, to the question how many motor skills does a human being actually has, how are they connected, what are their relations with other segments of the anthropological status and what is, in matter of importance, their influence on particular sports activities (Malacko & Rađo, 2004).

The aim of this study is to, based on the collected research, attain certain knowledge related to the impact of motor characteristics to situational success in handball.

## METHODS

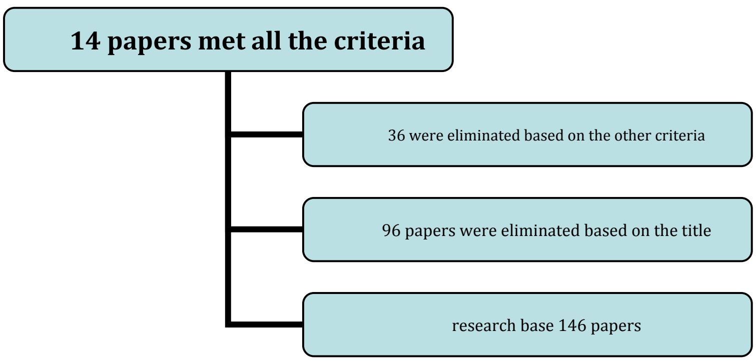
The references were collected based on the scientific papers that were available at the academic network "Kobson", which includes magazines of national and international importance, whereas some of the papers were found at the "Google Scholar" and "PubMed", the academic network browsers. The papers were found with the help of keywords such as: motor characteristics, situational performance, handball, physical fitness. Furthermore, the papers were selected based on the year in which the research was conducted and only those papers written in the period between 2002 to 2015 were taken into consideration.

The scientific papers were primarily selected based on several criteria. The first criterion included titles and keywords. Narrowed selection included the papers noting that their studies concerned the impact of motor skills on the result at a competition. The second criterion for the selection of scientific papers is that only the papers that described the impact of the development of motor characteristics to the efficiency level of certain technical elements that are significant for the final result. The third criterion for the selection was that the research included both male and female athletes who are professionally engaged in handball, as well as students who are trained to know the basic elements of the game of handball.

## THEORETICAL APPROACH TO THE PROBLEM

The study includes 14 selected scientific papers. The initial number of identified papers that fulfilled some of the criteria for the selection was 146. Just based on the title, 96 papers were eliminated and another 36 papers were eliminated on the basis of other criteria (the sample of participants, types of research and years of publication). (Figure 1.)

**Figure 1.**



# RESULTS

**TABLE 1** Chronological and spreadsheet display of the chosen researches

| | AUTHORS AND YEAR | NUMBER | SEX | AGE | THE INTENSITY OF STUDY | CONCLUSION |
|---|---|---|---|---|---|---|
| 1. | Rogulj, Srhoj & Barović (2002) | 57 | M/F | 18-19 | - General success in situational-motor tests | - Repetitive and static power have a negative impact in situational-motor variables. - Absolute and explosive power have a positive impact. |
| 2. | Vuleta, Bečić & Grujić (2003) | 53 | M | 13-14 | - General success in situational-motor tests | - Precision (hitting the target from a static position) has a positive impact in situational-motor tests. |
| 3. | Foretić Erceg, Bračanić Tocilj (2005) | 45 | M | 11-15 | - Testing of basic motor skills<br>- Anthropometric characteristics | - Explosive power of arms, shoulder and torso have a major impact on throwing velocity. |
| 4. | Marques, Van Den Tillaar, Vescovi & Gonzalez-Badillo (2007) | - | M | 24 | - Ball-throwing velocity, 3-step and dynamic power, force and speed of the lever in concentric muscle contraction while performing bench press | - Throwing velocity in elite players is associated with maximal dynamic power, strength and the speed of the lever. |
| 5. | Rogulj, Foretić, Srhoj, Čavala & Papić (2007) | 42 | M/F | 19-21 | - The influence of basic motor skills on velocity of the ball during a jump shot and a shot from the ground in handball | - Motor efficiency to a large extent determines the velocity of the ball<br>- Velocity of the ball from the jump shot and the shot from the ground at the level of statistical significance was determined only by explosive power in the form of throwing. |
| 6. | Lakota, Talović, Jelešković & Bonacin (2008) | 82 | M | 11-14 | - A programmed, three-month transformation procedure based on situational methods<br>- Movement control on the ground, and striking the goal | - There is a significant impact of the program on the development of situational-motor characteristics. |
| 7. | Karišik & Goranović (2010) | 60 | M | 19-33 | - The influence of motor abilities on success of movements in defense analysed<br>- Explosive power of the vertical jump and ball-throwing, agility, speed power, repetitive power and flexibility | – For successful execution of situational motor movement tasks without the ball, high level of motor skills, agility and explosive power of lower limbs are required. |
| 8. | Bulava, Rodić & Grujić (2011) | 22 | M | 20-25 | - Basic and specific motor skills | - Precision, as a specific motor ability, has a large share in the final outcome which is manifested through the ability of hitting a stationary target (goal post), most commonly during movement, but also from a static position. |
| 9. | Rogulj, Srhoj & Čavala (2011) | 20 | M | 15-16 | - Basic motor skills<br>- Situational-motor efficiency | - Speed and explosive power of the vertical jump, agility, leg movement frequency, repetitive power of the trunk and aerobic-anaerobic endurance are the most important determiners of situational success of young players. |
| 10. | Ilias, Panagiotis, Triantafylos, Dimitros & Loannis (2011) | 182 | M | 14.3 | - Differences in physical quality and anthropometric characteristics depending on players positions and relationship between throwing velocity and the measured parameters | - Anthropometric and physical differences exist in young players depending on different player positions. These parameters influence the velocity of the ball. |
| 11. | Herbert, Jurgen, Miriam, von Duvilard Serge & Erich (2012) | 24 | M | - | - Differences in performance and variability of movements for several throwing techniques in various phases of throwing and with different player skills | - The results indicated the increase of variability of common distal movements during the phase of acceleration. |
| 12. | Vila, Manchado, Rodriguez, Abraldes, Alcaraz & Ferragut (2012) | 130 | F | 24.98 ± 4.80 | - Describe anthropometric characteristics, throwing velocity, grip and leg muscle strength<br>- Identify possible differences of these parameters depending on player positions | - A higher level of ball-throwing velocity directly behind the 9-meter line was demonstrated by backs in comparison to the wings |
| 13. | Pantelis & Jorgen (2013) | 11 teams | M | - | - The differences between physical and physiological characteristics among elite players from elite handball teams, ranked differently | - Players from higher-ranked teams showed better results in all motor tests than the players from lower-ranked teams. |
| 14. | Massuça, Fragoso & Teles (2014) | 167 | M | - | - Differences in morphological, fitness-specific handball skills, physiological and "bio-social" components of elite and non-elite handball players. | - The results showed that the most important factor for determining the model of a handball player is the fitness component in respect to all other factors. |

# DISCUSSION

The youngest group of participants was between 11-14 years of age (Lakota, Talović, Jelešković & Bonacin, 2008). Excluding the studies in which the age of the particpants was not determined (Herbert, Jurgen, Miriam, von Duvilard Serge & Erich, 2012; Pantelis & Jorgen, 2013; Massuca, Fragoso & Teles, 2014) the oldest group was 25.74 ± 4.84 years old (Vila, Manchado, Rodriguez, Abraldes, Alcaraz & Ferragut, 2012). The group with the least number of participants counted 20 (Rogulj, Srhoj & Čavala, 2011), and the group with the most participants had 182 (Ilias, Panagiotis, Triantafyllos, Dimitrios & loannis, 2011). One study had only female participants as samples (Vila et al., 2012), whereas two other studies had only first-year students as participants (Rogulj, Srhoj & Banović, 2002; Rogulj, Foretić, Srhoj, Čavala & Papić, 2007). All other studies had professional handball players as participants.

## Correlation between throwing velocity and motor characteristics

Handball coaches have the task to, through their designed training process, infiltrate as successful handball players as possible, developing their physical abilities. For this reason, scientists have studied this issue and reached significant conclusions that contribute to the improvement of training planning. In order to determine which motor characteristics prevail in situational plays of the game of handbal, it was necessary to perform testing of a particular sample of participants that would be considered relevant to make the right conclusions. Sample diversity (amateurs, professional athletes) leads to a more precise determination of dominant motor characteristics in handball.

After testing of situational-motor skills of the first-year students, although statistically significant differences were not recorded, it is noticeable that repetitive and static strength expresses negative impact on performance in situational-motor variables, as opposed to absolute and explosive force, which have a positive contribution. Therefore, kinesiological structures based on long repetitions or endurance not appropriate for handball less contribute to situational success of players than maximally explosive movements done one time or in fewer repetitions one-time (Rogulj, Srhoj & Banović, 2002). This data was confirmed by the research of Rogulj, Foretić, Srhoj, Čavala & Papić (2007), who tested the basic motor characteristics of first-year students and came to the conclusion that the speed of the ball thrown from a jump shot and the speed of the ball thrown from the ground, at the level of statistical significance, are determined only by the explosive power of the throw. The results of regression analysis indicated that motor efficiency substantially determines the speed of the ball.

The shot is the basic element of execution in handball and the final result of the match depends on it. By perfecting the technique of throwing the ball and by improvement of motor skills that affect its performance, we contribute to a more favorable outcome at a game in comparison with the opponent who is inferior in all these parameters. However, in order to achieve the desired goal, it is necessary to harmonize the execution technique with the motor skills of a player, because the influence of some motor characteristics decreases in certain situations, whereas in others, the influence increases. Foretić, Erceg, Bradarić & Tocilj (2005) tested the basic motor skills of 45 handball players, 11-15 years of age. A series of multiple regression analysis showed that explosive power of arms, shoulder and torso has a large influence on the shot speed, but that the effect decreases with technically more complex shots such as a jump shot. Differences in shot speed from the ground and from the jump shot have a biomechanical ground. However, even though the shots vary in biomechanical terms, the research Herbert, Jurgen, Miriam, von Duvilard Serge & Erich (2012) indicates that, in addition to the fact that the variability of the movement grows in the phase of acceleration of a throw, handball players have the ability to compensate the increase of the variability of the movement in order to throw accurately, and more skilled players were capable to control the movement even when the variability of the movement decreased during a throw from the ground or from a running position. This leads to the conclusion that players with better coordination will be better at performing the element of execution in offense. Marques, Van Den Tillaar, Vescovi & González-Badillo (2007) conducted a research in which they established a connection between the throwing velocity, the 3-step and dynamic power and force and speed of the lever in concentric muscle contraction during the performance of bench press in elite, 14 years old handball players. The results showed that throwing velocity in elite handball players is associated with maximal dynamic power, force and the speed of the levers. This means that greater power, force and speed of the lever causes the increase in throwing velocity.

This is a very important piece of information that coaches could implement in planning and programming of their training process. It also demonstrates the correlation between power, as one of the basic motor characteristics, and throwing velocity. There are also motor characteristics that did not show any significant effect on throwing velocity. The research Ilias, Panagiotis, Triantafyllos, Dimitrios & loannis (2011) came to the conclusion that throwing velocity is significantly correlated with all variables except BMI and flexibility.

One of the most important, but also the most sensitive characteristics for which it is necessary to have a good kinesthetic sense, good judgment of the parameters of the objective and kinesthetic motion control at a certain path, is definitely precision. Bulava, Rodić & Gruić (2011), by examining the basic motor skills of 22 handball players, 20-25 years of age, came to the results which confirm that the precision, as a specific motor skill, has a large share in the final outcome, which is manifested through the ability of hitting a fixed target (the goal post), most commonly during movement, but also from a static position. The results of this study also confirm the fact that the development of precision can be influenced directly (with the contents related to the throw) or indirectly (contents that improve space-time alignment of the performance). That precision has a large share in the final result confirms an earlier research by Vuleta, Bedić & Gruić (2003) on a sample of 32 handball players 13-14 years of age. Although the inheritance coefficient for this motor characteristic is quite high, there is a possibility to improve it, but under the condition that the athlete be put into situational conditions of solving various, specific tasks, and then to achieve an appropriate relationship between technique and tactics. Research by Lakota, Talović, Jelešković & Bonacin (2008), in which 82 young handball players were involved in a three-month training process based on situational methods, 11-14 years of age, confirms that solving specific tasks can help to improve precision.

## Development of motor characteristics depending on player position

To determine the model of a handball player, the fitness component is the most accurate when compared to all the other components. In the process of forming a top handball player, it is necessary to put the emphasis on the development of motor characteristics which are most practiced in the game of handball (Massuca, Fragoso & Teles, 2014). In young handball players, the biggest differences were found in the variables for assessing the speed power and explosive power of vertical jump, agility, leg movement frequency, repetitive power of the trunk and aerobic-anaerobic endurance. The results of this research suggest that these characteristics, which most significantly determine the situational performance of young handball players, in the programming and implementation of the training process, need special attention This is also the case in the process of player selection – the advantage should be given to the players who are dominant in the above mentioned abilities (Rogulj, Srhoj & Čavala, 2011).

To properly program a training process, it is necessary to determine which motor characteristics are specific for individual player positions in handball. There is not a big difference in dominant parameters for different playing positions between male and female handball, except in the volume of expressing them, which occurs due to the physiological status of the body structure of men and women. The research by Vila et al. (2012) had 130 female handball players from Spain as participants (age 25.74 ± 4.84 years; player experience 14.92 ± 4.88 yr.). The results related to the motor characteristics were as follows: backs and circle runners showed more muscle mass than wings, and backs showed a higher level of throwing velocity directly behind the 9-meter line compared to the wings. The demonstration of these motor skills are influenced by anthropometric characteristics of players. Ilias, Panagiotis, Triantafyllos, Dimitrios & loannis (2011), while conducting their study, found a significant difference in all the examined variables depending on the players' positions, except for flexibility. Backs were taller, whereas the circle runners had a longer wing span and arm length. The wings were shorter, with less body weight and BMI. The wings and backs showed the best results in the standing vertical jump, 30-meter sprint, flexibility and VO2max. Goalkeepers showed the lowest performance in all motor skills tests.

The game of handball has become considerably more dynamic in recent years, with quick changes of direction in offense as well as in defense. For this reason, the requirements for player positions have significantly changed, therefore today there are players who play in only one phase of the game (defense/offense). To properly conduct a practice in order to facilitate the efficiency of defensive players, it is necessary to determine the dominant motor characteristics in those conditions of the game. Karišik & Goranović (2010), using a sample of 60 members of the top handball players of the Premier League of Bosnia and Herzegovina,19-33 years of age, analyzed the impact of motor skills on success of movement in defense. The motor space was tested with 7 variables for assessment of explosive power of vertical jump and throwing, agility, speed power, repetitive power and flexibility. Based on the gathered results, it can be concluded that the high level of motor skills, agility and explosive power of lower limbs correlates with the successful execution of movement tasks without the ball. From this, a conclusion can be drawn that explosive power is one of the most dominant and most important motor characteristics in handball players for achieving an effective performance in offense and defense.

The importance of the development of motor skills in handball players is reflected in the ranking at the end of the competitive period. It is well-known that in sports, only the best win, which means that, at the end of the season, the team with the best technically trained, tactically fitted players and players well-prepared in terms of motor skills will be the highest ranked team. This fact was confirmed by the research conducted by Pantelis & Jorgen (2013), where the players of the best ranked team achieved the best results in all motor tests.

# CONCLUSION

The aim of this paper is to, based on the collected studies, attain certain knowledge related to the impact of motor characteristics to situational success in handball, has been accomplished. Through analysis of 14 scientific papers, in which the aim was to test basic and specific motor activities of handball players, both male and female, and non-athletes with basic knowledge of handball (students), all of different ages, the conclusion was made that the examined parameters have a great impact on situational success in the game of handball itself.

During the effective implementation of the basic technical element in handball – the shot, the most dominant factors are explosive power and precision. This data can be of use to coaches when planning and programming the training process, but also when conducting the selection of young handball players. Motor characteristics, agility and explosive leg power are the most important factors in solving tasks on the defensive end. However, these characteristics can not separately be taken as decisive parameters for player selection. It is necessary to develop a complete motor status of players with a greater emphasis on motor characteristics that prevail in solving situational tasks of the game.

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# IMPACTS OF A SPECIFIC MODEL OF TRAINING ON IMPROVEMENT OF MAXIMAL OXYGEN UPTAKE IN FOOTBALL PLAYERS

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## SUMMARY

It is well known that aerobic power is very important, if not the most important functional parameter in modern football. Aerobic power is the parameter or property that we call maximum oxygen uptake. Training sessions for the improvement of maximum oxygen uptake require a well-planned program based on scientific facts and methods. In a sample of 17 football players from football club "Borac" Banja Luka it was investigated the possibility of improvement of maximum oxygen uptake, using the specific training model in duration of 4 weeks. To estimate maximal oxygen uptake was used beep-test. Value of the results obtained in the initial and final measurements were analyzed using t-test for paired samples ($p=\leq 0.05$). Based on data obtained by the analysis it was concluded that the specific training model proved to be effective in improving maximal oxygen uptake.

**Keywords:** maximal oxygen uptake, training, football players

## INTRODUCTION

Due to the complexity of the game of football, it is necessary for football players to possess a high level of functional characteristics so that they could respond to the technical-tactical demands of the game and achieve top sports results. It is a well-known fact that aerobic strength is a very important, if not the most important functional parameter in modern football. Aerobic strength is represented through the parameter or feature which is known as maximum oxygen uptake or $VO_{2max}$. Modern day football requires an oxygen intake of approximately 75% $VO_{2max}$ (Bangsbo, 1994), which is matched by an intensity close to the anaerobic threshold of top football players. For the past 20 years, many studies have been carried out on the topic of the anaerobic threshold of elite football players in order to gain insight which would to a great extent facilitate the programming of the training process and condition further progress. Verheijen (1998) determined that the values of maximum oxygen uptake in the case of football players of the first national league in Germany range between 60 and 67 ml/kg/min. Casajus (2001) recorded values of maximum oxygen uptake of 66,4 ml/kg/min among the football players of the Spanish first league. The value of maximum oxygen uptake of football players of the Norwegian first football league was 64,3 ml/kg/min (Helgerud et al., 2001). Training sessions for the improvement of maximum oxygen uptake require a well-planned program based on scientific facts and methods. The aim of this study was to determine how specially programmed training models lead to an improvement in maximum oxygen uptake among football players of the Premier league of Bosnia and Herzegovina.

## METHODS

### Subjects

Seventeen elite male football players (age, 26.12±5.86 years), from Football Club „Borac" Banjaluka, one of the top 16 teams in the Bosnia & Herzegovina 2011/12 Premier League participated in this study. All players had at least 3 years of professional and elite training experience. Before beginning the study all players underwent a physical examination by the team physician and were cleared of any disease or endocrine disorders, which could have limited their ability to effectively participate. Further, no athletes had a history of serious injury nor were any athletes taking medication during the study. All experimental procedures and possible risks and benefits were explained to each athlete. Further, each player participated voluntarily and signed a written consent form prior to the onset of participation. The study was designed in compliance with the recommendations for clinical research of the Declaration of Helsinki (2013) of the World Medical Association. This study was also reviewed and approved by the Board of directors of FC "Borac" Banjaluka.

## Procedure

The following variables were evaluated in the study: $VO_{2max}$ –maximum oxygen uptake (ml/kg/min) and $HR_{max}$ – maximum heart rate frequency (r/min).

In order to evaluate maximum oxygen uptake, the field BEEP test was used (the multistage fitness test) (Leger & Lambert 1982). During the test performance all of the participants wore a pulsometer POLAR S610 (Polar Electro Oy, Kempele, Finland), so maximum heart rate frequency was also noted.

The work program which was implemented in this study was divided into three seven-day micro cycles. During the first micro cycle one extensive and two intensive training sessions focusing on the improvement of maximum oxygen uptake were implemented (the 2 x 15' run, the 5 x 1000 m run and the Bangsbo modified sprint test, 16,5 min.). The second micro cycle consisted of two intensive training sessions (the 5 x 1000 m run and Billat 30"-30" – 20 min). During the third micro cycle two intense training sessions were also realized, with the addition that one training session was meant to sustain the effect (Billat 15"-15"- 18' and the 4 x 4 min run).

## Statistical analysis

All of the data collected during the study were processed using descriptive and comparative statistics. In order to test the differences between the initial and final status, the t-test for dependent (paired) samples was used, with the significance level set at $p \leq =0.05$. For the mathematical processing of the original data, the STATISTICA 7 for Windows program was used (StatSoft, Inc., Tulsa, OK).

## RESULTS

Based on table 1. it can be seen that the sample of participants was exceptionally homogenous, which is supported by the very low value of the coefficient of variation (CV). The aforementioned is valid for both studied variables, both at the initial and at the final measuring. The results of the maximum oxygen uptake ($VO_{2max}$) and maximum heart rate frequency ($HR_{max}$) at the initial and final measuring do not deviate in a statistically significant manner from the normal distribution. These data speak in favor of the application of procedures in the domain of parametric comparative statistics, irrespective of the smaller sample of participants.

**Table 1.** Descriptive parameters of relative maximal oxygen uptake and maximum heart rate in the initial and final state

| Varijable | N | Mean | St.dev. | Min. | Max. | CV | K-S |
|---|---|---|---|---|---|---|---|
| **$VO_{2max}$_I** | 17 | 57.46 | 1.67 | 53.78 | 60.90 | 2.91 | .242 |
| **$VO_{2max}$_F** | 17 | 59.07 | 2.58 | 54.00 | 63.02 | 3.93 | .175 |
| **$HR_{max}$_I** | 17 | 189.82 | 7.47 | 175.00 | 198.00 | 4.36 | .194 |
| **$HR_{max}$_F** | 17 | 190.17 | 8.61 | 176.00 | 201.00 | 4.53 | .139 |

Legend: N - number of subjects; Min. - minimum results; Max. - maximum results; Mean – the mean; St.dev. - standard deviation; CV - coefficient of variation; K-S - Kolmogorov/Smirnov distribution normality test results.

In order to determine the possible differences in the maximum oxygen uptake and maximum heart rate frequency, which are the consequence of the experimental treatment of the participants, the results of the initial and final measuring were subjected to a statistical comparative procedure through the application of a t-test for dependent (paired) samples. The results of the t-test indicate that the difference which occurred during the time between the initial and final state of the maximum oxygen uptake is statistically significant at the studied level of 0.05 (p=0.011). The negative t value indicates that the participants had a greater value than the maximum oxygen uptake at the final measuring. In the observed period, there were no statistically significant changes in maximal heart rate frequency (table 2.).

**Tabela 2.** Differences between initial and final state of relative maximal oxygen uptake and maximum heart rate frequency

| Varijable | Mean | Diff. | t | p |
|---|---|---|---|---|
| **$VO_{2max}$_I** | 57.46 | -1.62 | -2.87 | 0.011* |
| **$VO_{2max}$_F** | 59.07 | | | |
| **$HR_{max}$_I** | 189.82 | -0.35 | -0.26 | 0.795 |
| **$HR_{max}$_F** | 190.17 | | | |

Legend: Diff. - the difference between initial and final state; t - the value of T-test coefficient; p - significance of the T-test coefficient; * - statistically significant differences.

# DISCUSSION

During a football game, most of the used energy originates from the aerobic energy system (Bangsbo, 1994), and for that reason the determination of the maximum aerobic power of football players is expressed through maximum oxygen uptake, as a very important parameter. These data gain in value if we take into consideration that they are in high correlation with the overall covered distance by the football player during a match (Helgerud et al., 2001). The high value of $VO_{2max}$ enables the football player to retain a high level of technique, coordination and mental concentration in the final part of the game. Another quality which refer to the development of maximum oxygen uptake is the ability to perform the repetitive sprint activity. Research has indicated that better results in terms of abilities of repetitive sprint are achieved by those football players who have a better developed $VO_{2max}$, that is, the intensity of running speed decreased less with the number of repetitions (Aziz et al., 2000). Football is characterized by a continued course of activities with intermittent game intensity. At the same time light running [< 11km/h; < 80% maximum oxygen uptake ($VO_{2max}$)] is predominantly expressed from the overall group of movement activities, followed by walking and high intensity running (11-18 km/h; approximately 80% $VO_{2max}$), and then by sprint (11-27 km/h; < 85% $VO_{2max}$). Heart rate frequency (HR) constantly exceeds 150 beats/minute and during two thirds of the game exceeds 85% of the value of maximum heart rate frequency (Reilly et al., 2000). Precisely knowing the characteristics of modern day football, and starting from the effectiveness and economy of the training session, the continued method for the development of aerobic capacity is used less and less, and instead the interval method imposes itself as the best possible means of improvement of $VO_{2max}$. The training model applied in this study has proven to be successful, since following its application there has been an improvement in maximum oxygen uptake. However, the average value of $VO_{2max}$ of 59,07 ml/kg/min, achieved by the football players of the FC Borac from Banja Luka, is lower than the average values of elite football players of leading Europe countries, where the average values of maximum oxygen uptake were recorded at 66,4 ml/kg/min among the football players of the Spanish first league (Casajus, 2001), while the average value of maximum oxygen uptake among Norwegian football players of the first league was 64,3 ml/kg/min (Helgerud et al., 2001), but greater than the $VO_{2max}$ values (53,8 ml/kg/min) reported in the Mexican first division (Diaz et al., 2003) and in the Serbian & Montenegro Superleague (53,8 ml/kg/min) (Ostojić et al., 2003).

# CONCLUSION

The research was carried out with the aim of determining how the specially programmed training model impacts the improvement of maximum oxygen uptake in the case of football players. Seventeen football players took part in this study, members of the Borac football club from Banja Luka. Based on the obtained data and completed analyses, it can be concluded that the model applied in this study has proven to be successful, since a statistically significant improvement in maximum oxygen uptake was achieved.

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# PERFORMANCE ANALYSIS OF VOLEYBALL CLUBS IN THE PLAY-OFF STAGE OF THE "WIENER STADTISCHE" SERBIAN LEAGUE IN SEASON 2015/2016

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## SUMMARY

The aim of this scientific research paper is to carry out an analysis of the competitive activity and the statistical performance in the games of men volleyball teams that participated in the Serbian Volleyball League in season 2015/2016. The sample of this research consists of four men volleyball teams that have participated in the play-off stage of the competition called "WIENER STADTISCHE" Serbian Volleyball League and which have taken the last four places in the table at the end of the season. This research paper includes six games of the volleyball clubs Ribnica, Radnicki, Klek and Inđija i.e. their mutual matches in the play-off stage of the competition. The program "Data-volley", designated by the International Volleyball Federation, was used for the variables of the technical-tactical dimension of the competitive activity structure. Statistical and analytical research method were used in this research. With the conducted research it was concluded that the efficiency coefficients and the results of technical and tactical activities have a high level of correlation with the final outcome of the match, but any individual element in volleyball that has the determining percentage performance statistics in the final outcome of the match should not be singled out.

**Keywords:** voleyballl, analysis, performance, clubs

## INTRODUCTION

The volleyball technique takes a dominant place in the volleyball game. In volleyball, the technique has a central place and it is directly reflected in the score of the match. The practice has shown that there are differences in the quantity and the quality of specific motor skills manifestation of players within a single team (Milic, 2011). Every position on the team requires from the volleyball players to own, in the appropriate mutual relations, certain competitive characteristics (Nešić, 2002). For accessing the effectiveness of performing technical-tactical elements of the volleyball game, only performances with impeding the opponent are counted in. Then, the current state of special preparedness of the players is being determined. The method of watching the game video is also being used, but now the game is analyzed by segments (sets, parts of the sets...). The obtained indicators depict the current state of the physical and of the technical-tactical preparedness i.e. the state of the sporting form in which the individuals and the team are. Due to the previously mentioned, the achievement of top competitive scores is today virtually impossible without the appropriate awareness of the coaches, application of scientific findings in training procedures and in the procedures of modeling the athlete's state, the training process and the competitive activity itself (Milišić, 2003). An unbiased gathering of feedback on the competitive activity and its appropriate integration and presentation to the players leads to a positive effect on the quality of the training process (Shawaryn, 1999., Wilson, 1998., Antoniadis, 1997), which indicates a positive psychological influence both on the players and on the coaches. These findings are also indirectly confirmed by the results of the research on the effect of using statistics and video recordings on the quality of the communication between the coaches and the athletes, hich is reflected in a more efficient performance of the players on the field, especially in the area of smaller number of errors. In the research studies, which had for their subject the technical-tactical activity of the volleyball players during the match, the conclusion was reached that the factor of crucial importance was the efficiency of performing the technical-tactical elements, such as serve, block, defense, reception, dig and attack, which allow the volleyball game structure to be valorized with the help of the efficiency that is being displayed (Osmankač, 2000). Different authors have different visions of the structure of the competitive activity during the volleyball game (Strahonja, 1972, Vukovic & Milosevic1996., Patsiaouras, Moustakidis, Charitonidis, & Kokaridas, 2011).

# METHODS

## The sample of respondents

The sample of this research consists of four men volleyball teams that have participated in the play-off stage of the competition called "WIENER STADTISCHE" Serbian Volleyball League and which have taken the last four places in the table at the end of the season. In accordance to the Rules of the "WIENER STADTISCHE" Serbian Volleyball League, the league is played by the double point system, where the games are scheduled by "Berger" on the basis of the drawn team numbers. At the end of the league competition, the teams take final rankings on the table, unless the first-placed team from League is not the winner of the Play-Off. At the end of the competition, from the Super league to the First League goes the X-ranked team, or the team that took the last place on the table. In the 2015/2016 competing season the aforementioned was the Inđija team.

## The sample of variables

A group of variables related to the technical-tactical dimensions of the competitive activities was represented in the research. It goes without saying that the "Data-volley" program, standardized by the *International VolleyballFederation is being used for accessing the elements of the game* (Beal, 1987). Elements of the technique that are applied in the game and which were analyzed are:

1. serve
2. reception
3. attack and
4. block

**Serve**

- mark # is for a serve with which a point was directly made, the so-called ace
- mark + is for a serve that disabled a good reception for the opponent
- mark /, - i ! is for a serve that enabled a good reception for the opponent, that may be regarded as a fault
- mark = is a fault while serving with the direct point for the opponent (serve at
- the net or out).

**Reception**

- mark = is for a fault at reception (ace of the opposing team)
- mark / represents a fault at reception where the ball goes to the opponent's field.
- marks – i ! are for the reception with which a ball was added outside of the attack zone (outside of the 3 meters)
- mark + is for a good reception (within 3 meters)
- mark # is for an ideal reception, where the digger had no deviations.

**Attack**

- mark = represents a fault, a spike in out or in the net
- mark / represents a blocked attack
- mark – represents an attack which was defended by the opposing team
- mark + represents an attack which was defended by the opposing team but
- the point has been made
- mark # represents a point won directly.

**Block**

- mark # is for a fault while blocking
- mark / represents a fault with fishing
- mark ! represents a passive block
- mark # is for a direct point from the block.

# RESULTS WITH DISCUSSION

In this research, the basic sample was consisted of six games, of the four men volleyball teams which have taken the last four places, which were played in the play-off stage of the competition i.e. their matches. For the purposes of this analysis only those variables were selected that reflect the technical-tactical activities of the team during the match and which do not represent derived data. The significance of these results is reflected in the fact that efficient monitoring of the technical-tactical activities of a certain volleyball team is being enabled, with the help of a reduced set of indicators. By monitoring the variables that had the most important projections, a quality depiction will be received on the rest of the indicators of the technical-tactical activities of the team during the match.

RADNIČKI-INĐIJA 3:0 (25:20, 25:17, 25:19)

**Table 1.** Statistical overview of the technical-tactical elements of the teams Radnicki and

| Player | Skill | Tot | = | % | Bp | ps | / | % | Bp | Ps | - | % | ! | % | + | % | # | % | Bp | Ps |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Team | Serve | 74 | 10 | 14% | . | 10 | 5 | 7% | . | . | 10 | 14% | . | . | 42 | 57% | 7 | 9 % | 7 | . |
| RDN | Reception | 51 | 3 | 6% | 3 | 1 | 3% | 6% | 3 | . | 25 | 49% | . | . | 12 | 24% | 8 | 16% | . | . |
| | Attack | 66 | 5 | 8% | 4 | 1 | 8 | 12% | 6 | 2 | 1 | 2% | . . | | 11 | 17% | 41% | 62% | 9 | 32 |
| | Block | 12 | 96 | 50% | 1 | 5 | . | . | . | . | . | . | . | . | . | . | 6 | 50% | 6 | . |
| INĐ | Serve | 58 | 7 | 12% | . | 7 | 3 | 5% | . | . | 8 | 14% | . | . | 37 | 64% | 3 | 5 % | 3 | . |
| | Reception | 64 | 7 | 11% | 7 | . | 5% | 8% | 5 | . | 23 | 36% | . | . | 19 | 30% | 10 | 16% | . | . |
| | Attack | 68 | 11 | 16% | 11 | . | 6 | 9% | 6 | . | . | . | . | . | 23 | 34% | 28% | 41% | 4 | 24 |
| | Block | 11 | 3 | 27% | . | 3 | . | . | . | . | . | . | . | . | . . | | 8 | 73% | 6 | 2 |

By analyzing the table with the statistical overview of the technical-tactical elements of the teams Radnicki and Indjija from their second match in the second part of the championship we have noted that the both teams had similar statistical indicators. The Radnicki team had 10 faults while serving, while Indjija had 7. In ideal reception of serves where the digger had no deviation, the teams were equal also, there were 16% of those receptions of serves at both of the teams. Positive percentage values in the attack (spike) were significantly higher in the Radnicki team, namely there were 62% attacks where the Radnicki team has won a point directly from the attack, while the Indjija team had 41% of that kind of attacks.

RIBNICA-RADNIČKI 3:0 (25:22, 25:18, 28:26)

**Table 2.** Statistical overview of the technical-tactical elements of the teams Radnicki and Ribnica

| Player | Skill | Tot | = | % | Bp | ps | / | % | Bp | Ps | - | % | ! | % | + | % | # | % | Bp | Ps |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Team | Serve | 68 | 10 | 15% | . | 10 | 2 | 3% | . | . | 15 | 22% | . | . | 39 | 57% | 2 | 3 % | 2 | . |
| RDN | Reception | 66 | 3 | 5% | 3 | . | 2% | 3% | 2 | . | 23 | 35% | . | . | 17 | 26% | 21 | 32% | . | . |
| | Attack | 100 | 11 | 11% | 7 | 4 | 9 | 9% | 6 | 3 | . | . | . . | | 44 | 44% | 36% | 36% | 4 | 32 |
| | Block | 17 | 5 | 29% | 2 | 3 | . | . | . | . | . | . | . . | | . | . | 12 | 71% | 10 | 1 |
| RBN | Serve | 76 | 10 | 13% | . | 10 | 2 | 3% | . | . | 21 | 28% | . | . | 40 | 53% | 3 | 4 % | 3 | . |
| | Reception | 58 | 2 | 3% | 2 | . | 2 | 3% | 2 | . | 18 | 31% | . | . | 21 | 36% | 15 | 26% | . . | |
| | Attack | 102 | 4 | 4% | 2 | 2 | 12 | 12% | 10 | 2 | 1 | 1% | . | . | 45 | 44% | 40% | 39% | 13 | 27 |
| | Block | 10 | 1 | 10% | 1 | . | . | . | . | . | . | . | . . | | . | . | 9 | 90% | 6 | 3 |

At this game, whose statistical indicators are showed in the Table 2, Radnicki team had greater number of faults in manifesting technical-tactical elements and they lost this game with the final score of 3:0. Radnicki team had 11 offensive actions that ended with failure (spike in out or in the net), while team Ribnica had 4 actions like the mentioned above. More precise reception of serves of 32% compared to 26% is in favor of the Radnicki team, but according to all of these indicators the Radnicki team failed to turn such precise receptions into successful attacks.

INĐIJA-KLEK 0:3 (16:25, 20:25, 22:25)

**Table 3.** Statistical overview of the technical-tactical elements of the teams Indjija and Klek.

| Player | Skill | Tot | = | % | Bp | ps | / | % | Bp | Ps | - | % | ! | % | + | % | # | % | Bp | Ps |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Team | Serve | 58 | 12 | 21% | . | 12 | 2 | 3% | . | . | 10 | 17% | . | . | 32 | 55% | 2 | 3 % | 2 | . |
| INDJ | Reception | 67 | 8 | 12% | 8 | . | . | . | . | . | 37 | 55% | . | . | 2 | 3% | 20 | 30% | . | . |
| | Attack | 77 | 15 | 19% | 12 | 3 | 7 | 9% | 5 | 2 | . | . | . . | | 19 | 25% | 36% | 47% | 6 | 30 |
| | Block | 10 | . | . | . | . | . | . | . | . | . | . | . . | | . | . | 10 | 100% | 7 | 3 |
| KLK | Serve | 74 | 9 | 12% | . | 9 | . | . | . | . | 20 | 27% | . | . | 39 | 53% | 6 | 8 % | 6 | . |
| | Reception | 50 | 6 | 12% | 2 | 4 | 2 | 4% | 2 | . | 32 | 64% | . | . | . | . | 10 | 20% | . | . |
| | Attack | 58 | 4 | 7% | 2 | 2 | 10 | 17% | 7 | 3 | . | . | . | . | 13 | 22% | 31% | 53% | 7 | 24 |
| | Block | 7 | 1 | 10% | 1 | . | . | . | . | . | . | . | . . | | . | . | 7 | 100% | 5 | 3 |

The Table 3. shows the statistical indicators from the game between the teams of Indjija and Klek. The team Indjija made significantly more faults while serving, 21% of such serves by Inđija compared to 12% of such serves by the Klek team is probably one of the reasons for the defeat of the Indjija team. Indjija had better statistical indicators in block, achieving ten direct points from block, opposite from the seven that were made by the Klek team. Klek team had a higher percentage of serves that directly won a point, the so-called aces, to be precise 8%, while the Indjija team had only 3%.

RIBNICA-KLEK 3:1 (22:25, 25:22, 24:16, 25:19)

**Table 4.** Statistical overview of the technical-tactical elements of the teams Ribnica and Klek

| Player | Skill | Tot | = | % | Bp | ps | / | % | Bp | Ps | - | % | ! | % | + | % | # | % | Bp | Ps |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Team | Serve | 83 | 8 | 10% | . | 8 | 4 | 5% | . | . | 20 | 24% | . | . | 47 | 57% | 4 | 5% | 4 | . |
| KLK | Reception | 83 | 5 | 6% | 5 | . | 3 | 4% | 3 | . | 35 | 42% | . | . | 22 | 27% | 18 | 22% | . | . |
| | Attack | 123 | 17 | 14% | 14 | 3 | 15 | 12% | 10 | 5 | 4% 3% | | . . | | 51 | 41% | 36% | 29% | 6 | 30 |
| | Block | 12 | 1 | 8% | . | 1 | . | . | . | . | . | . | . . | | . | . | 11 | 92% | 5 | 6 |
| RBN | Serve | 96 | 12 | 12% | . | 12% | 3 | 3% | . | . | 18 | 19% | . | . | 58 | 60% | 5 | 5% | 5 | . |
| | Reception | 72 | 4 | 6% | 4 | . | 4 | 6% | 4 | . | 22 | 31% | . | . | 22 | 31% | 20 | 28% | . | . |
| | Attack | 119 | 12 | 10% | 10 | 2 | 11 | 9% | 5 | 6 | 1 | 1% | . | . | 45 | 38% | 50% | 42% | 11 | 39 |
| | Block | 23 | 7 | 30% | . | 7 | . | . | . | . | . | . | . . | | 1 4% | | 15 | 65% | 10 | 5 |

At this match the percentage of the statistical performance in almost all of elements is on the side of Ribnica that has also won this game with the result of 3:1. Reception, an important element which greatly affects the final result in volleyball was significantly better in the team of Ribnica i.e. the Ribnica team had 28% of the so called ideal receptions, while the Klek team had 22% of ideal receptions; the performance of the serve was the same, at 5%, while performance in the attack was 42% for the team Ribnica compared to 29% of the Klek team. Given the fact that the most of the variables are determining in the final outcome i.e. the ones that determine the winner, the final outcome of the game was completely expected.

INĐIJA-RIBNICA 2:3 (26:28, 16:25, 25:22, 25:17, 12:15)

**Table 5.** Statistical overview of the technical-tactical elements of the teams Indjija and Ribnica.

| Player | Skill | Tot | = | % | Bp | ps | / | % | Bp | Ps | - | % | ! | % | + | % | # | % | Bp | Ps |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Team | Serve | 104 | 13 | 12% | . | 13 | 6 | 6% | . | . | 31 | 30% | . | . | 44 | 42% | 10 | 10% | 10 | . |
| INDJ | Reception | 99 | 4 | 4% | 4 | . | 1 | 1% | 1 | . | 42 | 42% | . | . | . | . | 52 | 53% | . | . |
| | Attack | 125 | 22 | 18% | 17 | 5 | 10 | 8% | 10 | . | 1% 1% | | . . | | 36 | 29% | 56% | 45% | 12 | 4 |
| | Block | 14 | 1 | 8% | . | 1 | . | . | . | . | . | . | . . | | . | . | 14 | 100% | 9 | 5 |
| RBN | Serve | 108 | 7 | 6% | . | 7% | 1 | 1% | . | . | 52 | 48% | . | . | 43 | 40% | 5 | 5% | 5 | . |
| | Reception | 72 | 4 | 5% | 4 | . | 6 | 7% | 6 | . | 42 | 49% | . | . | 2 | 2% | 32 | 37% | . . | |
| | Attack | 110 | 17 | 15% | 11 | 6 | 14 | 13% | 9 | 5 | . | . | . | . | 23 | 21% | 56% | 51% | 13 | 43% |
| | Block | 10 | . . | . | . | | . | . | . | . | . | . | . . | | 1 4% | | 10 | 100% | 10 | . |

This match between the teams of Indjija and Ribnica, that has the statistical indicators presented in the Table 5, ended in victory for the Ribnica team with a score of 3:2. With the Indjija team, the percentage of serve performance was 10%, reception at 53% and attacks at 45%. The Ribnica team had the following performance in manifesting the technical-tactical elements: serve 5%, reception 37%, attack 51%. In this case it is not justified to conclude that most of the variables, which are determining the final outcome, ie. that determine the winner, have affected the final outcome of this match as the team that lost had slightly better percentage performance than the team that won the game. However, the presumption is that the attack performance has determined the winner of this game. In percentages, that performance was 10% better in Ribnica team which is also the winner of the game.

RADNIČKI-KLEK 2:3 (19:25, 23:25, 25:14, 25:18, 11:15)

**Table 6.** Statistical overview of the technical-tactical elements of the teams Radnicki and Klek

| Player | Skill | Tot | = | % | Bp | ps | / | % | Bp | Ps | - | % | ! | % | + | % | # | % | Bp | Ps |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Team | Serve | 104 | 13 | 12% | . | 13 | 4 | 4% | . | . | 41 | 39% | . | . | 16 | 15% | 6 | 6% | 6 | . |
| RDN | Reception | 83 | 3 | 4% | 3 | . | 6 | 7% | 6 | . | 7 | 8% | . | . | 18% | 22% | 28 | 34% | . | . |
| | Attack | 126 | 11 | 9% | 9 | 2 | 9 | 7% | 8 | 1 | 39% 31% | | . . | | 10 | 8% | 57% | 45% | 15 | 42 |
| | Block | 59 | 25 | 42% | 4 | 19% | . | . | . | . | . | . | . . | | 20% | 34% | 14 | 24% | 12 | 2 |
| KLK | Serve | 105 | 13 | 12% | . | 13% | 6 | 6% | . | . | 39 | 37% | . | . | 39 | 37% | 8 | 8% | 8 | . |
| | Reception | 89 | 4 | 4% | 4 | . | 3 | 3% | 3 | . | 36 | 40% | . | . | 15 | 17% | 31 | 35% | . | . |
| | Attack | 126 | 12 | 10% | 8 | 4 | 22 | 17% | 19 | 3 | 36 | 29% | . | . | 9 | 7% | 46% | 37% | 12 | 34% |
| | Block | 31 | 19 | 61% | 6 | 12 | . | . | . | . | . | . | . | . | . | . | 12 | 39% | 9 | 3 |

The Table 6. shows the statistical indicators from the game between the teams of Radnicki and Klek. From the table above we can see that the Radnicki team had the following percentage performance in manifesting the technical-tactical elements: 6% serve, 34% reception, 45% attack, and the Klek team 8% serve, reception 35%, attack 37%. In this case, the statistical indicators of this match showed that in volleyball, the attack is not a decisive element and that the percentage performances of a spike can not be called the key variables in the final outcome of the game. On this game the team that lost the game, and it is the Radnicki team , had 8% better percentage performance in attack.

## CONCLUSION

In the research of the technical-tactical activities of the volleyball clubs in the play-off stage of the "WIENER STADTISCHE" Serbian Volleyball in the season 2015/2016 on a sample of 6 matches which were played in the second part of the championship, the four following variables were monitored: serve, reception, attack and block. With the conducted research it was concluded that the efficiency coefficients and the results of technical-tactical activities have a high level of correlation with the final outcome of the match, but any individual element in volleyball that has the determining percentage performance statistics in the final outcome of the match should not be singled out. And if not all the games, this work is just that, and confirmed the. In various research studies which also had an aim to analyze the competitive activity in volleyball, results were made that showed that the attack is on the very top of the hierarchy of the technical-tactical elements and that serve and block also make contribution with slightly smaller values (Osmankač, 2000). The aforementioned data absolutely corresponds to the reflections in practice, and that is that these three elements deliver direct points to the game and that they determine the winner. Without a detailed study and an analysis of the training and the competitive activities, the problem of successful modeling of volleyball trainings and matches cannot be resolved. Knowledge on the structure of the competitive activity can improve the training and the competitive work with volleyball players, by specially working, during the training process, on the development of those technical-tactical elements that are essential for the success in a competition.

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# THE USE OF DOPING IN PARALYMPIC SPORT

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## SUMMARY

All sporting activities may be considered as a reason to force own body by drugs, substances or other methods, and this desire is common for both able-bodied and disabled athletes. The increasing profile of disability sport and its potential rewards combined with the frailty of human nature has led some athletes with disabilities to seek improved performance through the administration of banned substances. The use of these prohibited substances can lead to serious and harmful health hazards, including anti-social behavior, dependencies and deaths. As a specific prohibited method distinctive for Paralympic wheelchair sports is ''boosting'' by autonomic dysreflexia state which is serious life threatening condition. In Paralympic sport Paralympic athletes engaged in national and international competitions are typically subject to testing for prohibited substances and methods under the guidelines of the World Anti-Doping Agency (WADA) Code and the IPC Anti-Doping Code. The management of drugs has been dominated by the anti-doping policy, which has historically focused on secondary prevention rather than primary prevention.

**Keywords:** Athletes, prohibited substances, WADA, Anti-Doping Code.

## INTRODUCTION

Beside the all opportunities that can offer to the elite athletes, Paralympic Movement has the leading opportunity to promote healthy, active lifestyles and decrease the prevalence of chronic, noncommunicable diseases within the global population of people with disabilities (Blauwet et al., 2016). It is governed by International Paralympic Committee (IPC) which is a non-profit international organization. IPC organizes the Summer and Winter Paralympic Games, and serves as the international federation for 12 sports, supervising and coordinating the organization of their World Championships and other competitions. The mission of the IPC is to allow disabled athletes to achieve sporting excellence and to create opportunities for everyone at any level. A further aim of the IPC is to promote the Paralympic values of courage, determination, inspiration and equality (Blauwet et al., 2013).

Nowadays there are around 30 Paralympic sports as physical activities for people with different types of disabilities. As high performance sports activities, which are performed at Paralympic Games, demands placed on athletes who are competing are extremely high. Like in able-bodied athletes, the Paralympic athletes are faced with all advantages and disadvantages of dealing with elite sports, which can lead to certain benefits, but issues as well. Athletes are always looking to find the advantage over opponents by fair means, or by foul in some cases. Potentially hazardous risks to health through doping are taken in the pursuit of sporting excellence. The use of prohibited (banned) substances (doping) is considered to be a major global problem among sports players in and out of sports events. It is contentious issue in elite sport because is used to enhance performance and it can cause serious psychosocial and health problems (Webborn, 2005).

## DOPING TRENDS IN SPORT

The use of drugs to enhance physical performance is not new phenomenon since it has been a feature of human competition since the beginning of recorded history (Strauss & Curry, 1987). In the early era of modern sport, doping was mostly associated with professional cycling. Although some cyclists died from the intake of strong stimulants in the late nineteenth and early part of the twentieth century, sports authorities remained passive (Catlin et al., 2008). As an example, there are proofs that doping substances in cycling were used as far back as in the 1890s and were not banned for the first 60 years of the Tour (Hoberman, 2004). However in every sport the reasons were always the same - to increase strength or overcome fatigue (Yesalis & Bahrke, 2002). Looking at elite sport in the twentieth century, an unmistakable picture emerges of a doping pandemic of huge proportions (Bloodworth et al., 2012), which didn't miss Paralympic sport as well. The increasing profile of disability sport and its potential rewards combined with the frailty of human nature has led some athletes with disabilities to seek improved performance through the administration of banned substances.

## WADA AND IPC ANTI-DOPING CODE

Besides being the way of unfair competition, the use of these prohibited substances can lead to serious and harmful health hazards, including anti-social behavior, dependencies and even deaths (Clisby, 2005). Some athletes are aware of the substances' health hazards at variable degrees but others need more awareness and education on numerous prohibited substances (Ama et al., 2003).

In 1999, World Anti-Doping Agency (WADA) was established to regulate, monitor and control substance use around the world. The WADA produces a prohibited list of banned substances that is updated annually and documents the prohibited substances and methods of use inside and outside competition. According to WADA, two of the following three criteria must be met for a substance to be included on the prohibited list: (1) the substance increases or has the potential to increase performance; (2) the substance represents an actual or potential health risk to the athlete; and (3) the substance violates the spirit of sport (Al Ghobain et al., 2016).

Paralympic athletes engaged in national and international competitions are typically subject to testing for prohibited substances and methods under the guidelines of the World Anti-Doping Agency (WADA) Code and the IPC Anti-Doping Code (Blauwet et al., 2016). This may include both in-competition and out of- competition testing, involving the collection of blood and/or urine samples by certified doping control officers. Special investigations may also be performed in cases where suspicious behavior is identified on the part of athletes, trainers, coaches, or team medical personnel.

## SPECIFIC CONSIDERATIONS IN MEDICATION USE AMONG PARALYMPIC ATHLETES

Athletes with impairment are more likely to use certain classes of medications for the treatment of underlying medical conditions that require long term management. The pharmacological management of illness and injury in athletes involves unique considerations when compared to the general population. Many medications may be appropriately indicated to treat underlying medical conditions or sports specific medical concerns, such as exercise-induced asthma. However, when treating athletes, clinicians must closely consider the interaction between a medication's pharmacokinetics and the athlete's physiology, noting how this may affect performance. Additionally, some classes of medications may be used more frequently by athletes with impairment and deserve special attention.

Under the auspices of the Code, certain classes of medications and methods that have the potential for performance enhancement are deemed prohibited and are thus included on the WADA Prohibited List, which is updated annually. Athletes who are found to be utilizing these prohibited substances may be subject to sanctions. At times, however, athletes may require medications that are included on the Prohibited List for reasons that are medically valid. In these cases, the athlete must apply for a Therapeutic Use Exemption (TUE). This is accomplished by gathering the athlete's medical records and results of diagnostic testing, as well as submitting a formal application to the national federation, or major event TUE Committee that holds jurisdiction at the time of application. On review, a TUE will only be approved if it meets all of the criteria under the WADA International Standard for Therapeutic Use Exemptions (ISTUE).

The Table 1 contains the information on medication commonly used by Paralympic athletes and it is valid for calendar year 2015, and may be subject to change in subsequent years.

**Table 1**. The list of medications commonly used in Paralympic Athletes

| Medication | Common condition(s) treated | Potential adverse side effects | TUE requirements * |
|---|---|---|---|
| **Anti-spasticity medications** | | | |
| Baclofen | Spasmsandincreasedmuscletone | Fatigue, sedation | NO |
| Tizanidine | Spasms and increased muscle tone | Fatigue, sedation | NO |
| Botulinum toxin injection | Spasms and increased muscle tone | Skeletal muscle weakness | NO |
| **Analgesic medication** | | | |
| Non-steroidal anti-inflammatories (NSAIDS) | Soft tissue inflammation | Gastrointestinal bleeding or reflux, renal dysfunction | NO |
| Gabapentin | Neuropathic pain after neurological injury | Fatigue, sedation, weight gain | NO |
| Glucocorticoids | Systemic inflammation, autoimmune conditions | Flushing, insomnia, anxiety, elevated blood sugars, infection | YES[1] |
| Opiates | Severe pain | Fatigue, sedation, constipation, nausea, pruritus | YES |
| **Erectile dysfunction medications** | | | |
| Sildenafil | Erectile dysfunction due to neurological injury | Headache, dizziness, flushing, visual disturbance | NO |
| **Psychotropic medications** | | | |
| Methylphenidate (Ritalin) | Attention deficit hyperactivity disorder | Fast heart rate, palpitations, decreased appetite | YES |
| **Cardiovascular medications** | | | |
| Beta-blockers | Hypertension, tachycardia, tremor, anxiety | Low blood pressure, slow heart rate, dizziness, fatigue | YES[2] |
| Diuretics | Fluid retention, heart failure | Dehydration, renal dysfunction, electrolyte imbalance | YES |
| **Respiratory medications** | | | |
| Beta-agonists | Asthma, reactive airway disease | Tachycardia, anxiety, tremor, increased blood sugar, nausea | YES ** |

*Therapeutic Use Exemption (TUE) requirement as of April 2015, which may be subject to change.

[1]TUE for glucocorticoids required for oral, intravenous, or intramuscular dosing.

[2]TUE for beta-blockers required for precision sports of archery and shooting – recommended that athletes contact their national or federation anti-doping authority.

**TUE restrictions are dose dependent for salbutamol, formoterol, and salmeterol.

(Blauwet et al., 2016)

# AUTONOMIC DYSREFLEXIA

Like nondisabled athletes, athletes with disabilities must obey the laws of the World Anti-Doping Agency. Anti-doping in Paralympics however, has a disability specific dimension. For example, individuals with SCI at lesion levels above T6 demonstrate a unique reflex syndrome called autonomic dysreflexia. This reflex occurs spontaneously and results in a sympathetic discharge that elevates arterial blood pressure and associated cardiovascular responses, which can enhance physical performance (Mazzeo et al., 2015).

Athletes with high level SCI who compete in wheelchair sports can voluntarily induce autonomic dysreflexia before or during an event to enhance their performance. Research has demonstrated that this practice, commonly referred to as “boosting,” improves middle-distance wheelchair racing performance by approximately 10 percent in elite athletes with high level SCI (Burnham et al., 1994). This boosting elevate the arterial blood pressure during a wheelchair race to significantly higher, and in some cases life-threatening levels compared with the “unboosted” state. To ensure that all athletes compete safely on an equitable basis, the IPC Anti-Doping Code prohibits boosting and considers it an illegal and unethical practice.

Another example of the disability-specific dimension of anti-doping is "technical boosting" (Bhambhani et al.,2010). Technical boosting refers to an athlete's use of advanced technical equipment, such as wheelchairs made of light materials. Technical boosting could also be extended to concepts such as the "osseointegrated" prosthesis, in which a threaded titanium implant is inserted in the middiaphysis of the tibia or femur so that, once fully osseointegrated, it acts as an attachment site for a lower-limb external prosthesis. From a biomechanical viewpoint, this kind of interface obviously benefits performance compared with the classical technique that relies on a prosthetic limb that interfaces with the residual limb via a well-fitting socket. However, the use of osseointegrated prostheses in disability sport is not only a question of ergonomics but also of sport ethics (Vanlandewijck, 2006).

## CONSEQUENCES OF USING DOPING

Sports are generally thought to be an important measure of values and ideals such as team spirit, solidarity, tolerance, and fair play within an educational setting. However, there has always been "doping'' as an issue that is being regarded as unfair and immoral. But the doping problem seems to be more serious (Bernardin & Kohler, 2010). Doping can lead to severe, and sometimes even lethal, side effects (Blank et al., 2016). It can cause serious long-term health issues and life threatening problems. Considering the fact that health condition of people with disabilities is usually harmed in certain extent due to illness or type of disability, prohibited substances can have even worse consequences comparing to able-bodied athletes.

Mostly described in the scientific literature, doping prevalence, effects, and causes are discussed mainly within the framework of elite sports, such as the Olympic and Paralympic Games and other international competitions. However, the use of doping agents has become a public health concern not limited to professional sports. Already in 1996 "doping" in recreational sports was considered a severe problem by 44% of students and recruits in Switzerland (Kamber, 1996). Research also shows that performance-enhancing substances (PES) use and abuse is becoming a problem in the general population and the use of anabolic steroid (AAS) is not limited to professional sports (Blank et al., 2016).

## CONCLUSION

All sporting activities may be considered as a reason to force own body by drugs, substances or other methods, and this desire is common for both, able-bodied and disabled athletes (Legg and Mason, 1998). The management of drugs in sport has been dominated by the anti-doping policy, which has historically focused on secondary prevention (intervening after athletes have used via testing) rather than primary prevention (promoting abstinence). Luckily in last few years World Anti-Doping Code (WADC) refocuses anti-doping activity to give equal prominence to primary and secondary prevention, by suggesting a range of activities designed to prevent athletes from doping (Mazanov et al., 2011). At this point, most primary prevention activity by National Anti-Doping Organisations (NADOs) focuses on occasional education of current elite athletes or their support staff rather than the specific, targeted education programs seen in other drug programs.

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# THE EFFECTS OF PROGRAMMED EXERCISE ON THE DEVELOPMENT OF MOTOR SKILLS AND FUNCTIONAL ABILITIES OF HANDBALL PLAYERS

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## SUMMARY

The sample included 48 subjects, male high school students from Banja Luka, aged 16 and 17. The sample was divided into two homogenized subgroups. The first sub-group with 26 subjects made up the experimental group. This included students that, in addition to regular physical education, were covered by programmed training for the development of motor skills in their handball clubs of the Banja Luka region. Their treatment lasted for 24 training classes, taken four times a week, lasting 60 minutes each. The second subsample with 22 subjects made up the control group. Those were students that, in addition to regular physical education classes, were covered by extracurricular training activities of handball within the school system. The training exercises of the control group also consisted of 24 classes of 60 minutes taken four times a week. The study was conducted in order to determine the effects of programmed exercise on the transformation processes of motor skills and functional abilities for high school age handball players. To assess these skills, eight motor tests and three tests of functional abilities were applied. The data were obtained by the method of multivariate analysis of covariance. Compared to the control group, the experimental group demonstrated statistically significant improvements in their results in the treated motor and functional abilities when the final and initial measurements were compared.

**Keywords**: multivariate analysis of covariance, the young handball players, programmed exercise, motor abilities.

## INTRODUCTION

It is known that sport games must respect the principles of work in implementation of the methodical design process of sport training based on the latest scientific knowledge and the application of modern and efficient methodological procedures.

Handball is a collective, dynamic and creative contact game with a high tempo and rhythm, whose activity is based on natural forms of movement, which along with specific forms of movement that characterize a competitive activity, makes handball a polystructural complex sport with an unpredictable activity dynamic of cyclic and acyclic types. That means it is classified as a situational or non-standardized activity. In solving technical and tactical tasks in very complex and demanding circumstances, players are asked to show technically perfect execution of elements of the handball game in situational conditions. Maximum concentration, the ability of situational tactical reasoning, lucidity and orientation in space and time in relation to the ball, teammates and opposing players, while fully meeting rules and regulations, require a lot of mentally and physically exhausting commitment from the players.

The analysis of the programmed exercise effects are increasingly a subject of scientific research (Gruić, Vuleta & Ohnjec, 2010; Vuleta, & Krakan, 2010; Memagić & Associates, 2011). To successfully analyze the effects of training, it is important to satisfactorily resolve the issues of programming and control of the training process and the selection of methodological procedures that are appropriate to the analyzed problem. Along with the technical and tactical knowledge of the handball player, motor skills are particularly important for the development and maintenance of capabilities and characteristics as they form the foundation for learning specific motor techniques.

Functional abilities (anaerobic and aerobic capacity) have a direct impact on the size and character and development of young handball players working capacity and are directly linked to the morphological characteristics and motor abilities in all motor exercises (Jukić, 1998; Gorostiaga & Associates, 1999; Rakovac & Heimar, 2003; Blažinčić, 2010).

Achieving high performance in handball is conditioned by the early specialization of young handball players and their scientific selection based on parameters which have been proven to influence the success of the game and thus to achieve efficient results. Regarding this, some researchers (Kurelić & Associates, 1975; Pokrajac, 1983; Vuleta, Milanović & Jukic, 2000 Bompa, 2006; Milanovic & Associates, 2007; Durakovic, 2007) state that the diagnosis of training and sports form is the perquisite for optimal planning, programming and control of the training process of sport. In the process of sports training, diagnostic procedures determine the individual characteristics of an athlete using tests with established metric characteristics or subjective evaluation of leading capabilities and qualities.

The aim of this study was to determine the difference between the level of motor and functional abilities of young handball players covered by programmed exercise in handball clubs in Banja Luka and the students who, in addition to regular physical education classes, are covered by handball extracurricular activities within the school system of physical education. Realization of such a goal would enable the formation of rational procedures for optimal planning, programming and control of the training process of young handball players.

# METHODS

## Sample of participants

The sample consisted of 48 high school students, aged 15 and 16, involved in regular physical education and training process within the handball clubs of the Banja Luka region. The overall sample was divided into two homogenized sub groups:

The first sub-group of 26 subjects made up the experimental group. It included students who, in addition to regular physical education classes, realised programmed training for the development of motor skills in their handball clubs. Their training schedule lasted for 24 classes of 60 minutes taken, four times a week. The second sub-group of 22 subjects made up the control group. They were students who, in addition to regular physical education classes, were covered by extracurricular activities of handball within the school system. The training of the control group also lasted for 24 classes of 60 minute taken, four times a week.

## Sample of measuring instruments

Both groups were subjected to the nine tests for motor abilities and three tests of functional abilities, once prior to the training schedule and once after its completion.

The evaluation of the motor segment of sprint speed is defined by tests of high start running 50 m - (ref.as MT50) and high start running 30 m (ref.as MT30); explosive power is estimated by the tests: standing long jump (ref.as MSDSM) and the standing triple jump (ref.as MTRSK); segmental speed was defined by the tests: hand tapping (ref.as MTAPR) and foot tapping (ref.as MTAPN). The assessment of repetitive strength was tested using: hull lifting for 30s (ref.as MZGIB) and push-ups (ref.as MSKLE). The measurement characteristics of these tests have been confirmed via research by Kurelić and associates (1975).

To assess the functional abilities, three tests were performed: pulse frequency after the load (ref.as FPPOP), anaerobic strongest “Margaria” test (ref.as FMARG) and vital lung capacity (ref.as FVKPL). These tests are used in the research of Heimari and Bear (1997).

The programmed exercise in the experimental period, for the experimental group, in handball clubs had a largely transformational character for the development of motor and functional skills and it increased technical and tactical skills. The exercises were used to develop running speed, agility, dynamic flexibility, coordination, explosive and repetitive strength, aerobic and anaerobic capacity by long distance running, variable running - fartlek, interval running and the like.

## Statistical analysis

The data acquired in the study from both experimental and control groups were analyzed by univariate and multivariate analysis of covariance.

# RESULTS

**Table 1**. Multivariate analysis of covariance between the experimental and control groups in motor skills of the final test with the neutralization of the difference in the initial test.

| Wilks' Lambda | F | df 1 | df 2 | P-level |
|---|---|---|---|---|
| .589 | 8.67 | 8 | 48 | .000** |

Legend: the value of Bartlett's test (Wilks' Lambda) Rao F-approximation to the level of significance (P-Level) degrees of freedom (df1 and df2).

**Table 2.** Univariate analysis of covariance between the experimental and control groups in motor skills in the final test with the neutralization of the difference in the initial test.

| TESTS | Adj. Means (e) | Adj. Means (k) | F | P-Level |
|---|---|---|---|---|
| MT20V | 34.45 | 36.92 | 4.57 | .000** |
| MT50V | 78.72 | 81.17 | 5.62 | .000** |
| MSDSM | 264.52 | 247.31 | 4.52 | .000** |
| MTRSK | 592.26 | 532.48 | 3.46 | .002* |
| MTAPR | 42.72 | 39.23 | 3.25 | .004* |
| MTAPN | 31.16 | 27.82 | 4.32 | .000** |
| MDT30 | 18.74 | 15.24 | 5.35 | .000** |
| MSKLE | 23.82 | 16.16 | 3.07 | .008* |

Legend: the arithmetic mean of the experimental group (Mean (e) the arithmetic mean of the control group (Mean (k), the value of F-test (F) and the level of significance (P-Level)

**Table 3**. Multivariate analysis of covariance between the experimental and control groups in the functional abilities of the final test with the neutralization of the difference in the initial testing.

| Wilks' Lambda | F | df 1 | df 2 | P-level |
|---|---|---|---|---|
| .732 | 4.36 | 3 | 40 | .003** |

Legend: the value of Bartlett's test (Wilks' Lambda) Rao's F-approximation and level of significance (P-Level) degrees of freedom (df1 and df2)

Table 1 shows the multivariate analysis of covariance, which determines the realized effects of experimental treatments on the development of motor skills of the experimental group compared to the control group, on the final test with the neutralization of the recorded difference in the initial testing. The results show that there is a statistically significant difference in the multivariate level between the experimental and control groups at a significance level greater than .01 (P-level = .000), confirmed by the value of Wilks' Lambda test (.589) and F-test (8.67 ). The existing difference occurs due to the influence of programmed exercise, which effectively acted on the development of motor skills in the experimental group.

Table 2 shows the univariate level of analysis of covariance between the experimental and control groups in motor abilities on the final test with the neutralization and fragmentation results in the initial test. There was a statistically significant effect in all tests at the level of reliability of 99%, high start running 20V (ref. as MT20V .000), high start running 50V (MT50V .000), standing long jump (ref. as MSDSM .000), standing triple jump (ref. as MTRSK .002), hand tapping (MTAPR .004), foot tapping (ref. as MTAPN .000), hull lifting for 30S (ref. as MDT30 .000) and push-ups (ref. as MSKLE .008).

The multivariate analysis of covariance in space of functional capacity (Table 3), indicates that there is a statistically significant difference in the multivariate level between the experimental and control groups at a significance level greater than .01 (P-level = .003), as confirmed by the values of the coefficients of Wilks' Lambda test (.732) and F-test (4.36). Existing differences occurs due to the influence of programmed exercise that worked efficiently in the development of functional capabilities of the experimental group.

**Table 4.** Univariate analysis of covariance between the experimental and control groups in the functional abilities of the final test with the neutralization of the difference in the initial testing.

| Tests | Adj. Means (e) | Adj. Means (k) | F | P-level |
|---|---|---|---|---|
| FPPOP | 154.00 | 162.00 | 4.52 | .001** |
| FMARG | 3.46 | 3.62 | 5.28 | .000** |
| FVKPL | 4952.00 | 4684.00 | 4.36 | .003** |

Legend: the arithmetic mean of the experimental group (Mean (e) the arithmetic mean of the control group (Mean (k), the value of F-test (F) and the level of significance (P-Level))

The univariate level of analysis of covariance between the experimental and control groups in the tests for assessing functional abilities on the final test with the neutralization and fragmentation of results in the initial test (Table 4) shows that there is a statistically significant effect in pulse frequency after the load (ref. as FPPOP .001), of Margaria test (ref. as FMARG .000) and test of the vital lung capacity (ref. as FVKPL .003) at the confidence level of 99%.

# DISCUSSION

The study was conducted in order to determine the effects of programmed exercise on the transformation processes of motor skills and functional abilities in high school age students who were divided into experimental and control group. The experimental group of participants included students that, in addition to regular physical education, were covered by programmed training for the development of motor skills in their handball clubs. The control group of participants included students that, in addition to regular physical education classes, were covered by extracurricular training activities of handball within the school system.

To assess motor skills and functional abilities, eight motor tests and three tests of functional abilities were applied. The data were obtained by the method of multivariate analysis of covariance.

The achieved, statistically significantly better results in motor skills and functional abilities at the end of the experimental period within the experimental group are certainly the result of the correct methodological design of programmed exercise in the process of planning and programming, dosage, distribution and control of the applied loads along with increased intensification of training workloads in accordance with the genuine needs of the participants. The experimental group's achieved results were contributed to by the application of methods and means of motoric exercises in subjects which have increased their ability for rapid and complete motor control under high levels of load, enabling increased activity of agonist muscles and the increase of motor abilities.

The applied programmed exercise (Table 1, 2, 3 and 4) in handball clubs has contributed to statistically significant transformation of tested motor skills and functional abilities, which means that adaptive programmed exercise was absolutely appropriate to the anthropological status of the experimental group of handball players.

At the end of the experimental period, the low level of results of motor and functional abilities for the control group of handball players was probably the result of the lack of effective handball training within the school system.

# CONCLUSION

Based on the obtained results, we can conclude that training process in handball clubs lead to a significant increase in both motor skills and functional abilities in handball players who trained in handball clubs of the Banja Luka region. Compared to the control group, the experimental group demonstrated statistically significant improvements in their results in the treated motor skills and functional abilities when the final and initial measurements were compared.

We believe that it is necessary to conduct extensive research to test the effects of programmed exercise on a larger sample of handball players and a larger number of anthropological dimensions and characteristics. That knowledge could serve as the basis for developing a program of training that could be applied in the handball clubs for secondary school age players.

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# Physical Activity and Health

# RELATIONSHIP BETWEEN CARDIORESPIRATORY FITNESS AND BLOOD PRESSURE OF MACEDONIAN ADOLESCENTS

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## SUMMARY

Background: Knowledge about the relationship between cardiorespiratory fitness and health outcome is important, because such information adds essential information to the aggregated data that serve as the basis for physical activity guidelines.Objective: The purpose of this study was to evaluate relationship between cardiorespiratory fitness and blood pressure in normotensive individual.Methods: the research was realized on a sample of 1892 respondents of which 992 (52%) boys and 900 (48%) girls at the age of 11 to 14 years. The average age of the respondents was 12,4±1,1 years. The cardiorespiratory fitness was assessed by using the three minute step test. Blood pressure was measured three times at interval of 60 seconds, and the result was the median value of the three measurements. The relation between blood pressure and cardiorespiratory fitness is determined by the correlation and regression analysis. Results: it has been determined the statistically significant negative correlation between cardiorespiratory fitness and blood pressure (systolic and diastolic). The cardiorespiratory fitness shows curvilinear (2nd degree polynomial) regressive relation with the systolic pressure and linear relation with the diastolic pressure. The determination coefficient (R2) for cardiorespiratory fitness was 14.3% and 1.7% for systolic and diastolic blood pressure respectively.Conclusion: The greatest benefit may be achieved when increasing the fitness from low to moderate cardiorespiratory fitness. It is therefore important to direct action towards those adolescents who are the least physically fit to increase their cardiorespiratory fitness and hence reduced their blood pressure

**Keywords:** Cardiorespiratory fitness, blood pressure, Adolescents

## INTRODUCTION

Hypertension is a health problem that is of national importance. It is a major risk factor for the occurrence of atherosclerosis and cardiovascular, cerebrovascular and renal diseases that are leading or among the leading causes of mortality and morbitet as in ours, an in the most developed and less developed countries. Epidemiological studies show a correlation between low physical activity and/or low level of fitness and cardiovascular aliments (U.S. Department, 1997). Biological risk factors for the occurrence of cardiovascular diseases track from childhood and adolescence into adulthood (Andersen 1996; Twisk et al., 1997). The low level of fitness is associated with an increased risk of high blood pressure for middle-aged men and women (Paffenbarger et al. 1983; Blair et al., 1984). But there are many fewer researches which explain the etiological relationship between fitness and blood pressure for children and adolescents (Hagberg et al., 1983; Hagberg et al., 1994; Fraser et al., 1983). Explaining the relation between blood pressure and physical fitness is useful for building strategies and recommendations to improve the lifestyle and health of adolescents.

Knowledge about the relationship between cardiorespiratory fitness and health outcome is important, because such information adds essential information to the aggregated data that serve as the basis for physical activity guidelines (Biddle et aI, 1999). Therefore, the purpose of this study was to evaluate relationship between cardiorespiratory fitness and blood pressure in normotensive adolescent.

## METHODS

### Subjects

This cross-sectional study included 1892 adolescents, which were defined as a population of healthy adolescents at the age of 11-14 years, from Macedonian ethnicity and urban origin. The children were selected according to the method of random choice and they were from several primary schools in Skopje. The sample is divided into two subsamples according to gender and that is 992 male respondents and 900 female respondents. The average age of the respondents of both gender is 12,4±1,1 years.

The study included students for whom their parents had given consent to take part in the research, who were psychically and physically healthy and who regularly attended the classes of physical and health education. The respondents were treated in accordance with the Helsinki Declaration. Measurements were realized in March, April and May 2013, in standard school conditions at regular classes of physical and health education. The measurement was realized by experts from the area of kinesiology and medicine, previously trained to perform functional tests and blood pressure.

## Blood pressure

The blood pressure measurement (systolic and diastolic) is realized by experts from the medicine, doctor-specialists pediatrician fields. The measurements were performed in a separate room with optimum ambient conditions in a relaxed state of the respondent, and the relaxation is conducted at least five minutes before the measuring. The measurements was realized on forearm above the wrist on the palm, with clinically tested electronic digital device for measuring blood pressure from the company "Omron". The measurement was conducted on the left hand and before measuring care was taken that the cuff was properly inserted, the hand is at the height of the heart, and the respondent sit properly, not to move nor to talk. Blood pressure was measured three times at intervals of 60 seconds, and the result was the median value of the three measurements. In the age group studied, the High Blood Pressure (HBP) was regarded as the average (from three measurements) of systolic and/or diastolic pressure at the 95th percentile for age and gender, adjusted to height percentile.We adopted the methodological recommendations of the Update on the Task Force Report on High Blood Pressure in Children and Adolescent.

## Evaluation of Physical Fitness

The aerobic capacity is evaluated with the three-minute step test. The participant had a task to go up and down of the bench which is 30,5 cm high for three minutes in four cycles (up, up, down, down) with standardized rhythm from 96 beats per minute (bmp) which was dictated by the metronome. After the completion of the test (in response to a signal) the participant supposed to sit on the bench in order to measure the heart rate, and as well after the first and second minute at rest. If the participant felt dizziness, losing breath, sickness and headache, the test was aborted. The heart rate is measured by monitor for registration of the hearth rate (Polar RS800). The heart rate at rest, heart rate immediatelly after completion of the test, heart rate after the first minute at rest and the rate after the second minute at rest was considered as final result. The maximum oxygen consumption was calculated by the formula: VO2 max = -2,045 + (Height in cm * 0,025) + (Resting Heart Rate * 0,01) + (Step Test Heart rate load + Heart rate recovery first minute + Heart rate recovery second minute )/Resting Heart Rate ) * -0,405) (Jacks, et. al., 2011).

## Data Analysis

Statistical analysis was carried out using statistical software package SPSS version 22.0. Descriptive statistics of mean and standard deviation were used to examine the data. Pearson moment correlation was used to find correlation between cardiorespiratory fitness and blood pressure. Regression analysis was also carried out to see relationship between the variables. The graded relation between cardiorespiratory fitness and blood pressure were analyzed using excel package models. P-value < 0.05 was considered to be statistically significant.

# RESULTS

The research was realized on a sample of 1892 respondents of which 992 (52%) boys and 900 (48%) girls at the age of 11 to 14 years. The average age of the respondents was 12,4±1,1 years.

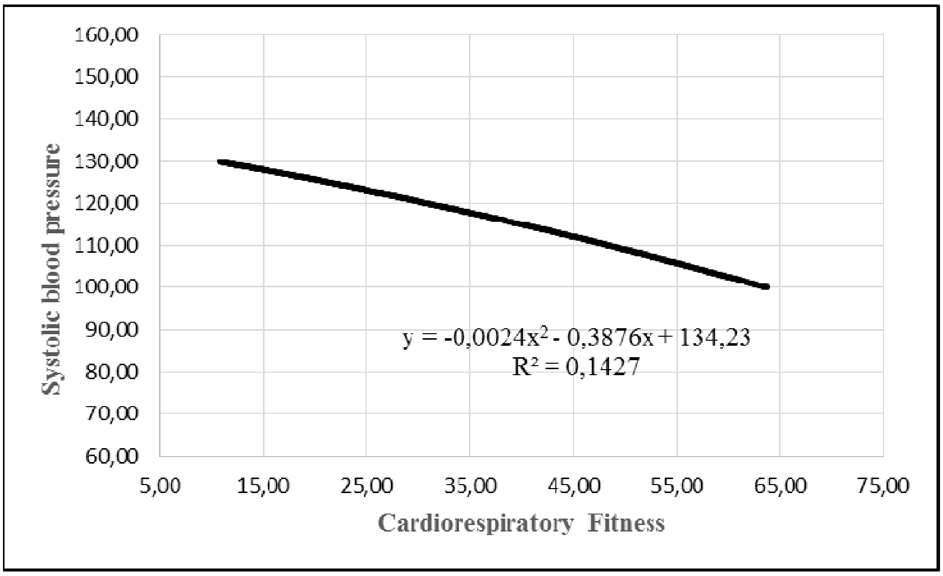
In Table 1 are shown the characteristics of the sample. From the review of the Table 1 in which are shown the values of the arithmetic means, standard deviations and the level of statistical significance, it can be seen that there are statistically significant differences among the participants of the male and female in SBP (mmHg) and DBP (mmHg). From the review of the obtained results, can be seen that boys have higher systolic (SBP mmHg), and lower diastolic blood pressure (DBP mmHg) compared to girls. Statistically significant differences were found in the variables age and cardiorespiratory fitness. In Table 2 are shown the correlation coefficients between the variables for assessing of the blood pressure and the measures for assessing the cardiorespiratory fitness for the total sample and separately for boys and girls. From the review of the Table 2 can be seen that for both gender there is also a statistically significant negative correlation between the blood pressure in the total sample; (systolic and diastolic respectively) and cardiorespiratory fitness. There was also significant strong correlation between systolic and diastolic blood pressure.

**Table 1.** Descriptive Statistics by Gender

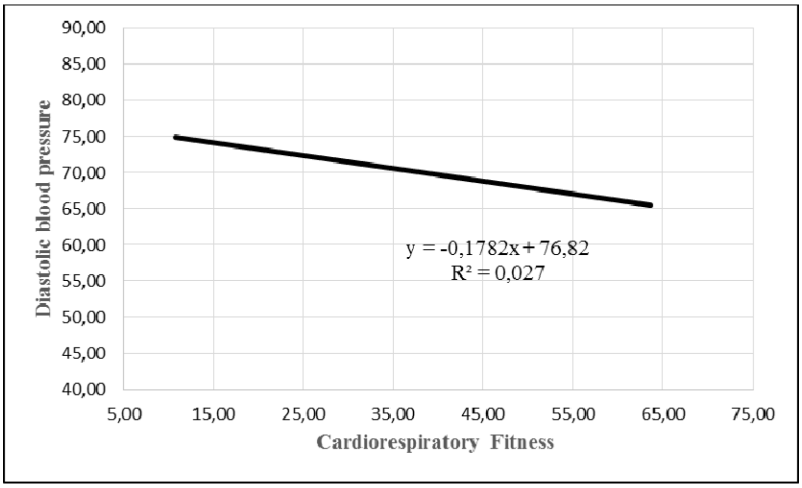
| Variables | Male | | Female | | F | P |
|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | | |
| Age(years) | 12,42 | 1,13 | 12,43 | 1,13 | ,01 | ,931 |
| SBP (mmHg) | 116,00 | 13,12 | 113,47 | 12,24 | 18,14 | ,000 |
| DBP (mmHg) | 70,82 | 9,67 | 72,09 | 8,84 | 8,63 | ,003 |
| $VO_2$_ml_min_kg | 41,31 | 8,13 | 41,28 | 7,89 | ,01 | ,945 |

**Table 2.** Correlation Matrix between Cardiorespiratory Fitness and Blood Pressure

| Variables | Male | Female | Total |
|---|---|---|---|
| SBP (mmHg) | -,411** | -,357** | -,384** |
| DBP (mmHg) | -,181** | -,147** | -,167** |
| Note. Significance, * p < .05, ** p < .01 | | | |




**Figures 1.** The relation between cardiorespiratory fitness and systolic blood pressure




**Figures 2.** The relation between cardiorespiratory fitness and diastolic blood pressure

Figures 1 and 2 show the relation between cardiorespiratory fitness and systolic and diastolic blood pressure respectively. The systolic blood pressure showed a significant curvilinear (2nd degree polynomial) relation with cardiorespiratory fitness. The regression equation was y = -0,0024x2 - 0,3876x + 134,23. Cardiorespiratory fitness explained 14,3% of total variance. The diastolic blood pressure also showed a significant linear relation with cardiorespiratory fitness. The regression equation was y = -0,1782x + 76,82. The percentage contribution to the total variance from cardiorespiratory fitness was 2,7%.

# DISCUSSION

The aim of this research was to determine the relation between cardiorespiratory fitness with blood pressure for adolescents. The advantage of this study is the relatively large number of respondents who past the cardiorespiratory test, and their blood pressure was measured. The results show a graded relation between cardiorespiratory fitness and blood pressure (systolic and diastolic). The cardiorespiratory fitness shows a curvilinear (2nd degree polynomial) regressive relation with the systolic pressure explained with 14.3% of the total variance and linear regressive correlation with diastolic pressure explained with 1.7% of the total variance. This observation was similar to the study of Klasson-Heggebo et al, (2006). Systolic and diastolic blood pressure were significantly related to cardiorespiratory fitness, with a somewhat weaker association for diastolic than systolic blood pressure. These results are in accordance with those of Hansen et al, (1990); Andersen (1994); Boreham et al (2001); Klasson-Heggebø et al (2006) and Koley (2007). The association was weak, but may be clinically relevant.

Epidemiological studies suggest that physical activity and/or fitness effectively control blood pressure in hypertensive adults, but it is not clear whether the same happens for children (Thomas et al, 2003). In this research is confirmed the relation between cardiorespiratory fitness and blood pressure for adolescents at the age of 11 to 14 years, and this is confirmed in some previous research (Shea et al, 1994 and Klasson-Heggebø, 2006). In a number of previous researches it is not confirmed the statistically significant relation between the cardiorespiratory fitness and the blood pressure (Jenner et al, 1992 and Rodrigues et al, 2007). It is believed that the contradictory result may be due to methodological differences and the diversity off actors that affect blood pressure. Such factors include physical activity, mental activity, age, sex, BMI etc (Hitendrasinh G et. al, 2004; Rodrigues et al, 2007). Furthermore, there is great variety in the methods employed in clinical investigations to identify cardiorespiratory fitness, such as direct and indirect measurements of VO2 max and recovery heart rate which can cause results to diverge between studies.

Hansen et al. also showed the effecti veness of physical training in lowering blood pressure and increasing physical fitness among population of children. After a six-month treatment in the experimental group the systolic pressure decreased by 4.9 mmHg, and the diastolic by 3.8 mmHg compared to the controlled group. The weight gain of 3 kg was similar in the two groups during the 6 months and reflected growth (Hansen et al., 1991). This study and others suggest the need for adolescents to be involved in physical activities to improve their cardiorespiratory fitness, and there by lowering their blood pressure, because it had been shown that certain cardiovascular adaptations with fitness training which cause lower blood pressure do exist. The stroke volume increases with lower heart rate, there by increased capillarization of muscles and greater extraction of oxygen from the arteries (Koley, 2007).

To confirm the results, further researches are necessary, particularly through experimental and interventional studies. In short, the results indicate that there is a relation between the level of the cardiorespiratory fitness and blood pressure and likely the change in cardiorespiratory fitness is related with blood pressure for adolescents.

## CONCLUSION

In this research is determined the curvilinear relation (2nd degree polynomial) between the cardiorespiratory fitness and systolic pressure and linear relation between the cardiorespiratory fitness and systolic pressure. Therefore the greatest benefit may be achieved when increasing the fitness from low to moderate. It is therefore important to direct action towards those adolescents who are the least physically fit.

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# RELATIONSHIPS BETWEEN OVERWEIGHT, OBESITY AND PHYSICAL FITNESS OF SEVEN - TO EIGHT-YEAR-OLD MACEDONIAN CHILDREN

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## SUMMARY

Background: Macedonian children show the same tendencies in overweight and obesity as children in developed countries a decade ago. Childhood overweight is associated with chronic diseases, early mortality in adulthood and psycho-social effects with lifelong consequences. This study aimed to determine relationships between overweig ht, obesity and physical fitness of nine- to ten-year-old Macedonian children.Methods: Anthropometric (body-mass index [BMI], fat percentage) and physical fitness (body composition, muscle strength, muscle endurance, flexibility) measurements were obtained from 2218 children aged seven to eight years (1149 boys, 1069 girls) using the Eurofit fitness testing battery. International cut-off points were used to categorize children into normal-weight, overweight or obese categories. Data were analyzed using descriptive statistics, Spearman rank order correlation and variance of analysisResults: The percentage of the overweight and obese children, classified according to the BMI (Cole et al.), is equal to 36% of the Macedonian children of the same age. Both male and female respondents with a high or an increased BMI have lower muscle mass percentage and show poor test results in the evaluation of the body strength, explosive power, speed, agility and coordination. Conclusions: Health-enhancing physical fitness of young children is negatively affected by overweight and obesity, and intervention strategies are recommended to improve the quality of life of such children but also to prevent early mortality during adulthood.

**Keywords:** Body Mass Index, Macedonian children, EUROFIT, body composition

## INTRODUCTION

Obesity, generally is defined as an excessive accumulation of body fat in the body that is in clinical practice, usually expressed through body mass index (BMI), where the values are equal to or more than 95-th percentile value for children of the same age and sex, while overweight when the values in the range of 85th and 95th percentile (Barlow, & Expert Committee, 2007). Obesity is a chronic non-communicable disease which occurs as a consequence of several factors, divided into two main groups: genotype and environmental conditions. There is no general consensus about the exact causes of this disease; it is believed that occurs as the integration of social behavioral, cultural, physiologic, metabolic and genetic factors (National Institutes of Health of USA, 2000).

Overweight and obesity are responsible for 80% of the cases with diabetes type, 2,35% for ischemic cardiac disease and 55% for high blood pressure in adults in the area of Europe causing over one million deaths annually (Tsigos et al., 2008; National Institutes of Health of USA, 1998; Vukovic et al., 2012; Kisic- Tepavchevic et al., 2008). Obesity in early ages is a reason for shortened life expectancy, contributes to great burden of diseases in adulthood (Freedman, et al., 2001) and jeopardize the health protection and security system.

Obese children have a great prevalence to remain fat in the adulthood (Biro, & Wien, 2010; Whitaker, et al.,1997; Serdula, et al., 1993). Apart from the genetic predisposition and other biologic factors (birth weight, intrauterine growth) it is considered that a child behavior plays one of the key roles in development of the obesity (Burke, 2006). This group of factors presumes first of all the nutrition and the level of physical activity. Lack of physical activity and increased food intake are some of the dominant factors in development of obesity in the recent twenty years (Lobstein, Baur, & Uauy, 2004; Roberts, Lucas, & Hirsch, 2000; Lustig, 2006).

Large research studies have shown a steady upward trend in the prevalence of overweight and obesity in the last 20 years or as at the global level, with an increase between 10 and 40% in developed and in developing countries (Ford, & Mokdad, 2008).

Prevention and education of children of preschool and school-age children, is of great importance. The most sensitive period in children in development of overweight and obesity coincides with the period of the puberty and rapid growth and development, and this is a period in which it is possible to make preventive action.

Apart from regular physical activity, it is necessary to inform children about the importance of proper nutrition and a healthy lifestylePursuant to the foregoing, the aim of the research is to determine the connectivity of the fitness with the different body weight status, categorized by the BMI and percent of body fats in children at the age of 7 and 8 years.

# METHODS

## Sample of respondents

The research was realized on a sample of 2238 childrens of Macedonian nationality, from 19 primary schools from the central and east part of the Republic, out of which 8 are in rural and 11 are in urban environment. The sample has been divided into two sub-samples by gender – 1157 of the respondents are boys and 1081 respondents are girls. The average age of the respondents of both genders was 7,53±0,5 years.

The study included students for whom their parents had given consent to take part in the research, who were psychically and physically healthy and who regularly attended the classes of physical and health education. The respondents were treated in accordance with the Helsinki Declaration. Measurements were realized in March, April and May 2012, in standard school conditions at regular classes of physical and health education. The measurement was realized by experts from the area of kinesiology and medicine, previously trained to perform functional tests and to take anthropometric measures.

## Anthropometric measures and body composition

Measuring of the anthropometric measurements was realized at the recommendations given by IBP-International Biology Program, (Lohman et al., 1988). For estimation of the morphologic characteristics the following anthropometric measures have been applied: body height in standing position (cm), body weight (kg), circumference of the upper arm and circumference of the calf (cm), as well as the body mass index (BMI).

Components of the body composition have been determined by the method of bioelectrical impedance (measuring of the electric conductivity – Bioelectrical Impedance Analysis - BIA). The measuring was realized by a Body Composition Monitor, model "OMRON - BF511", by means of which we have measured the body weight, fat tissue percent and muscular mass percent. Prior to commencing the measurement we had entered the parameters of gender, years and body height of the respondent in the Body Composition Monitor. In order to provide better precision of the results obtained from the estimation of the body composition, prior to each measuring, we ensured that the preconditions recommended by ACSM (2005) and Heyward (2006) had been fulfilled.

## Evaluation of Physical Fitness

Prior to starting the study, the researchers involved in the project undertook training sessions in order to guarantee the standardization, validation, and reliability of the measurements (Moreno et al., 2003). Seven tests, forming part of the EUROFIT battery, validated and standardized by the European Council, were applied in the following order:

1. Sit and Reach test. With the subject seated on the floor and using a standardized support, the maximum distance reached with the tip of the fingers by forward flexion of the trunk is measured. Test indicative of amplitude of movement or flexibility.
2. Hand Grip test. With the use of a digital Takei TKK 5101 dynamometer (range, 1-100 kg), the maximum grip strength was measured for both hands.
3. Standing broad jump test. The maximum horizontal distance attained, with feet together, was measured. This test evaluates lower limb explosive-strength.
4. Bent Arm Hang test. A standardized test was used to measure the maximum time hanging from a fixed bar. This test estimates the upper limb endurance- strength.
5. Sit-ups 30 sek. Maximum number of sit ups achieved in 30 seconds. This test measures the endurance of the abdominal muscles
6. Shuttle run: 4×10 meters. This test provides an integral evaluation of the speed of

movement, agility and coordination. The subject does four shuttle runs as fast as possible between 2 lines 10 meters apart. At each end the subject places or picks up an object (a sponge) beside the line on the floor.

## Definition of weight status

Four weight status groups were established in this study: underweight, normal weight, overweight and obesity. Participants were categorized according to the international gender and age-specific BMI (kg/m2) cut-off points (Cole et al., 2000,2007). These points have been particularly established for children and adolescents aged from 2 too18 years, separately for males and females and for 0.5 year age groups. These cutoff values are based on percentiles passing at age 18 years through BMI 18.5 kg/m2 for underweight, 25 kg/m2 for overweight and 30 kg/m2 for obesity (Cole et al., 2000, 2007).

## Statistical analysis

The data are presented as frequencies (percentage) for categorical variables and mean (SD) for continuous variables. Gender differences in fitness and anthropometric characteristics were analyzed by one-way analysis of variance (ANOVA). Categorical data (weight status) were analyzed using the $\chi^2$ - test. Relationships between the variables were determined by Spearman correlation matrices. Adjustment for age was performed using analysis of covariance (ANCOVA) to examine differences in fitness level among weight status groups. Because a significant interaction was found for weight status and gender in relation to all fitness tests ($p < 0.05$), all the analyses were performed separately for boys and girls. Bonferroni's adjustments were used for pair wise comparisons. All the analyses were performed using the Statistical Package for Social Sciences software (SPSS, v. 20.0 for Windows; SPSS Inc., Chicago, IL, USA), and values of $p < 0.05$ were considered statistically significant.

# RESULTS

In Table 1 are shown the characteristics of the sample which is applied in this research. Results of the analysis from the variance (Table 1) show that in the variables the average age, volume of arm, body height, body fat percentage, fat-free mass, BMI (kg/m2) and muscular mass there is no statistically significant differences between boys and girls. In all other variables there are statistically significant differences in terms of gender ($p < 0.05$). The distribution of the normal, excessive weight and obesity for children, as assessed by BMI compared to age and gender are also shown in Table 1. The values of the $\chi^2$ test (p = . ,807) that indicate that there is no statistically significant differences in the level of nutrition among boys and girls of this age.

In Table 2 and 3 are shown the coefficients of the correlation between BMI and the percentage of body fat and anthropometric measures, assess measures of the body composition and the test for assessing fitness abilities for the respondents of both gender. From the review of the tables can be seen that all anthropometric measures and measures for assessing body composition (except for the percentage of muscle mass) in both gender show statistically significant positive correlation (ranging from .247 to .978) with a body mass index and the percentage of body fat. Statistically significant negative correlation (ranging from .-159 to .-510) is determined between the BMI and percentage of body fat with fitness tests: standing long jump, raising the trunk for 30 seconds, pull-ups endurance, shuttle run 4x10 meters. Positive correlation with BMI it showed only the test: palm dynamometry, while statistically significant correlation between BMI and the percentage of body fat has been determined in the test: sit and reach. Correlation coefficients are somewhat higher between the percentage of body fat with variables for assessing the anthropometric measures and the body composition and the fitness tests in terms of BMI. For both gender highest negative correlation with BMI and body fat percentage show the fitness test: bent arm hang.

**Table 1.** Characteristics of the study sample by gender

| | Total | | Boys | | Girls | | P* |
|---|---|---|---|---|---|---|---|
| | (n=2176) | | (n=1091) | | (n=1085) | | |
| Age (years) | 7,53 | 0,50 | 7,52 | 0,50 | 7,53 | 0,50 | ,859 |
| Arm circumference (cm) | 19,57 | 2,99 | 19,51 | 3,11 | 19,64 | 2,86 | ,307 |
| Thigh circumference (cm) | 40,05 | 5,85 | 39,65 | 6,16 | 40,45 | 5,49 | ,002 |
| Height (cm) | 129,57 | 6,87 | 129,72 | 6,79 | 129,41 | 6,94 | ,305 |
| Weight (kg) | 30,22 | 7,57 | 30,53 | 7,71 | 29,91 | 7,42 | ,056 |
| Body fat (%) | 22,19 | 8,03 | 22,73 | 7,64 | 21,64 | 8,37 | ,002 |
| Fat mass (kg) | 7,21 | 4,34 | 7,42 | 4,32 | 7,01 | 4,36 | ,032 |
| Fat-free mass (kg) | 23,24 | 3,86 | 23,39 | 4,09 | 23,08 | 3,61 | ,059 |
| BMI (kg/m$^2$) | 17,93 | 3,27 | 18,04 | 3,30 | 17,82 | 3,24 | ,119 |
| Muscular mass (%) | 29,45 | 2,63 | 29,47 | 2,98 | 29,43 | 2,22 | ,745 |
| Standing long jump (cm) | 111,54 | 19,30 | 117,80 | 19,79 | 105,27 | 16,58 | ,000 |
| Sit-ups 30 sek. (n) | 11,20 | 5,07 | 12,06 | 4,88 | 10,34 | 5,11 | ,000 |
| Bent arm hang (s) | 3,83 | 4,58 | 4,76 | 5,26 | 2,90 | 3,55 | ,000 |
| Handgrip (kg) | 10,88 | 4,27 | 11,53 | 4,56 | 10,16 | 3,80 | ,000 |
| Sit and reach (cm) | 15,67 | 5,71 | 15,04 | 5,75 | 16,31 | 5,59 | ,000 |
| Shuttle run 4x10 (s) | 15,70 | 2,00 | 15,11 | 1,87 | 16,29 | 1,95 | ,000 |
| Normal weight** | 1386 | 65,8% | 694 | 66,1% | 692 | 65,5% | |
| Overweight | 446 | 21,2% | 224 | 21,3% | 222 | 21,0% | |
| Obese | 275 | 13,1% | 132 | 12,6% | 143 | 13,5% | ,807 |

*P < 0.010 for difference between boys and girls (ANOVA); ns, non-significant.
**P < 0.010 for difference between boys and girls (Chi-Square Tests); ns, non-significant.

**Table 2.** Correlation quotients of BMI and body fat percentage with anthropometrical and physical parameters (boys)

| | BMI | | | | Body fat percentage | | | |
|---|---|---|---|---|---|---|---|---|
| | T | N | O | OB | T | N | O | OB |
| **Anthropometrical parameters** | | | | | | | | |
| Arm circumference (cm) | ,893** | ,861** | ,900** | ,902** | ,833** | ,792** | ,838** | ,855** |
| Thigh circumference (cm) | ,872** | ,836** | ,882** | ,879** | ,802** | ,756** | ,813** | ,829** |
| Height (cm) | ,393** | ,269** | ,467** | ,472** | ,231** | ,096** | ,312** | ,351** |
| Weight (kg) | ,873** | ,832** | ,897** | ,901** | ,773** | ,714** | ,807** | ,832** |
| Muscular mass (%) | ,141** | ,085** | ,188** | ,159** | -,048 | -,108** | ,005 | ,002 |
| Fat mass (kg) | ,979** | ,974** | ,977** | ,979** | ,968** | ,965** | ,968** | ,978** |
| Fat-free mass (kg) | ,627** | ,526** | ,685** | ,692** | ,470** | ,349** | ,535** | ,573** |
| **Physical parameters** | | | | | | | | |
| Standing long jump (cm) | -,164** | -,191** | -,090** | -,139** | -,200** | -,215** | -,112** | -,144** |
| Sit-ups 30 sek. (n) | -,164** | -,161** | -,102** | -,152** | -,198** | -,189** | -,125** | -,166** |
| Bent arm hang (s) | -,507** | -,449** | -,472** | -,500** | -,504** | -,440** | -,456** | -,482** |
| Handgrip (kg) | ,269** | ,165** | ,302** | ,309** | ,194** | ,094** | ,237** | ,268** |
| Sit and reach (cm) | -,016 | ,035 | ,001 | ,000 | -,006 | ,041 | ,013 | ,002 |
| Shuttle run 4x10 m | ,126** | ,171** | ,069* | ,075* | ,157** | ,192** | ,088** | ,083** |

T = Total; N = Normal weight; O = Overweight; OB = Obese; * = p < 0.05; ** = p < 0.01;

In the Table 4 and 5 are shown the average values of the parameters for assessing the anthropometric measures, body composition and fitness abilities, after partition of the age. For both gender are determined statistically significant differences in all parameters for assessing the anthropometric measures, body composition and tests for assessing the fitness among the groups of respondents formed on the basis of the classification of BMI, except the fitness test: sit and reach.

From the values of arithmetic means and the level of the statistically significance in Tables 4 and 5 can be seen that students of both gender with moderate excessive body weight achieve better results in the test: palm dynamometry compared to those with normal weight (p < 0.00) (Tables 4 and 5), and lower results in other fitness tests. For the male and female respondents in the test deep bend sit are not determined statistically significant differences among the children classified with normal, moderate and increased BMI index.

**Table 3.** Correlation quotients of BMI and body fat percentage with anthropometrical and physical parameters (girls)

| | BMI | | | | Body fat percentage | | | |
|---|---|---|---|---|---|---|---|---|
| | T | N | O | OB | T | N | O | OB |
| **Anthropometrical parameters** | | | | | | | | |
| Arm circumference (cm) | ,881** | ,846** | ,902** | ,897** | ,829** | ,777** | ,850** | ,853** |
| Thigh circumference (cm) | ,857** | ,819** | ,880** | ,879** | ,799** | ,744** | ,821** | ,830** |
| Height (cm) | ,363** | ,247** | ,455** | ,466** | ,235** | ,103** | ,322** | ,343** |
| Weight (kg) | ,870** | ,830** | ,897** | ,898** | ,791** | ,731** | ,819** | ,830** |
| Muscular mass (%) | -,016 | -,002 | ,139** | ,101** | -,183** | -,180** | -,030 | -,057 |
| Fat mass (kg) | ,976** | ,973** | ,977** | ,976** | ,975** | ,971** | ,972** | ,978** |
| Fat-free mass (kg) | ,613** | ,514** | ,683** | ,687** | ,481** | ,360** | ,549** | ,566** |
| **Physical parameters** | | | | | | | | |
| Standing long jump (cm) | -,159** | -,122** | -,161** | -,187** | -,175** | -,134** | -,165** | -,191** |
| Sit-ups 30 sek. (n) | -,148** | -,113** | -,140** | -,168** | -,165** | -,127** | -,152** | -,180** |
| Bent arm hang (s) | -,487** | -,409** | -,497** | -,510** | -,477** | -,392** | -,475** | -,492** |
| Handgrip (kg) | ,240** | ,182** | ,243** | ,280** | ,194** | ,131** | ,196** | ,247** |
| Sit and reach (cm) | ,032 | ,029 | ,033 | ,047 | ,030 | ,028 | ,033 | ,047 |
| Shuttle run 4x10 m | ,128** | ,107** | ,127** | ,129** | ,144** | ,118** | ,133** | ,136** |
| T = Total; N = Normal weight; O = Overweight; OB = Obese; * = p < 0.05; ** = p < 0.01; | | | | | | | | |

**Table 4.** Significance of differences in physical fitness components in the various BMI categories in the boys

| | Normal weight | | Overweight | | Obese | | F | Sig. | Post hoc pairwaise comparisons |
|---|---|---|---|---|---|---|---|---|---|
| | M | SD | M | SD | M | SD | | | |
| Arm circumference (cm) | 17,98 | 1,62 | 21,58 | 1,58 | 24,41 | 2,07 | 1254,24 | ,000 | 1&2; 1&3; 2&3 |
| Thigh circumference (cm) | 37,03 | 3,38 | 43,85 | 3,35 | 48,94 | 4,41 | 992,53 | ,000 | 1&2; 1&3; 2&3 |
| Height (cm) | 127,63 | 5,97 | 131,33 | 6,42 | 133,00 | 6,39 | 90,64 | ,000 | 1&2; 1&3; 2&3 |
| Weight (kg) | 26,35 | 3,58 | 34,31 | 4,47 | 41,96 | 7,11 | 1172,58 | ,000 | 1&2; 1&3; 2&3 |
| Fat mass (%) | 18,10 | 4,79 | 28,00 | 2,88 | 34,93 | 4,10 | 1272,65 | ,000 | 1&2; 1&3; 2&3 |
| Muscular mass (%) | 29,27 | 2,88 | 29,96 | 2,32 | 28,94 | 2,24 | 10,05 | ,000 | 1&2; 2&3 |
| Standing long jump (cm) | 118,33 | 19,57 | 110,95 | 18,03 | 101,64 | 16,87 | 67,08 | ,000 | 1&2; 1&3; 2&3 |
| Sit-ups 30 sek. (n) | 12,19 | 4,84 | 11,17 | 4,81 | 8,63 | 5,19 | 38,62 | ,000 | 1&2; 1&3; 2&3 |
| Bent arm hang (s) | 5,86 | 5,40 | 2,12 | 3,02 | 0,62 | 1,47 | 129,52 | ,000 | 1&2; 1&3; 2&3 |
| Handgrip (kg) | 10,32 | 4,11 | 11,67 | 4,46 | 12,67 | 4,65 | 28,23 | ,000 | 1&2; 1&3; 2&3 |
| Sit and reach (cm) | 15,39 | 5,81 | 14,95 | 5,73 | 15,16 | 5,48 | 0,62 | ,538 | ns |
| Shuttle run 4x10 m | 15,49 | 2,05 | 15,92 | 1,93 | 16,48 | 2,06 | 20,20 | ,000 | 1&2; 1&3; 2&3 |
| 1 = Normal weight; 2 = Overweight; 3 = Obese | | | | | | | | | |

**Table 5.** Significance of differences in physical fitness components in the various BMI categories in the girls

| | Normal weight | | Overweight | | Obese | | F | Sig. | Post hoc pairwaise comparisons |
|---|---|---|---|---|---|---|---|---|---|
| | M | SD | M | SD | M | SD | | | |
| Arm circumference (cm) | 18,15 | 1,60 | 21,66 | 1,51 | 24,24 | 2,08 | 1201,51 | ,000 | 1&2; 1&3; 2&3 |
| Thigh circumference (cm) | 37,53 | 3,47 | 44,10 | 3,39 | 49,12 | 4,29 | 971,87 | ,000 | 1&2; 1&3; 2&3 |
| Height (cm) | 127,72 | 6,00 | 130,89 | 6,29 | 133,08 | 6,24 | 80,86 | ,000 | 1&2; 1&3; 2&3 |
| Weight (kg) | 26,24 | 3,56 | 34,04 | 4,16 | 41,43 | 6,39 | 1206,14 | ,000 | 1&2; 1&3; 2&3 |
| Fat mass (%) | 17,61 | 4,96 | 28,34 | 2,94 | 34,83 | 4,42 | 1276,18 | ,000 | 1&2; 1&3; 2&3 |
| Muscular mass (%) | 29,37 | 2,70 | 29,41 | 1,87 | 28,52 | 1,89 | 9,44 | ,000 | 1&3; 2&3 |
| Standing long jump (cm) | 111,79 | 16,70 | 106,29 | 15,46 | 97,69 | 15,82 | 53,63 | ,000 | 1&2; 1&3; 2&3 |
| Sit-ups 30 sek. (n) | 11,43 | 4,89 | 10,50 | 4,83 | 8,28 | 5,37 | 27,90 | ,000 | 1&2; 1&3; 2&3 |
| Bent arm hang (s) | 4,67 | 4,47 | 1,95 | 2,95 | 0,31 | 1,08 | 111,80 | ,000 | 1&2; 1&3; 2&3 |
| Handgrip (kg) | 9,57 | 3,68 | 10,83 | 4,00 | 11,85 | 4,14 | 29,76 | ,000 | 1&2; 1&3; 2&3 |
| Sit and reach (cm) | 15,65 | 5,75 | 15,81 | 5,52 | 16,22 | 5,62 | 0,70 | ,495 | ns |
| Shuttle run 4x10 m | 16,01 | 2,00 | 16,35 | 1,94 | 16,99 | 1,98 | 17,13 | ,000 | 1&2; 1&3; 2&3 |
| 1 = Normal weight; 2 = Overweight; 3 = Obese | | | | | | | | | |

# DISCUSSION

Obesity in childhood and adolescence is becoming a global epidemic and is threatening to take on dimensions of the epidemic in Macedonia. The percentage of the excessively fed and obese children at seven and eight years old classified on the basis of BMI criteria in the survey is 35%. Regarding the previous researches realized on Macedonian adolescents from 9 to 14 years old can be concluded that the percentage of the excessively fed and obese children at eleven and twelve years old classified on the basis of BMI was 35%, at thirteen and fourteen years 31%, while nine and ten years 39% (Gontarev, S., & Ruzdija, K. 2014; Živkovic et al. 2014; Gontarev, S. et al. 2014). Similar results for the excessive nutrition and obesity are obtained in several international studies (Jehn et al., 2006; Ortega, 2007; Al-Nakeeb et al., 2007; Ostojic et. al., 2011).

Over 19% of the respondents have a percentage of body fat greater than 30%. Such high percentage of body fat is associated with increased risk of acute and chronic diseases especially osteoratritis, high blood pressure, diabetes mellitus and cardiovascular disease which can led to poorer quality of life, increased personal and financial burden on the individual, family and society shortening of lifespan. (Williams et al., 1992; Aristimino et al., 1984; Berenson et al., 1980; 1982; Dugan, 2008) .

In a way, the lower level of fitness ability for the excessively fed and obese children may be associated with muscle insufficiency due to insufficient physical activity which has indirect influence on the occurrence of disorders of the postulate status or the occurrence of bodily deformities (Вуканић, 2006; Мадић, 2009). The muscle insufficiency occurred in these conditions have a consequence of muscle strength that occurs even later (Wearing, et al., 2006). It is necessary to mention that there are a small number of longitudinal scientific studies that followed the physical development in children. Many studies have examined how obesity affects the muscle and bone system in childhood, but there is a need for a longitudinal studies that will determine the long-term influence on the thickness of the muscle and the bone system and their function (Wearing, et al., 2006). In terms of flexibility, our research indicate that girls and boys with moderate or excessive overweight achieve similar results as those with normal weight. This is probably due to the fact that the flexibility is not directly related to the strength, which on the other hand depends on the level of physical activity.

There are several studies that had similar methodology as this research, i.e. the goal was to determine the relationship of excessive nutrition and obesity with the fitness ability. In Greece is realized a research that is applied EUROFIT battery on the tests, in which obese children achieved significant lower results in all tests except the test for assessing the flexibility (Tokmakidis, Kasambalis, & Christodoulos, 2006). Significantly lower results in tests for assessing the strength, speed, coordination and explosive strength for children at 6 to 12 years are observed in other studies (Kostić, et al., 2007; Castro-Piñero, et al.,2009; Milanese, et al., 2010; Ara, et al., 2007; Graf, et al., 2004; D'Hondt, Deforche, De Bourdeaudhuij, & Lenoir, 2008; Zhu, Sheng, Wu, & Cairney, 2010). A strong negative correlation between aerobic endurance and obesity for children at 6 to 14 years is determined in the research in Serbia and China (Ostojić, et al., 2011; Shang, et al., 2010). In some researches have not been determined the significant differences between normal fitness abilities, excessive nutrition and obese children, but 44 to 47% of the results are below average for the analyzed age (De Toja, et al., 2009). In general children show weaker results in developing fitness abilities, 75% of children at six years have poorly developed abdominal muscle, 50% of them cannot stand on one leg more than 30 seconds, 50-60% have a disorder of postural status, 40% of them have back pain (Grossing,2008). In Switzerland in twelve years olds is reported a muscle weakness for 50% of the children (Zophi, Serino, & Wirz, 2008).

The solution to the problem of excessively fed and obese children is certainly physical activity. Unfortunately there are not many studies that prove the direct influence of physical exercise on obesity in children (Watts, Jones, Davis,& Green, 2005), i.e.is still working on the harmonization of the common standards of assessment before the implementation of the program of work with obese children (Eisenmann, 2011).

One of the possible solutions is the SHARK program designed to develop fitness abilities in excessively fed and obese children. The program is conducted in children at age of 8 to 12 years and lasts 8 weeks. Measurements are conducted after the realized program and 9 months later, indicate on significant improvement in fitness level abilities (Cliff, et al., 2007). And the program kid FIT has been proved successful in controlling the weight and improving the fitness abilities in obese children (Bush, et al., 2007). In addition to this is the conclusion from the research that people with lower level of fitness abilities and those with higher BMI values obligatory are recommended exercises to strengthen the dorsal and abdominal muscles and development of flexibility (Cantell, Crawford, & Tish Doyle-Baker, 2008).

Except in tests for assessment the flexibility and palm dynamometry, the children who are excessively fed show statistically significant lower values in manifesting of dimensions of the strength, speed and coordination regarding with the children with normal body weight. These results suggest the conclusion that children who are excessively fed and obese children need education, but a programmed physical activity in accordance with their capabilities or need to improve their level of fitness abilities that will not distract from regular physical activity.

The results can partially be explained by the lack of fundamental motor skills in physical education as well as expertise of people who educate children in the period of preschool to sixth grade in elementary school. One of the reasons to insufficient or inadequate physical activity and good habits related to nutrition may be requested in the quantity and quality of physical education in preschool and young school age. For sure the “sportification” and the whole concept of physical education that is focused exclusively on the development of motor skills, requires a through review and change.

Such research should be an integral part of physical education and the analysis of the end of the school year, would give insight into the morphological and motor status of the children in the local government, region and the country as it could adequately respond to the problem with obese children in school age.

## CONCLUSION

The research presents current study of the prevalence of obesity and overweight among children in the central and eastern part of the Republic of Macedonia based on the population approach, which primarily is put on prevention. The results indicate that more than two out of ten is overweight and more than one child in ten is obese. It affects the prevalence of the obesity in the later life age. The prevalence of overweight and the obesity on the basis of BMI among Macedonian children is 35%.

Macedonian children of both gender with moderately increased or high BMI have: a lower percentage of muscle mass, a higher percentage of body fat and achieve lower results in the tests for assessing fitness. Children in both gender who have moderate overweight or excessive overweight achieve lower results in the tests: standing long jump, shuttle running 4x10meters and raising the trunk for 30 seconds, show similar results in terms of flexibility to respondents who have normal body weight and better results in the test of dynamometry of palm.

Correlation coefficients between the percentage of body fat and fitness abilities are somewhat higher for boys compared to girls. On the other hand, the correlation coefficients between BMI and fitness abilities are somewhat higher for girls compared to boys.

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# USEFULNESS OF HEART RATE RECOVERY IN SPORT MEDICINE

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## SUMMARY

The Heart rate recovery is defined as the reduction in heart rate that occurs after peak exercise and is usually measured in the first or second minute after exercise. This is simple, non-invasive method for evaluation of cardiorespiratory fitness, sport endurance and autonomic nervous system function. As promptly as the heart rate is decreasing, the heart and body are of better general health and of better physical fitness. Generally speaking, all athletes are training to improve their fitness and sport performance through increasing training load over time. The body of athlete may tolerate increased load only if it's in parallel with periods of relaxation and such training technique may improve physical performance. However, if the load is extremely high, syndrome of overtraining may ensue. The characteristic symptoms are tiredness, lack of enthusiasm, neurohumoral disturbances and lack of heart rate diminishing after the exercise. By knowing the importance of HRR assessment in sport medicine, its normal values and demand for HRR regular measuring, athletes may follow their fitness status since the changes in HRR may be the clue to unrecognized syndrome of overtraining or some other health problems including heart disease. The aim of this review is to analyze current knowledge on the importance of HRR assessment in timely recognizing of autonomic dysfunction and overtraining syndrome in athletes.


**Keywords**: heart rate recovery, assessment, overtraining sy, athletes

Abbreviations: HRR- heart rate recovery, OTS-overtraing sy, ANS-autonomic nervous system

## PHYSIOLOGICAL BASIS OF HRR

The autonomic nervous system (ANS) consists of two main divisions, the sympathetic and the parasympathetic nervous systems that act in opposition to each other on heart. The sympathetic nervous system is often considered the "fight or flight" system, while the parasympathetic nervous system is often considered the "rest and digest" or "feed and breed" system. Stimulation of the sympathetic branch exerts facilitatory effects on function, increasing heart rate and myocardial contractility, whereas the stimulation of the parasympathetic branch exerts inhibitory effects that decrease heart rate and contractility. The interplay between these two branches is complex and susceptible to control at several levels, from centrally mediated baroreceptors and chemoreceptors to local interneuronal interactions. As ANS is interconnected with many physiological regulatory systems the quantification of ANS activity and simpathovagal balance may be important clinical tool for fitness assessment as well as the assessment of the body's functional adaptation to acute and chronic exercise. The simplest definition of HRR is that it represents the decrease in heart rate that occurs after maximal exercise. It represents the changes in autonomic tone that occurs immediately after cessation of exercise and is mainly mediated via parasympathetic autonomic nervous system(Betts J. Gordon (2013). Anatomy & physiology). Through the HRR monitoring it is possible to follow up adequate exercise dose during training process and eventual occurrence of fatigue and overtraining syndrome. It can be measured at the end of first or second minute after peak exercise. The faster heart rate decrease means the better physical adaption and overall body fitness. It was shown that HRR correlate with body fitness improvement. In addition decreased HRR has been shown to be a simple, specific and noninvasive biomarker of poor body fitness and overtraining syndrome.(Dejan Stanojevic et al. 2013).

## HRR IN MEDICINE

It was shown that decreased vagal activity as reflected as low HRR caries increased risk for sudden death. An abnormal cut off value of the recovery of heart rate less than 22 beats per minute after the peak exercise is defined as a powerful and independent predictor of the risk of death(Shetler et al., 2001). In patients with myocardial infarction HRR values to > or =12 bpm predict better cardiac survival.(Hai et al., 2010). This study of Minai et al. shows that heart rate recovery at 1 minute (HRR1) after 6-minute walk test is an easily measured biomarker that is predictive of clinical worsening and time to clinical worsening in patients with idiopathic pulmonary arterial hypertension.(Minai et al. 2012)

Ty et al. demonstrated that delayed HRR after exercise predicts incident T2DM in men, even after adjusting for fasting glucose, HOMA-IR, HOMA-β, and HbA1c. However, only HRR 1 had clinical significance.(Yuetal.2016).

While comparing different markers of ANS function such as heart rate variability, tests of baroreceptor sensitivity and HRR, Cole at al. in their research give advantage to HRR parameters for ANS assessment, because of determination simplicity, and it isn't necessary to perform 24h holter ECG monitoring or specific baroreceptor tests. HRR is usually measured in different time frames, between 30 seconds and 2 minutes. Literature data shows different opinions among authors about reliability of the first and second minute measurements. Bosquet et al. showed no differences in reliability between the HRR after 1 minute and 2 minute and on the other hand Lamberts et al. demonstrated that values of reproducibility expressed , as a coefficient variation are significantly higher after second minute than after first minute. Lamberts averaged the heart rate at the end of the exercise over the last 15 seconds , and took the the first minute value as the average over seconds 45 and 60. This method seems to be more objective than measurements at the moment of cessation of exercise.(Bosquet, Gamelin, & Berthoin, 2008; Cole, Blackstone, Pashkow, Snader, & Lauer, 1999; Robert P Lamberts, Lemmink, Durandt, & Lambert, 2004; Robert P Lamberts, Swart, Noakes, & Lambert, 2009)

## THE IMPLICATIONS OF HRR IN SPORT

The athletes train to improve their level of flexibility or strength or to achieve better sport performance. Exercise is important biological stimulus, where the hall body, particular ANS and adrenal glands play the major role to keep and balance the homeostasis. According to the current scientific thinking, well designed training process should be set up as to gradually increase workload and to enable exercise stress to rise slowly. Hence the intervals between exercises should be long enough to permit regeneration of muscle function. Every well-established training program comprising components of repeated load but without adequate time for body recovering might lead to the occurrence of several side effects such as lack of improving cardiorespiratory and physical fitness and chronic fatigue. Performance decline in exercise or lack of body fitness improvement is characterized by a number of physiological and psychological symptoms as well as signs of maladaptation. The weeks and months are sometimes required for athlete to return to usual fitness. Such a state of diminished conditioning is well known in literature as a " Burnout training stress syndrome" (Kreher & Schwartz, 2012). Thus the physiological parameters estimation represents a primary and principal method in recognition of overtrained athletes. Some authors suggest HRR as the most sensitive and timely enough parameter to be used for detection of such pathology and further adequate stress dosage. The findings of Borresen and Lambert, are in contradiction with other reports in that there assume a HRR decline during increasing of training workload. They speculate that abrupt change in workload during training might lead to development of overtraining symptoms and signs such as HRR decline(Borresen & Lambert, 2007). However the majority reports found greater HRR values in well trained vs untrained subjects. (Halson & Jeukendrup, 2004; R P Lamberts, Swart, Capostagno, Noakes, & Lambert, 2010; Robert P Lamberts et al., 2004).Two most cited longitudinal studies confirm that HRR values are steady when there is no change in physical fitness (Buchheit, Mendez-Villanueva, Quod, Poulos, & Bourdon, 2010; R P Lamberts et al., 2010). Lehman at al. speculate that rapid decline in HRR is related with acute exercise while the lower decline is related with the state of chronic fatigue (Lehmann, Foster, Dickhuth, & Gastmann, 1998). These results suggest that HRR might be potentially useful tool, to identify not only changes in physical fitness but also to follow accumulation of fatigue and potential risk for developing overtraining syndrome.

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# SPORTS AND RECREATIONAL ACTIVITIES OF CHILDREN AGED 15

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## SUMMARY

The level of physical activity is often used as a parameter for monitoring and evaluation of public health and it is almost always associated with health status. Physical activity is essential for a healthy and balanced development of children and youth. The aim of this study was to determine the involvement in sports and recreational activities of boys and girls aged 15. The sample consisted of 500 first grade students of secondary schools in Nis (15 years of age), of which there were 250 boys and 250 girls. A questionnaire used in the research Mitic et al (2010) was used here too for the assessment of involvement in sporting and recreational activities. The questionnaire contained a total of 11 questions, and the differences were determined by Chi-square test. The results of the research showed that boys are more regularly engaged in sporting and recreational activities than girls. Significant differences were found in the way of exercise in their free time between boys and girls (p = .000), in the selection of school clubs in physical education (p = .000), as well as their membership in different social organizations (p = .000). We also found differences in doing sports in a sports club (p = .001), as well as the differences concerning the choice of an independent exercise program (p = .030). The conclusion is that boys are more engaged in sporting and recreational activities than girls aged 15.

**Keywords:** recreation, sport, activity, adolescents

## INTRODUCTION

Physical activity is defined as any physical movement of skeletal muscles that results in energy consumption bigger than the one during the rest (Thompson et al., 2003). Practically, it includes all forms of activity, such as a daily walk or riding a bike, activities related to work, active play and active vacation (such as exercising in the gym), dancing, gardening, as well as a recreational and competitive sport. In contrast, physical inactivity is not only a lack of activity, but a collection of particular behavior at work, at school, at home or in transport, which is dominated by sitting or lying down, while energy consumption is very low. Typically, this behavior includes watching TV or working at your computer; travelling home, to school, to work by car, bus or train; sitting and reading, talking, doing homework or listening to music (Department of Health, Physical Activity, Health Improvement and Protection, 2011).

The level of physical activity is often used as a parameter for monitoring and evaluation of public health and is almost always associated with health status. Collecting data at the level of the population or part of the population often involves self-assessment levels of physical activity using questionnaires, surveys and interviews. This method, which is much cheaper than direct measurement method, may show some tendencies and changes of habits in this population group (Pantelic, Kostic, Milanovic, Uzunović, Alexandrovich, 2011). Physical activity is essential for a healthy and balanced development of children and youth (Popovic, 2008), and the involvement in some form of sporting and recreational activities can meet daily need for exercising. Insufficient and inadequate physical activity reduces the functional capacity of many systems of organs, especially the cardiovascular and respiratory system while nervous tension leads to various mental illnesses. This situation leads to a reduction in working capacity and a disturbance of physical and mental health of young people (Jorgić, 2008). Many studies have proven the positive effect of physical activity in leisure time on the prevention of diseases such as cardiovascular disease, type 2 diabetes, osteoarthritis, osteoporosis, breast cancer and colon cancer (US Department of Health and Human Services, 1996 Colditz et al, 2003.). The level of physical activity declines throughout life, in the best case, the decline begins with starting school. During the school years, the level of physical activity declines by about 50% (Sallis, 1993). Health Research et al. (1994) proves that doing the intensive physical activity three or more times a week among children aged 14 to 16 decreases from 81% to 67% for boys, i.e., from 61% to 41% for girls.

The goal of the research is to determine the involvement in sports and recreational activities of boys and girls aged 15 - their involvement in recreation, physical education, physical activity and certain forms of sport and recreational activities.

# METHODS

## Subjects

The study included 500 students of the first year of high school in Nis, aged 15, of which there were 250 boys and 250 girls. The sample was randomly involved in the research. Before the beginning of the interviewing each of the students involved in the study received the approval from the parents to consent to research and was explained the purpose of the research.

## Procedure

The instrument used in the work is a modified questionnaire used in the study Mitic and associates (2010). The questionnaire contained a total of 11 questions with which it was possible to respond to the set goal.

## Statistical analysis

For each question, the basic descriptive parameters were made, for boys and girls separately, by calculating the frequency and percentage. The chi-square test ($\chi 2$) of independence was applied for determining the differences between the group of boys and the group of girls.

All data were analyzed using the statistical package for data processing SPSS20.0, and the level of statistical significance was 0.05.

# RESULTS

The results of descriptive statistics are shown in Table 1.

When asked if they are a member of a social organization, the majority of respondents replied that they are members of a sports club (boys 44.7%, girls 30.1%). Also, a number of respondents are a member of the school's Sports Club, (boys 16.7%, girls 23.0%). A larger number of girls are a member of the cultural and artistic society (25.8%) compared to boys (9.8%).

When asked whether the respondents are the members of some school clubs in the field of physical education, the results show that boys are mostly the members of the school football team (28.4%), followed by basketball (16.3%), volleyball (13.0%), handball ( 10.7%). Girls are mainly the members of the volleyball school clubs (29.1%), followed by basketball (16.2%), handball (10.9%), and dance group (10.2%).

The answers to the question whether they have been to a mountain for winter holiday so far, indicate that 29.9% of boys and 28.0% of girls have never been to the mountain in winter, 30.4% of boys and 38.3% girls went there once, while 39 , 7% of boys and 33.7% girls were there two or more times.

**Table 1.** Basic parameters of descriptive statistics

| Statement | Options | Boy(250) Frq (%) | Girl(250) Frq (%) |
|---|---|---|---|
| **Are you a member of some social organization** | Youth association | 0 (0,0) | 2(0,8) |
| | Mountaineering society | 21 (9,8) | 8 (3,1) |
| | Scout organization | 8(3,7) | 20 (7,8) |
| | Recreational society | 5(2,3) | 11(4,3) |
| | Hunting society | 16(7,4) | 5(2,0) |
| | Fishing society | 12(5,6) | 8(3,1) |
| | Folk dancing society | 21(9,8) | 66(25,8) |
| | School sport society | 36(16,7) | 59(23,0) |
| | Sports club | 96(44,7) | 77(30,1) |
| **Are you a member of a physical education school club?** | Athletics | 12(5,6) | 23 (8,7) |
| | Handball | 23 (10,7) | 29 (10,9) |
| | Gymnastics | 9(4,2) | 19(7,2) |
| | Karate | 21(9,8) | 12(4,5) |
| | Basketball | 35(16,3) | 43(16,2) |
| | Judo | 7(3,3) | 16(6,0) |
| | Basketball | 28(13,0) | 77(29,1) |
| | Dancing club | 8(3,7) | 27 (10,2) |
| | Football | 61(28,4) | 15(5,7) |
| | Table tennis | 11(5,1) | 4(1,5) |
| **Have you ever been on winter holidays?** | Never | 64(29,9) | 74 (28,0) |
| | Once | 65 (30,4) | 101(38,3) |
| | Regularly | 85 (39,7) | 89 (33,7) |
| **Have you ever and if yes, how many times in the last year have you been to a picnic site in town with your school?** | Not once | 112 (54,9) | 138(53,9) |
| | Up to 5 times | 80 (39,2) | 105(41,0) |
| | From 6 to 10 times | 6(2,9) | 10 (3,9) |
| | More than 11 times | 6(2,9) | 3(1,2) |
| **Have you been to a picnic site with your parents in the last year?** | Not once | 81 (39,7) | 106 (42,1) |
| | Up to 5 times | 91(44,6) | 108 (42,9) |
| | From 6 to 10 times | 24(11,8) | 28 (11,1) |
| | More than 11 times | 8 (3,9) | 10(4,0) |
| **Have you been to a picnic site with your friends in the last year?** | Not once | 74(35,6) | 76(30,4) |
| | Up to 5 times | 91(43,8) | 112(44,8) |
| | From 6 to 10 times | 23(11,1) | 34(13,6) |
| | More than 11 times | 20 (9,6) | 28(11,2) |
| **I exercise in my free time** | Never | 25 (11,8) | 43(16,4) |
| | Sometimes | 99(46,9) | 165 (63,0) |
| | Regularly | 87(41,2) | 54(20,6) |
| **In my free time I do exercises in one of the sports centers** | Never | 82 (38,7) | 105 (44,4) |
| | Sometimes | 87(41,0) | 111(42,7) |
| | Regularly | 43(20,3) | 44(16,9) |
| **In my free time I do exercises which are my personal programme of exercises** | Never | 83 (39,0) | 133 (51,2) |
| | Sometimes | 89 (41,8) | 88(33,8) |
| | Regularly | 41(19,2) | 39(15,0) |
| **I do sports in a sports club** | Never | 69(32,6) | 118(45,4) |
| | Sometimes | 43(20,3) | 63 (24,2) |
| | Regularly | 100 (47,2) | 179(30,4) |
| **I do not do exercises in my free time because I do not have company for exercises, I do not exercise alone…** | Never | 165(79,0) | 192(75,3) |
| | Sometimes | 33 (15,8) | 43 (16,9) |
| | Regularly | 11 (5,3) | 20 (7,8) |

**Legend**: *Frq. - frequencies - number of subjects*

The answers to the question whether and how many times in the past year they were at the picnic site with the school, the tabulation shows that 54.9% of boys was never there, up to 5 times was 39.2%, 6-10 times 2.9% and more than 11 times was 2.9% of boys. The girls replied that they (53.9%) had never been to one, 41.0% of them - 5 times, 6 to 11times 3.9% of them and more than 11 times 1.2%.

When asked how many times they went on a picnic with their parents in the last year, both boys and girls had similar responses, 39.7% of boys and 42.1% of girls had never been there, up to 5 times was 44.6% of boys and 42.9% of girls, 6 to 10 times was 11.8% of boys and 11.1% girls, and for more than 11 times the result was 3.9% of boys and 4.0% girls.

The answers to the question of whether and how many times they went to a picnic site in the city with friends in the last year show that both boys and girls had about the same experience, and that it was up to 5 times for 43.8% of boys and 44.8 % of girls, 35.6% of boys and 30.4% girls had never been to one, and the smallest number of them answered that they were there more than 11 times, 9.6% of boys and 11.2% of girls.

The answer to the question *In my free time I do exercises with my friends in a way that we arrange running, going for a walk, playing football, basketball*, shows that: boys exercise regularly (41.2%), sometimes a little less than half of respondents (46 , 9%), while those who never do exercises make 11.8%. The girls, unlike boys, exercise much less regularly (20.6%), sometimes little more than boys (63.0%), and those who never exercise make 16.4%.

Asked whether in their free time they do exercise by going to some of the sports centers, 20.3% of boys responded that they regularly do exercises in sports centers, sometimes 41.0%, 38.7% never. 16.9% of girls regularly do exercises in sports centers, 42.7% sometimes and 40.4% never.

When asked if in their free time the respondents do exercises by having their personal programme that they regularly carry out, they answered: boys regularly conduct their exercise program (19.2%), sometimes (41.8%) never (39 , 0%). Girls regularly conduct their exercise program (15.0%), sometimes (33.8%), never more than half of respondents (51.2%). The results indicate that the boys do sports regularly in a sports club 47.2%, 20.3% sometimes and those who never do sports make 32.6%. The girls, unlike boys regularly do sports (30.4%), sometimes (24.2%) and never (45.4%).

Asked whether *in their free time they do not do exercises because they have no company to exercise, they do not go anywhere to exercise because they do not want to do that alone, do not go to a sports center*, boys and girls responded about the same – they never do exercises because they do not have friends for that activity.

Table 2 shows the discovered differences between boys and girls, where we used Chi-square test ($\chi^2$) of independence.

**Table 2.** The differences between boys and girls

| Statement | Boy vs Girl | |
|---|---|---|
| | $\chi^2$ | Sig. |
| Are you a member of a social organization? | 49,52 | .000 |
| Are you a member of a school club from the area of physical education? | 74,40 | .000 |
| Have you ever been on a winter holiday? | 3,43 | .180 |
| Have you ever and if yes, how many times in the last year have you been to a picnic site in town with your school? | 2,23 | .526 |
| Have you been to a picnic site with your parents in the last year? | 1,58 | .812 |
| Have you been to a picnic site with your friends in the last year? | 1,82 | .611 |
| I exercise in my free time | 23,77 | .000 |
| In my free time I do exercises in one of the sports centers | 8,77 | .645 |
| In my free time I do exercises which are my personal programme of exercises | 7,03 | .030 |
| I do sports in a sports club | 15,96 | .001 |
| I do not do exercises in my free time because I do not have company for exercises, I do not exercise alone… | 2,60 | .458 |

**Legend**: *$\chi^2$-chi-square test;** - level of signification p< .01 inside every group; Sig – test between the groups*

# DISCUSSION

The conducted study provided data on the engagement in sporting and recreational activities of pupils of the first year of high school in Nis. The differences were established in structure and frequency of sports-recreational activities in relation to sex. The research results indicate that a small number of students are regularly engaged in physical activity (41.2% boys and 20.6% girls). Similar results came from the studies of Milanovic (2012), whose results indicate that 79.9% of respondents have no regular physical activity, and that only 30.7% of respondents have hobbies, most of which imply sedentary behavior.

The accomplished study found that boys (41.2%) are more active than girls (20.6%). Also, boys

(47.2%) are members of a sports club in a greater number than girls (30.4%). Other researchers come to similar results indicating a higher level of physical activity in boys compared with girls. The results of numerous descriptive epidemiological studies suggest that physical activity decreases with age (Sallis et al., 2000), and is especially apparent in the adolescent age (Rowland, 1999). Also, in studies published in many different countries, it is suggested that boys are more active than girls (Caspersen et al., 2000: goest & Yang, 2000; Riddoch et al., 2004) .Corbin, Pangraz & Le Masurier (2004) in their research have dealt with the sex as a factor of influence on physical activity and it begins to manifest itself in early adolescence. Namely, significant differences in weekly physical activity between the girls and boys of the same age start from the age of 10and are present up to 15 years.

The current study came to the result that the boys usually play football (28.4%), basketball (16.3%) and volleyball (13.0%), while girls are in most cases engaged in volleyball (29.1%) and basketball (16.2%). A two-year study conducted in the UK (Hayes, 2002) showed that the main sporting activities of the young in their free time are mainly football and cycling with boys, or swimming and walking with girls. Boys in Canada in their free time mostly ride a bike and surf the Internet, while girls walk in the countryside and help their parents (Mark et al., 2006). In the area of Melbourne children are mainly engaged in activities that do not require any effort, such as going to their friends and watching movies (Wheeler, 1993), while a study of the population of children conducted in Denmark shows that one of the main activities of children in their free time is doing sports (Mehlbye & Jensen, 2003).

In the conducted study, the largest number of active high school students prefers training in the company of their peers whether it is spontaneous (as arranged with friends) or organized (in sports clubs) mode of engagement, (boys are more involved than girls), while it is a small percentage of students who realize their needs for sport and recreation in sports centers, which can possibly be explained by the lack of funding for this type of activity.

# CONCLUSION

In the current study we came to the conclusion that the boys are more regularly engaged in sports and recreational activities than girls. There was a statistically significant difference in the way of exercise in their spare time between boys and girls aged 15.When it comes doing sports in a sports club, or having their personal exercise programme which they follow, then going for a run with friends and doing the variety of physical activities, boys are more regular than girls. Engaging in physical activity or sport greatly contributes to a healthier physical and mental development of children. The usefulness of physical activity and sport as a factor in the prevention of a variety of negative impacts during the maturation of young people is the main issue of a large number of studies (Pate et al, 2000). However, despite all the recommendations for physical activity, in spite of the pointing out the important health benefits of physical exercise, children and young people are becoming less physically active. Sedentary lifestyle is more prevalent among young people.

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# THE INFLUENCE OF PHYSICAL ACTIVITY ON OBESITY IN CHILDREN AGED 7-14 YEARS

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## SUMMARY

Overweight and obesity were declared epidemics by the World Health Organization (WHO, 2000). The prevalence of overweight and obesity is particularly dramatic in economically developed countries, not only in adults but also in children and teenagers. Obesity can arise from various factors. Genetic inheritance factors related with high body mass index (BMI) or body fat are between 25 and 40%, which suggests that other factors, such as environmental factors, also play a key role here. Physical activity and physical exercise are an important prerequisite for maintaining one's health. Not just running, but other easier exercises as well, can contribute to creating a subjective feeling of being healthy. For the purpose of this research, the search through electronic academic database (Pub Med, Web of knowledge and SportDiscus) has been conducted, after which, the abstracts of relevant studies have been analyzed and 30 most representative studies related with the subject matter of this research have been chosen. The descriptive statistics was used in this study. The objective of the research was to determine the influence of physical activity on the obesity of children and teenagers based on the research conducted so far. Systematic analysis of 30 selected scientific papers which satisfied the inclusive criteria determined at the beginning of the research showed a significant connection between physical activity and the appearance of overweight or obesity in children aged 7-14 years.

**Keywords:** physical activity, fitness, exercise, overweight, obesity, children.

## INTRODUCTION

Overweight and obesity were declared epidemics by the World Health Organization (WHO, 2000). The prevalence of overweight and obesity is particularly dramatic in economically developed countries, not only in adults but also in children and teenagers. In Germany, for example, 17% of teenagers aged 14 to 17 years are overweight and almost 9% are obese (Kurth & Schaffrath Rosario, 2007). Similarly, in the United States, 18% of teenagers aged 12 to 19 years are obese (Ogdenm et al., 2010).

Obesity can arise from various factors. Genetic inheritance factors related with high body mass index (BMI) or body fat are between 25 and 40%, which suggests that other factors, such as environmental factors, also play a key role here. Family environment and genetic predisposition influence body development and fat content distribution (Bouchard et al., 1997). Other important factors include lifestyle factors, such as, physical activity (PA), smoking, alcohol consumption, healthy diet, "sedentary activities" and healthy body weight (Pronk et al., 2004).

Several epidemiological and research studies have identified the influence of physical activity and physical fitness on overweight in children and teenagers (Wareham et al., 2005; DiPietro et al., 1995).

According to the definition given by the World Health Organization, physical activity is defined as a 30-minute physical activity, at least three times a week, with the intensity which is, depending on the age, 25-30% higher than the pulse at standstill (WHO, 2010).

Along with physical exercise, physical activity is an important prerequisite for maintaining one's health. Not just running, but other easier exercises as well, can contribute to creating a subjective feeling of being healthy. The lack of physical activity leads to serious consequences within the entire muscular system and it can also cause certain diseases (cardiovascular diseases, osteoporosis, colon cancer, hypertension, etc.). Physical activity stimulates blood circulation in the body (Niebauer & Cooke, 1996; Manfredini et al., 2009). When there is no physical activity, blood does not circulate properly and there is no matter exchange which is so important for our health and healthy life, and our skin does not properly perform its function. The accumulated toxins and metabolic waste are not eliminated from the body as it would be the case when, due to physical activity, the blood stream is stimulated and accelerated, the skin is kept healthy and the lungs are filled with clean, fresh air (Niebauer & Cooke, 1996).

# METHODS

For the purpose of this research, a thorough search through electronic academic database (*Pub Med, Web of knowledge and SportDiscus*) has been conducted. The following keywords were used: *physical activity, fitness, exercise, overweight, obesity, children*. While selecting scientific papers to be studied, the parameter related with the age of the subjects included in the research limiting it to 7-14 years of age was also added. During the first phase of the research, 80 scientific papers containing in their titles some of the above stated keywords were collected. After that, by means of a further screening process, the number of scientific papers to be analyzed was reduced to 47. The third phase of the research included the analyses of the abstracts of the selected papers after which 30 representative papers, matching the subject matter of this study, were selected.

After collecting the relevant papers, the parameters which were used and entered into the table were defined. The characteristics of the sample of the subjects of each paper were carefully analyzed (age, gender, the number of subjects, the number of groups) as well as the characteristics of the research methods (the sample of the measuring instruments – the variable), the characteristics of the implemented treatment (it refers only to longitudinal studies) and also the results of the research which the authors obtained.

# RESULTS

| **Author and year** | **Sample of subjects** | | | | **Material and methods** | **Results** |
|---|---|---|---|---|---|---|
| | **Number** | **Groups** | **Gender** | **Age** | **Tests** | |
| Adamo et al., 2011 | 453 | 2 | m/f | 9-13 | 20 m shuttle run, deep forward bend and isometric hand grip | In terms of nutritional and motoric transition, Kenyan children are a little behind in aerobic fitness when compared to Canadian children |
| Ara et al., 2007 | 1068 | 2 | m/f | 7-12 | BMI, aerobic capacity, strength, speed, flexibility | No significant difference was found in boys in terms of physically active or physically inactive groups, whereas physically active girls were found to be less obese than physically inactive ones. By means of a regression analysis it was determined that physical activity has great impact on BMI in boys but not in girls, whereas the maximum vital capacity (VO2 max) was closely related with obesity in both genders. |
| Brunet et al., 2007 | 1140 | | m/f | 7-10 | BMI, waist circumference (WC). Physical aptitude test consisted in a standing long jump, 1-minute sit-ups and a “shuttle run” test. | A negative correlation among BMI, WC and all fitness tests in both genders was determined, however, more significant results were found in older children. |
| Magnusson et al., 2008 | 488 | | m/f | 9 | Height, body weight, 4 skinfolds and maximum load test on bicycle ergometer, sociological questionnaire for parents, measuring of physical activity with accelerometer for 5 consecutive days | A significant prediction of practicing sports on the part of parents, especially mothers on fitness and obesity of children was determined here. |
| Nassis et al., 2005 | 1362 | 2 | m/f | 6-13 | Height, body weight, 4 skinfolds (body fat | There was less obesity in children who had higher values in cardiorespiratory fitness (CRF). |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | percentage was calculated), BMI. CRF (cardiorespiratory fitness) – "Shuttle run" test | |
| Stigman et al., 2009 | 304 | | m/f | 8 | Total percentage of body fat (BF%), fat percentage in abdominal region (AF%), fat free mass (FFM), waist circumference (WC), body height, body weight, BMI, CRF (20-m Shuttle run test) | Within the same BMI category, children with higher CRF have significantly lower waist circumference values (WC), body fat percentage (BF%) and AF% when compared to children with lower CRF. |
| Tomaszewski et al., 2011 | 308 | | m/f | 9 | Body height, body mass, arm span, waist and hip circumference, shoulder width, hip width and 5 skinfolds, BMI, "International Test of Physical Fitness" | Body height and longitudinal dimensionality contribute to physical fitness of boys to considerably less extent than body mass and circular dimensionality. An alarming prevalence of obese children was determined. |
| Monyeki et al., 2012 | 256 | | m/f | 14 | BMI, EUROFIT battery tests | A connection between fitness and BMI in undernourished girls with high fitness results was determined; the same applied for both obese boys and obese girls |
| Soares Ferreira et al., 2013 | 924 | | m/f | 12-17 | Body height, body weight, BMI, waist circumference and fat percentage measured by means of a bioelectric impedance analysis, 20-minute "Shuttle run" test, survey, sit-ups, push-ups. | Based on BMI the following was determined:<br>Overweight 23.5% men and 21.4% women.<br>Obesity 5.4% men and 3.4% women.<br><br>(according to waist circumference-WC)<br>overweight 67.4 % men and 74.3 % women<br>Overweight 30.1% men and 36.2% women<br><br>%FM<br>Overweight 13.8 % men and 20.2 % women<br>Overweight 4.4% men and 28.4% women<br>FA level<br>Low 25.9% men and 26.3% women<br>Cardiorespiratory fitness<br>47.65%(low) in men and women<br>Muscle fitness push-ups (men =14.66±10.36 repetitions; women =8.11±7.22 repetitions); sit-ups (men =41.35±23.76 repetitions; women =33.87±21.78 repetitions); and forward bends (men =26.24±5.02 cm; women =26.37±5.28 cm) |
| Tovar et al., 2008 | 655 | | m/f | 7-18 | Questionnaire, body weight, body height, fat percentage measured by means of bioelectric impedance analysis, PACER, forward bend, sit-ups, push-ups and hand dynamometry | Connection between overweight and not so good results in aerobic fitness test was established, as well as the connection with lower PA level estimated with the questionnaire. |
| Albon et al., 2010 | 3306 | | m/f | 10-14 | Body weight, BMI, 550m sprint, sit-ups, flexibility, standing long jump, 4 x 9-m sprints **Duration of the** | The average body weight increased by 4.5kg in men and by 3.9kg in women within the period of 12 years. The average values of BMI increased by 0.6% in men and 0.5% in women. Sprint result was worse by 1.5% in men and 1.7% in women. |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | **program** 1991-2003(12years) | |
| Chen et al., 2002 | 878207 | | m/f | 8-14 | BMI, Fitness tests (800/1600m sprint /walking), standing long jump, bent leg sit-ups, forward bend | BMI is significantly linked with fitness tests results. The upper BMI limit, 43% of subjects grouped as physically fit, has lower values than those of the total population. |
| Tokmakidis et al., 2006 | 709 | | m/f | 8.9+/-1.6 | Anthropometry, motor and cardiovascular fitness assessment (EUROFIT battery tests), BMI | 59.4% normal BMI, 25.8% overweight 14.8%. No significant differences between genders were determined. Higher BMI values are associated with poor fitness test results (except for flexibility). |
| Ortega et al., 2007 | 2859 | | m/f | 13-18 | BMI, waist circumference, maturation status, cardiorespiratory fitness, questionnaire | No significant link between free time physical activity and BMI or waist circumference was found. Cardiorespiratory fitness is inversely proportional to waist circumference and BMI. |
| Laguna et al., 2013 | 439 | | m/f | 8-10 | Anthropometry, BMI, GT1M accelerometer (6-day measuring) | Boys who did not have 67-minute moderate or high-intensity physical activity ran greater risk of being overweight and obese. Girls who did not have 57-minute physical activity ran greater risk of being obese. These results confirm current recommendations related with the importance of daily physical activity. |
| Monyeki et al., 2005 | 462 | | m/f | 7-14 | BMI, SSF (sum of skinfolds), %BF (body fat), FFM (fat free body mass) and WHR (waist and hip ratio). Fitness test (standing long jump, sit-ups, 10 x 5 m shuttle run, 50 m sprint, 1,600 m sprint, flamingo test, hand taping, forward bend, pull-up endurance | High BMI and FFM correlation. High values of BMI or SSF are associated with the poor result on pull-up endurance test and 1,600m sprint. BMI is significantly related with the result on flamingo test. WHR positive relation with pull-up endurance and negative relation with forward bend. Significant relation was found between BMI and standing long jump, forward bend, flamingo and hand taping test results. SSF was related with forward bend test. FFM was negatively related with pull-up endurance test and 1,600m sprint in girls, as well as with the 50m sprint in boys. FFM was significantly related with the standing long jump (in both boys and girls), with flamingo test and forward bend test (in boys). |
| Abril et al., 2013 | 743 | | m/f | 6-9 | International Obesity Task Force cutoffs(BMI, waist circumference) and PA assessment questionnaire and nutrition | There was no difference between genders, however, it was determined that overweight and obesity were 1.5-2 times more present in nine-year-olds than in six-year-olds. Multivariate model showed that higher values of BMI and waist circumference are significantly related with the lack of PA. Insufficient PA (75% of children) is related with 13% to 18% of increased risk of overweight, obesity and extreme obesity. In children who have breakfast and three or more meals a day (in 96,7% and 85,9 % of children), no overweight or obesity was found. Lower BMI was determined in children who eat fruit during recess in school. |
| Kovács et al., 2009 | 51 | | m/f | 6.5-12.5 | Aerobic training. Heart rate between 120-185 heartbeats in a minute. BMI, waist circumference, body composition (bioelectrical impedance | It has been determined that, with a proper training program, the monitored cardiovascular fitness and obesity parameters were improved (waist circumference, VO2MAX, muscle mass, systolic blood pressure, LDL cholesterol, abdominal obesity, hypertension and high triglycerides). |

| | | | | | | |
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| | | | | | analysis), aerobe capacity (ergometer), blood pressure, lipids and insulin sensitivity (HOMA) are treated. **Duration of the program** 15-week aerobic training (60 minutes 3 times a week) | |
| Li et al., 2007 | 210 | | m/f | 9-11 | Body mass percentage (fat%), fat mass (FM), body mass index (BMI), waist circumference, thigh circumference, waist and thigh circumference ratio. PA related habits were assessed by means of a validated questionnaire (MVPA level) | Nine-year-old girls who were in the upper quarter according to MVPA results had significantly lower fat percentage than girls of the same age; ten and eleven-year-old girls who were in the upper MVPA quarter showed significantly less increase in all body mass indicators. In terms of mass percentage, no significant difference was determined in physically active (upper MVPA quarter) and physically less active boys aged 9-11 years. |
| Ornelas et al., 2011 | 86 | | m/f | 9.8 | VO2MAX, PA level measured with accelerometer, fat mass (FM) measured as a sum of skinfolds and waist circumference **Duration of the program** Children were monitored in a period of eight years | CRF significantly increased in boys and decreased in girls. Body fat percentage decreased in time in boys and increased in girls. It was determined that CRF is a significant predictor of waist circumference, waist skinfold thickness and fat mass. |
| Sacchetti et al., 2012 | 497 | | m/f | 8-9 | Anthropometry, BMI, PA assessment questionnaire, fitness test (forward bend, throwing of medicine balls, standing long jump, 20 m sprint, forward roll) | Body weight and BMI in boys and girls are positively correlated with medicine ball throwing and are negatively correlated with a long jump and sprint test, whereas no correlation was found with back flexibility and body coordination. Daily PA and sports activity has no significant correlation with body weight and BMI whereas it is positively correlated with children's motor skills. |
| Mota et al., 206 | 255 | 3 | m/f | 8-10 | CRF (1 mile sprint), FITNESSGRAM, BMI. | Overweight (30.5% vs. 29.1%) and obesity (13.2% vs. 12.6%) was similar in both boys and girls. A total of 109 children (42.7%) was overweight or obese. The sum of skinfolds, body weight and BMI was significantly lower in skinny boys and girls when compared with their overweight and obese peers. In terms of height, no significant difference was determined in girls, whereas in boys, significant difference was determined only between non-obese and obese ones. In terms of CRF, no difference was determined within the group of obese boys, whereas significant difference was found in girls. Overweight and obese girls showed worse results in terms of physical fitness. |

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| Kim et al., 2005 | 6297 | | m/f | 5-14 | BMI, endurance running, abdominal strength, flexibility, abdominal strength and agility (FITNESSGRAM), amateur athletic association | The number of successfully performed tests was lower in subjects whose BMI was above 80th percentile. The appearance of overweight within a one-year period, amounted to 7% in girls who were not physically fit and to 2% in girls who were physically fit. Poor result in endurance running and in strength test was associated with overweight in both boys and girls. Endurance running is a significant predictor of overweight in girls. |
| Larouche et al., 2014 | 491 | | m/f | 10-13 | Pedometer, BMI, waist circumference, 20m shuttle run, hand grip, waist flexibility, lying face-down plank using forearms, training ground | The number of steps was significantly correlated with the determined aerobic ability, the time spent on the training ground, the result achieved on the training ground, isometric abdominal endurance (plank) and hand grip strength. There was no significant correlation with waist circumference, waist flexibility or obesity status. |
| Galavíz et al., 2012 | 193 | | m/f | 11-12 | BMI, the skinfold sum, waist circumference, pedometry, 20m shuttle run test. | Fitness and PA have negative correlation with obesity measures in both boys and girls. Significant difference in waist circumference, skinfold thickness and BMI was determined between boys and girls from the highest and the lowest quarter of subjects ranked according to their fitness. |
| Ostojic et al., 2011 | 1121 | | m/f | 6-14 | Anthropometry (BMI, waist circumference, body fat), physical fitness (aerobe capacity-VO2MAX). | Significant difference was determined between boys and girls in terms of obesity (6.8% to 8.2%). Boys had significantly lower BMI, body mass, waist circumference, the sum of 6 skinfolds and body fat when compared to girl. The highest body weight, BMI, body fat and waist circumference values were determined in girls aged 14, which indicates the presence of extreme obesity in schoolchildren in Serbia. The negative correlation between body fat and VO2MAX was moderately high. The research showed high obesity levels in schoolchildren in Serbia and strong negative correlation between aerobic fitness and body fat. |
| Torrijos-Niño et al., 2014 | 893 | | m/f | 9-11 | Physical fitness (CRF, muscular fitness, speed/agility), body weight, body height, education level of parents and academic achievement | Obese boys had lower values of academic achievement when compared to overweight boys or those with normal body weight. Good cardiorespiratory endurance and speed/agility levels are connected with good academic achievement. |
| Héroux et al., 2013 | 1108 | | m/f | 9-13 | BMI, waist circumference, triceps skinfold, aerobic fitness, muscular fitness. | Obesity was most pronounced in Mexican children (9.2% boys, 8.4% girls) and it was least pronounced in Kenyan children. (0.9% boys, 2.8% girls). Aerobic fitness (VO2MAX) was the highest in Kenyan children (50.2 boys, 46.7 girls) and the lowest in Canadian children. (41.3 boys, 38.3 girls). Aerobic fitness was negatively correlated with body composition measures regardless of the country or the gender. Muscular fitness is not related with body composition of children from Kenya, however, it has a small positive correlation with BMI and waist circumference of children from Canada and Mexico. |
| Rodriguez et al., 2014 | 119 | | m/f | 9.2 | Body weight and height, BMI, body fat percentage, aerobe endurance and demographic | Significant decrease in BMI of overweight children was determined during the school year but not during the summer holiday. Body fat percentage significantly decreased during school year and summer holiday |

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| | | | | | status. | especially in girls. Aerobe endurance increased significantly during school year but not during summer holiday. |
| Drenowatz et al., 2014 | 1594 | | m/f | 7.1 | Body height and weight, BMI, percentile BMI BMIPCT), questionnaire for parents (sports activities of children and time spent in front of TV), composite fitness test. | Significant correlation between fitness, practicing sports, time spent in front of TV and BMIPCT was found. More time spent in front of TV is associated with great negative correlation with overweight through obesity. |

The analysis of the samples of subjects in the selected scientific papers showed that all the research was conducted on a large number of subjects. Only two studies were conducted on a smaller number of subjects (51 subjects – Kovacs et al., 2009, 86 subjects - Ornelas et al., 2011). Interestingly, the number of subjects in one of the studies was even 878,207 (Chen et al., 2002). In 18 studies (Adamo et al., 2011; Magnusson et al., 2008; Stigman et al., 2009; Tomaszewski et al., 2011; Monyeki et al., 2012; Soares Ferreira et al., 2013; Tovar et al., 2008; Tokmakidis et al., 2006; Laguna et al., 2013; Monyeki et al., 2005; Abril et al., 2013; Li et al., 2007; Sacchetti et al., 2012; Mota et al., 2006; Larouche et al., 2014; Galavíz et al., 2012; Torrijos-Niño et al., 2014; Rodriguez et al., 2014) the number of subjects varied from 100 to 1000. In 8 studies (Ara et al., 2007; Brunet et al., 2007; Nassis et al., 2005; Albon et al., 2010; Ortega et al., 2007; Ostojic et al., 2011; Héroux et al., 2013; Drenowatz et al., 2014) the number of subjects ranged from 1,000 to 5,000 subjects. One study was conducted on 6,297 subjects (Kim et al., 2005). In only two studies (Tovar et al., 2008; Tomaszewski et al., 2011) there were only male subjects, whereas in the remaining 28 studies, the sample consisted of both boys and girls. In terms of age, in 28 studies, the study of the influence of physical activity on obesity in children and teenagers included children and teenagers aged 7-14, whereas in two studies, the sample included children up to 18 years of age.

In terms of the design of the studies, out of 30 selected papers, 27 are cross-sectional studies (Adamo et al., 2011; Ara et al., 2007; Brunet et al., 2007; Magnusson et al., 2008; Nassis et al., 2005; Stigman et al., 2009; Tomaszewski et al., 2011; Monyeki et al., 2012; Soares Ferreira et al., 2013; Tovar et al., 2008; Chen et al., 2002; Tokmakidis et al., 2006; Ortega et al., 2007; Laguna et al., 2013; Monyeki et al., 2005; Abril et al., 2013; Li et al., 2007; Sacchetti et al., 2012; Mota et al., 206; Kim et al., 2005; Larouche et al., 2014; Galavíz et al., 2012; Ostojic et al., 2011; Torrijos-Niño et al., 2014; Héroux et al., 2013; Rodriguez et al., 2014; Drenowatz et al., 2014), whereas 3 papers are longitudinal studies. Out of those 3 longitudinal studies, in 2 of them (Albon et al., 2010; Ornelas et al., 2011), children were monitored in the period of 12, that is, 8 years. In those papers, there was no special physical exercise program except for the PE classes which children had at school on regular bases. In those long-term studies, anthropometric and body composition parameters, as well as the results on physical aptitude assessment tests were monitored. In just one paper (Kovacs et al., 2009), 60 minutes of a 15-week aerobic training was used three times a week. The following cardiovascular and obesity parameters were monitored in the subjects: waist circumference, VO2max, muscle mass, systolic blood pressure, LDL, abdominal obesity, hypertension, triglycerides. By means of an experimental method, the authors have determined the efficiency of the implemented training program on children aged 6.5 to 12.5 years. There was a significant improvement of cardiovascular fitness and significant decrease of all the parameters related with obesity in children. The remaining 27 studies have cross-sectional design and in those studies, the correlation between physical activity and obesity in children and teenagers was determined mainly based on the correlation of results on physical aptitude assessment tests and anthropometric and body composition variables.

Physical aptitude assessment of children and teenagers in the selected papers was done with the help of the following instruments (tests): 20m “Shuttle run test”, maximum endurance test on bicyclergometer, sit-ups, push-ups, standing long jump, 50m sprint, 1,600m sprint, medicine ball throwing, hand grip strength, forward bend, flamingo test. The above mentioned tests cover the entire motor area (strength, flexibility, speed, balance, functional aptitude – endurance, coordination). In most papers the emphasis is on cardiorespiratory fitness because it is one of the best indicators of regular physical activity.

Especially interesting papers are those which used accelerometer for assessing physical activity level in children and teenagers (Magnusson et al., 2008; Laguna et al., 2013; Ornelas et al., 2011).

Accelerometry method is being more and more frequently used in sports science. The reason for that is that it uses a very cheap device which costs around 20$ but gives valid, reliable and objective results (Esliger et al., 2010). In all three papers, the subjects wore accelerometer 5-7 days, which qualified the level of daily physical activity and used it in examining the influence of physical activity on obesity in children and teenagers.

In two studies, physical activity was assessed with a pedometer (Larouche et al., 2014; Galavíz et al., 2012). Pedometer is another device with confirmed validity and reliability (McNamara et al., 2010) which is used for measuring physical activity in children and teenagers.

The analysis of the results presented by the authors of the selected papers shows high correlation between obesity and physical aptitude parameters. In one paper, (Adamo et al., 2011) a comparison of physical activity level and obesity in children and adolescence in Kenya and Canada was made. The study showed that there are no obese cases among Kenyan children, and that the number of overweight ones is significantly lower than in their Canadian peers. The study also showed that the aerobe endurance parameters and muscle strength were better in children from Kenya. The authors drew a conclusion that these results are determined by a higher level of physical activity of Kenyan children, their nutritional habits and a very specific environment in which they live.

In some studies (Ara et al., 2007; Monyeki et al., 2012; Soares et al., 2013; Albon et al., 2010; Tokmakidis et al., 2006; Abril et al., 2013), levels of physical activity and obesity between boys and girls were compared. The authors concluded that physical activity of girls was mostly lower than the physical activity of boys, and that the level of obesity and overweight was somewhat higher in girls, which was also expected to be the case.

In several studies (Magnusson et al., 2008; Soares et al., 2013; Ortega et al., 2007; Abril et al., 2013; Li et al., 2007; Sacchetti et al., 2012; Dernowatz et al., 2014), the ex post facto method was applied using a questionnaire. Based on the results of the questionnaires, the children were grouped in physically active and physically inactive categories, and after that, correlation between their activity and obesity, as well as correlation between physical activity and the parameters of cardiovascular and muscular fitness was determined. The authors determined negative correlation between physical activity and physical aptitude.

# CONCLUSION

The objective of this study was to determine the influence of physical activity on obesity in children and teenagers, relying on the research conducted so far. Systematic analysis of 30 selected papers, which satisfied the inclusion criteria determined at the beginning of the research, showed that there is significant correlation between physical activity and the appearance of overweight or obesity in children aged 7-14. Obesity has reached epidemiological proportions worldwide and it has become a serious health problem at the top of the list of risk factors responsible for the appearance of chronic diseases such as heart diseases, hypertension, diabetes etc. This study included mostly cross-sectional studies; however, that does not diminish the significance of the obtained results because the level of physical activity was evaluated by means of monitoring physical aptitude, which was in positive correlation with regular sports activities and physical education.

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# GENDER DIFFERENCES IN THE BODY COMPOSITION OF ADOLESCENTS

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## SUMMARY

With the aim to examine gender differences in body composition, on a sample of male (39) and female students (44) aged 13.5 ± 0.6 years was carried out study of morphological measures: body height (BH), body mass (BM), body mass index (BMI), biceps skinfold (BISF), triceps skinfold (TRSF), subscapular skinfold (SSSF), stomach skinfold (STSF), lowerleg skinfold (LLSF) and components of body composition: fat mass percentage (FM%), fat-free mass percentage (% FFM) and total body water percentage (%TBW). The results show that male students have significantly better results in all measured parameters, except in the body mass index (BMI) and abdominal skinfold (STSF), where differences were not observed. The female students had significantly higher values of skinfold and fat mass (FM), and male students higher value of fat free mass (FFM) and total body water (TBW).

**Keywords:** gender differences, body composition, adolescents.

## INTRODUCTION

Regular physical activity in childhood provides immediate health benefits, through a positive impact on body composition and development of muscular and skeletal system (Malina & Bouchard, 1991). Based on data from scientific studies on the character and quality of physical education in school (Sallis et al., 1997; Brankovic, 2001, Dragic, 2003; Koutedakis & Bouziotas, 2003; Jurg et al., 2006), it can be concluded that physical education is not sufficiently oriented to systematic and comprehensive physical exercise, but also that it lacks the appropriate intensity, causing stimuli that would be in the function of improving physical development and physical abilities of students (Pate et al., 2006). Present data suggest that the level of physical activity decreases during the adolescent period, while the prevalence of inactivity increases (Leslie, Fotheringham, Owen, & Bauman, 2001). As a result of this level of exercise, obesity appears as a frequent and undesirable component of physical development. Some of the components of the physical development of students was subject of many researchs of domestic and foreign authors, and most often studied students obesity, which is usually assessed with body mass index (BMI), however, there are few that had body composition as center of interest. BMI is employed globally to classify students as normal, overweight and obese (WHO, 2005). Compared with assessment methods of body fat percentage (BF), it is inexpensive and easily to administer. However, its application has been questioned (Ode et al., 2007), because it is associated with fat mass, as well as with fat free mass. For instance, as BMI is increased by high amounts of both fat and fat free mass, a very muscular students with low BF could be classified as overweight. Assessment of body composition is usually carried out measurements of subcutaneous fat tissue in multiple points and using the bioelectrical impedance. Recent studies have shown that the relationship between BMI and BF is influenced by physical activity, gender and age (Ode et al., 2007; Morimoto et al., 2007; Srdić et al., 2012). For these reasons it is important to highlight that the periodical assessment of body composition of students is significantly more insight into the physical development of students, and well as obesity as one of its components.

The aim of this study is to determine the status of body composition pupils aged 14 years and to determine TC differences in relation to gender of students.

# METHODS

## Subjects

Thirty nine male students (age, 13.41±0.28 years; height, 165.26±10.18 cm) and forty four female students (age, 13.45±0.29 years; height, 161.27±6.15 cm) from Primary school „Dušan Radović“ in Niš (Republic of Serbia) participated in this study. All students are in seventh grade and participated voluntarily. All parents of students signed a written consent form prior to the onset of participation. The study was designed in compliance with the recommendations for clinical research of the Declaration of Helsinki of the World Medical Association (2013). This study was also reviewed and approved by the Director of Elementary school "Dušan Radović". Further, no students had a history of serious injury nor were any student taking medication during the study. All experimental procedures and possible risks and benefits were explained to each student.

## Procedure

Anthropometric and BC assessments included: body height (BH), body mass (BM), body mass index (BMI), biceps skinfold (BISF), triceps skinfold (TRSF), subscapular skinfold (SSSF), stomach skinfold (STSF), lowerleg skinfold (LLSF), fat mass percentage (%FM), fat-free mass percentage (%FFM) and total body water percentage (%TBW). Participants wore single-layer shorts and lightweight T-shirt during data collection. The participants stood barefoot in an upright position on foot electrodes on the instrument platform and both arms and legs were widely separated from each other. Anthropometric variables were measured according to the instructions of the IBP (Weiner & Lourie, 1969) at the beginning of the study. Body height was measured to the nearest 0.1 cm. Skinfold measuring was performed using GPM caliper (GPM GmbH, Switzerland) with a measurement accuracy 0.2 mm. Pressure of instrument clamps which compress the skin and subcutaneous tissue is standard (amounts to $10 g/mm^2$). The measurement result was read 2 seconds after the clamps caught the skinfold. The measurement was carried out in five-point: on the biceps, triceps, subscapula, stomach and lowerleg. Body composition parameters were assessed by a bioelectrical impedance by electronic scales SOEHNLE Body Balance Chicago (Soehnle Co, Germany), which according to the technical specifications of the device get results with an accuracy of 0.1%. Impedance and body mass (BM) are automatically measured, and the subject's height (BH) and age are manually entered into the system. Mass (kg) and percentage (%) of fat mass, fat-free mass and total body water measured automatically, and has been shown on the display. The participants were asked to avoid the following procedures before body composition measurement as described by Rech et al. (2008): not to perform any physical exercises during 12 hours before testing, not to eat or drink anything during the four hours before the evaluation, to urinate at least 30 minutes before the evaluation and not to take any diuretics during the seven days prior to the test.

## Statistical analysis

Descriptive statistical methods were applied for the basic statistical data analysis and the distribution of the measurement results for both groups. An T-test for Indepedent samples by groups was used for the analysis of the differences in results between male and female students, and the conclusion significance was set at the level of $p<0.05$. Statistical methods was applied from the statistics package STATISTICA 7.0 for Windows (StatSoft, Inc., Tulsa, OK).

# RESULTS

Based on table 1. it can be seen that the sample of male students was heterogenous, which is supported by the very high value of the coefficient of variation (CV), especially in variables of the subcutaneous adipose tissue and fet mass percentage. All skewness and kurtosis results (Skew.; Kurt.) of variables do not deviate in a statistically significant manner from the normal distribution. These data speak in favor of the application of procedures in the domain of parametric comparative statistics.

Based on table 2. it can be seen that the sample of female students was heterogenous, but this heterogeneity is not expressed as in males students, which is supported by the moderately high value of the coefficient of variation (CV), also in variables of the subcutaneous adipose tissue. All skewness and kurtosis results of variables (Skew.; Kurt.) do not deviate in a statistically significant manner from the normal distribution. These data speak in favor of the application of procedures in the domain of parametric comparative statistics.

**Table 1.** Anthropometric and BC descriptive parameters of male students

| Variable | N | Mean | Min. | Max. | Std.Dev. | Coef.Var. | Skew. | Kurt. |
|---|---|---|---|---|---|---|---|---|
| **BH** (cm) | 39 | 165.26 | 145.30 | 191.80 | 10.18 | 6.16 | 0.09 | -0.12 |
| **BM** (kg) | 39 | 57.03 | 34.60 | 84.50 | 12.39 | 21.72 | 0.18 | -0.41 |
| **BMI** ($kg/m^2$) | 39 | 20.73 | 15.48 | 28.11 | 3.42 | 16.48 | 0.66 | -0.57 |
| **SSSF** (mm) | 39 | 10.34 | 4.40 | 25.00 | 5.87 | 56.77 | 1.13 | 0.16 |
| **TRSF** (mm) | 39 | 12.44 | 4.40 | 23.00 | 5.21 | 41.85 | 0.63 | -0.79 |
| **BISF** (mm) | 39 | 7.50 | 3.20 | 14.20 | 3.34 | 44.51 | 0.59 | -0.84 |
| **STSF** (mm) | 39 | 14.94 | 4.20 | 32.00 | 8.28 | 55.40 | 0.58 | -0.85 |
| **LLSF** (mm) | 39 | 15.96 | 6.60 | 26.00 | 4.31 | 27.02 | 0.33 | 0.02 |
| **FM** (%) | 39 | 14.22 | 5.00 | 29.20 | 6.45 | 45.34 | 0.61 | -0.47 |
| **FFM** (%) | 39 | 51.91 | 43.60 | 61.50 | 5.00 | 9.62 | 0.19 | -0.89 |
| **TBW** (%) | 39 | 68.06 | 56.90 | 79.90 | 6.47 | 9.50 | 0.19 | -0.92 |

Legend: N - number of subjects; Mean – the mean; Min. - minimum results; Max. - maximum results; St.dev. - standard deviation; CV - coefficient of variation; Skew. – skewness; Kurt. - kutosis.

**Table 2.** Anthropometric and BC descriptive parameters of female students

| Variable | N | Mean | Min. | Max. | Std.Dev. | Coef.Var. | Skew. | Kurt. |
|---|---|---|---|---|---|---|---|---|
| **BH** (cm) | 44 | 161.27 | 140.20 | 174.50 | 6.15 | 3.82 | -0.80 | 2.26 |
| **BM** (kg) | 44 | 52.58 | 34.50 | 74.90 | 7.46 | 14.19 | 0.66 | 1.30 |
| **BMI** ($kg/m^2$) | 44 | 20.19 | 16.68 | 26.92 | 2.46 | 12.20 | 0.71 | -0.03 |
| **SSSF** (mm) | 44 | 14.44 | 7.80 | 24.20 | 4.18 | 28.98 | 0.51 | -0.42 |
| **TRSF** (mm) | 44 | 15.70 | 8.40 | 24.20 | 3.54 | 22.58 | 0.38 | 0.09 |
| **BISF** (mm) | 44 | 11.05 | 6.00 | 20.00 | 3.00 | 27.18 | 0.58 | 0.56 |
| **STSF** (mm) | 44 | 17.72 | 8.20 | 29.00 | 4.42 | 24.93 | 0.07 | -0.26 |
| **LLSF** (mm) | 44 | 17.48 | 12.20 | 23.20 | 2.47 | 14.11 | -0.16 | -0.14 |
| **FM** (%) | 44 | 27.58 | 19.40 | 39.60 | 4.72 | 17.10 | 0.65 | -0.00 |
| **FFM** (%) | 44 | 41.99 | 35.70 | 46.80 | 2.61 | 6.22 | -0.36 | -0.40 |
| **TBW** (%) | 44 | 58.16 | 49.30 | 65.20 | 3.76 | 6.47 | -0.39 | -0.40 |

Legend: N - number of subjects; Mean – the mean; Min. - minimum results; Max. - maximum results; St.dev. - standard deviation; CV - coefficient of variation; Skew. – skewness; Kurt. - kutosis.

**Table 3.** Gender differences in BC beetwen male and female students

| Variable | Mean MS | Mean FS | Diff. | t-value | p |
|---|---|---|---|---|---|
| **BH** (cm) | 165.26 | 161.28 | 3.98 | 2.19 | 0.032† |
| **BM** (kg) | 57.03 | 52.58 | 4.45 | 2.01 | 0.048† |
| **BMI** ($kg/m^2$) | 20.73 | 20.19 | 0.54 | 0.83 | 0.409 |
| **SSSF** (mm) | 10.34 | 14.44 | -4.10 | -3.69 | 0.000†† |
| **TRSF** (mm) | 12.44 | 15.70 | -3.26 | -3.37 | 0.001†† |
| **BISF** (mm) | 7.50 | 11.05 | -3.55 | -5.10 | 0.000†† |
| **STSF** (mm) | 14.94 | 17.72 | -2.78 | -1.93 | 0.056 |
| **LLSF** (mm) | 15.96 | 17.48 | -1.52 | -1.99 | 0.050† |
| **FM** (%) | 14.22 | 27.58 | -13.36 | -10.86 | 0.000†† |
| **FFM** (%) | 51.91 | 41.99 | 9.92 | 11.51 | 0.000†† |
| **TBW** (%) | 68.06 | 58.16 | 9.90 | 8.65 | 0.000†† |

Legend: Mean MS – the mean of male students; Mean MS – the mean of female students; Diff.. – differences beetwen group means; t-value - the value of T-test coefficient; p - significance of the T-test coefficient; † - statistically significant differences at p<0.05 level; †† - statistically significant differences at p<0.01 level.

In order to determine the possible differences in BC, the results of the both groups were subjected to a statistical comparative procedure through the application of a T-test for independent samples by groups. The results of the T-test indicate that the difference between groups is statistically significant at the studied levels of 0.05 and 0.01. The negative t values indicates that the female students had a greater values than the male students, and positive t value that is inversely (table 3.). Male students have better results in all research variables, since the higher value of the subcutaneous adipose tissue is a weaker result. At the 0.01 level of significance male students have significantly lower value of skinfolds

(SSSF; TRSF and BISF), as well as in BC components (FM; FFM and TBW). At the 0.05 level of significance male students have significantly lower value of lowerleg skinfold (LLSF) and higher body height (BH) and body mass (BM). The significant difference are not recorded in the body mass index (BMI) and in stomach skinfold (STSF).

## DISCUSSION

Physical activity during childhood and adolescence may have a positive impact on growth and body composition development. The association patterns between physical activity and body composition, in particular body fat mass has been explored in longitudinal as well as cross sectional studies, however with inconsistent results. Several studies plead for a significant negative association between physical activity and body fat mass (Davies et al., 1995; Ball et al., 2001; Abbott et al., 2004; Rennie et al., 2005), while others reported only a weak relationship between physical activity and body composition parameters (Goran et al., 1997; Stevens et al., 2004; Ekelund et al., 2005). Body composition during adolescence, however is not only influenced by physical activity and sportive behavior, it is also associated with ethnicity, socio-economic parameters, parental body composition and gender (Gordon-Larson et al., 1999). It is well documented that the amount of body fat and fat free mass differ significantly between boys and girls (Taylor et al., 1997). In the present study gender typical differences in body composition were found for adolescents students. All students were enrolled in the present study, and girls exhibited a significantly higher amount of body fat, while their male counterparts showed significantly higher values of fat free mass. These findings are in accordance to those of numerous previous studies (Faulkner et al., 1993; Nelson et al., 1997; Taylor et al., 1997; Kirchengast, 2002). From a physiological point of view these differences are explained by the gender typical differences of the endocrinological and metabolic situation during adolescence. However, there is also relationship between behavioral factors and body composition independent of gender. Body composition parameters were significantly influenced by gender, but by physical activity patterns too.

## CONCLUSION

Based on the presented result of this study, we can conclude that the observed gender differences in body composition, where the male students had significantly lower values of skinfolds and fat mass from the female students and higher value of fat free mass and total body water, stemming from a physiological point of view. These differences are explained by the gender typical differences of the endocrinological and metabolic situation during adolescence.

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# THE NEGATIVE ADAPTATIONS OF THE BRAIN DURING PROLONGED PHYSICAL INACTIVITY: IS THERE A WAY TO COUNTERACT THEM?

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## SUMMARY

Prolonged periods of physical inactivity trigger various alternations on the functional and metabolic level of the human body. However, adaptations of the central nervous systems are less known and thoroughly studied. The aim of this study was to assess the behavioral and central adaptations of the brain after 14-day bed rest as well as 12 consecutive sessions of cognitive training. Sixteen older (60±3y) healthy volunteers were randomly divided into cognitive treatment and an active control group. No significant interactions (between group and within Pre- and Post-bed rest) were found for behavior data ($p>0.05$). To the opposite, there was a negative adaptation in the control group (evident with increased motor-related peak amplitude after the end of bed rest; $p<0.05$), which was not the case in the cognitive group ($p>0.05$). Our results suggest that prolonged periods of physical inactivity or bed rest should be reduced to the minimum also from the central adaptation point of view as well as that cognitive intervention can serve as a tool to mitigate them. Future studies could replicate our findings and study them on different age and gender groups.

**Keywords**: bed rest, immobilization, aging, computerized cognitive training, brain electrocortical activity

## 1.INTRODUCTION

A growing body of evidence suggests that prolonged periods of physical inactivity or bed rest lead to a significant negative functional and metabolic adaptations of the human body (Pisot et al., 2016). These effects are most evident in the cardiovascular (Blomqvist et al., 1994; Perhonen et al., 2001; Traon et al., 1998), skeletal (Leblanc, Schneider, Evans, Engelbretson, & Krebs, 1990; Rittweger et al., 2009) and neuromuscular (Grogorieva & Kozlovskaia, 1987; Pisot et al., 2008) systems, with some evidence of potential deficits on brain structure (Li et al., 2015) and functioning (Ioseliani, Narinskaia, & Khisambeev Sh, 1985; Lipnicki & Gunga, 2009; Marusic, Meeusen, Pisot, & Kavcic, 2014).

Evidence regarding brain adaptation levels after prolonged periods of bed rest are scarce. Even though bed rest models were introduced in the 1960s to simulate acute adaptations to a microgravity environment (Adams, Caiozzo, & Baldwin, 2003), its effects on the human organism appear similar to those that take place after periods of physical inactivity, sedentary lifestyle, immobilization, and even space flight (Marusic et al., 2014). Moreover, bed rest can represent an accelerated form of the ageing process (Timiras, 1994; Vernikos & Schneider, 2009).

The EEG literature of the aging effects highlights higher activation levels in older as compared to younger individuals (Falkenstein, Yordanova, & Kolev, 2006). Yordanova, Kolev, Hohnsbein, and Falkenstein (2004) showed that functional dysregulation of the contralateral motor cortex causes behavioral slowing in older adults and that this deficit becomes more evident with higher task complexity. The aim of this study was therefore to assess the effects of prolonged bed rest and cognitive intervention on the brain electrocortical adaptations with a focus on motor-related potentials.

# 2. METHODS

## 2.1 Participants

A total of 16 males (60 ± 3 years, height 175 ± 5 cm, body mass 80 ± 13 kg) volunteered to participate in the project “Bed Rest Study – PANGeA, Valdoltra 2012”. Participants were recruited through public promotions of the project, newspaper advertisements, and word-of-mouth recommendation from three coastal towns in Slovenia. Participants underwent 14 days of horizontal bed rest with a supervised 28-day recovery period. All participants were right-handed, had normal or corrected-to-normal vision, and reported no history of cardiovascular disease, neurological or psychiatric conditions. All procedures were carried out in accordance with the Declaration of Helsinki and were approved by the Republic of Slovenia National Medical Ethics Committee. Written informed consent was obtained from all participants prior to the bed rest experiment.

Participants were medically examined prior the study inclusion with an interview, routine blood and urine analysis, and fitness battery test. Exclusion criteria were: regular alcohol consumption; ferromagnetic implants; history of deep vein thrombosis with D-dimer < 500 μg·L-1; acute or chronic skeletal, neuromuscular, metabolic and cardiovascular disease condition; pulmonary embolism; a Short Physical Performance Battery score < 9; and a VO2max < 21 mlO2·kg-1·min-1.

## 2.2 Study design

This bed rest study was a controlled, longitudinal, interventional study. To achieve the aims of the study (simulate prolonged physical inactivity), the participants had to lay in their bed continuously for 14 days. During the bed rest, participants were allowed only to turn on all sides of the body, or put no more than two pillows under the head, and were not allowed to stand up, sit on the bed, or raise the arms above the level of their head. Hospital staff regularly checked physical condition of the participants and transferred them with their beds to the bathroom for personal hygiene. They received standard hospital meals three times a day at 7.30 a.m., 12 a.m. and 6 p.m. The bedrooms (3-4 persons per room) were air-conditioned and the room temperature was kept comfortably below 25 °C. During the bed rest study participants were allowed to read books and newspapers, use the internet, watch TV and listen to the radio, and freely communicate to each other.

Eight participants were randomly selected for the CCT (Intervention group), while the other eight served as active controls (Control group). In separate rooms, the interventional group performed cognitive training for approximately 50 minutes a day, whereas the Control group watched documentaries at the same time, and for the same duration. The bed rest study was performed at Orthopaedic Hospital Valdoltra, University of Primorska, Ankaran, Slovenia. For virtual navigation training, the virtual maze navigation task was used where participants needed to navigate through virtual environment with the use of a joystick, each day 50 minutes, for 12 consecutive days during bed rest study (all the details are presented in the following article: Marusic et al., 2015).

## 2.3 Electroencephalographic (EEG) measurements and EEG data analyses

Scalp electroencephalographic (EEG) activity was recorded using Brain Vision (Brain Vision, Inc.) equipment, with 64 Acti Cap electrodes, modified according to the International 10-20 System. The recording locations included eight midline sites, with the FCz electrode as an on-line reference and a ground at midline location AFz. Already during EEG measurements, low- and high-pass filter settings were set at 70 Hz and 0.1 Hz, respectively. Impedances were maintained below 10 kΩ for each channel and balanced across all channels within a 5 kΩ range. The sampling rate was 2000 Hz with 32-bit resolution.

After electrode cap with 64 electrodes was placed on the head, the baseline measurements with eyes open and closed were performed. Afterwards, the participants were instructed to synchronize their finger tapping with visual stimuli that was presented on a 17-inch flat panel LCD monitor (situated approximately 50 centimeters in front of them). Markers of visual stimuli and finger responses were saved in the EEG signal to be further able to extract event related potentials (ERPs). No feedback was provided to participants regarding accuracy of their tapping motion and a familiarization protocol was performed to adapt motion mechanisms prior to the task.

All data was analyzed with EEGLAB Matlab toolbox (Delorme & Makeig, 2004).

**Behavioral data:**

Altogether, there were 200 visual stimuli for finger tapping tasks. Depending on subject’s synchronization rate the number of responses varied, however in the optimal conditions were exactly 200. The visual stimuli were presented in the middle of a monitor (duration 300 ms, intensity 50 cd/m2, visual angles 1° horizontal/1.5° vertical,) placed in front of the subject's eyes.

**EEG baseline frequency analysis:**

Baseline EEG was decomposed with Fast Fourier Transform (FFT) to different band ranges: theta (4–7.5 Hz), alpha 1 (8–10.5 Hz), alpha 2 (11–12.5 Hz), beta 1 (13–19.5 Hz), and beta 2 (20–29.5 Hz). Prior to FFT, EEG epochs were transformed into the reference-free current source density (CSD) distribution. 64 channels were pooled in 6 regions of interest (ROI):

- Frontal (Fp1, Fp2, AF3, AF7, AF4, AF8, F7, F5, F3, F1, Fz, F2, F4, F6, F8, Fc5, FC3, FC1, FC2, FC4, FC6),
- Left temporal (FT9, FT7, T7, TP7, TP9),
- Right temporal (FT10, FT8, T8, TP8, TP10),
- Central (C5, C3, C1, Cz, C2, C4, C6, CP5, CP3, CP1, CPz, CP2, CP4, CP6),
- Parietal (P7, P5, P3, P1, Pz, P2, P4, P6, P8, PO7, PO3, POz, PO4, PO8), and
- Occipital (PO9, O1, Oz, O2, PO10).

**Motor response processing:**

The segmentation for motor related potentials was set from -800 to -600 milliseconds for baseline and from -800 to +200 milliseconds for each epoch. The most negative displacement of motor related potentials (latency and amplitude) was extracted from each motor related potentials at contralateral side of right hand (Yordanova et al., 2004).

## 2.4 Statistical analysis

We used IBM SPSS Statistics 22.0 software (SPSS, Inc., Chicago, Ill, USA) for data analysis. Normality of the distribution of the parameters was tested with the Shapiro-Wilk's test. Due to the small sample size and relatively high variability of data of the two groups, as imposed by the nature of bed rest studies, an a priori decision was made to use analysis of covariance (ANCOVA) with pre-bed rest values as covariate to artificially balance the baseline conditions. Interactions between groups and within conditions are further presented as well as percent of change and difference scores were additionally calculated for certain parameters. Statistical significance was set at the level of $p<0.05$.

# 3.RESULTS

For the finger tapping data, 2-way repeated measures analysis of variance (RM ANOVA) showed no significant interaction effect between both groups and both time points ($p=0.661$).

Furthermore, no significant change in baseline measurement from motor-related processes (foot tapping) was found for the motor related potentials maximum peak amplitude ($p=0.215$) and latency ($p=0.099$) between both groups. The 2-way RM ANOVA showed a non-significant trend for motor related potentials peak amplitude ($p=0.064$), and significant group effect for motor related potentials latency ($p=0.007$).

Post-hoc test and the percent of change analysis showed that motor related potentials peak amplitude was decreased for -10.71 ± 65.66 % in the cognitive group. To the opposite, there was an increase for 148.35 ± 190.25 % in the control group at the end of bed rest. Finally, there were no significant differences between two groups for the motor related potential latencies. Due to high variability of the data, the following figure depicts difference score calculation:

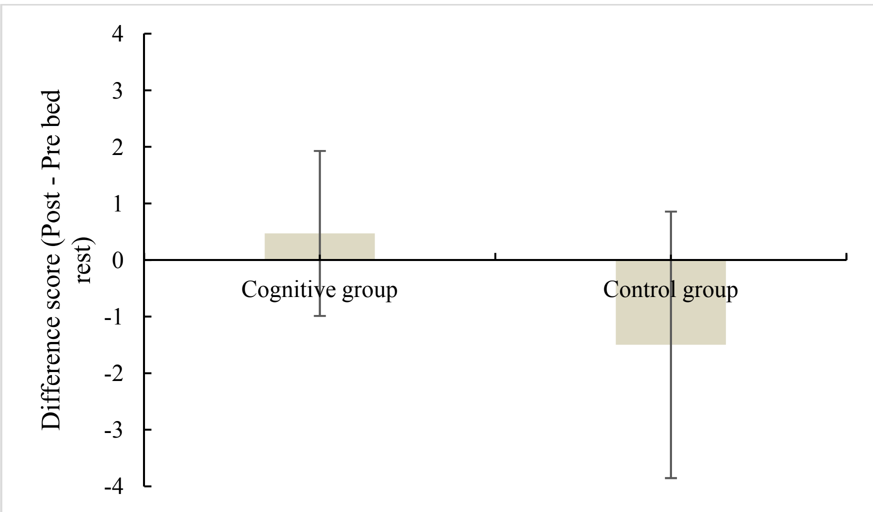


**Figure 1:** Difference score between Pre- and Post-bed rest of motor related potential amplitude for cognitive (left) and control (right) group.

# 4.DISCUSSION AND CONCLUSION

The first aim of this study was to assess behavioral and central adaptations of the brain in older adult population after completing fourteen days of complete physical inactivity or bed rest. The second aim was to assess whether a cognitive intervention might be helpful for mitigating and/or preventing physical inactivity-related changes. Our results suggest that fourteen days of bed rest triggers specific central adaptations that are detectable with electroencephalographic assessment tool (EEG/ERP). Namely, even though there were no behavioral changes in both groups of our older adults at the end of bed rest, there were noticeable increases in the maximum peak amplitude of motor related potentials only in the control subjects. To the contrary, no significant changes were found in the group which completed twelve consecutive sessions of cognitive training during the bed rest period.

In the EEG methodology, motor-related potentials are used for analysis of motor processing. Motor-related potentials are extracted at contralateral motor cortical areas as response-locked potentials. According to the scheme of the human homunculus (Nakamura et al., 1998; Stancák & Wackermann, 1998), motor related potentials are usually extracted from the electrode C3 for finger and C4 for foot movements. With increase of age, older adults seem to increase activation levels to be able to compensate for the same level of performance, which is usually assessed with reaction times (Falkenstein et al., 2006). Furthermore, the behavioral slowing in elderly is even more evident when task complexity increases where functional dysregulation of the contralateral motor cortex becomes evident (Yordanova et al. 2004). The results of our control group are therefore in general agreement with the above mentioned age-related changes which were observed in a non-bed rest studies. Subjects in the control group experienced profound dysregulation of the contralateral motor cortex, which was shown with increased maximum peak amplitudes of motor-related potentials.

The present study confirms previously observed results, which demonstrate that cognitive training can serve as an effective tool to counteract prolonged physical inactivity-related adaptations. Our group previously reported positive transfer of cognitive training to specifically trained as well as specifically untrained cognitive functions (Marusic et al., *in revision*), and a distal untrained domain such as complex dual-task locomotion (Marusic et al., 2015). In addition, we found that it positively affects plasma brain-derived neurotrophic factor (Soavi et al., 2016) and to some extend also vascular function (Goswami et al., 2015).

Future studies could replicate our findings on a bigger sample sizes as well as conduct both interventions (bed rest and cognitive training) in different age and gender groups. The high variability of the observed data is pointing to the fact that other assessment techniques could be applied in the future studies with gradual increase of task complexity.

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# EFFECTS OF DANCE AEROBIC ON BODY COMPOSITION

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## SUMMARY

In addition to traditional forms of everyday physical exercising there have emerged some different forms which are more interesting and more appealing compared to some earlier forms of exercise. Dance aerobic is one of those forms of physical exercise which can have a positive influence on the development of some of the components of physical fitness and body composition. The objective of this paper was to review the scientific research related to the dance aerobics effects on the body composition in people aged 20 to 60. The conclusion is that dance aerobics can influence body composition, and that the effects of the applied program depend on the type of the program, its intensity and its application model.

**Keywords:** aerobic dance, effects, abilities, body composition

## INTRODUCTION

In order to reduce the risks of cardiovascular diseases, osteoporosis, diabetes, hypertension and other diseases, as well as to ensure normal functioning of all the organs and the systems in the body, it is necessary to perform some of the physical activities regularly. It is considered that physical inactivity and poor diet are associated with around 400,000 deaths per year. (Mokdad et al., 2000; according to Lanningham – Foster et al., 2008). A large number of diseases caused by obesity and a higher percentage of fat which accompanies obesity represent a significant problem for developed industrial countries. (Manson, Colditz, & Stampfer,, 1990; Terry, Stefanick, Haskell, & Wood, 1991). The increasing number of nutritionists and sports professionals is becoming more and more interested in dealing with the issue of reducing fat percentage in obese people as well as athletes, and they are exploring new ways of reducing fat percentage in the body and determining the effects of training on the changes in the body composition.

There are a lot of training models and methods of exercising which are used in order to reduce body fat percentage, amongst which running and cycling are said to be the most effective and the most popular ways. These methods are often taken as the most adequate ones, since it is the easiest way to determine the appropriate strain intensity (40 - 60 % $VO_{2max}$) (Shimamoto, Adachi, Takahashi, & Tanaka, 1998). However, in recent years, apart from everyday „traditional" forms of physical exercises, there have emerged some other forms of physical exercise which are more appealing and more interesting compared to the previous forms of recreation. Dance as one of these types of exercise can take many forms and can be run in different conditions and without expensive equipment, which makes it acceptable to a wide range of people and ages. Dance techniques in some dances like Disco Dance for example include slides, jumps, hops, turns, pirouettes and kicks, and therefore can contribute to the changes in coordination, strength, speed and ability to perform rhythmic structures since the dance structures must be performed on music of certain speed (Uzunović, 2008; Uzunović, Kostić, i Pantelić, 2011).Those dance elements also must be performed quickly and with specific degree of intensity, in accordance with the rules of competition and with the nature of the dance, which leed in changes in strength, i.e., explosive strength of the legs, arms and shoulders. (Uzunović, Kostić, & Živković, 2010). Some dances are also acceptable for the elderly because of its favorable effects on arthritis, osteoporosis and neurological conditions, and promote fun, healthy living, social interaction and so on. (Keogh, Kilding, Pidgeon, Ashley, & Gillis, 2009).

Dance aerobic, as one of such forms of exercising, has attracted much attention for the reasons of its positive effects on the functional abilities of a man (Pantelić, Kostić, Mikalački, Đurašković, Čokorilo et al., 2007) and at the same time it is an easy and fun form of exercise that can be practiced by everyone. By performing simple dance elements combined with various types of jumps, spins and some other elements with the appropriate music tempo, engaging the muscles of the entire body and depending on the intensity and the duration, it affects the cardiovascular, respiratory system and body composition.

# METHODS

## Paper selection

Out of the total 43 papers that made the initial selection list based on the titles and keywords, only 31 scientific research papers, which were addressing the issue of the effect of dance aerobics on the body composition, were shortlisted. One of the criteria for the paper selection was the age of the participants, with the participants aged 20 – 60, as well as the subjects that fall into the category of overweight people (BMI ≥ 25) or the category of obese people (BMI ≥ 30). The subjects were divided into these two groups based on the obesity categorization done by World Health Organization according to the BMI (Body Mass Index).

## Research method

The paper categorization was based on the tested component of body composition, sex, gender, the length of the experimental treatment and the BMI. The most frequently tested components are the cardiovascular fitness and body composition. Out of 31 papers shortlisted, 28 papers have samples with female participants, while two papers have samples with male participants included. In the majority of papers the subject sample is divided into an experimental and control group or into more experimental groups depending on the program. In most of the papers experimental programs used in the researches have been conducted 3 times per week for the period of 10-12 weeks. The longest experimental treatment lasted for 24 weeks and the shortest for 8 weeks.

## Overview of previous research

**Table 1.** Researches examinig effects of dance aerobics on body composition

| Author | Total Sample Size | Age Range | Target Group | EG Intervention | CG Intervention | Length and Frequency of Treatment |
|---|---|---|---|---|---|---|
| Pantelic, Milanovic, Sporis, & Stojanovic – Tosic (2013) | 59 (EG-29; CG-30) | 21 - 24 | Young women | Disco model of aerobic training to music | No intervention | 3x per week; 12 weeks |
| Kostic, Đuraskovic, Miletic, & Mikalacki, (2006) | 46 (EG-26; CG-20) | 20 – 25 | Students | Aerobic dance | No intervention | 3x per week; 12 weeks |
| Okura, Nakata, Lee, Ohkawara, & Tanaka (2005) | 225 (4 EG) | 21 – 66 | Obese and overweight women | Step aerobics | No control group | 3x per week; 14 weeks |
| Okura, Nakata, Ohkawara, Numao, Katayama, Matsuo & Tanaka (2007) | 67 (2 EG) | 34 – 66 | Sedentary overweight and obese women | Step aerobics | No control group | 3x per week; 14 weeks |
| Akdur, Sozen, Yigit, Balota, & Guven (2007) | 60 (3 EG) | 34 ± 11 | Sedentary obese women | Step aerobics, walking and diet | No control group | 3x per week; 10 weeks |
| Okura, Nakata, & Tanaka (2003) | 90 (3 EG) | 34 – 66 | Obese women | Step aerobics | No control group | 3x per week; 14 weeks |
| Andersen, Wadden, Bartlett, Zemel, Verde, & Franckowiak (1999) | 40 (2 EG) | 21 – 60 | Obese women | Step aerobics | No control group | 16 weeks |

| | | | | | | |
|---|---|---|---|---|---|---|
| Petrofsky, Batt, Collins, Yang, LeMoine et al. (2008) | 60 (EG-30; CG-30) | 20 – 65 | Adult females | Video tape aerobic workout to music | No intervention | 7 days per week, 10 days |
| Sekulic, Rausavljevic, & Zenic (2003) | 47 (2 EG); | 18 – 21 | Students | HI-LO aerobic; Step aerobics | No control group | 3x per week; 9 weeks |
| Marandi, Abadi, Esfarjani, Mojtahedi, & Ghasemi (2013) | 45 (2 EG; 1 CG) | 25 – 40 | Obese and overweight women | Light and moderate aerobics | No intervention | 3x per week; 10 weeks |
| Kravitz, Cisar, Christensen, & Setterlund (1993) | 24 (2 EG) | | Female students | Step training with and without handweights | No control group | 8 weeks |
| Shimamoto, Adachi, Takahashi, & Tanaka (1998) | 60 (2 EG) | 50.9 ± 6.7 | Obese middle – aged women | Aerobic dance | No control group | 2-3 days per week; 12 weeks |
| Hopkins, Murrah, Hoeger, & Rhodes (1990) | 53 | | Sedentary elderly women | Low impact aerobic | | 12 weeks |
| Kin Isler & Kosar (2006) | 118 (EG–60; CG-58) | 21 – 26 | Sedentary men and women | Step aerobics | No intervention | 3x per week; 10 weeks |
| *** Blessing, Wilson, Puckett, & Ford (1987) | 28 | | Female students | Aerobic dance with hand-held weights | | 8 weeks |
| *** Dowdy, Cureton, Duval, & Ouzts (1985) | 28 (EG-18; CG-10) | 25 – 44 | Middle aged women | Aerobic dance | No intervention | 3x per week; 10 weeks |
| *** Porcari, Chapek, Huntley, Brice, & Price (1995) | 49 (EG-21; CG-28) | 19,4 | Female students | Step aerobics | No intervention | 3x per week; 10 weeks |
| Ossanloo, Najar, & Zafari (2012) | 80 (EG-40; CG-40) | 25 – 45 | Sedentary females | Aerobic dance, step aerobics and resistanca training | No intervention | 3x per week; 12 weeks |
| Ossanloo, Zafari, & Najar (2012) | 80 (EG-40; CG-40) | 25 – 45 | Sedentary females | Aerobic dance, step aerobics and resistanca training | No intervention | 3x per week; 12 weeks |
| Engels, Bowen, & Wirth (1995) | 20 (2EG) | | Female students | Low impact aerobic | No control group | 3x per week; 10 weeks |
| Kravitz, Heyward, Stolarczyk, & Wilmerding (1997) | 44 (2 EG) | 18 – 36 | Female students | Step aerobics with and without handheld weights | No control group | 3x per week; 12 weeks |
| Stojiljkovic, Mandaric, Todorovic, & Mitic (2010) | 10 | 33.6 ± 6 | Adult females | “Omnibus” aerobics | No control group | 3x per week; 24 weeks |

EG – experimental group; CG – control group; *** no statistical significance

**Body composition of dancers**

It is widely known that dancers, due to the nature of their activity and the aesthetic component of dance, are graceful with clearly apparent musculature and are assumed to have a low body fat percentage. It is also noted that dancers have low measurements of waist, hips and thighs circumference (To, Wong, & Chan, 1997), which are favored due to the aesthetic component of dance. Body composition in dance, is usually viewed from the aspect of the ballet, with the average values of body fat in a female dancers from 16 - 18% (Clarkson, Freedson, Keller, Carney & Skrinar, 1985; van Marken Lichtenbelt, Fogelholm, Ottenheijm, Westerterp, 1995) and 12 - 14% (Mišigoj-Durakovic, Matkovic, Ruzic, Durakovic, Babic et al, 2001) and from 5 – 15% in the male dancers (Koutedakis, Cross, Sharp, 1996). Rosentswieg & Tate, (1979) based on Evans, Tiburzi, & Norton, (1985) found that the fat percentage in professional dancers is 21,4%, whereas modern dancers have 19,8%, and classical ballet dancers have 16,4 %. However, these values recorded in male and female ballet dancers may not be used as a representative sample of all the dancers as ballet dancers are regarded as the thinnest of all dancers. (Pacy, Khalouha, Koutedakis, 1996). Evans, Tiburzi, & Norton, (1985) recorded lower body weight values and lower fat percentage in female dancers in their study compared to the female population at the faculty. Novak, Magilland, & Schutte (1978) have discovered that dancers have lower body weight and lower body fat percentage and that dance should be used as a means of maintaining physical fitness and ideal body weight. It is evident that the low percentage of body fat in dancers is a result of many years of active training. Dancers have to move their body in space constantly, thus moving their own weight gracefully in performing different types of jumps, spins and other dance elements. The question is, however, whether dance can be used as an adequate form of physical exercise which will have an impact on the body composition. Some specific researches have shown positive effects of aerobic dance on body composition.

**Effects of dance aerobic on body fat percentage and visceral fat**

Kostić, Đurašković, Miletić i Mikalački, (2006) in a sample of 46 women aged 20 to 25, studied the effects of the aerobic dance on the cardiovascular fitness and body composition. The experimental group consisted of 26 women, whereas the control group included 20 women. The experimental program of aerobic dance lasted for 3 months with a one-hour training three times a week. The results showed that there was a statistically significant difference in the variables for cardiovascular fitness and body composition between the initial and final measurements with the experimental group and between the experimental and the control group during the final measurement. The study confirmed the previous findings on the important positive impact of the dance aerobic workout on the changes of the parameters of the cardiovascular endurance and body composition in young women.

Pantelic, Milanovic, Sporis & Stojanovic – Tosic (2013) also concluded that dance aerobic programme decreases subcutaneous fatty tissue and body composition of the young women. They tested the experimental disco – model of aerobic training to music which was created with aim of affecting the body composition on a sample of 29 young women (age 23.1± 1.0 years). Results showed that after 12 weeks of application of this dance aerobic model, body mass was reduced by -3.7 % and muscle mass increased by 2.4 %. Also there was a decrease in skinfolds and percantage of body fat, therefore this model of dance aerobic contributed to the changes in the body composition of subjects.

Regular exercise can be more effective in reducing visceral fat compared to the effects of a weight loss diet. It is shown that regular exercise is more effective in reducing visceral fat without a major reduction of the body weight and that visceral fat is reduced more than subcutaneous fat. (Ross, Dagnone, Jones, Smith, Paddags, Hudson, & Janssen, 2000).

Okura, Nakata, Lee, Ohkawara, & Tanaka (2005) have found in a sample of 209 obese and overweight women that in people who are obese, with whom most of the fat is visceral fat, the visceral fat reduction efficiency is higher, if the step aerobic exercises are added to the existing weight loss diet compared to the weight loss diet without any additional physical activity. Similar results were obtained by Okura, Nakata, Ohkawara, Numao, Katayama, Matsuo, & Tanaka (2007) who have found that the use of aerobic dance during the period of 14 weeks in combination with an appropriate weight loss diet leads to the metabolic syndrome improvement as well as a reduction in the BMI, visceral fat and triglycerides. Sasai, Katayama, Nakata, Ohkubo, & Tanaka (2009) concluded that the level of visceral fat reduction depended on the obesity phenotype. The results of their research have shown that the application of the aerobic exercise program and the exercises with the lower strain level for the period of twelve weeks led to a greater visceral fat reduction in the subjects with a higher amount of visceral fat (High Intra - abdominal Fat – HIF ≥ 200 $cm^2$) compared to the subjects with an average amount of visceral fat (Moderate Intra -

abdominal Fat – MIF ≤ 200 $cm^2$) (15.1 ± 26.0 $cm^2$ for MIF and 43.3 ± 41.9 $cm^2$ for HIF) as well as a greater body weight reduction (2.3 ± 2.2 kg for MIF and 3.2 ± 3.0 for HIF).

Although there have been many studies which have had a positive effect on the fat percentage reduction, there are some studies in which there have been no changes of the mentioned body composition. One of the reasons for having such contradictory studies can be inadequate nutrition during the program implementation and a greater intake of calories or an insufficient duration and frequency of the workout. Since the absence in training and improper training can lead to a lack of desired changes, some authors believe that the professional supervision during the exercise, as well as additional educational component is necessary to achieve maximum results.(Gillet, P. & Caserta, M., 1996).

**Effects of dance aerobic programmes and weight loss diet on body composition**

Akdur, Sozen, Yigit, Balota & Guven (2007) in their research examined the effects of three different training programs on physical fitness and physiological parameters in 60 sedentary female subjects who did not suffer from hypertension, diabetes or any cardiovascular disease. The subjects of the research sample were divided into three groups with one group applying dance aerobic program, another one applying a walking program and a weight loss diet and the third one applying a weight loss diet only. The survey results showed that the step aerobics group had better results in the body weight reduction, BMI reduction and a decrease in total body mass compared to the group that applied a weight loss diet only. The step aerobics group and the group that applied a walking program also showed a decrease in the LDL cholesterol level. Based on the findings the authors concluded that the best exercise model that had an impact on physical fitness and physiological parameters was the application of step aerobics combined with a low calorie diet. Also, combining highly intensive dance aerobic program with a weight loss diet can affect the maintenance of fat-free mass as well as bone- free mass and reduce the risk of cardiovascular diseases. (Okura, Nakata, & Tanaka, 2003). Andersen, Wadden, Bartlett, Zemel, Verde, & Franckowiak (1999) obtained the same results in their research which showed that after the application of a 16-week dance aerobic program combined with a low calorie diet, there was a statistically significant reduction in body weight (8.3 ± 3.8 kg), fat-free mass (0.5 ± 1.3 kg), serum triglyceride levels (16.3 %) as well as total cholesterol levels (10.1 %). Petrofsky, Batt, Berk, Collins, Yang et al., (2008) applied a dance aerobic program on a sample of 60 female subjects combined with a dietary plan in order to reduce body weight and improve cardiovascular fitness. The participants performed a one-hour aerobic dance exercise for 10 days. The research results showed that the application of this program led to the reduction in body weight, fat –mass percentage, BMI (Body Mass Index) as well as waist circumference.

**Effects of HI (High Impact) – LI (Low Impact) aerobic programmes and Step aerobic programme on body composition**

In their study, Sekulić, Rausavljević and Zenić (2003) tried to determine the difference in the training effects between step aerobics program and HI – LI aerobics as well as analyze the changes in morphological and motor measures in female students. The sample consisted of two groups of female students. One group participated in a HI – LI aerobics program (N = 24), whereas the other group participated in a step aerobics program (n = 23). The results showed that both programs led to the reduction in skinfold-thickness measurements and subcutaneous adipose tissue reduction. Given that there were no statistically significant differences in circumference measurements, the authors believe that the reduction in skinfold-thickness also caused a minor muscle hypertrophy and that that was the reason there was no difference in circumference measurements. Grant, Davidson, Aitchison & Wilson, (1998) have concluded that LI aerobics can be suitable for people who are overweight as well as the persons who are not in good physical condition. Consistent with this conclusion are and recommendations of the research Marandi, Abadi, Esfarjani, Mojtahed, & Ghasemi (2012), where it is recommended to begin with light aerobic dance programs and slowly progresses to severe, given that aerobic both lower and greater intensity, significantly reduce body weight, percentage body fat, BMI, fat weight, lean body weight, waist and hip ratio, and HDL cholesterol. Similar results have been obtained by Kravitz, Cisar, Christensen, & Setterlund, (1993) who, in a sample of 24 female student who volunteered and were divided into two groups, found that the application of the appropriate dance aerobic program caused a reduction in body fat percentage and fat mass, the endomorphic component of the somatotype was reduced, while the mesomorphic component was increased.

Shimamoto, Adachi, Takahashi, & Tanaka (1998) tested the hypothesis that the application of the LI dance aerobic was a useful exercising technique for reducing body weight in obese middle-aged women. The results of their study showed that there was a decrease in body weight and percentage of body fat and thereby confirmed their hypothesis, while Hopkins, Murrah, Hoeger, & Rhodes (1990) found that the LI aerobic had positive effect on all components of functional fitness (except for motor control and coordination), including reduction of body fat.

Kin – Isler & Kosar, (2006) in their study investigated the effects of the 10-week step aerobic workout on the anaerobic capacity in men and women. The sample of the subjects included 118 students aged 21 to 26. The sample was divided into two groups, one step aerobics group and one control group. Before and after a ten-week period during which the program was implemented, the measurements of the body composition, muscular strength and the anaerobic capacities of the subjects were carried out. The Wingate test and the vertical jump test were used. The results showed that this ten-week dance aerobic program did not contribute the reduction in body weight and fat percentage, as well as the increase in lean body mass (Lean Body Mass). Body compositon and cardiovascular fitness have not changed in any study of Smith (1987) who concluded that aerobic dance and aerobic dance in the water can not be used as an effective model of exercise to improve these two components. Similar results were obtained by Kin - Isler, Kosar, & Korkuzus, (2001), Velazquez & Wilmore, (1991); Dowdy, Cureton, Duval, & Ouzts (1985); Blessing, Wilson, Puckett, & Ford (1987) and Porcari, Chapek, Huntley, Brice, & Price (1995) who also did not reduce body weight and percentage of body fat after following the program step aerobics lasting 8, 10 or 12 weeks.

**Effects of dance aerobic programmes combined with other forms of exercise on body composition**

In several studies were used a combined aerobic dance programs and other forms of exercise. Gasti & Hiremath (2012) were determining whether calisthenic exercises, aerobic dance, or a combination of these two types of exercise have effects on the physical fitness of males. The results of their study showed that aerobic dance is effective in improving lean body mass and reducing the percentage of body fat compared with the combination of these two types of exercise or a calisthenics workout alone. In contrast to this combined program, the course of twelve training that included aerobic dance, step aerobics and resistance training had resulted in reducing the percentage of fat and HDL (High Density Lipoprotein Cholesterol) (Ossanloo, Najar, & Zafar, 2012 ) and body weight, body mass index (engl. BMI) and body fat percentage (Ossanloo, Zafari, & Najar, 2012).

Engels, Bowen & Wirth, (1995) studied the effects of the additional weight strain in a ten-week program of LI dance aerobic on aerobic power and body composition. A total of 20 female students were included in the sample. The results showed a statistically significant reduction in the body fat percentage (2.9%). Based on these results the authors concluded that LI dance aerobic was an efficient way of increasing the aerobic power and the change of a body composition in the female students, while the additional weight strain during the aerobic dance did not contribute the additional training effects that had not already been incurred as a result of an aerobic dance workout.

Kravitz, Heyward, Stolarczyk & Wilmerding, (1997) compared the effects of a 12-week step aerobics workout with and without hand weights on cardio respiratory fitness, body composition, muscular strength and the injury risk in women aged 18 – 36. The subjects participated either in the step aerobics program with hand weights (Hand Weight group) or without hand weights (No Hand Weight group). The program was carried out 3 days a week for 30 minutes at the intensity of 75 to 90% of the maximum heart rate ($HR_{max}$). The obtained results showed the fat percentage decrease and the fat-free mass increase (Fat Free Mass).

Grant, Armstrong, Sutherland, Wilson, Aitchisont et al., (1993) studied physiological and psychological responses to a fitness session called “pop mobility” in the sample of ten female students with the average age 21,2 who volunteered to participate. The authors concluded that this program could be used for the purposes of weight reduction.

Stojiljkovic, Mandaric, Todorovic and Mitic (2010) applied the "Omnibus" aerobic program consisting of 12 different types of aerobics and other forms of exercise for 24 weeks on a sample of 10 women average 33.6 years ± 6 . The six-month implementation of this program has led to significant changes – reduction in BMI, percentage body fat and body weight and a decrease in circular measures of waist, thighs, calves, upper arm, chest and waist and hip.

Viskić - Štalec, Štalec, Katić, Podvorac, & Katović, (2007), in a sample of 220 high school students, determined that the application of a specific program which included aerobic dance and rhythmic gymnastics could influence the reduction in body weight and subcutaneous adipose tissue.

# CONCLUSION

The results of the research of the effects of dance aerobics on body composition in young people show that the application of the appropriate dance aerobics models can affect body composition in terms of reducing the body weight, body fat percentage, visceral fat and increasing “lean body mass” (Lean Body Mass) or „fat free mass“ (Fat Free Mass). Regardless of whether HI (high impact) or LI (low impact) aerobics or step aerobics is applied, all models will lead to the changes in body composition. Depending on the physical fitness of an individual, HI aerobics can be used by people who are physically fitter in order to increase or maintain aerobic fitness, whereas LI aerobics can be used by people with excessive body weight or by the ones who are not physically fit (Grant, Davidson, Aitchison & Wilson, 1998). Due to the fact that in some studies there have been no changes in body composition, which may be the result of an inadequate nutrition during the program implementation, it is recommended that along with the dance aerobic program application, an adequate dietary regime is implemented, so that the best effect possible can be reached.

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# LEVEL OF PHYSICAL ACTIVITY OF ADOLESCENTS OF DIFFERENT AGES FROM ZRENJANIN

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## SUMMARY

The survey was conducted on a sample of 379 subjects, secondary school students from Zrenjanin - Zrenjanin Grammar School students (N=179), Medical School (N=153) and Agricultural High School (47 students). The study included 226 female students and 153 male students. Two hundred and one subject (201) of the first year of secondary school and 178 subjects of the fourth year entered the sample. International Physical Activity Questionnaire (IPAQ) was applied in order to assess the level of physical activity (IPAQ). For the entire sample, statistically significant differences in relation to age of the subjects (P=.00) were observed. First grade students statistically significantly differ from the fourth grade students in the level of physical activity, mostly in the variable Walking MET, when it comes to gender, higher level of activity can be attributed to the younger age categories of subjects. Based on the obtained data, it can be concluded that the majority of high school students from Zrenjanin has a low level of physical activity. This study can be the basis for further research, as well as a starting point for troubleshooting physical activity and emphasizing the inclusion of young people in sports and physical activity in Zrenjanin and beyond. The age affiliation was identified as a predictor of reduced physical activity in adolescents in the given sample.

**Keywords:** adolescents, physical activity, age, differences.

## INTRODUCTION

Physical activity and the BMI lately are one of the most common subjects of research and challenges of many international scientists. Around the world, strategies for health promotion are developed and implemented, which are primarily based on improving physical activity. Among these, the World Health Organization - WHO 2004 and the US Department of Health and Human Services (2000) stand out. Evaluation of physical activity is now considered the first stage in planning and designing intervention measures that can contribute to health (Dishman, Washburn & Heath, 2004). In addition to strategies for improving health through emphasis on physical activity, the standardization of measurements of physical activity is also needed so that the results of the studies could be mutually compared. Physical activity essentially consists of movement and changing body position, in order to achieve a result that depends only on the personal abilities of the performer. Caspersen, Powell and Christenson (Caspersen, Powell, & Christenson, 1985) have defined physical activity as any bodily movement produced by skeletal muscles that results in calorie consumption. Physical activity comprises exercise, training, competition, but also intense professional work, chores and other activities that cause physical stress (Ostojić and Stojanović, 2010).

Physical activity depends on biological, psychological and social factors. Biological factors that influence the level of physical activity the most are age and gender. Younger school children are physically active compared to older school children in activities of moderate intensity, and during their education, the level of physical activity declines by about 50% and the decline continues throughout life (Sallis, Prochaska & Taylor, 2000). The level of physical activity is also influenced by phenotype and social factors. According to research by Brockman et al. (Brockman et al. 2009), professional physical activity development programs need to be adjusted to groups from various socio-economic backgrounds.

The average level of physical activity declines with age by 2.7% per year in boys and 7.4% in girls (Sallis, Prochaska & Taylor, 2000). The increase in estrogen levels during adolescence in girls contributes to the increase in body fat, while the influence of male sex hormones in boys during the same period leads to an increase in muscle mass. Changes made in the body composition favor the boys when it comes to dealing with sports and physical activity in general (Matić and Maksimović, 2007).

As for the young population, the age interval from 15 to 18 years of age is particularly critical because a significant relationship has been determined between the acquired healthy lifestyles and behavior and the level of physical fitness in youth with styles and physical form in adulthood (Matton et al, 2006; Mikkila et al, 2004; Telama et al, 2005). Also, research shows that although specific conditions and diseases are not manifested in childhood and adolescence, unhealthy lifestyles in childhood significantly increase the chance of illness in adulthood (Boreham et al, 2002; Twisk et al, 2002). However, despite the fact that in the developed countries of Western Europe and the United States in recent years a significant number of studies (AGAHLS, HELENA, CARDIA, NIYHP, AVENA, Framingham study, etc.) examines the significance of bad eating habits, level of physical activity and the level of physical form of adolescents in terms of prevalence, development and progression of chronic non-communicable diseases.

A review article on the determinants of physical activity of children, adolescents and adults, Sallis (Sallis, 2000) states that age is a powerful predictor of physical activity, with declining levels of physical activity throughout life, in the best case, the decline begins with the start of school. During education, the level of activity decreases by about 50% (Sallis, 1993). Females in all age groups are less active than men (Pate et al, 1994). The mentioned meta analysis (Sallis, 1993) states that children aged 6-7 years are more active when it comes to moderate to intense physical activity (46 minutes per day) compared to children aged 10 to 16 years (16-45 minutes a day). The boys are about 20% more active than girls, and the average level of physical activity declines with age to 2.7% per year for boys and 7.4% for girls. A review study of current patterns of physical activity of children (Corbin, Pangrazi & Le Masurier, 2004) states that boys of all ages and classes during education are more active than girls, regardless of how and what type of physical activity is assessed. As the authors claim, data also exist that children are more active than adolescents. A study of risk behavior among young people (Heath et al, 1994) showed that between the 9th and 12th grade (ages 14 to 16 years) engagement in intense physical activity three or more times a week steadily declines from 81% to 67% in boys, respectively, from 61% to 41% in girls.

Given the importance of physical activity, especially for children and youth, a study was conducted using the international IPAQ questionnaire. It measured the level of physical activity of the population of secondary school students in the City of Zrenjanin, in order to determine the differences in relation to age, so as to facilitate the development of a youth strategy for this, according to administrative territory, second largest city in the Republic of Serbia. Essentially, the aim of this study was to gain insight into the current state of physical activity among secondary school students in the City of Zrenjanin, as a first step in taking measures for its improvement. The aim of research was to study the form of physical activity of students of Zrenjanin secondary schools according to age. The subject of the research is the level of physical activity (moderate intensity physical activity and walking). The research started with the following assumptions: $H_1$ - physical activity of secondary school students in Zrenjanin is not satisfactory; $H_2$ - there is a statistically significant difference in the pattern of physical activity among students of different ages.

# METHODS

## Subjects

The study applied empirical methods and non-experimental methods of theoretical analysis. The study was of transverse character and data were collected using the international standardized questionnaire. Only a part of IPAQ questionnaire was used, i.e. the part related to physical activity in free time.

The study included 379 subjects, secondary school students from Zrenjanin (Table 1). Of the total number, the most common subjects in the study were students of Zrenjanin Grammar School 47.23% (179 students), followed by students of Medical School 40.37% (153), while the fewest subjects were from Agricultural High School 12.40% (47 students). The survey included 226 female subjects (59.63%) and 153 male subjects (41.27%). Taking into account the year of secondary school, it can be concluded that the structure of the sample was a balanced one: 201 subjects of first year of secondary school in Zrenjanin (53.03%) and 178 subjects of fourth year (46.97%) (Graph 2).

## Procedure

The study used survey technique of combined type. In addition to the general guidance for practical application and issues relating to the social status features (location, school, sex, age, social status, assessment of physical education, general success), this instrument contained questions related to the frequency and type of physical activity, engaging in organized sports and recreation, as well as attending school sports sections. The survey provided complete anonymity of subjects. The survey was conducted under standard conditions, during the normal hours of physical education in schools and in the presence of physical education teachers. The answers regarding activities allow an assessment of energy consumption, which is usually expressed as a continuous variable using *metabolic equivalent* (MET). On the basis of these, the subjects were classified into three categories: low, moderate and high physical activity.

Since the subjects' responses are usually expressed in minutes one spends in a particular physical activity, the result of physical activity is expressed in MET-minutes. MET-minutes are the products of the MET values of activities (walking = 3.3 METs, moderate intensity physical activity = 4 METs, highly intensive activity = 8 METs) and minutes spent doing that activity. The result in MET-minutes is the equivalent of spent calories for a person of 60 kg (IPAQ, 2005).

## Statistical analysis

Data analysis was done in the SPSS Statistics 20.0 IBM software package. Data analysis included descriptive statistics of analyzed variables for the level of physical activity of students: arithmetic mean (AS), standard deviation (S), minimum value (MIN), maximum value (MAX), measurement result and coefficient of variation (CV). The Kolmogorov-Smirnov test was used to determine the normal distribution of the selected variables. The existence of statistically significant differences in the pattern of physical activity among students of different ages was analyzed for all the variables using multivariate (MANOVA) and univariate analysis of variance (ANOVA).

## RESULTS

Based on descriptive statistics (Table 1), high variability of results has been observed in all three analyzed variables for assessing physical activity of adolescents from Zrenjanin: Walking MET, Moderate MET and Intensive MET, indicating the large individual differences in the pattern of weekly physical activity.

**Table 1** Analysis of physical activity at the level of the entire sample

| Variable | N | MIN | MAX | AS | S | CV (%) |
|---|---|---|---|---|---|---|
| Walking MET | 379 | 33 | 2970 | 911.42 | 755.67 | 82.91 |
| Moderate MET | 379 | 0 | 4320 | 668.76 | 738.05 | 110.36 |
| Intensive MET | 378 | 0 | 7200 | 736.55 | 1276.73 | 173.34 |

Legend: N - number of subjects; AS - mean; S - standard deviation; MIN - minimum recorded measurement result; MAX - maximum recorded measurement result; CV - coefficient of variation.

**Table 2** Descriptive statistics of variables for assessing physical activity of subjects of different ages

| Variable | Gender | AS | S | MIN | MAX | CV (%) | KSp |
|---|---|---|---|---|---|---|---|
| Walking MET | I | 1040.32 | 768.97 | 50 | 2970 | 73.92 | 0.09 |
| | IV | 765.56 | 714.96 | 33 | 2376 | 93.35 | 0.13 |
| Moderate MET | I | 730.95 | 738.01 | 0 | 4320 | 100.96 | 0.07 |
| | IV | 598.54 | 733.84 | 0 | 4320 | 122.60 | 0.05 |
| Intensive MET | I | 773.48 | 578.26 | 0 | 5760 | 74.76 | 0.11 |
| | IV | 695.06 | 577.35 | 0 | 7200 | 83.06 | 0.17 |

Legend: AS - mean; S - standard deviation; MIN - minimum recorded measurement result; MAX - maximum recorded measurement result; CV - coefficient of variation; KSP - level of statistical significance of Kolmogorov-Smirnov coefficient

Descriptive statistics of subjects of different ages (Table 2) indicates the heterogeneity of the results of all analyzed variables for assessing physical activity. As in the previous case, one can talk about the different habits of adolescents from Zrenjanin. Distribution of the analyzed variables, 2 out of 3 do not differ significantly from the normal distribution, while variable Moderate MET in subsample of subjects of IV class statistically significantly deviates from the normal distribution.

Based on F values (Table 3), it can be concluded that there is a statistically significant difference (P=.00) between subjects of different ages in physical activity, observing the whole system of applied variables. Univariate analysis of variance (ANOVA) showed that at the level of individual variables, statistically significant differences exist in one of the three analyzed variables: Walking MET (p=.00) in favor of first-class subsample of subjects from secondary school from Zrenjanin. Statistically significant differences were not found in the remaining two analyzed variables.

Values of Kolmogorov-Smirnov test (KSP) indicate normality of the distribution of most of the analyzed variables for assessing physical activity in both subsamples of different ages. A significant statistical deviation was noted only in the variable Moderate MET in subsample of subjects of class IV (Table 4).

**Table 3** Differences of subjects of different ages in physical activity

| Variable | Group | AS | f | p |
|---|---|---|---|---|
| **Walking MET** | **I**<br>IV | 1040.32<br>765.86 | **12.52** | **.00** |
| Moderate MET | I<br>IV | 730.95<br>598.54 | 2.99 | .09 |
| Intensive MET | I<br>IV | 773.48<br>695.06 | .36 | .55 |

F=4.49 P=.00

Legend: f – univariate f test; p - level of statistical significance of f test; F – multivariate Wilcoxon F test; p - statistical significance multivariate F test

**Table 4** Descriptive statistics of variables for assessing physical activity of male subjects of different ages

| Variable | Class | AS | S | MIN | MAX | CV (%) | KSp |
|---|---|---|---|---|---|---|---|
| Walking MET | I | 982.96 | 767,73 | 50 | 2970 | 78.10 | 0.10 |
| | IV | 726.26 | 684,98 | 50 | 2376 | 94.32 | 0.15 |
| Moderate MET | I | 773.71 | 676,94 | 0 | 2880 | 87.49 | 0.08 |
| | IV | 608.12 | 802,57 | 0 | 4320 | 131.98 | 0.04 |
| Intensive MET | I | 1290.52 | 1632,63 | 0 | 5760 | 126.50 | 0.06 |
| | IV | 1190.00 | 1709,37 | 0 | 7200 | 143.64 | 0.06 |

Legend: AS - mean; S - standard deviation; MIN - minimum recorded measurement result; MAX - maximum recorded measurement result; CV - coefficient of variation; KSp - level of statistical significance of the Kolmogorov-Smirnov coefficient

**Table 5** Differences of male subjects of different ages in physical activity

| Variable | Group | f | p |
|---|---|---|---|
| **Walking MET** | **I**<br>IV | **4.54** | **.04** |
| Moderate MET | I<br>IV | 1.91 | .17 |
| Intensive MET | I<br>IV | .13 | .70 |

F=1.82 P=.15

Legend: f – univariate f test; p - level of statistical significance of f test; F - Wilcoxon multivariate F test; p - statistical significance of the multivariate F test

Based on the F values (Table 5), it is concluded that there is no statistically significant difference (P=.15) between the male subjects of different ages in the level of physical activity, when observing the whole system of applied variables. Based on the individual analysis of each variable, it is concluded that significant differences exist in the variables: Walking MET (p=.04) in favor of the subsample of fist-class subjects, but it may be due to individual differences, because the whole system of variables was not statistically significant. Here it is assumed that it is the impact/contribution of individuals who are very active in the field of walking. It is likely that there are also plenty of commuters who walk to school or transport on a daily basis.

Regarding the subsample of subjects, the highest variability of results has been noted, especially in the variables of moderate (Moderate MET) and intensive (Intensive MET) physical activity, in subjects of first and fourth grades of Zrenjanin secondary schools (Table 6). Values of Kolmogorov-Smirnov test (KSP) indicate normality of the distribution of most of the variables in both subsamples formed on the basis of age, while two significant differences are observed in the variable Intensive MET in both subsamples.

**Table 6** Descriptive statistics of variables for assessing physical activity of female subjects of different ages

| Variable | Class | AS | S | MIN | MAX | CV (%) | KSp |
|---|---|---|---|---|---|---|---|
| Walking MET | I | 1085.91 | 770.33 | 50 | 2673 | 70.94 | .12 |
| | IV | 788.09 | 733.28 | 33 | 2376 | 93.04 | .13 |
| Moderate MET | I | 696.96 | 784.49 | 0 | 4320 | 112.55 | .06 |
| | IV | 593.16 | 695.93 | 0 | 3600 | 117.33 | .08 |
| Intensive MET | I | 358.92 | 658.69 | 0 | 3840 | 170.86 | .03 |
| | IV | 417.19 | 842.63 | 0 | 5200 | 201.97 | .03 |

Legend: AS - mean; S - standard deviation; MIN - minimum recorded measurement result; MAX - maximum recorded measurement result; CV - coefficient of variation; KSp - level of statistical significance of the Kolmogorov-Smirnov coefficient

Based on F values (Table 7), it can be concluded that there is a statistically significant difference (P=.02) between the female subjects of different ages in the level of physical activity, when observing the whole system of applied variables. The individual analysis of each variable shows that there are significant differences in the variables: Walking MET (p=.00) in favor of the subsample of first class female subjects. In the remaining two analyzed variables, Moderate MET and Intensive MET, statistically significant differences were not found.

**Table 7** Differences of female subjects of different ages in physical activity

| Variable | Group | AS | f | p |
|---|---|---|---|---|
| **Walking MET** | **I** | 1085.91 | **8.51** | **.00** |
| | IV | 788.09 | | |
| Moderate MET | I | 696.96 | 1.05 | .31 |
| | IV | 593.16 | | |
| Intensive MET | I | 358.92 | 0.33 | .57 |
| | IV | 41719 | | |

F=3.34 P=.02

Legend: f – univariate f test; p - level of statistical significance of f test; F - Wilcoxon multivariate F test; p - statistical significance of the multivariate F test

# DISCUSSION

Physical activity of boys and girls is largely determined by their gender, age and morphological characteristics. One can not ignore the influence of family, school and the community. It was therefore interesting to examine the level of physical activity of adolescents from an evnvironment such as the City of Zrenjanin. The aim of this study was to determine differences in relation to gender and age of secondary school students. Physical activity is indispensable for children and youth. A characteristic of the current situation of children and young people in the world and in Serbia is the decline of motor and functional abilities, and although these abilities of children and adolescents should grow with age, they are declining.

Taking into account the average values of the analyzed variables for assessing physical activity, Walking MET, Moderate MET and Intensive MET, a moderate level of physical activity of students may be noted. The level of physical activity on average is not low, but it is also not high, which is due to lifestyle, use of means of transport on a daily basis and spending free time using the computer, rarely playing sports. More time is spent with tablets or mobile phones in a sitting position. The heterogeneity of the results of the analyzed variables for the assessment of the level of physical activity among subjects of different gender: Walking MET, Moderate MET and Intensive MET is a consequence of a different way of life of Zrenjanin adolescents attending secondary school. They are the consequence of different life habits and the fact that subjects from suburban (more rural communities) come to Zrenjanin in order to get an education and have a need for a different way of life (movement). The consequence of this heterogeneity of results is the fact that there are a large number of adolescent athletes (30%) involved in sports clubs, but also those who do not have greater physical load during the week, except going to school (by some means of transport). The level of physical activity of adolescents from Zrenjanin is lower than the average values of adolescents from European countries (Sallis, Prochaska & Taylor, 2000). Teenagers do not have a sufficient level of moderate physical activity a week (minimum 150 minutes of focused physical activity), but they walk enough during the week. Apart from the lack of physical activity, adolescents avoid physical education classes whenever they can. Females do it above all, especially older students (students of final years of secondary school).

According to the results, adolescents' age also brings about a decline in physical activity, and this fact confirms previous studies (e.g. Heath et al, 1994), confirming the third hypothesis of the study. There are significant differences in the level of physical activity of subjects of different ages. The difference in the variable Walking MET is dominant, where the average first-grade students spend more time walking on a weekly basis. A great variability of results has been noted in subsamples of subjects of different ages as a result of the large difference in the expression of physical activity of varying intensity. There are a number of subjects who engage in sports, so their level of physical activity is more intense, but there are plenty of subjects who do not have a satisfactory level of physical activity, ie, it is minimal.

A great variability of results has been noted in subsamples of subjects of different ages, which is due to the large differences in the manifestation of physical activity of varying intensity. There are a number of subjects who engage in sports, so their level of physical activity is more intense, but there are plenty of subjects who do not have a satisfactory level of physical activity, ie, it is minimal.

Differences were identified in both males and females in the variable Intensive MET compared to the age of the subjects. Daily need of adolescents for movement is greater. This probably relates to different habits of children of first and fourth grades of secondary school, different interests. There are also activities after school. If they come from more rural areas and the outskirts of Zrenjanin, their habits are different, they are certainly more active because they have to cross greater distances than the children who live in the city.

# CONCLUSION

The results of concrete research carried out on secondary school students from Zrenjanin enable a comparison with the results obtained so far in the Republic of Serbia. This makes it possible to inform the wider community about the state of the physical activity of secondary school students. Consequently, a "starting point" has been realized from which relevant institutions in the Republic of Serbia and the City of Zrenjanin can move towards the adoption of appropriate measures in terms of planning and development in the field of physical education. Based on the results, the hypotheses can be accepted.

The results confirm the existence of differences in the pattern and level of physical activity of adolescents of different ages, taking into account the gender as well. These results may to some extent contribute to better and clearer addressing the significance of practicing regular physical activity. Based on the results, emphasizing the teaching of physical education among adolescents in Zrenjanin and its surroundings can be carried out more adequately, but it should also apply to all secondary school students in Serbia. Based on the obtained research data, recommendations for proper physical exercise and nutrition can be written, as well as reaching the desirable degree of physical fitness as a function of youth health on the basis of the results obtained for each school and student profile. In the forthcoming period, permanent influence on the consciousness of adolescents should be exercised and commitment should be shown in terms of presenting the importance of physical activity through a certain number of workshops for adolescents about the positive benefits of regular physical activity and its impact in the prevention of disease.

In the forthcoming period, permanent influence on the consciousness of adolescents should be exercised and commitment should be shown in terms of presenting the importance of physical activity through a certain number of workshops for adolescents about the positive benefits of regular physical activity and its impact in the prevention of disease.

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# RATING OF THE PHYSICAL FITNESS LEVEL IN PHYSICAL EDUCATION FEMALE STUDENTS USING "EUROFIT-TEST"

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## SUMMARY

This work is based on the results of Cross-sectional experimental study results, which was implemented in Study-Year 2015/2016 within female students of the third year of undergraduate studies at the Faculty of Sport and Physical Education (FSFV), University of Niš. The study is for the first time realized with application of this tests battery for the course of Rhythmic gymnastics (VI semester of classes 3+3/45+45). The test was carried out in the framework of the teaching practice, as pre-exam requirements, based on which the student can achieve a maximum 10.0 out of 60 points. Other pre-exam obligations relating to the mandatory compositions of RG, and which are implemented partially in the form of three practical exam-tests, followed by seminar work, regular presence at the theoretical and practical lessons, including lectures with bonus points for interactive teaching. The sample of examinees, which implemented educational practice, a total of 28 FE-female student especially selected at the entrance exam (compared to the assumed above average motor status), turned them into the regular curriculum (third year of study in accordance with the Bologna Declaration). For the purposes of this study "EUROFIT-Test" (according to Adam et al., 1998) was applied for assessment of the status of motor abilities. The pilot study was conducted at the end of 6th Summer semester within the female students, under the guidance and supervision of the Rhythmic Gymnastics teacher. Based on the conducted testing, a female student's result are displayed as a Histograms for each tested variable and analyzed as the individual. and group case studies.

**Keywords:** EUROFIT-Test, PE-female students, Estimation, Rating-Physical Fitness, Case-Study

## INTRODUCTION

The previous researches point out that in past have been paid enough attention, as to the development, as well as to estimation of somatic and physical predisposition, particularly of the movement ability. Some authors are most often opted for occasional samples of respondents aged from 11 to 17 years of age. Usually that were the individual studies, but also was realized a monograph study of the national interest by (Kurelić, et al. 1975) id the area of former Yugoslavia, within the particular Republic centers, academic and educational institutions (primary and secondary Schools.

In that time it has been applied standardized battery tests for the assessment of morphological characteristics - International Biological Program (IBP), and basic motor abilities on the representative sub-samples of respondents of non-pairs ages, in the context of higher graders of primary school students and in the secondary schools. However, the battery like this could not provide all necessary answers, while the research results of our population could not be complex compare with the research results of population in other countries in region and wide or with research results conducted in other European countries and in the world.

The Group of experts for the Physical education and Sport at Council of Europe (1983, 1987), have provided the system of the evaluation through the standardized battery tests named EUROFIT-Test, which eliminate common testing problems in the past and creates preconditions for the establishment of new norms which are adjusted to the specific selected samples of respondents according to sex, age, professional or sports orientation and according to the ethnic of origin.

**Issue.** The study of Physical education and Sport, both in our country and in the region, EU, and other European and world countries, requires from students the significant universal, as well as specific predisposition (abilities, skills). This also applies to certain subjects of study requiring possession of the specific skills (such as Physical Education (PE) - Musical education - and Art education). Within the PE, and its specific disciplines exists some current problems in the selection of candidates for study in the context of personnel schools:

With what level of somatic and motor preconditions occur applicants for the study registration in the field of physical education and sport?

-With what level of somatic and motor preconditions are finished studies at the appropriate personnel schools?

-What kind of somatic and motor precondition should meet the student with respect to universality and specificity of studies, in the time of the enrollment in the high education institution?

**Motor development of the higher-education youth.** Life expectancy in terms of development can be deployed in multiple developmental periods. Because each person is unique and has its own individual and specific traits in its development, it is not possible to accurately and objectively layout of the different periods. Similar individual-specific differences exist in terms of gender, ethnicity and national origin. For these reasons, grouping, or development classification of individuals, within a period to be considered as a pre determined agreement, a consensus of individual authors or groups of experts from different scientific fields.

From the point of the orientation of this research project, implemented on a sample of the higher education population, it was of the greatest interest de facto studying y the development of motor skills in adolescence (16-20 years), as well as thereafter, during the period of young adulthood (21-30 years). Both of these periods have own specifics. Kasa (2000) states that at the end of this period, one individual complete their physical and spiritual maturation and becomes a young adult man and a young woman. During this period, practically ending physical growth. Ossification and bone growth are completed. Bodily proportions receive its final appearance. Secondary sexual characteristics are finishing their development. The final function is taking over all the internal organs. The movements of the body are fused, the coordination of the whole body achieves harmony, and movement efficiency reaches its maximum value.

It should be noted that at this point ends psychological development of the individual as well. This means that all mental processes reach their full value. The development of motion skills, especially of fitness (strength, speed and endurance) in this period reached a maximum value, for people who engage in regular physical activity. At the age of 18-20 years have achieved the pinnacle of motor development, power is most intensely developed over 14 years, and slows down after 18 years. A young man of 20 years but shows the typical indicators of kinesiology, which is further influenced by the development of motion skills improve, possibly stagnating or shrinking due to inactivity.

The differences in motor skills are conditioned by profession of an individual, movement regime, training, lifestyle, self-discipline and the like. It should be noted that the difference in motor skills between boys and girls in this period is very pronounced. It is caused by differences in the anatomy of the body, functional ability and psychological sphere. For example, the muscle strength of women reaches an average of 63% of the power of a man. The women of the general population in this developmental period, show a lower level of expression of every individual achievement, as compared to men. They are equal to the men only in the speed of movement frequency, of the different parts of the body, and exert a greater value only in terms of the development of move ability (flexibility).

In the movement locomotion, such as jumping, throwing, shooting and other movable activities, markedly lagging behind men. Even in the period of puberty, the development of motor achievements markedly slows the female population. Motor achievements are in regularly trained men improves to 18-19 years, after which improve substantially reduced. Of course, it depends on what kind of training the person is burdened. In people who train regularly or participate in sports, results are improving after 20 years as well. Gender differences in achievement recorded also according to sports orientation and specialization. Tied for the results achieved by women and men in particular coordinating capabilities.

# METHODS

## Subjects

Sample include in total 28 healthy female persons, special selected samples (in regard to the assumed above average motor status), which are including in regular Educational Study Curriculum in the frame of the third year of study in compliance with the Bologna Declaration. For the needs of these study was applied "EUROFIT-Test" (according to Adam et al, 1998), which is for the first time applied on sample of PE female students, aged 22 years and elderly. The study is implemente d on the end of Summer semester, third Year of Basic-Academic-Studies, with collaboration of PhD students at the study Faculty of Sport and Physical Education, University of Niš, and supervised by the corresponding teacher.

## Procedure

**Eurofit-Test.** Collection of nine tests that covers flexibility, speed, endurance and strength. Battery of tests is a standardized and designed by the Council of Europe, for the school children and has been used in many European schools since 1988. The battery of tests is the designed in manner that testing can be completed within 35 to 40 minutes, using very simple equipment. The tests used in study are: (1) Flamingo, (2) Plate-Taping, (3) Deep-forward-bend, (4) Standing-Long-Jump, (5) Hand-grip, (6) Lying in the backward position-sitting with flexed legs, (7) Hand-grip on horizontal bar, Stamina/endurance with flexed hands, (8) Running between cones (from front to back, 10x5 m), (9) 20m Shuttle-Run (Beep test), for evaluation of Cardio-Respiratory-Endurance.

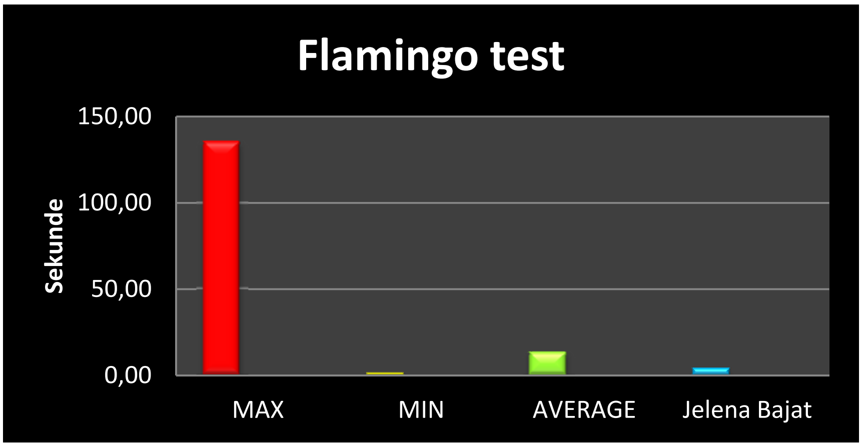
## Statistical analysis

Based on realized testing, results of female students are presented in form of two histograms (1-2), in the first are noted 4 levels (MIN, and MAX value, AVERAGE, and personnel result of student. In the second histogram are presented results of all other female students, placed in some equidistant segments (fitness zone). In majority cases the results were placed in five segments, where was evidenced normal dispersion of results. However, on particular test, because of grate dispersion of results, it was a need to paced results in more levels, as was mentioned by presentation of those tests. Comparative analysis of some case studies has used for the evaluation of estimated differences between measured female students within sample, with notification of mean value (AVERAGE), and evident ion of MIN, and MAX value, as well as individual students achievement in the frame of group.

# RESULTS

### 1. Case Study – Flamingo (FLM)

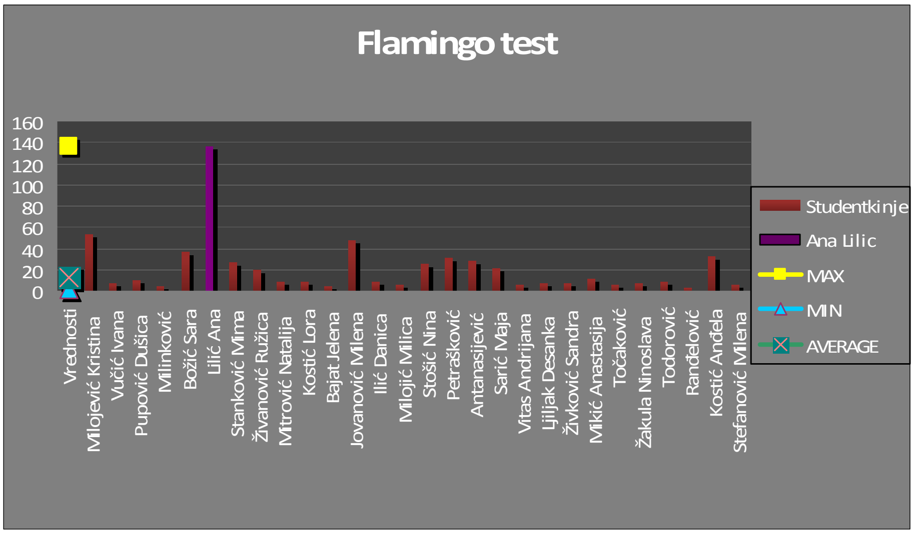
**Histogram 1. Flamingo test**




This test estimates the ability to keep balance position in harder circumstances. Except good development of vestibular apparatus, it is necessary as well the strength of lower extremities (dominant leg), as well as high level of possibility of concentration.

In following histograms (1-2) are presented parallel results of Ana Lilić (and Jelena Bajat) with noticed MAX-, and MIN- values of testing of all other female students, and calculated AVERAGE values on the Total sample (N=28).

**Histogram 2**



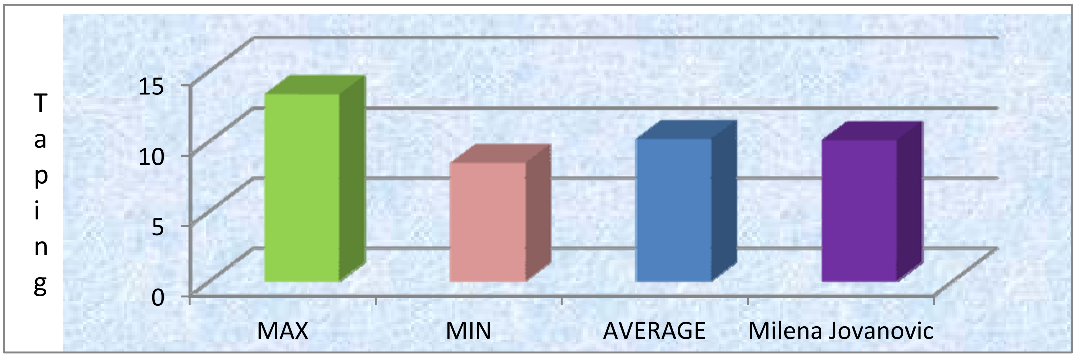

**Legend: MAX**–value (135.5 sec), **MIN**– value (1.2 sec), **AVERAGE**–mean value (13.26 sec)**, *Ana Lilić* –** individual student's result **(135.5 sec)**, that is identical to MAX-value on the balance test (Flamingo), while the personnel result of ***Jelena Bajat*** (3.97 sec) is placed in zone of MIN-values (below average, see Histograms 1-2).

## 2. Case Study – Plate-Taping (PLT)

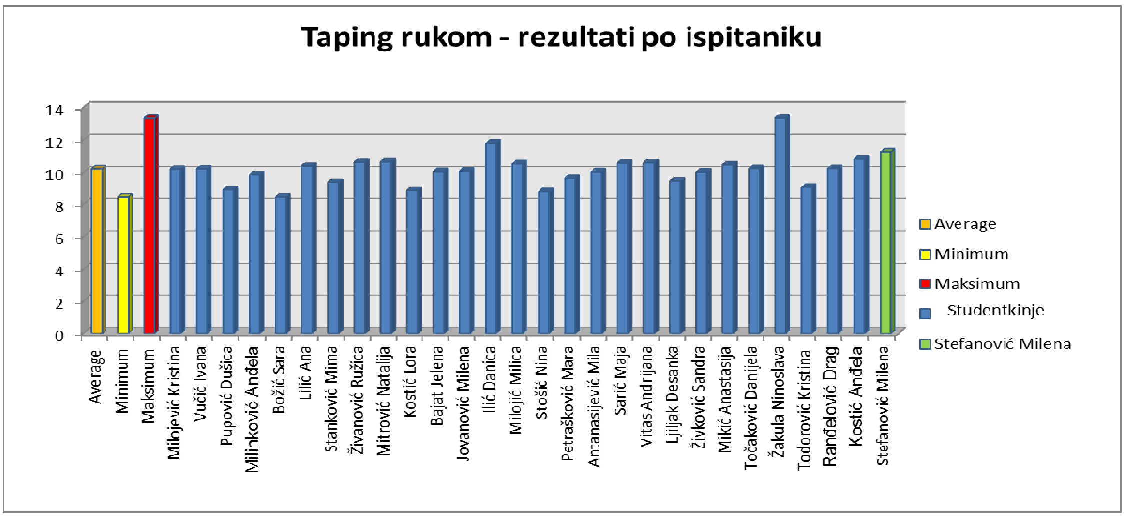
Test ***Plate-taping*** evaluate the speed of movement frequency of dominate hand, in time limited period (25-ciclus/30-sec), and the task is performed on the special shaped horizontal plate. On the base of the testing, results of students (Milena Stefanović, and Milena Jovanović) are evidenced in form of two Histograms (3-4), first for the 4-level rating (MIN, and MAX result, mean value – AVERAGE and student's personnel result. On the second histogram are evidenced results of all female students, placed in particular equidistant segments (fitness zone). In this test results are placed in seven segments, because of non-unified results.

On the stated histograms (3-4) it is evident that the personnel result (11.24 sec) of student Milena Stefanović is placed between MAX (13.34 sec), and mean value (12.43 sec) of the all other female students, and the MIN value is (8.43 sec), and the result of Milena Jovanović is placed in the AVERAGE fitness zone. The results in this test are ***inverse values****, which means that minima value is *„de facto“* the best result.

**Histogram 3 – Plate tapping**

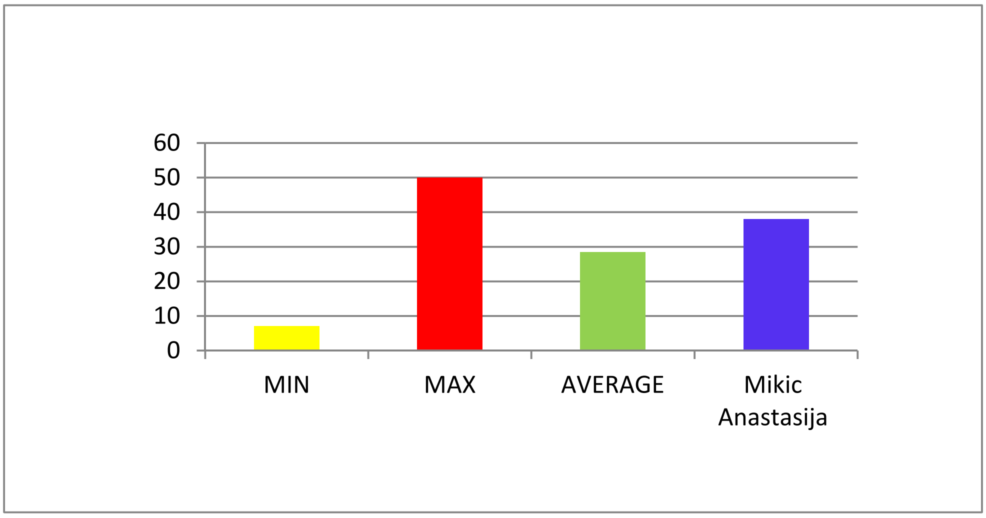


**Histogram 4**




## 3. Study Case – Seat and–reach (Deep Forward Bend)

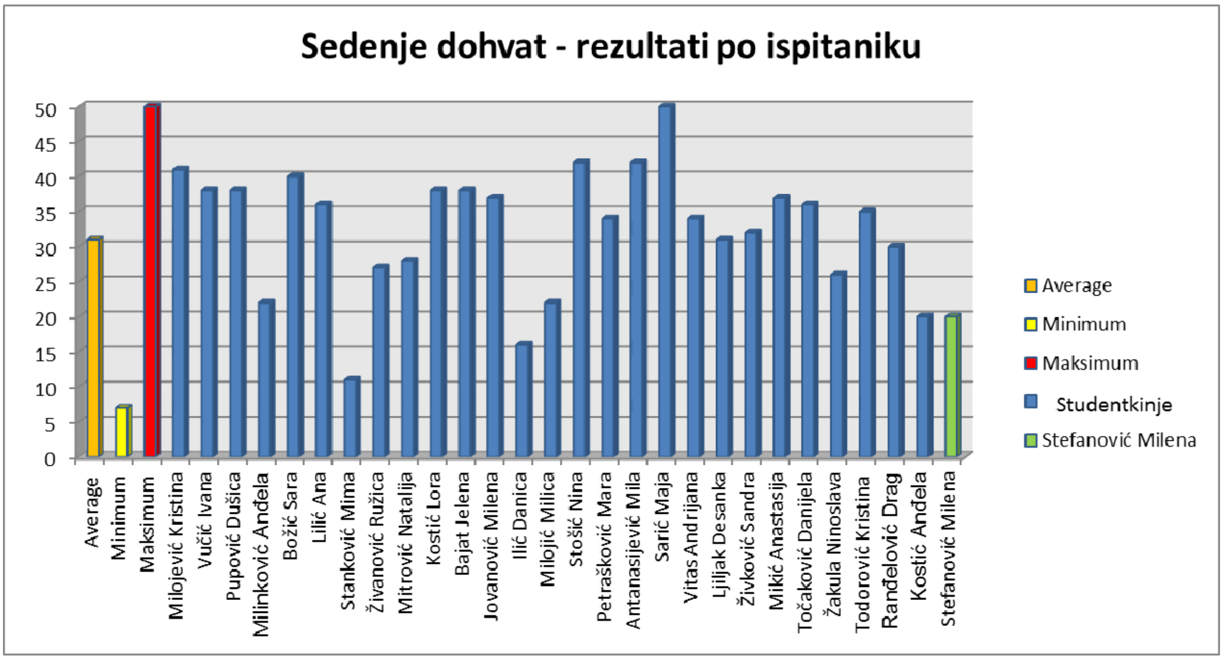
**Histogram 5**




On the base of testing performed, female students results are stated in form of two histograms (5-6), on the first are evidenced 4 levels (MIN, and MAX result, mean value, and the student's result. On the second are evidenced results of all female students, placed in particular equidistant levels (fitness zone). Results of this test are placed in five levels, because of the relative high results disperses.

On the presented histograms (5-6) it is evident that the personnel student's result of Anastasija Mikić (37) is placed in between above AVERAGE (30.83 cm) and MAX-value zone (50 cm), while the personnel result of Milena Stefanović (19 cm) is placed between below average and MIN fitness zone (7cm).

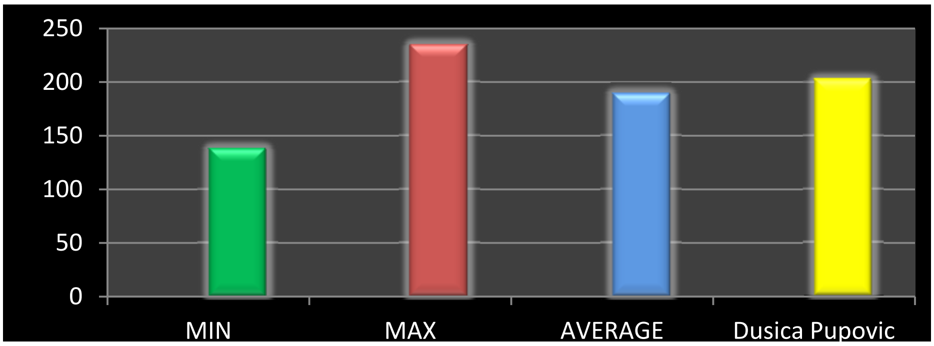
**Histogram 6**




## 4. Case Study – Standing-Long-Jump (SLJ)

This test estimates explosive power of lower extremities, or the ability to mobilize maximal amount of muscles units in one motion. Except good development level of lower legs muscles potency, it is need for unify the whole body coordination, considering hand movement, take-off, air movement and lending position, with high level of concentration ability.

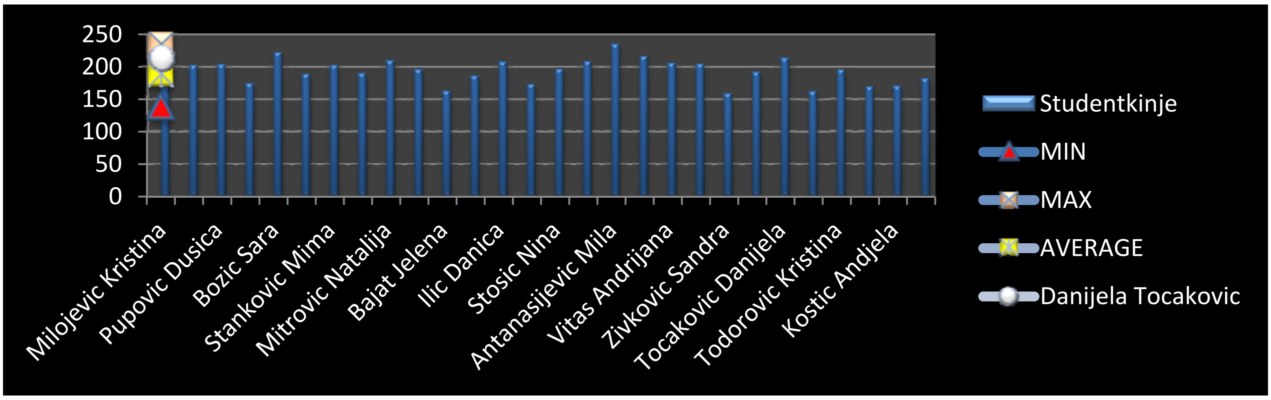
**Histogram 7**




**Legend: MIN –** result (138 cm), **MAX –** result (234.5 cm), **AVERAGE** – mean value (188.9 cm), **Dušica Pupović –** personnel result (203 cm)

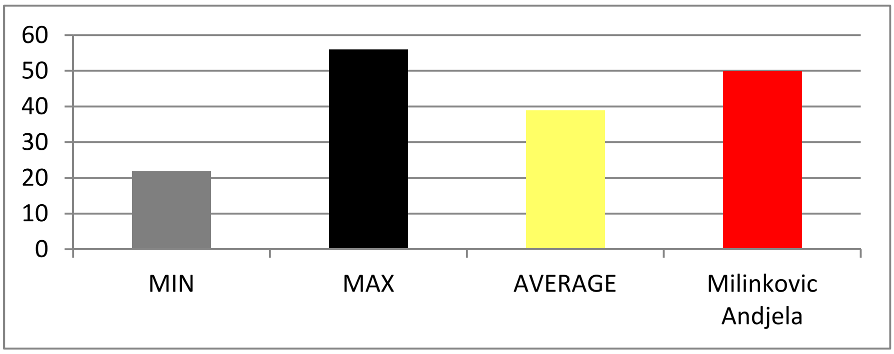
On the base of implemented testing, in ***standing-long-jump***, results of female students are provided in form of two histograms (7-8), on the first are evidenced 4 levels (MIN, and MAX result, mean value – AVERAGE, and personnel result of female students Dušica Pupović, and Danijela Točaković. On the second histogram are evidenced results of all female students, placed in five equidistant segments (fitness zone), result dispersion is not very high. Personnel result of Danijela Točaković (213 cm) is placed in fitness zone of above average results (Fifth level), and the personnel result of Dusica is in the AVERAGE zone.

**Histogram 8**




## 5. Case Study – Hand grip (DIN)

**Histogram 9**



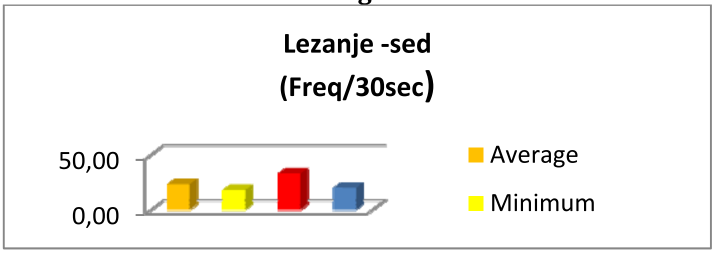

On the base of implemented testing, using hand dynamometer (***hand-grip)***, for the evaluation of isometric muscles potential of dominant hand, results of female students are provided in form of two histograms (9-10), on the first are evidenced 4 levels (MIN, and MAX result, mean value – AVERAGE, and personnel result of female student Milena Stefanović. On the second histogram are evidenced results of all female students, placed in two equidistant segments (fitness zone), while the results dispersion is not very high.

On the presented histograms (9-10) it is evident that the personnel result of female student Anđela Milinković (48.5 kg) is placed in zone of above average values, between MAX (56 kg), and AVERAGE value (41.65 kg) of all other female students. Results are placed in six equidistant segments, and hers is in the fifth fitness zone (above average).

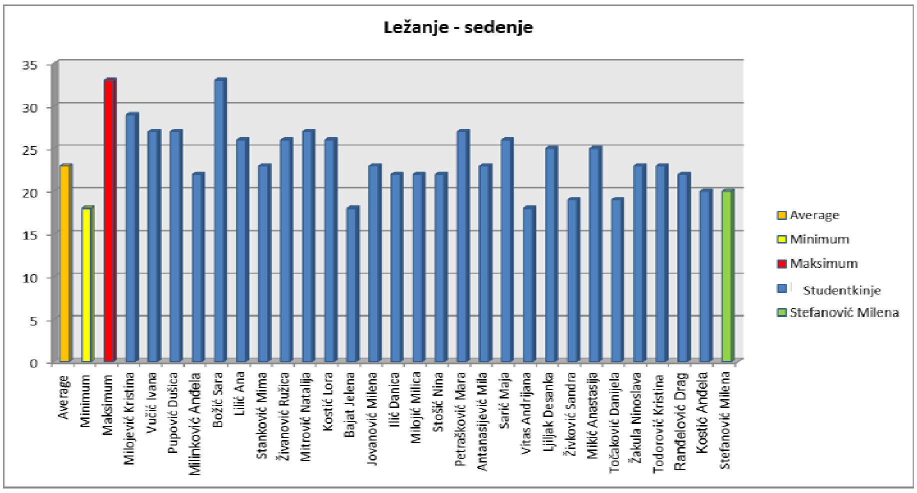
**Histogram 10**

## 6. Case Study – Laying on the back - seat (ABD)

**Histogram 11**




**Histogram 12**




This test estimate so called speed endurance, or repetitive potential of abdominal muscles in time limited interval on special defined test protocol, in regard to the arms position (hands close connected behind the neck), with flexed knees, and fixed foots.

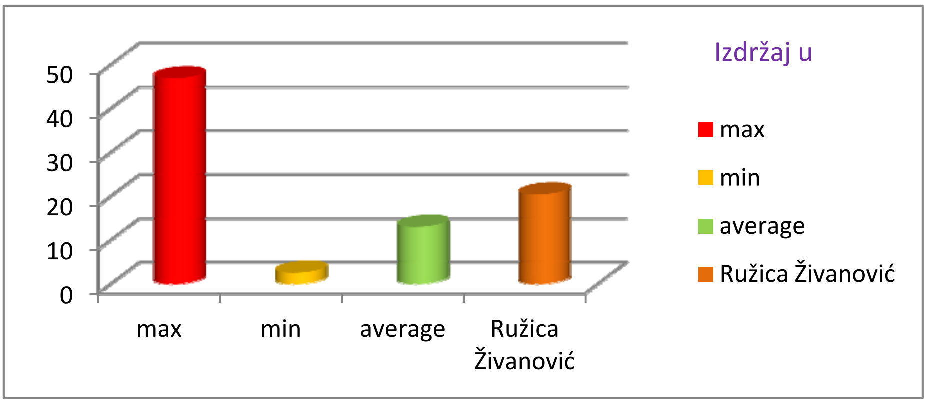
**Histogram 11-12.** Comparison of the individual result of testing Stefanović Milena relative to the basic descriptive parameters (MAX, MEAN, MIN) of all other female students on test *Laying on the back – sitting position.*

On the presented histograms (11-12) it is evident that the personnel result of female student Milena Stefanović is placed in zone between MIN-value (18 cycles), and AVERAGE value (23.33 cycles) of the results all other female students. Results are placed in seven equidistant segments, and her result is in the fourth fitness zone.

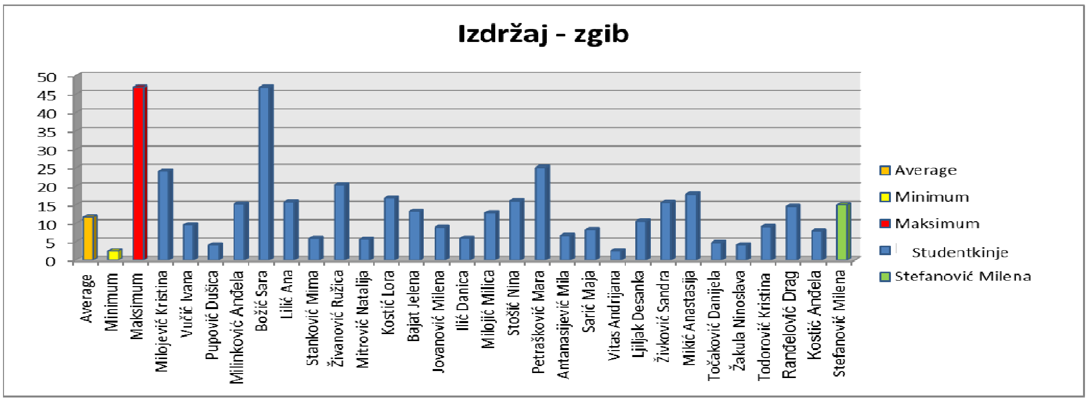
## 7. Case Study – Grip of both flexed arms in hang position on horizontal bar (AGH)

Comparison of individual result of Stefanović Milena in regard to basic descriptive parameters (MAX, MEAN, MIN) of all other students on test of ***Static endurance*** (evaluate the isometric muscle potential of arms and upper body. On presented histograms (13-14) it is evident that personal result of Ružica Živanović (20.38 sec) is placed in above average zone, between MAX (46.85 sec), and mean values (11.73 sec), in view of the particular equidistant segments (second fitness zone). On this test is noted very significant dispersion of results.

**Histogram 13**

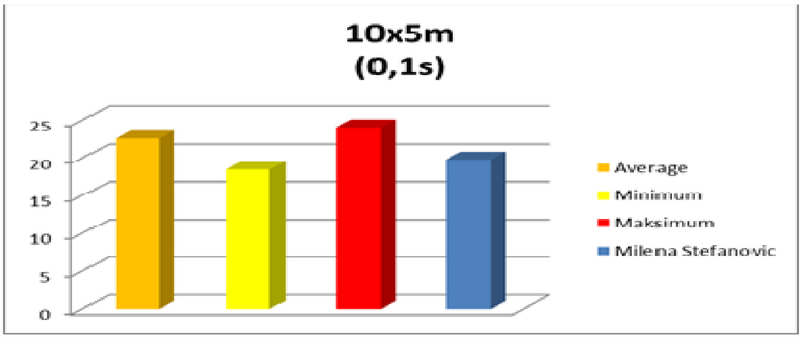



**Histogram 14**




## 8. Case Study – Agility – Shuttle run (SHR)

**Histogram 15**

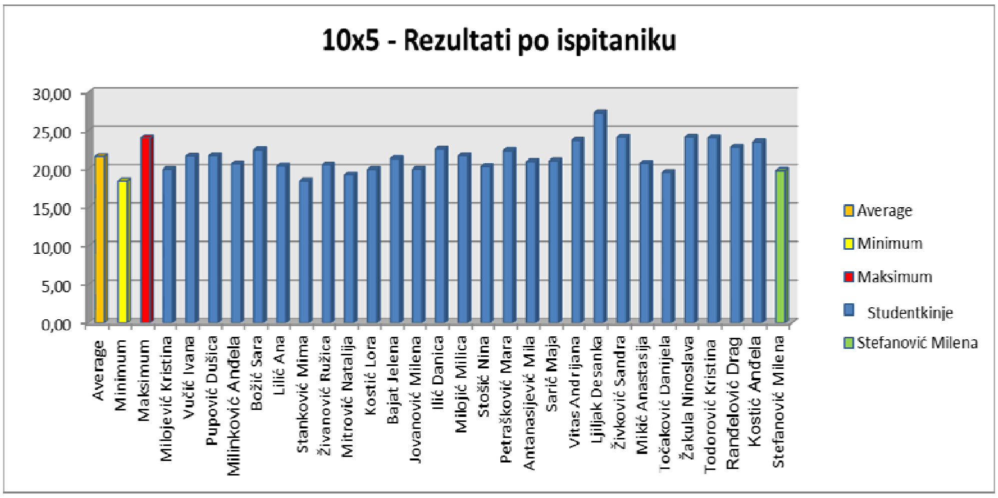



On the agility test, which estimates running speed between cones (10x5m), it is necessary explosive strength, as well as good move ability, and running speed.

**Histogram 15-16.** Comparisons of individual result of Stefanović Milena in regard to basic descriptive parameters (MAX, MEAN, and MIN) of all other students on test of Shuttle run (10x5m).

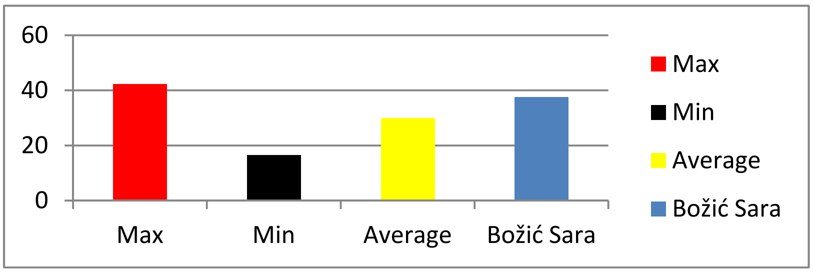
On the presented histograms (15-16) it is evident that the personnel result of female student Milena Stefanović (19.8 sec) is placed between mean value (21.63 sec), and MIN value (18.45 sec) of the all other female students, while the MAX value (24.05 sec) is placed in sixth equidistant segment (fitness zone). Result in this test is ***inverse value*,*** which means that MIN- value is „de facto“ ***the best result*** – shortest time, estimated in 1/10 sec, in shuttle run behind the cones (10x5m), while MAX-value is „de facto“ ***the lowest result.***

**Histogram 16**



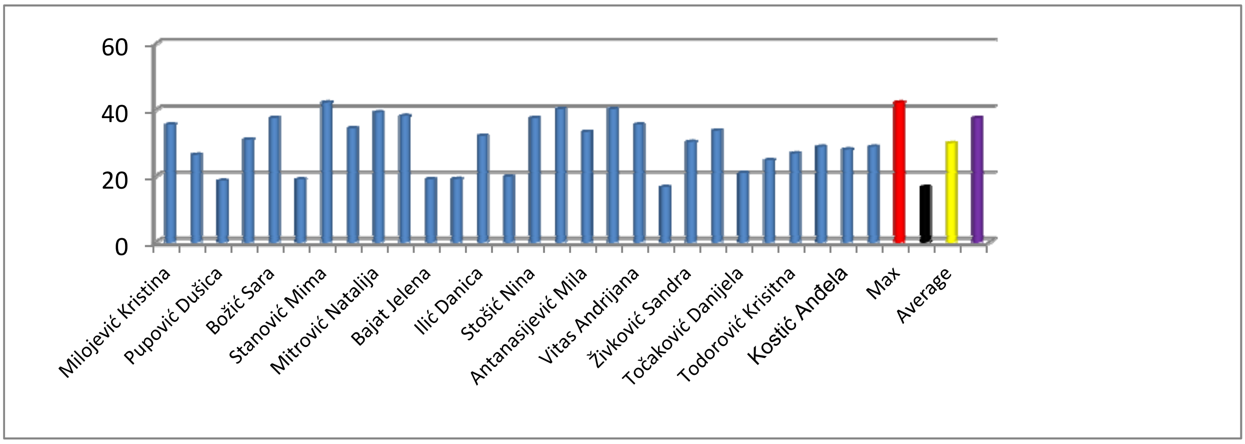

## 9. Case Study–Cardio-Respiratory-Endurance (CRE) – Shuttle-run-20m-distance

**Histogram 17**




**Legend:** MAX-value (42.2ml/kg/min); MIN-value (16.6ml/kg/min); AVERAGE (29.893ml/kg/min); Personnel result of female student Sara Božić (37.5 ml/kg/min)

**Histogram 18**




On the base of realized testing procedure, the students' results are presented in form of two histograms (17-18). On the first are evidenced 4 levels (MIN, and MAX, AVERAGE, and personnel student result of Sara Božić. On the second histogram are presented results of the all students, placed in particular equidistant segments (fitness zone). Results are placed in nine levels (fitness zone), because grate dispersion.

As we can see in Histogram 19, the highest differences, relative to the estimated values of measured female students (MAX – MIN, and AVERAGE) are in tests for the balance evaluation (Flamingo), and isometric muscles potential of arms and shoulders (Flexed-arms-Endurance). On the tests for the estimation of the speed of movement frequency Plate–Taping with dominant hand, and agility (shuttle run 10x5 m) the results of female students are unified, and all are placed in the same fitness zone, in the first equidistant level, that points on better values of female students in these tests, which belong to the area of speed reaction time.

**Histogram 19**

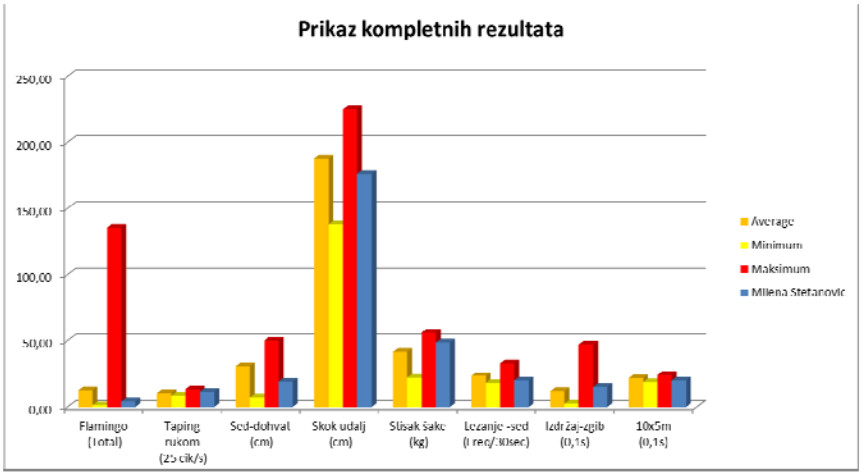



**Table 2.** Total table of estimated **AVERAGE / Mean values**, evidenced **MIN-, and MAX-** results of all FSFV female students compared to the individual results of **Milena Stefanović,** and the adequate Fitness zone

| EUROFIT-Test | AVERAGE | MIN | MAX | RANGE | M.S. | Fit-zone |
|---|---|---|---|---|---|---|
| 1. Flamingo – FLB (sec) | 13.27 | 1.2 | 135.5 | 134.3 | 5.14 | below average |
| 2. Plate Tapping – PLT (sec)* | 12.43 | 8.43* | 13.34* | 4.91 | 11.24 | above average* |
| 3. Deep forward bend - DFB (cm) | 30.83 | 07 | 50 | 43 | 19 | below average |
| 4. Standing-Long-Jump - SLJ (cm) | 187.9 | 138 | 225 | 87 | 176 | below average |
| 5. Hand-grip - DIN (kg) | 41.65 | 22 | 56 | 34 | 48.5 | above average |
| 6. Abdominals– ABD (freq./30s) | 23.33 | 18 | 33 | 15 | 20 | above average |
| 7. Flexed-Arm-Hang-Isometric–ZGI (**s**) | 11.37 | 2.51 | 46.85 | 44.34 | 14.98 | above average |
| 8. Agility – Shuttle Run -10x5 (sec)* | 22.55 | 21.06* | 24.05 | 2.99 | 19.08 | above average * |
| 9. Cardio-Respiratory-Endurance – R20m (ml/kg/min) | 29.89 | 16.6 | 42.2 | 25.6 | 28.8 | mean value |

**Table 3.** Total, absolute, and relative frequency of achieved results on particular tests, when considered their placement in some equidistant levels (Fitness zone).

| ***EUROFIT- TEST –*** [Abs.(**f**)/Rel.(%)] | **MIN** | **Below average** | **Mean value** | **Above average** | **MAX** |
|---|---|---|---|---|---|
| Sample (N=28) | f (%) | f (%) | f (%) | f (%) | f (%) |
| 1. Flamingo – FLB (sec) | 1 (3.57) | 18 **(62.28)** | 1(3.57) | 7 (25.0) | 1(3.57) |
| 2. Plate Tapping – PLT sec)* | 1(3.57)* | **15 (53.57)*** | 3 (10.71)* | 10 (35.71) | 1(3.57)* |
| 3. Deep forward bend - DFB (cm) | 1(3.57) | 9 (32.14) | 1(3.57) | **16 (57.14)** | 1(3.57) |
| 4. Standing-Long-Jump - SLJ (cm) | 1(3.57) | **17 (60.71)** | 1(3.57) | 8 (28.57) | 1(3.57) |
| 5. Hand-grip - DIN (kg) | 1(3.57) | 8 (28.57) | 1(3.57) | **17 (60.71)** | 1(3.57) |
| 6. Abdominals– ABD (freq./30s) | 1(3.57) | 10 (35.71) | **1(3.57)** | **15 (53.57)** | 1(3.57) |
| 7. Flexed-Arm-Hang-Isometrics–ZGI *(s)* | 1(3.57) | 11 (39.28) | 1(3.57) | **14 (50.0)** | 1(3.57) |
| 8. Agility – Shuttle Run -10x5 (sec)* | 1(3.57) | 10 (35.71) | 4 (14.28) | **12 (42.86)** | 1(3.57) |
| 9. Cardio-Respiratory-Endurance – R20m (ml/kg/min) | 4 (14.28) | 6 (21.43) | 7 (25.0) | **10 (35.71)** | 1 (3.57) |
| ***Fitness Zone*** | (1) Unsatisfied | (2) Satisfied | (3) Good | (4) Very good | (5) Excellent |

**** inverse value (MIN value – the best result, and opposite)***

# DISCUSSION

**Physical and movement abilities of children, youth and young adults**

In many countries of the world, experts have also focused to solving issues of population health state, its promotion and the searching for factors closely related to this issue. Statistical data continuously indicate the unsatisfactory state of health of the population, both in our country and in the EU and the world. We belong to the group of European countries with the shortest average (mean) value of the length-life.

At this point we are faced with a difficult task - especially to fight the passivity of a large part of our population, with reduced responsibility for their own health and physical fitness. The results of modern research proves, even with higher reliability, that appropriate physical activities have a positive impact on health improvement, improved physical fitness and motor efficiency, both in school and student population, as well as in adult population.

National programs for health promotion, in some countries, also contain Development Programs and improvement of motor skills, which should eventually contribute to the general improvement in the health status of the population in these countries. Health in childhood and adolescence is considered optimal periods to create of positive habits and lasting relationship with regular sports and physical activities during future life.

Table-1. Comparative indices of the numerical values of presented variables for the evaluation of bodily status and EUROFIT–Tests in female student of Pedagogical Faculty (PF), University of Prešov and General population in the Slovakia (SVK) on Initial (I-1), and Final measurement (F-2), and students of University of Ljubljana (U-Lj-S) in former YU Republic of Slovenia), as well as at current sample of the 3rd year of study student on FSFV, University of Niš in Serbia (cross-sectional).

| **Variables** | **Initial** (I-1) | | **Final** (F-2) | | Cross-sectional (1987/1988) | Cross-sectional (2015/2016) |
|---|---|---|---|---|---|---|
| **Body Composition** | **PF PU** | **SVK** | **PF PU** | **SVK** | **U-Lj-SLO** | **FSFV-U-N-SRB** |
| 1. Body High (cm) | 166.13 | 168.51 | 166.51 | 168.20 | 178.00 | 167.85 |
| 2. Body Weight (kg) | 57.39 | 55.21 | 55.55 | 56.69 | 76.00 | 60.255 |
| 3.Body-Mass-Index | 20.3 | - | 19.51 | - | - | 21.385 |
| **EUROFIT-Test** | | | | | - | |
| 1. Flamingo (sec) | 4.14 | 12.59 | 2.44 | 11.59 | | (12.43)* 13.26 |
| 2. Plate-Taping (**s**)* | | | | | | (12.43)* |
| 3. Seat-reach (cm) | 25.79 | 27.21 | 28.52 | 26.85 | 65.00* | 30.83 |
| 4. Standing-Long-Jump (cm) | 166.12 | 173.61 | 178.57 | 173.77 | 216 | (187.9) 188.9 |
| 5. Hand grip (kg) | | | | | | 41.65 |
| 6. Laying back-seat (freq./30**s**) | 21.02 | 23.51 | 23.57 | 25.10 | - | 23.33 |
| 7. Flexed-Hand-Grip-Endurance (sec) | 27.56 | 22.71 | 35.51 | 22.14 | 69.00 | 11.37 |
| 8. Agility (**s**)* | 22.36 | 21.07 | 21.28 | 21.78 | - | 22.55* |
| 9. C-R-Endurance (ml/kg/min) | 37.79 | 37.71 | 41.61 | 35.71 | - | |

One can not imagine the planning and implementation of programs in motor activity without control of their efficiency, with respect to individual differences and potential possibilities for development of certain motor skills. Be sure that the motor fitness tests are considered as the most important means of pedagogical control in certain sensitive periods of the development. In forming the test-batteries, both in our country and in the world, the goal to be achieved is considered the starting point.

Due to the different approaches to the solution of the health problems of the population, coupled with the physical fitness of children and youth of school age, and young adults, as well as the lack of unified testing methods of physical fitness, so far has been impossible in correct and methodologically appropriate way to compare the results of previous, and contemporary researches. The international organization dealing with the issue of testing, as well as experts in physical education in our country for many years have to initiate the establishment of a single system, which will allow you to determine the level of basic motor skills, as in children and youth, as well as in young adult population.

However, until now, has not found universal test-battery, accepted in practice of physical education, which could be internationally applicable, for comparison of results in this area. Experts in the field of physical education and sport in some European countries (Slovakia, Czech Republic, Poland, Slovenia, Bulgaria, Finland, Germany, Belgium, and the Netherlands) as well as in our home country, still insist to use the traditional battery of tests, or with various modifications. Table 2 shows some comparative numerical data on conducted researches in some of these countries and with the current study, heir considered. Some of these results are evidenced in Table 1, in regard to results comparison.

# CONCLUSION

- The results of this pilot study have provided us with the answers to the questions, as defined in the introductory part of the paper. Because of the relatively small sample of respondents (N-28), on which it was for the first time implemented testing of the physical abilities of a female student (FSFV), applying EUROFIT-Test, the results of this study, so far, it is not possible to generalize.
- This study provides some data on the level of physical fitness of female students and contributes to the updating and expansion of empirical and scientific information on the status and level of some motor parameters and physical condition of female students (FSFV).
- At the same time, it should to contribute to a more objective selection of students for this profile of personnel, by establishing norms (standards) for the evaluation of movement capabilities.
- Current research has been realized as a part of the research study work, in framework of doctoral studies (DAS), and the mandatory teaching practice at the basic academic studies (BAS), within rhythmic gymnastics, as specific professional subject, intended for female students.
- Testing was conducted at the end of the VI summer semester, in school year 2015-2016, with applying of the adequate scientific methodology. This was contributed to avoid some irregularities, whether for objective or subjective reasons.
- At the same time, this study has, as well the practical contribution, since it will in all future studies with a similar orientation be allowed to objectively compare the results with actual data from this study.

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# HIPPOTHERAPY IN THE FUNCTION OF TREATMENT AND PREVENTION OF NEUROPHYSIOLOGYCAL AND SENSORY DYSFUNCTION

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## SUMMARY

Hippotherapeutic treatment has a basis in neuropsychology and must be determined for each patient (client) separately or individually dosed with pre-made therapeutic plan. There is no other treatment that offers the possibility to persons with disabilities of motor skills and movement in space in an upright position, which can be routed to other people's feet as required! The reason is three-dimensional movement of the horse's backs with the movement of horses (up-down, right-left, front-back), and it gives a result in the rotation of the pelvis and trunk riders (90-120 km / min). Sitting on the warm back of a horse, a person with paraplegia, must constantly react to these movements, imitating the real movement despite the paralysis of the legs. In fact, he sits up against the force of gravity, with the help of muscle strength of the hull and gets a sense of a stable symmetrical body position. Due to continued swinging his legs stretched out and mobilizing the hips, hippotherapists should especially pay attention to the position of the pelvis from which movements are directed towards the trunk and limbs. At the same time happens activation of large joints (shoulders and hips), and is rough and fine motor skills limbs facilitated. The paper emphasizes that hippotherapeutic treatment must be prescribed and administered by a team in which there are kinesiologists, managers, defectologists, physiotherapists, occupational therapists, who have completed special training in hippotherapy, kinesiotherapists, coaches and hyppotherapy specialists etc. With the help of horses, all of them achieve goals in line with their profession, and the movement and treatment of movement are the basis of all this.

**Keywords**: hippotherapy/neurophysiology/horses/team/ movement

## INTRODUCTION

Hippotherapy is a physical, occupational and speech therapy treatment strategie of persons with disabilities that uses the movement of horses to achieve functional goals. Hippotherapy means treatment with the help of horses (Greek *hippos* = horse; therapy = treatment) and refers to the use of three-dimensional mode the movement of horses as a means of treating people with functional limitations, neuromotor and sensory dysfunction. Hippotherapy treatment has a neurophysiological basis and must be prescribed by a team of experts, primarily: speech therapists, physiotherapists, kinesiotherapists, kinesiology, occupational therapists who have completed special training in hippotherapy, coaches and specialists hypotherapy etc.

The terminology which is used in this article seeks to unify the statements that are in wide practical use, taking into account hierarchy of scientific concepts.

There are three main areas that needs to correlate application of the horses for therapeutic purposes:

- *medicine*: therapy aimed at developing motor skills of disabled person or "hippotherapy";
- *pedagogy / special education*: therapy with the aim of developing personal behavior, "pedagogical riding", "special education riding";
- *sport*: therapy for the purpose of recreation, competition, development of motivation and so on, or recreational horse riding.

Hippotherapy is therapy with horses and on horseback. Advanced definition is: "Hippotherapy means physiotherapy procedures in which disabled persons, sick people and horse, with its three-dimensional movements, participants pre-planned and thought out medical-therapeutic treatment, whereby a man, through the overall movement, physically, emotionally, mentally and socially engaged."

In Serbia, about fifty equestrian clubs and associations are involved in some activities (therapeutic or recreational) with persons with disabilities and disabled people, and a barely two or three associations have good organization and educated professionals (organized team) for this area. Experience from around the world suggests a strong management team which is consists of highly specialized managers trained to work in equestrian organizations that have, above all, more activities in work with children and people with disabilities and disabled persons. At the head of such cavalry organization must be educated top manager with educated team who will be able to carry out activities and programs through the following organizations:

- organization of training for operational managers for equestrian clubs and associations (practical classes);
- organization of volunteers and working with volunteers;
- team who worry about the training and education of horses, concerned about care of horses and horse equipment and users, and all for the purpose of therapeutic riding;
- training for therapists for performing therapies and activities with help of a horse;
- eduction of operational trainers for sporting activities of people with disabilities;
- organization of events and competitions (national and international) in various equestrian disciplines;
- organization of team for realization of plans and programs of "summer camps" for people with disabilities;
- organization and realization of recreational horse riding for disabled persons.

Sports riding is therapy with different goals: recreation, competition, development of motivation, etc. The range of offers is diverse - of the great importance to leisure time, to the regular sports competition. So, on the first place is the social integration of people with disabilities. Because of riding is the only sport in which people with disabilities can be compared with healthy people - the horse makes this possible. When riding, there are the same requirements of healthy people and disabled people, and disabled people can compensate for their problems by special devices, such as specially designed bridle, saddle and stirrups.

Own capacity for equestrian sport invalid-rider must first check with doctor. If there are no contraindications, he can begin to engage in this sport. Also, people with very difficult disabilities, without limbs, can achieve results in riding. The lack of limbs is not an obstacle to indulge the movements of the horse. Even after amputation, disturbed sense of balance can be most easily trained and again founded, just with riding. Certain secondary damage, such as curvature of the spine, can be alleviated. Therapeutic riding can be defined as using of horses and activities oriented towards PWD (person with disability), rehabilitation method, activity, action, therapy, a form of equestrian, kinesiotherapeutical method.

International Federation for therapeutic riding F.R.D.I. (Federation Riding for Disabled International) in Münster (Germany) in 2009 adopted a new division.

The reason for the changes is that the therapeutic effects do not stem only from riding horses, but from the activities and relationships that happend around the horse: perception and grooming horses, learning and socializing with horse.

## HIPPOTHERAPY TREATMENT

Hippotherapy treatment has a neurophysiological basis and must be prescribed by a doctor, for each patient, individually dosed with pre-made therapeutic plan. No other treatment does not offer disabled people with severe impairment of motor skills movement in space in an upright position, that can guide how he want, on others feet! The reason is three-dimensional folding of horse back with the movement of horse (up and down, right and left, forward and back), and result is rotation of the pelvis and trunk of the rider (90-120 km/min). Sitting on the warm back of a horse, disabled person must constantly react to these movements, depicting real movement despite the paralysis of the legs. The muscle power on the hull he uprights against gravity and gets a sense of a stable symmetrical body position. Due to continued swinging stretched out legs and mobilizing the hips, hyppotherapeuts must especially pay attention to the position of pelvis, from which movements are directed towards the trunk and limbs. At the same time the large joints are engaged in (shoulders and hips), so the rough and fine motor skill of limbs is facilitated.

Hippotherapy is complex therapy procedure which must be strictly individually dosed by doctors, which is a basic prerequisite for the appropriate method of treatment aimed at the planned destination. Due to operation of multiple movements of horses to an "rider", it must be obviously that the laic and unprofessional procedure may harm the patient. So, further training of physiotherapists is necessary. Persons who want to complete further education for hippotherapist must have at least secondary medical school – direction physiotherapy, and at least one year of physiotherapy practice.

## Health-pedagogical treatment

*Health-pedagogical riding* is primarily distinguished with educational function. The concept implies pedagogical, psychological, physiotherapy, rehabilitation and socio-integrative offers of treatment through therapeutic riding. The individual development of a person through riding, which has a favorable impact on its development, health and behavior.

Health-pedagogical riding and voltage is very complex therapeutic procedure, whose goals can be broken down into three areas:

1. **area of kinesiology:**
    - improving physical involvement in keeping with the movement of horses;
    - give and release physical stiffness due rhythmic launch horses;
    - improving the balance and coordination;
    - improving their own observations of its body structure;
2. **emotional-cognitive area:**
    - learning observations;
    - learning to take criticism from adults;
    - develop of self-confidence;
    - reducing of fears;
    - strengthen the faith in own abilities;
    - development of awareness of responsibility;
    - increasing tolerance in frustration;
3. **social area:**
    - gathering and maintaining the common goals set;
    - recognition abilities of others;
    - teach and compromise (to subordinate own requirements to the group dynamics);
    - reduce aggressive behavior;
    - building relationships - companionship;
    - developing of self-confidence.

All these complex objectives can be achieved by establishing adequate and appropriate triangle a horse - a child - health educator.

Team of experts which is conducting pedagogical riding and voltage consists of special education teachers, school counselors, psychologists, kinesiologists with mandatory additional theoretical and practical training in therapeutic riding.

## Equestrian sport - therapy for people with special sensory dysfunction

People with special needs can be included in various forms of equestrian, depending on their own capabilities (weight sensory dysfunction), wishes and recommendations of physiotherapists. Therapeutic riding is a learning process that monitors the riding instructor. Work can be done individually, but more often in the group. In cooperation with a physiotherapist they planned objectives of the program and evaluate achieved. Therapeutic targets are set individually for each person based on knowledge of its capabilities and limitations. It is used in 25 different types of diagnosis, sensory-neurophysiological dysfunction, or disability, such as: cerebral palsy, spina bifida, muscular dystrophy, autism, mental retardation, Down syndrome, hyperactivity, epilepsy, difficulty speaking, reading and writing, impairments of vision and hearing, emotional disturbances, behavioral, educational neglect, abuse and many others.

In common riding is conducted when person can not adjust to the movements of the horse, when there is an imbalance and/or control of the head. In this case, the instructor or therapist sitting behind the rider, supports and monitors the balance. In order to achieve the desired goal, it is necessary to share tools and guides. Hippotherapy is a form of medical treatment which is achieved to a therapeutic target using a three-dimensional movements of the horse. Specially trained physiotherapists, occupational and speech therapists use this form of treatment for clients who have damage of the movement. Stride creates a sensory stimulus which is changing, it is rhythmic and repeated. Rider is answering with body movements with personal movements of the pelvis during walking. Various options of the horse walk allow to the therapist grading sensibly irritation and the use of movement in combination with other forms of treatment to achieve the goal. Patients enthusiastically responds to a pleasant way of learning and exercise in a natural environment.

Recreational riding for people with sensory dysfunction allows the development of potential and continue to exercise the cavalry. It can be performed in several forms: from common riding with another person because of the inability of independent riding, to participate in competitions in dressage and cavalry. One part of the people with special needs join into clubs and eventually deals with the cavalry as a member of the club.

## EFFECTS OF THERAPEUTIC RIDING

Feelings of satisfaction and control arising from riding and management of an animal of about five hundred kilograms is a powerful drug that boosts confidence. Riding is giving experience of freedom and mobility, they are unknown to disabled persons. Contact with animal that has no prejudice, is making a special love.

The beauty and nobility of the horse, its warmth and rhythm of movement, represents a combination with unique therapeutic effect.

Therapeutic riding includes medical, sports and educational aspect. The program includes a conceived contact with a horse, learning to control the horse in motion (with various levels of independence), learning and practicing riding on a horse (specially adapted according to the type of handicap), teaching in the barn, games on horseback, trail riding, dressage elements and preparation for sports competition for experienced riders.

Movements and patterns emerge in the form of actions and reactions. Lorenz (1973) has called this "comparison". The execution and the final result of the movement depends on connection with differentiation of the "mental images" and "external reality". This includes entire personality. With physically handicapped children, and they are main focus of this article, the treatment of physiotherapists has a specific function and sensitive task. Each therapeutic approach that does not deal with the whole person is a failure. It simply can not be done when the focus remains only on physical inability or isolating physical function. Especially in hippotherapy, which is a therapeutic assistant horse, therapy does not have to be limited to physical deficiencies. Therefore background in social education can provide helpful for use in this method of treatment.

Many approaches, based on different training methods, provide insight into relationship of mind and body. Physiotherapist relies primarily on medical and kinesiology approach, a special education teacher through the cognitive plan of targets would like to introduce and direct a child to him. The central place in that is sensory approach. Each of senses must be solved and bring into consciousness. This starts with vision, hearing, smell and touch, and this includes vestibular proprioceptive senses. Too often, these last two sensory systems ARC are not taken into account.

On horseback child can listen steps of the horse, walking pace or trot. At each step child's joints and muscles must be adapted to mobile support - horseback. From child we may search for to complete some of the exercises with closed eyes to eliminate one of the senses. This, in turn, stimulates tactile and proprioceptive senses and creates an increased awareness of his own body and constant movement.

In area of social interaction, hypotherapy involves the interaction of two living beings: the child and a horse. As we mentioned, the child is encouraged from the beginning to make contact with a horse. This ability to build a relationship is important for the development of the child's self-image. Unlike humans, horses do not anticipate any child physics of defects. This can be very important because many children with disabilities and neurophysiological and sensory dysfunction in meeting with people face with scared or worried facial expression or other adverse reactions.

Therapeutic exercise for lying down or sluggish relaxed on a horse, creating intense contacts to further enhance relationship between a child and a horse. Kids say to the horse: "You're so warm and soft," or "Your mane tickles my nose" and other similar words. Let the child decide, as much as possible, when will horse walk or when he have trot to go. Well-trained horse reacts appropriately to commands of a child.

The therapist is involved in socio-emotional development of the child, helping him to improve his relationship with a horse. This creates a chain of trust: a child – a horse - therapist.

Discussion after the therapy is not just reflection of the content of treatment, it goes further than that, and therapist is trying to indicate child to remember what he/she felt, smelled and heard through use of visualization and images. In addition, they are also using relaxation exercises similar to some in psychotherapy.

Through dialogue and visual-motor experiences, child is able to learn, especially in the areas of social interaction. Therapist shows different movements and encourage child to copy movements with help of gestures and facial expressions in the mirror. Therapist must accept any anxiety while working with the child and focus its strategy for exercises on improving the current situation with that child.

It should be noted that the treatment stimulates vestibular and proprioceptive sense of the child. This leads to greater self-awareness, improving self-image, which results as greater confidence and reducing fear. When child overcome initial problems and fears, the therapist can create new demands and sets new goals and thereby endangers the child, step by step, towards a fuller and better quality of life. Through hypotherapy children with disabilities, with neurophysiological and sensory dysfunction, can detect unknown pleasure of physical activity. Successful resolution of initial problems and positive atmosphere leading to increased motivation and enjoyment in learning, so child is ready to learn new skills. To complete the treatment, hipoterapeutist must work with a therapist for special education and psycho-therapeutic techniques, which is trained for TWH/AWH.

## Therapy with the help of horses and children with cerebral palsy

People of all ages with cerebral palsy can enjoy interacting with horses. Children with cerebral palsy can learn to ride and to share with their peers. In adults, this is a kind of leisure activities. Riding requires skills such as good posture, good coordination and maintain balance on the horse. The riders with cerebral palsy can progress from riding with therapist at his side, to independent riding. Some people with cerebral palsy prefer to learn to ride a chariot, and even can learn to lead the horse in a specially designed chair.

In addition, therapy with help of horses for children with disabilities, neurophysiological and sensory dysfunction, has an impact on confidence through improved image of themselves (animal care), developing a love for fellow beings, improves learning concentration and spatial awareness, encourages ability to take control and responsibility, ability to transfer what they have learned on horseback to everyday life, helps in overcoming fears, strengthen a sense of trust and faith in their own abilities, reduce frustration. As for cognitive development, therapy with help of a horse has an impact on the construction of a sense of responsibility, builds friendships and trust in relation to the horse, the therapist and the other riders, learning to receive and impart aid, respect for common rules, learn to compromise, reducing aggression.

## Indications and contraindications of hippotherapy

Indications for hypotherapy are the following diagnosis: cerebral palsy, multiple sclerosis, stroke consequences, consequences of traumatic brain injury, paraplegia, rheumatoid arthritis, spina bifida, muscular dystrophy, amputations, mental retardation, Down syndrome, autism...

Contraindications for hypotherapy are distortion of the spine greater than 30%, instability of the spine, arthritis and hip dislocations, severe osteoporosis and pathological fractures, hemophilia, open sores (bed sores), uncontrollable seizures, cerebrovascular disturbances due to aneurysm or angioma, and medical therapy that influence blood coagulation.

## CONCLUSION

Hippotherapy is a form of medical-kinesiology treatment, where is for achieving a therapeutic target need to use a three-dimensional movements of the horse. Specially trained physiotherapists, kinesiologists, kinesiotherapists, occupational and speech therapists use this form of treatment for clients who have damage of the movement, or neurophysiological and sensory dysfunction. Stride creates a sensory stimulus that is changing, he is rhythmic and repeated. Rider fits body movements with movements of the pelvis during walking. Various options allow the horse walk therapist grading sensory (mechanoreceptors, proprioceptors) irritation, and use movement in combination with other forms of treatment to achieve the goal. Patients react enthusiastically on a pleasant way of learning and exercising in a natural environment.

Typical treatment programs for Asperger syndrome and autism with a focus on behavior modification and improvement. The complexity of behavior is gradually increased in an attempt to help in further development. Medicines are sometimes prescribed for people with Asperger syndrome or autism, but only to control symptoms such as hyperactivity or attack. Currently there is no known cure for this type of disease or condition, whatever you want to watch. The study therapy with the help of horses is relatively new. However, even among professionals who believe that more researchs is all right, there is a general consensus that therapy with animals can be very useful addition to the treatment program for children with autism or Asperger syndrome.

Therapy with help of a horse seems to have the best results. Rhythmic movements while the child rides a horse causes that children focuses on the movement. Child indirectly teaches how to better focus, a fact is backed up by soothing while riding. Some therapists on ranches have a policy to let the horse to choose the child, instead of "assignment" of the child and the horse to one another. It is a unique method that has excellent results. Followers of persons will take child to the horses and watch reaction of the horse. As the horse approached the head or sniffing the child, this is an indication that a bond is formed and the child is "chosen".

Experts who are constantly involved in therapy and activities with a help of horses, in their development programs for children with autism always have a story, they talk about very clear conclusions on the improvement which they see in children. It is not only in terms of basic communication and improve motor skills, but many children experience an improvement in their overall mood. Children who have previously been angry and aggressive, or who rarely smiles, suddenly calm and smile more easily and more often.

As with other types of therapy with help of animals, the introduction of animals to interact with the child, looks calm and reassure the child. Playful nature of the animal looks attracted on an autistic child, and get out of it "grenades". Children who have been closed have become open as a result of treatment with the help of a horse. They often begin by making eye contact with an animal, and then with other people. Shortly thereafter, the child often becomes relatively open; again, with the animal, and then to people. So, whether you call it hippotherapy, equine assisted therapy or therapeutic horseback riding, this is a powerful process that can not be mechanically replicated. Anyone with any type of physical or mental disability can benefit - relief from therapies and participate in activities with the help of a horse.

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# SENSORY INTEGRATION THROUGH HIPPOTHERAPY AND IMPROVEMENT OF BIOPSYCHOPHYSICAL BASIS OF MOVEMENT

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## SUMMARY

The paper discusses the results of hippotherapy through sensory integration to improve overall motor status. Application of hippotherapy has a multidisciplinary approach and the study of the movement has a multidisciplinary character involving the fields of biology, medicine, defectology, psychology, sport. The science of movement is constantly evolving and changing. Physiologists and psychologists have long been interested in willing movement. This study made it possible to reach out to the basicpsychophysiological mechanisms of movement. Teams of defectologists and psychologists are interested in the study of neurological processes which are related to the application possibilities of movement in rehabilitation and motor learning. The role of hippotherapy through sensory process of rehabilitation of children with physical disabilities are the most acceptable and most appjalicable in our country,without taking into account the pending system standards, unlicensed horses, a small number of trained staff. Because of all this, experts and researchers in this area are focused on topics aimed at finding workable solutions, and providing opportunities for our children with physical disabilities to obtain better quality of life, education and rehabilitation.

**Keywords**: sensory integration, biopsychophysical abilities, hippotherapy, move

## INTRODUCTION

It is not known exactly when the therapeutic riding has become a specialized discipline. There are historical records which speak about invalids who rode horses even in ancient Greece. Even then, it was known that riding is not just a form of transportation, but riding is a means of improving health and quality of life of people with disabilities.

Hundred years before, England recognized the riding for invalids as a useful form of therapy and offered therapeutic riding to the wounded soldiers in an oxford hospital during World War II. By 1950 the British physiotherapists have explored the possibilities of riding as therapy for all forms of handicap. British Association of therapeutic riding, The British Riding for the Disabled Association (RDA), was founded in 1969 with the help of the royal family.

Liz Hartel drew attention to riding for the invalids when she won a silver medal for ridding dressage at the Olympic Games in Helsinki in 1952, despite the fact that both her legs were partially paralyzed because of poliomyelitis. She and Ula Harpoti, physical therapist from Copenhagen, continued to use horses as therapy for their patients.

In the USA, the therapeutic riding developed as a form of recreation and a form of motivation for education because of its therapeutic possibilities. North American Association of therapeutic riding, The North American Riding for the Handicapped Association (NARHA), was founded in 1969 as an advisory board to different therapeutic riding associations in the United States and neighboring countries.

Today, people who used the therapeutic possibilities of riding demonstrate outstanding achievement in national and international competitions.

Hippotherapy (physical therapy on horseback, she uses the horse as a therapist) has evolved as a recognized medical branches in numerous countries. Therapeutic riding is a recognized and well-known method for improving the lives of those who refuse to allow disease and disability that limit them.

Hippotherapy works as an independent procedure, which means that by itself has a therapeutic effect and it is a supplement to the standard authorized therapeutic procedures. It gives the opportunity to interact with animals and this leads to new experiences, stimulate the senses, explore new textures, smells ... Movement of horses offers well-modulated sensory inputs of vestibular, proprioceptive, tactile and visual system. The rider can forget the pain and the daily struggle that life brings to the disabled, by joking, laughing and feeling free and proud.

Hippotherapy is based on neurophysiotherapeutic methods in medical-therapeutically procedure of neurological basis. The aim of hippotherapy is to improve the neurological stimulation and sensorimotor area (improve posture, coordination, body symmetry, balance, regulation of muscle tone, flexibility and stabilization of the scaling up of the pelvis ...), designed for people with diseases of the central and peripheral nervous system (eg, spasticity, ataxia, dyskinesia , multiple sclerosis ...), people with diseases of the locomotor apparatus and for those who need rehabilitation after accidents or strokes.

With the help of hippotherapy user's health can be improved on the physical, emotional, psychological, social and educational fields. In the physical field, hippotherapy affects: on normalizing muscle tone, enhancing muscle strength, increase range of motion, reduce stereotyped movements, posture control, improvement of coordination and balance, symmetry of movement. The basis of the therapeutic effect of hippotherapy, as well as all other forms of three-dimensional movement of a riding horse back where at a frequency of 50 - 60 steps per minute is transferred to the rider from 90 to 110 pulses (which is equal to the rhythm of human walking). In the correct position the rider they are transferred from the pelvis to the hull, and indirectly the whole body and are the physiological training of the pelvis and trunk. Three-dimensional movements are transmitted from horse backs to the patient through all three levels:

- in the sagittal plane - the pelvis moves forward and backward;
- in the frontal plane pelvis is shifted from the left to the right;
- in the transverse plane are present rotation and diagonal movements of the pelvis.

The rider is in fact located in the so-called inhibitory, neutral position that minimizes muscle spasms, has a broad base of support in the seating area and thighs, which facilitates (facilitate) seating, and perform abduction (expansion) of the thighs, which is important for patients who are constantly in a wheelchair. The user is more mobile and stronger, it improves blood circulation and breathing, sensory integration, directs his attention and increases concentration. Adopts new concepts, but also eliminates the skill of riding. When it comes to psychological results, they are reflected in the following: improved self-confidence, increased interest in his own life and the surrounding world, developing patience, control and discipline. Social benefits of hippotherapy include: developing friendships, development of love and respect for animals, satisfaction, gaining new experiences.

*Sports and recreational riding* aims at realizing the positive effects that sport brings with it - improving the health status, the formation and training of specific skills and knowledge to perform the typical structure of the movement development emotional processes caused by sporting activity, the positive direction of the value of feelings and motivation, positive personality traits, creating quality relationships, the possibility of later participation in top-level sport (sport rehabilitation). The highlight of therapeutic riding is a sport riding of the invalid person.

Therapy with horses (TWH) creates to the user a special program of work with the set therapeutic objectives, descriptions of selected methods, procedures and use of equipment and didactic materials and guided analysis evaluation of therapeutic procedures. Experts who have the basic profile of education: teachers, therapists, social pedagogues, psychologists, teachers, educators, occupational therapists, physiotherapists, social workers, doctors and other health professionals who have completed additional training in TWH and cavalry (specialization) perform TWH. Activities by means of horse (AWH) are, opposed to treatment by means of horse (TWH), spontaneous, goals are not set and does not evaluate the general care (an important comfort and pleasure, relaxation, companionship, friendship, activity). AWH perform various professions, with additional education regardless of their level of qualification.

This paper describes the results of hippotherapy through sensory integration to improve overall motor movement. Given that the use of hippotherapy has a multidisciplinary approach and the study of the movement has a multidisciplinary character and includes the fields of biology, medicine, special education, psychology, sport. The science of movement is constantly evolving and changing. Physiology and psychology has long been interested in the voluntary movement. This study made it possible to approach to the basic psychophysiological mechanisms of movement. Teams of therapists and psychologists are interested in the study of neurological processes pertaining to the application possibilities of movements in rehabilitation and motor learning. The role of hippotherapy through sensory process of rehabilitation of children with physical disabilities are the most acceptable and most applicable in our country, in terms of a delay pending system standard, unlicensed horses, a small number of trained staff. These are all questions that experts and researchers in this field are directed towards topics that are aimed at finding feasible solutions and to provide opportunities for our children with physical disabilities to obtain better quality of life, education and rehabilitation. Our experts were lucky that the training being carried out in Slovenia, Austria and Sweden, where they have the opportunity to explore the very large number of respondents who for years dealing with the cavalry (persons with disabilities and healthy children). Increasingly they are working on the implementation of EU programs. One of accredited programs, multidisciplinary and comprehensive model is Slovenia. Here, 14 highly educated professionals from Serbia ends their education (defectologists, psychologists, doctors, veterinarians, teachers, physical education teachers). Sensory integration is the neurological process that organizes information from different senses and the environment, but also gives the body an opportunity to reply in relation to the environment. If we make an overview of the different sensory systems and of the rehabilitation on the back of a horse through the sensorimotor stimulation, we see the horse as a motivator and that is also recommended.

## SENSORY INTEGRATION WITH HORSES AND ON HORSEBACK

Therefore, sensory integration is useful occupation of the patient, with the aim of awakening all the senses in a natural environment, keeping work habits and skills or forming new ones, if the former is so disturbed that it is impossible to restore. Sensory integration aims at: social reintegration, professional and vocational rehabilitation of the child through sensory integration, which is carried out with horses and riding. It encourages patient to work and belonging to a group, teaches him to determine the time planning and provides a feeling that is capable of working. Activities that were carried on horseback and with horse leads to a better approximation to reality and socioeconomic conditions that are represented in one community. Horse walk also imitates the normal gait of a healthy man. The movement is the basis of this behavior and it is very important that this activity with this target group is implemented with sensory-motor integration. Every room in the equestrian club is under strict control. This work is part of many years of research conducted by a team of professionals: managers kk "Impuls plus", doctors specialists, hippotherapists, therapists, social workers, special educators, veterinarians, sports officials in equestrian sport, educators, teachers united through projects approved by the competent institutions.

The multidisciplinary team has a higher education and in the last two years has been active in research on the impact of sensory integration on horseback and with horse as a successful method in rehabilitation.

### Sensory integration program therapy on horseback and with horse

Sensory integration therapy program includes children with dysfunction and sensory integration difficulties, self-regulation, disorders of muscle tone, difficulty in fine and rough motor skills, motor planning disorder, poor organization of behavior, perception disorder, arousal disorder, impaired alertness and difficulty of gameplay. Sensory integration dysfunction as a neurological disorder can appear as separate problem or can be labeled as a particular condition, syndrome or disease in cases of insufficient maturity of the nervous system due to premature birth, children with difficulties in motor development, cerebral palsy, children with autistic spectrum children visually impaired, children with attention deficit disorder (ADHD), children with difficulties in language and speech, learning, children with hearing impairment, children with intellectual disabilities and others. Operating on the processes of sensory integration and their (re) habilitation always improve functional abilities and restores the behavior of the child. Sensory integration therapy according to J. Aires improves quality of adaptive behavior of the child, allowing him adequate response to the demands of the environmentvestibular system.

### The vestibular system

Contains and gives information about the position and movement of people in space.

The vestibular system allows:

- an orientation in space;
- controlling muscle tension;
- maintaining a balance;
- stabilization of the eyes in space during head movements.

## Proprioceptive system

It gives information about the movements of the joints and body, information on the extent, strength, duration, direction of movement, posture or body parts in space and tone muscles.

The main task is to facilitate the movement and obtain feedback on the completion of the move. Together with the vestibular system manages muscle tone, control of posture and creating schemes organs.

## The tactile system

Responds to touch, pressure, pain, temperature and vibration. Provides information about the location, time and origin of a touch, and films, the composition and shape of the object. Objectives: to identify the object by touch, the localization of touch, contributes to the development scheme of the body, refusing to protect the system.

## The visual system

*The source of information on the movement, involved in motor planning and anticipation. Coupled with the vestibular system for controlling the balance.*

## Auditory system

Tasks: transformation of of sound impulses in a sensuous perception

Functional significance:

- unconsciously listening
- consciously listening
- contributes to an orientation in space
- development of speech
- attention, concentration and level of irritation.

## Optical and gustatory system

**IMPORTANCE OF SENSORY INTEGRATION FOR HUMAN DEVELOPMENT**
**information received from sensory receptors**

**posture, balance, tone, overcoming gravity, somatosensory awareness, motor planning**

**concentration, creativity, work habits, reading, writing, math, problem solving**

**motor skills, perceptual skills, emotional maturation**

## Signs of problems with sensory integration

- excessive or insufficient sensitivity of touch, sound, sight, movement, shackles or smells;
- problems with attention and self-control: background noise or visual impact by disruptive, irritable, difficult to soothe;
- Removing and / or withdrawal;
- social and emotional difficulties;
- problems with balance, movement, communication and speech motor planning.

## Sensory integration program therapy on horseback and with horse

Sensory integration therapy program includes children with dysfunction and sensory integration difficulties, self-regulation, disorders of muscle tone, difficulty in fine and rough motor skills, motor planning disorder, poor organization of behavior, perception disorder, arousal disorder, impaired alertness and difficulty of gameplay. Sensory integration dysfunction as a neurological disorder can appear as separate problem or can be labeled as a particular condition, syndrome or disease in cases of insufficient maturity of the nervous system due to premature birth, children with difficulties in motor development, cerebral palsy, children with autistic spectrum children visually impaired, children with attention deficit disorder (ADHD), children with difficulties in language and speech, learning, children with hearing impairment, children with intellectual disabilities and others. Operating on the processes of sensory integration and their (re) habilitation always improve functional abilities and restores the behavior of the child. Sensory integration therapy according to J. Aires improves quality of adaptive behavior of the child, allowing him adequate response to the demands of the environmentvestibular system.

## The aim and purpose of SI therapy

Improving the ability of the child to interact with objects in space:

- increasing the reaction time to adapt to sensory irritation;
- developing adaptation responses;
- an increase in self-confidence and self-esteem;
- improving cognitive abilities, acquire language skills, raising the quality of school achievement;
- develop personal and social skills.

## The benefits of hippotherapy

With the help of hippotherapy user's health can be improved with the physical, emotional, psychological, social and educational aspects. On the physical plane, hippotherapy affects: normalizing muscle tone, enhancing muscle strength, increase range of motion, reduce stereotyped movements, posture control, improvement of coordination and balance, symmetry of movement. The basis of the therapeutic effect of hippotherapy, as well as all other forms of three-dimensional movement of a riding horse back where at a frequency of 50 - 60 steps per minute is transferred to the rider from 90 to 110 pulses (which is equal to the rhythm of human walking). In the correct position the rider they are transferred from the pelvis to the hull, and indirectly the whole body and are the physiological training of the pelvis and trunk. Three-dimensional movements are transmitted from horse backs to the patient through all three levels: in the sagittal plane of the pelvis moves forward and backward, in the frontal plane pelvis is shifted from the left to the right, in the transverse plane are present rotation and diagonal movements of the pelvis. The rider is in fact located in the so-called inhibitory, neutral position that minimizes muscle spasms, has a broad base of support in the seating area and thighs, which facilitates (facilitate) seating, and perform abduction (expansion) of the thighs, which is important for patients who are constantly in a wheelchair. The user is more mobile and stronger, it improves blood circulation and breathing, sensory integration, directs his attention and increases concentration. Adopts new concepts, but also eliminates the skill of riding. When it comes to psychological results, they are reflected in the following: improved self-confidence, increased interest in his own life and the surrounding world, developing patience, control and discipline. Social benefits of hippotherapy include: developing friendships, love and respect for animals, satisfaction, gaining new experiences. Educational effects are: learning to read, learning math, motor planning, improve coordination of the hand-eye, improve visual and spatial perception.

Physiotherapist has a role to use different motor patterns that exist within the movement of horses and combines them in solving the problems of patients with motor impairments. Thus allows a favorable functional outcome pertaining to training and practicing the most important motor skills-or the possibility of sitting, standing and walking. The basis for carrying out hippotherapy are different concepts in physiotherapy (Bobath, PNF, Vojta). The occupational therapist is able to combine the effects of the movement of horses to other standard techniques while working on practicing fine motor control, sensory integration, skills retention, improving attention, practicing activities of daily living. Speech therapists can use horse moves in facilitating physiological systems which encourage speech In combination with standard therapeutic modalities logopedic speech therapist conducts effective treatment of communication disorders and this results in functional communication.

Hippotherapy is indicated by the doctor. Specially trained therapists carry out this treatment and evaluate each patient individually to determine eligibility to hypotherapy as one of the modalities of treatment strategies. Hippotherapist finally assess the state and he is responsible for patient safety, for the proper conduct of the horse and the proper help of an assistant. Therapists work closely with a coductor of the horse to take advantage of the various aspects of the movement of horses, location, type of equipment and activities in order to establish the best treatment plan and get the expected results.

Learning to ride a horse requires balance and coordination Many children with motor disabilities have the disorder of muscle tone and consequently have a coordination disorder too. Therapy with the help of horses for children gives the child physically pleasant experience that has influence on the muscle tone, coordination and balance, improves posture, relaxation, improves mobility of pelvic belt which affects the mobility of the hips and provides spine balance, stabilization of the head, body and limbs. Facilitates learning of independent sitting, standing and walking through a very effective sensory integration.

## CONCLUSION

A large number of researchers around the world in various scientific disciplines searching for a strategy used by the nervous system in programming movements. A large number of experiments have been performed to define the variable responsible for these processes. Researchers are interested in motor skills to understand the organization of the processes involved in the selection and execution of movement. The main object of this paper is a movement as the basis of conduct, which requires a serious multidisciplinary approach. especially in improving the bio psycho physical basis of the movement with the help of a horse.

Around the world, hundreds of thousands of people with disabilities, their families, various experts, but also lay people, feel or recognize the benefits and / or support therapy and activities with the help of a horse (TWH / AWH). To a child with physical, cognitive or emotional disabilities is not limited interactions with horses. In fact, such interactions can cause very great pleasure. For example, experience of the rhythmical movements of horses can be very useful. Riding a horse, rider's body moves in a manner similar to human walking, so that riders who have hippotherapy treatments (physical therapy on horseback), often show improvement in flexibility, balance and muscle strength. Whether it is a five-year child with Down syndrome, the 45-year-old who needs recovery from spinal cord injury, an older man who is recovering from a stroke or a teenager who struggles with depression, research shows that all TWH/AWH could be experienced as physical and emotional rebirth. For people with emotional challenges, a unique relationship formed with the horse can lead to increase of confidence, patience and self-esteem.

An attempt was made to implement the experience of authority from around the world who are engaged in this type of activity the last hundred years. In Serbia, it is still at the level of improvisations. In the world every little serious equestrian club has a well-organized management. If we compare the experience of centers of America and Europe (where this kind of rehabilitation woven into the system) with our country the conclusion is that the system in the Republic of Serbia does not recognize this area. Why did we take as a starting point "movement as the basis of conduct" man in general? Each movement, even the simplest, looked very complex. We had to explore motor movements in children / people with mental disabilities and we had to test the motor skills of healthy children / persons and to compare it to show and demonstrate the role of the horse's movements (which are most similar to man's walk). In this way we will get the answer to the question: what is the role of horses in the implementation of rehabilitation / habilitation of children with disabilities and invalidity?

Alongside the existence of the movement, when one rides a horse, tactile senses are stimulated. The skin of the horses is unclear, mane and tail are rough, and the nose is soft. The discovery of these sensations often helps to pull the child out, stimulating the development of his verbal communication and interests in other physical objects. Motor skills have also developed - how a child learns to ride. Therapy with the help of a horse offers a safe, secure environment in which the therapist or other staff will be able to be close to the new skills that they will learn.

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All Ridersup http://www.allridersup.org

All Star Equestrian Fundation http://www.allstarfoundation.org

Alen’s Place Terapeutic Riding Centar http://www.allensplace.org

Amazing Wings Therapeutic Riding Centar http://www.amazingwingsinc.com/

American Terapeutic Riding Centar http://www.atrcok.org/

Angels on Horseback http://www.angelsonhorseback.org

Animal Assisted Therapy Services http://www.animalassistedtherapyservices.org/

The Appalachian Foothills Terapeutic Equaestrian Centar http://www.aftec.us

Appalachian Terapeutic Riding Centar http://www.atrcriding.com

ARISE at theFarmhttp://ariseatthefarm.org/

ASPIRE TherapeuticRiding Program http://www.aspiretrp.org/

Astridewith Pride http://www.astridewithpride.org/itd

(http://www.avtizem.org/Kaj je avtizem.html

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# *Physical Education*

# IMPACT OF ENGAGING IN SPORT ON DIFFERENCES IN MOTOR SKILLS OF MALE ADOLESCENTS

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## SUMMARY

When speaking about the program contents realization, it has been noticed that according to the number of classes in the curriculum there is inadequate representation of teaching of physical education in schools. Considering that fact, the number of adolescents in the schools who are engaged in some sport or some sports activity is increasing. The determination of differences between the motor skills of male adolescents' athletes and non-athletes was the main goal of this research. For the purpose of measuring the 8 parameters of basic motor skills from the battery of EUROFIT tests the sample of 65 participants was tested - the first and second grade students of the high school, aged 14.10 - 16.10, divided into two subsamples (30 athletes and 35 non-athletes). In accordance with the results of this research, the significant indicated statistical differences were determined in favor of group of athletes in the following tests: sit ups in 30 seconds (SUP, p=0.047) and 20-meter multistage shuttle run (20mSRT, p=0.002). Derived conclusion is that the identified differences exist due to a fact that group of male adolescents-athletes were in the training process.

**Keywords:** athletes, non-athletes, Physical Education, sport activity

## INTRODUCTION

One of the main components in constant learning and quality education throughout life is the physical education. There are numerous negative consequences of neglecting the physical education caused by the decrease in the quality of education, which are mainly affecting healthy status in the future as well as the overall public health. In order to perform various physical activities students are provided the necessary skills, knowledge and understanding through physical education, physical shape maintaining, physical activity evaluation as a segment of an active life-style, together with enjoying in physical activities (Hardman, 2007).

The effects of physical activity (sports disciplines and branches involved in the teaching of physical education) are directly connected to the male adolescents and the level of motor skills. There are appropriate methods and the organizational methods of work which teachers are using for developing the physical education planning, together with an insight in the level of students' motor skills, and the selection of adequate physical exercises based on which goals are set and tasks of physical education are realized. This is very useful for homogenization of groups in the training process, selection of coaches for the sports branches and determination of the position in the team.

In this age group, the motor skills of adolescents represent the result of principles of growth and development, their adaptation to the type and intensity of physical exercise and the interconnection among the genetic factors. There is specific delicate period for each of the motor skills in which the greatest advance in development is achieved. An important source of variability in shape, functions and capabilities of the human body could be noticed through the individual differences in dynamic of growth. Taking into consideration the requirements that physical activity sets to a body, there is a turbulent and complex phenomenon of growth and development as a regular process in which we can define a series of laws in which the level of individual development shows a special interest, as indicated by Misigoj-Duraković (2008). Nowadays, when we are in the era of computers, cell-phones and cars, it is obvious that the interest of adolescents in physical activity and sports involvement in everyday life is significantly decreased (Ministry of Education, Science and Technological Development of the Republic of Serbia, 2008). Adolescence period among boys, according to Rowland (1999, 2005), is recognized as a risk factor for physical inactivity. Derived conclusion of the above mentioned is that this represents a threat to the normal development of locomotor system and motor skills.

An interest in the involvement of children and adolescents in sport activities has been increased in recent years, considering the fact that the growing up process, according to some researchers, is especially sensitive to the possibility of negative effects expressing (Aoron *et al.*, 1995; Drabik, 1996; Marcus *et al.*, 2000). According to the group of authors (Nesic, Lolic, Srdic and Meholjic-Fetahovic, 2011) the significance of inclusion of the adolescents in sports and sports-recreational activities relies on creating a versatile personality of each individual, the development and spreading the sports values; fostering the friendship, cooperation, fair play, pertinacity, individuality; development of an appropriate competitive spirit, etc.

The high level of functional, motor and range of non-listed abilities of an athlete is one of the most important factors of success in most sports, combined with athlete's good physical preparation and the corresponding training process. In order to achieve a good sport performance, it is necessary to have a good physical preparation, which includes working on improvement of the essential motor skills (Mitrovic & Djuraskovic, 2013).

To some extent, the expression of one characteristic is caused by development level of other characteristics (so-called versatility), and, as Zaciorski (1995) explains, encouraging the development of particular antropomotoric characteristics shouldn't be isolated from development of other characteristics. During the adolescence period it is very important, as Djuraskovic (2009) emphasizes, that versatility is applied in terms of several sports branches, serving as a supplement to the narrow specialization and avoiding the training process monotony. Considering the fact that there is a possibility of successful learning of the elements of sports techniques and puberty renewal in early adolescence period, it is necessary to intensify work on effectively learning the elements of sports technique by adolescents. It is firstly necessary to start with a systematic training in those disciplines where the speed, flexibility and agility dominate, and then continue with endurance and strength. For the purpose of harmonious development, it is necessary, in practice, to adopt a rule that as earlier it is started with a specialization in sport, the more time must be devoted to additional exercises and training. The case with the adolescents who are not engaged in sports and whose physical activity is limited only to regular teaching of physical education, is that due to insufficient number of classes for the greater motor development and shape gaining, the less probably will be their reaching a high level of motor skills. As indicated in researches of numerous authors (Batricevic, 2008; Bolanca, Cavala, & Rogulj, 2010; Bajric, Bajric, & Jovanovic, 2011; Oxyzoglou & Oxyzoglou, 2011) during the period of adolescence, it can be noticed a huge difference in particular motor skills between the ones who participate in sports, compared to those who do not.

The main goal and the issue in this research actually were to examine whether there are significant and huge differences in motor skills of male adolescents who are engaged and participate in sports and the not involving ones.

# METHODS

## Subjects

Sixty-five participants, male adolescents - pupils of first and second grade of high school, aged from 14.10 to 16.10 years were the sample of this research, all coming from smaller municipality belonging to inner part of the Republic of Serbia, divided in two subsamples, i.e.: 30 athletes (aged 15.55 ± 0.56 years, body weight 70.01 ± 12.46 kg, body height 177.75 ± 6,74 cm and body mass index value BMI 22.07 ± 3.27 kg•m$^{-2}$) and 35 non-athletes (average age 15.54 ± 0.56 years, body weight 65.98 ± 10.96 kg, body height 178.27 ± 7.02 cm and BMI 20.70 ± 2.82 kg•m$^{-2}$). The following formula was used in order to calculate the value of body mass index (BMI), as the measure of participants' nourishment, in accordance with the World Health Organization (1997):

$$\textbf{\textit{BMI}}\ (kg \bullet m^{-2}) = BW\ (kg)\ /\ BH^2\ (m^2),$$

where BW stands for body weight and BH stands for body height.

## Procedure

Measurings and testings were carried out in the morning hours. The instruments were of a standard type, with testing of their precision before each measurement. The premise in which the measurings were executed, as well as a sports hall in which the tests were carried out during a regular physical education classes, were sufficiently spacious, well-lit, with a temperature of 18 to 22 Cº. The results of the variables measurings were read when the respondents were ending up certain tests. Persons who were entering the results prior to enrollment, repeated the measured values said by the measurers. Certain variables were always measured by the same measurers.

The first group's members, regardless of their regular teaching of physical education, were engaged in sports, while the members of the second group weren't engaged in any sport. In accordance with the curriculum determined by the Ministry of Education, Science and Technological Development of the Republic of Serbia, this group was only involved in regular classes of physical education two times a week.

Classification according to sports (Table 1) - the group of athletes who are engaged in sports for about 19 months.

**Table 1**. Structure of engaging in sports - subsample of athletes

| FOOTBALL | BASKETBALL | WEIGHT LIFTING | HANDBALL | KARATE | VOLLEYBALL | SWIMMING | TOTAL |
|---|---|---|---|---|---|---|---|
| 10 | 7 | 5 | 3 | 3 | 1 | 1 | 30 |

Out of the total number of 30 adolescents-athletes, 10 adolescents are engaged in football, 7 adolescents basketball, 5 adolescents weight lifting, while handball and karate were practiced by 3 adolescents, and one adolescent per volleyball and swimming. The main condition for these adolescents to be in the group of athletes was that at least three times a week they practice and compete in their age group of selected sports.

Motor skills were tested using the EUROFIT battery motor tests (Council of Europe, Committee for the Development of Sport, 1988; Eurofit, 1993; Kukolj *et al.*, 1993), by applying the following tests:

- "Flamingo" balance test (measures the balance maintaining ability) - BAL (***s***),
- Plate tapping (measures hand coordination and segmentary speed) - PLT (***s***),
- Sit and reach (measures the hip joints and the spine mobility) - SAR (***cm***),
- Standing broad jump (measures the explosive strength of legs) - SBJ (***cm***),
- Sit ups in 30 seconds (measures repetitive and explosive strength of abdominal muscles) - SUP (***the number of repetitions - reps***),
- Bent arm hang (measures static strength of shoulders and arms) - BAH (***s***),
- Pin running 10x5 meters (measures the speed - agility) - 10x5m (***s***),
- 20-meter multistage shuttle run (measures aerobic-anaerobic endurance) - 20mSRT (***ml/kg/min*** - according to Sudarov, 2007).

## Statistical analysis

In order to analyze the obtained data, the statistical software SPSS Statistics for Windows, Version 20.0 (IBM Corp. Released, 2011) was used. The descriptive statistical parameters were included in used statistical procedures for data processing, while T-test for independent samples was used for determination of statistically significant differences between the subsamples.

# RESULTS

The results of descriptive statistics of male adolescents' motor skills for athletes and non-athletes are shown on the basis of obtained data (Table 2).

Adolescents athletes, as shown in the table above, have higher numerical values of arithmetic mean at six parameters (BAL, PLT, SBJ, SUP, 10x5m, 20mSRT) while the values are higher of adolescents non-athletes for two parameters (SAR, BAH) for assessment of motor space. In three parameters (BAL, BAH, 10x5m) the group of non-athletes have better maximum values (Max.) as well as one better minimum value (Min.) in one parameter (10x5m).

The conclusion after examining descriptive parameters is that both groups of tested adolescents were homogeneous, as suggested by the coefficient of variation (cV %). In the ability of maintaining the balance (BAL - 72.07%) the homogeneity of the results in the group of athletes is the least presented together with the static strength of arms and shoulders (BAH - 57.07%), where as for the group of non-athletes, it is presented in the static strength of arms and shoulders (BAH - 58.26%) and the ability of maintaining the balance (BAL - 93.93%).

The T-test for independent samples (Table 3) was used for examining the differences in motor skills between adolescents athletes and non-athletes. After analyzing the obtained results of T-test for independent samples, in the following tests the significant differences were noticed between the subsamples: at the significance level p<0.05, in sit ups in 30 seconds test - SUP (p=0.047); and at the level of p<0.01, and 20-meter multistage shuttle run - 20mSRT (p=0.002). On the contrary, in the following tests there were not found the significant differences between athletes and non-athletes: „Flamingo“ balance test - BAL (p=0.446), plate tapping - PLT (p=0.133), sit and reach SAR (p=0.931), standing broad jump - SBJ (p=0.328), bent arm hang BAH (p=0.698) and in the pin running 10x5 meters 10x5m (p=0.147).

Table 2. The results of descriptive statistics of motor skills for both subsamples of male adolescents

| Parameters | *Mean* | | *SD* | | *cV %* | | *Min.* | | *Max.* | |
|---|---|---|---|---|---|---|---|---|---|---|
| | *athletes* | *non-ath.* | *athletes* | *non-ath.* | *athletes* | *non-ath.* | *athletes* | *non-ath.* | *athletes* | *non-ath.* |
| *BAL (s)* | 5.98 | 5.11 | 4.31 | 4.80 | 72.07 | 93.93 | 2.00 | 1.96 | 24.30 | 30.75 |
| *PLT (s)* | 10.98 | 11.49 | 1.48 | 1.18 | 13.48 | 10.27 | 14.18 | 15.00 | 8.78 | 9.87 |
| *SAR (cm)* | 33.75 | 33.91 | 7.10 | 7.94 | 21.04 | 23.41 | 16.00 | 9.00 | 46.00 | 44.00 |
| *SBJ (cm)* | 204.30 | 198.57 | 25.30 | 21.61 | 12.38 | 10.88 | 155.00 | 155.00 | 260.00 | 250.00 |
| *SUP (reps)* | 26.80 | 24.29 | 5.57 | 4.44 | 20.78 | 18.28 | 16.00 | 18.00 | 39.00 | 36.00 |
| *BAH (s)* | 42.95 | 45.43 | 24.51 | 26.47 | 57.07 | 58.26 | 8.20 | 7.13 | 110.00 | 120.00 |
| *10x5m (s)* | 19.50 | 20.01 | 1.51 | 1.28 | 7.74 | 6.40 | 23.64 | 23.03 | 17.73 | 17.08 |
| *20mSRT (ml/kg/min)* | 45.50 | 40.56 | 5.14 | 5.79 | 11.30 | 14.27 | 35.62 | 30.53 | 57.29 | 54.99 |

Legend: *Mean* - Arithmetic mean; *SD* - Standard deviation; *cV%* - coefficient of variation; *Min.* - Minimum value; *Max.* - Maximum value; *athletes* - adolescents athletes; *non-ath.* - adolescents non-athletes;

Table 3. Significance of differences in motor skills of adolescents athletes and non-athletes (T-test for independent samples)

| Parameters | Mean - A | Mean - N | t | df | p |
|---|---|---|---|---|---|
| BAL-A *vs.* BAL-N | 5.98 | 5.11 | 0.766 | 63 | 0.446 |
| PLT-A *vs.* PLT-N | 10.98 | 11.49 | -1.523 | 63 | 0.133 |
| SAR-A *vs.* SAR-N | 33.75 | 33.91 | -0.087 | 63 | 0.931 |
| SBJ-A vs. SBJ-N | 204.30 | 198.57 | 0.985 | 63 | 0.328 |
| SUP-A vs. SUP-N | 26.80 | 24.29 | 2.026 | 63 | **0.047*** |
| BAH-A vs. BAH-N | 42.95 | 45.43 | -0.390 | 63 | 0.698 |
| 10x5m-A vs. 10x5m-N | 19.50 | 20.01 | -1.467 | 63 | 0.147 |
| 20mSRT-A vs. 20mSRT-N | 45.50 | 40.56 | 3.613 | 63 | **0.001**** |

Legend: Mean - A (Arithmetic mean of athletes), Mean - N (Arithmetic mean of non-athletes), t - value of T-test, df - number of freedom degree, p - significant level. * - p<0.05, **p<0.01

# DISCUSSION

After reviewing the descriptive parameters (Table 2), the derived conclusion is that the adolescents athletes had higher numerical values of arithmetic mean for six parameters for assessing the motor space (BAL, PLT, SBJ, SUP, 10x5m, 20mSRT) while the adolescents non-athletes had it for two parameters (SAR, BAH). The regular teaching of physical education, as presumption, was not the only influence to the above result but there was also an active engagement in sport more than three times a week, because according to some authors (Rowland, 1990; Beedie, Terry, & Lane, 2000) there is no anthropological function such as morphological characteristics, psychological characteristics, social characteristics, cognitive, motor and functional abilities or the health characteristics to which the movement or some form of physical activity does not achieve a significant positive impact.

As suggested by the values of coefficient of variation (Peric, 1996; Hair, Anderson, Tatham, & Black, 1998), the derived conclusion is that both subsamples of tested adolescents were homogeneous. In both subsamples, the homogeneity of the results is presented the least in the ability of balance maintaining - BAL (Athletes - 72.07% *vs.* Non-athletes - 93.93%) and in the static strength of shoulders and arms - BAH (Athletes - 57.07% *vs.* Non-athletes - 58.26%). Besides putting the less emphasis to the exercises for improvement of balance during practice, some of the reasons of non-homogeneity of the results in the tests of balance maintaining ability (BAL) for both subsamples of adolescents could be: different physical predispositions, different level of exercises during teaching of physical education in the previous period, period of increased sensitivity of development - puberty, when speaking about distortion of coordination, which could have negative impact on results (Djuraskovic, 2009; Suzovic & Porcic, 2012). The possible causes of non-homogeneity of the results in the test of bent arm hang (BAH) for both subsamples of adolescents could be found in: less attention given to strength exercises for the shoulders during practice, different physical predispositions, diversity of the organized engagement in sports (football, basketball, weight lifting, handball, karate, volleyball, swimming), period of increased sensitivity of development - puberty, volume and intensity of the current physical activity, and according to some researches (Biddle & Armstrong, 1992; Markovic, 2009) the main factor in this test, the factor of motivation. As for the subsample of non-athletes according to Martinez-Gonzalez *et al.* (2001), it is the result of hypokinesia due to reduced physical activity in leisure time or the diversity of physical activities that are individually engaged. Possible reasons are also the volume and intensity of the current physical activity, as well as according to Loucaides, Chedzoy, & Bennett (2004) a lack of will in the moment - motivation, which varies for each of the adolescents non-athletes, resulting in reduced range of motion due to insufficient physical activity of the group of non-athletes (Popovic, 2004; Suzovic & Porcic, 2012). The similarity motor space of adolescents is indicated in the obtained results with the results of other authors' researches (Markovic, 2009; Zeljkovic & Zeljkovic, 2009), as well as with the results of motor space of athletes and non-athletes research (Popovic, 2004; Petrovic, 2010; Djuric, 2014).

As shown in the analysis of the results of T-test, there aren't significant differences between the subsamples in six out of eight parameters of motor skills, while significant differences at level of $p<0.05$ (SUP) and level of $p<0.01$ (20mSRT) have been shown in the results of two motoric tests (sit ups in 30 seconds - SUP and 20-meter multistage shuttle run - 20mSRT). The statistical importance of repetitive and explosive strength of abdominal muscles was being indicated in the results, as well as aerobic-anaerobic endurance on success in sports in which the group of athletes is engaged. At the same time, the following tests haven't shown significant differences in motor abilities: segmentary speed and hand coordination (plate tapping - PLT), balance („Flamingo" balance test - BAL), static strength of arms and shoulders (bent arm hang - BAH), flexibility (sit and reach - SAR), explosive strength of legs (standing broad jump - SBJ), and speed - agility (pin running 10x5 meters - 10x5m). It can be noticed that, in favor of the group of athletes, there are some of the causes of significant differences only in two out of eight tests of motor space, and those are primarily: the intensity of the training, the optimum dosage of certain segments of the training, the training program and the length of their engagement in the chosen sport, characteristics of smaller municipalities in the inner parts of the Republic of Serbia, which affect the way of life of adolescents, as well as climate changes and conditions (Prskalo, Kraljevic, & Kovacic, 2011; Gadzic & Vuckovic, 2012).

The T-test results have determined the significant differences in motor skills between athletes and non-athletes which are very similar to the research of Simonovic et al. (2011) where in comparison to the motor skills of athletes (karatists) and non-athletes there are significant differences shown in the test of repetitive and explosive strength - sit and reach (0.000) in relation to 0.047 obtained in the present research. Compared to Batricevic's (2008) research of motor skills of sports active and inactive students, age 14 and 15 ± 6 months, the T-test analysis in the present research has also shown significant differences in tests of strength and endurance, while there are no significant differences determined in the test of coordination.

The results of the subjected survey coincide with the results of the differences research in motor skills of judo athletes and untrained students, aged 16 - 17 years (Djuric, 2014), where, for the variable sit ups in 30 seconds - SUP, the students athletes (judo athletes) have better results compared to students non-athletes, on a statistically significant level ($p = 0.014$). The results of the group of authors research (Mazic, Zivotic-Vanovic, Igracki, Zivanic and Velkovski, 2001) realized with 76 participants of the average aged 16.6 ± 0.3, divided into two groups of 38 athletes and 38 non-athletes, where the relative values of oxygen uptake ($VO_{2rel}$ Athletes - 46.58 ml/kg/min; $VO_{2rel}$ Non Athletes - 37.63 ml/kg/min) similar with our research, and T-test, where there were statistically significant differences determined also in favor of a group of athletes on a statistically significant level of 0.001.

# CONCLUSION

Higher level of motor skills determined for male adolescents athletes, is directly the result of their intensified motor engagement and greater volume of physical activities - playing sports 3 or more times a week, and regular teaching of physical education - 2 times a week, in comparison to the subsample of non-athletes attending only regular teaching of physical education in the school (2 classes a week). The overall conclusion of this research is that, compared to the subsample of non-athletes, there are statistically significant differences determined in favor of motor skills of the subsample of adolescents engaged in sport. Following the obtained results of the subjected research, it could be pointed out that the development of students' motor skills is of a higher quality if applied under the influence of systematic sport training in comparison to motor skills development at students who only attend teaching of physical education in school (Loko *et al.*, 2003; Kopas, Obadov, & Drid, 2008). Obtained results are the stimulus for initiation and persistence in nurturing the school sport sections and sport societies in as greater number of schools as possible.

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# EXTRA CURRICULAR SPORT ACTIVITIES AND THEIR IMPACT ON THE ASSESS OF PERSONAL COMPETENCE. CASE STUDY IN THE GROUP OF CHILDREN, DEPRIVED OF PARENTAL CARES

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## SUMMARY

The research aim is to assess how the extracurricular sport activities work on the competence self-assessment made by children, deprived of parents'cares. 152 institutionalized children are inquired. They are at the age of 8 up to14, divided into 3 age groups, of both sexes, classified as *engaged in sport activities* and *non-engaged in sport activities*. The method applied is based on Harter's Personal Competence Assessment Inquiry (S. Harter, 1982, adapted by N. S. Chernishev, 1997). The results, achieved on the base of the data analysis of the competence self-estimation of the children from the homes for children, deprived of parental cares, demonstrate that inclusion in such extracurricular sport activities helps them to improve their communicative skills in the peers'group and to develop their physical abilities and the general spirits as well, but practically it does not significantly influence over their knowledge competence.

**Keywords**: children deprived of parental care, sport, extracurricular sport activities, self-assessment, self-confidence.

## INTRODUCTION

At the age between the 7$^{th}$ and the 14$^{th}$ year after the birth the child begins to set up his/her sense of identity. This time period is the so-called *middle childhood* or *middle early life*. The child is making his/her first steps towards maturity, s/he begins to mould the own character as independent, i.e. self-dependent, and self-aware personality, develops his/her self-respect and individuality basically through a comparison with the peers in the peer group. Social relations and roles change vigorously: the child goes out of the family circle and get into an environment where for the first time should make independent, self-reliant, single-handed decisions: goes to school, communicates with peers and elder people who are out of his/ her big family relations; everyday out of home situations generate the need to be self-dependent. The socialization in the bigger community starts. And if these changes are not adapted to their new necessities (in school, at home or in the institution), children may lose self-confidence and self-trust, and to give way to negative behavioral models such as idleness, dropout of school, aggressive behavior, etc.

Self-assessment plays a key role in the process of the global self-realization of the young individuality (Stolin, V., 1983; Pantileev, S., 1991). The Self-image or Self-concept assigns to the perceptions each particular person creates about his/her own physical and intellectual skills, specifically essential and other features (Berndt, T., 1997; Harter, S., 1985).

Motor development in the childhood is closely related to the setting up of the so-called *personality nuclear*: *Self-sentiment, Self-image and Self-system* (Berns, P., 1986). In early life this process is under the influence of **two basic factors**: what the estimation of the elders is and what the child own activities are. (Bojovič, L., 1997). According to some researchers (Harter, S., 1993) child Self-respect, as a whole, is determined by the extent to which the child feels his/herself to manifest own competence in spheres of social interactions that are specifically important for him/her.

Many studies give a proof that the physical activity improves and facilitates socialization process (Vilhjaimsson, R. & G. Kristjansdottir, 2003; Moore, L. et al., 1991; Sallis, J. et al., 1998) and is positively associated with a higher degree of self-assessment, self-confidence and self-awareness (Iannotti, R. et al., Group HPAF, 2009), while the diminished physical activity increases the symptoms of depression, anxiety and shyness (Brodersen N. et al. 2005; Steptoe A. & N. Butlen, 1996).

Participation in sport activities is related to such positive results as improvement of peer group relations, increase of self-confidence and decrease of anxiety (Kirkcaldy B. et al., 2002; Marsh H., 1998; Smith A., 2003).

More than 1800 Bulgarian children live in the institutions for children, deprived of parental cares. There they find shelter, food, clothing and everyday cares. However, these children are deprived of family environment that stimulates their physical activity. The access of such children to the sport facilities is considerably limited. In addition, their habitual physical activity is significantly worse in comparison with the habitual physical activity of their peers, coming from normal family environment, because of the nature of the living conditions in such institutions.

The Bulgarian researcher Savova, T. (2006) published one of the few research papers about the state and development of the need and motivation sphere of the grow-ups, aged 11-15, living in institutions for children, deprived of parental cares, and compared the data with the position of their peers, brought up in normal family surroundings in Bulgaria. In this country there is not a research conducted about the impact of the extracurricular sport activity on the institutionalized child personal competence self-assessment.

## RESEARCH

The goal of the present study is to estimate how the extracurricular sport activities exert influence on the self-estimation in respect to the own competence of a child, being member of the specific group of children, deprived of parental cares.

## METHODS

### Subjects

We studied 152 children who live in 8 Bulgarian institutions for children, deprived of parental cares, of both sexes - 90 boys and 62 girls. They were at the age between 8 and 14, divided into three age subcategories – a/ 8 to10 olds; b/ 11 to 12 olds; and c/ 13 to 14 olds. As for the variable „sport as additional activity", we divided the children into two groups – a/ engaged in sports; and b/ non-engaged in any sport.

Most experts (Harter S., 1985; Marsh H. & P. Gouvernet , 1989) share the idea that the children, above the age of 8, may already differentiate their own personal skills in various fields. There are some analysts who state that even younger than this age may do so if the inquiry questionnaires are formulated in a way appropriate for their cognitive skills ( Marsh H. et al., 1998). This was our argument to use Harter's Personal Competence Assessment Inquiry method (S. Harter, 1982, adapted by N.S. Chernishev, 1997) for the aims of this specific research.

Harter's Scale (Harter S.1982) provides a possibility to determine how the growing up person evaluates his/her individual competencies in life spheres that are of highest personal priority. These competencies are grouped in three main areas: **cognitive** (school activities), **social** (peer communication skills) and **physical** (extracurricular activities and sportive skills). In addition, Harter's Scale includes a specific scale that evaluates the total **self-perception** (i.e. global self-assessment), independently from the registered abilities and skills. At the same time, Harter's Scale does not affect the parent-child relationship and so, it opens the door to use it in orphanage case studies.

### Procedure

The inquiry is individual: the interviewer read the statement to the child and asks which of the given answers is closest to his/her mental image; then they precise whether this answer is the only correct – ***Always***; or correct only in some cases – ***Sometimes***; finally both should check up the figure. The data are processed in four subscale technique and each subscale consists of seven statements, totally – 28 pairs. Half of these statements presuppose high level of competence and the other half – low level of competence. It should be settled whether the answer is true in every situation or just in any: if the option "***Always***" is chosen, the mark for the extreme *maximum bad, unsuccessful*, is 1, and the mark for the extreme *maximum friendly, favorable*, is 4; if the child's choice is option "***Sometimes***" in case of *bad, unsuccessful* the mark is 2, in case of *friendly, successful* the mark is 3. In each scale the evaluation gradation of the child's self-assessment is as follows: a/ from 7 to 10 – low; b/ from 11 to 14 – average low; c/ from 15 to 19 – average; d/ from 20 to 23 – average high; e/ from 24 to 28 – high.

### Statistical analysis

For statistical analysis of study results was used analysis of variance. The comparison between the groups was performed by t-test for independent samples at α<0,05.

## RESULTS AND DISCUSSION

The first assessment subscale concerns the child **cognitive competence**: school activity and knowledge mastering; the degree of fleetness to get good marks at school; the ingenuity needed to get a correct answer and the speed, swiftness to assimilate the read-out. The submitted below results clearly manifest that the institutionalized children feel uncertain in their cognitive skills and as such they rate them at a lower rank (Fig. 1). Growing older, as expected, the institutionalized children increase their cognitive competence. This is what we have watched attentively during the observation process. The differences between both sexes in all three age subcategories are in favor of the girls; however, they are not substantial. .

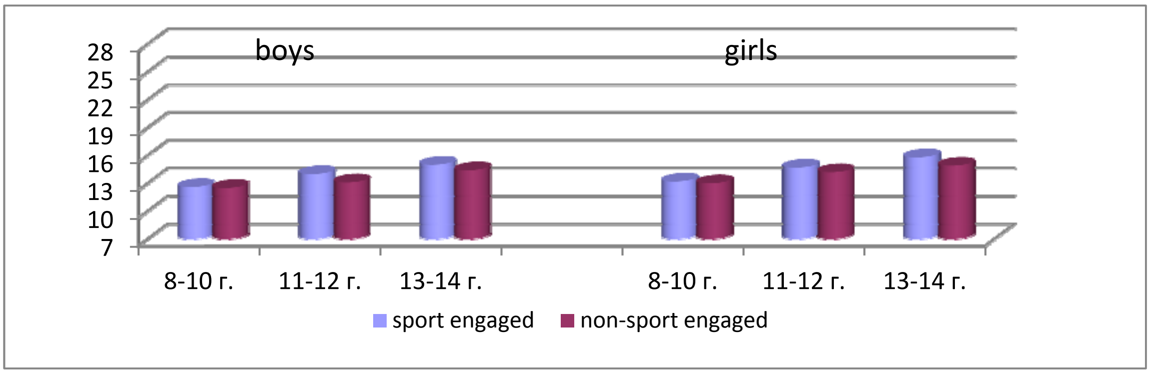
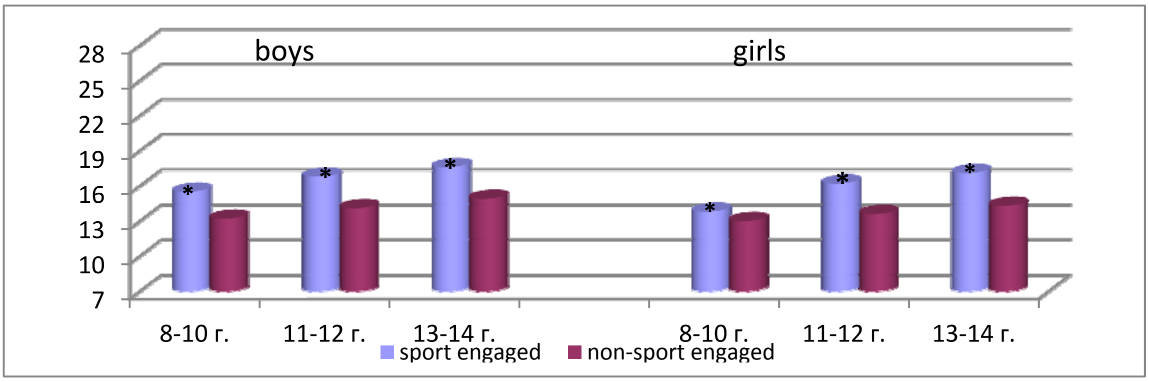



**Fig. 1** Child self-evaluations of the personal competences in the group of institutionalized children, measured by Harter's Scale (Harter S. 1982) –Cognitive Competence Subscale

The second subscale evaluates **communication skills** studying the peer group relationship and the degree to which they are successful, as well the amount of friends, personal popularity within the peer circles, the ability to be liked by those around you. As obvious from Figure 2, the sport engaged children of both sexes manifest higher results – in all age subcategories the self-assessment is at average level and going up to average-high, while in the group of non-sport engaged children it is in the limits of average-low level.

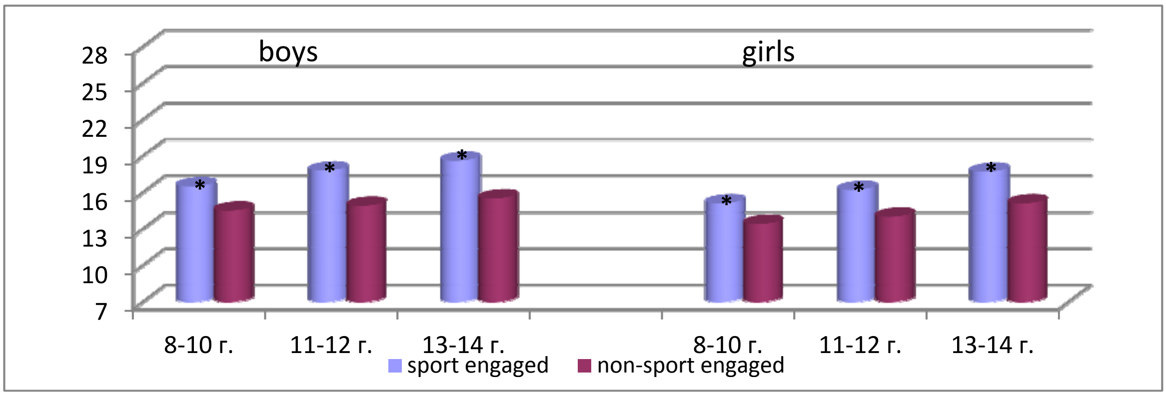
Once again we are facing the trend to enhance the competence while growing up which is more clearly articulated among the sport-engaged boys; the self-assessment in the group of the girls is lower and this tendency does not change among the age groups in comparison to the target group of the boys.

The third self-assessment subscale notifies the **competence in the extracurricular activities**, mainly in games and in sport activities (Fig. 3).




** Availability of statistically considerable margin among the groups at α<0,05*

**Fig. 2.** Study of child self-assessment of personal competence in the group of institutionalized children, measured by Harter's Scale (Harter S. 1982) –Peer Communication Competence Subscale

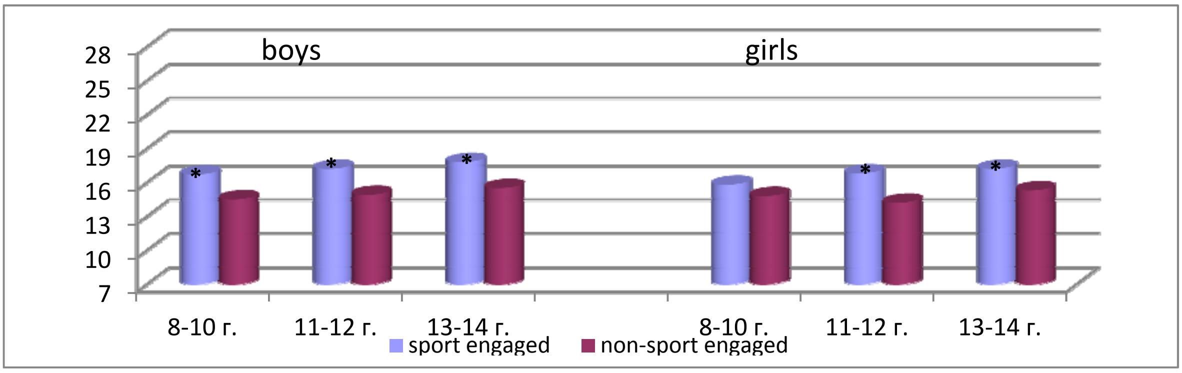



* *Availability of statistically considerable margin among the groups at α<0,05*

**Fig. 3.** Child self-assessment of personal competence in the group of institutionalized children, measured by Harter's Scale (Harter S. 1982) – Extracurricular Activities Competence Subscale

As obvious by the above table, the institutionalized children, involved in extracurricular sport activities, are more positive in their extracurricular skills than their peers who are non-sport engaged. As the age grows up and in the boys group, compared to the girls', we register a slight tendency of increasing the extracurricular competence.

The fourth subscale estimates the children's **total self-perception (global self-assessment);** this evaluation is independent from the other estimations (Fig. 4 ).




* *Availability of statistically considerable margin among the groups at α<0,05*

**Figure4.** Child self-assessment of personal competence in the group of institutionalized children, measured by Harter's Scale (Harter S. 1982) –Global evaluation Subscale

As obvious from the table in both cases – sport-engaged and non-sport engaged institutionalized children, the global self-assessment continues to be relatively stable in all the three age subcategories. Another evaluation specificity of the perception of the Self as totality is the lack of significant intersexual distinctions and differences. However, the children, practicing sport, manifest significantly higher levels of self-confidence and spirits and this could be traced in the three age subcategories among both sex groups. Their self-assessments are at an average level in the interval from15,8 to 17,8. In the peer group of non-sport engaged these results are at the level of average to low and getting to the average levels in the upper age groups. This indicates that participation in any kind of sport activity makes children more self-confident and has an effect on their total self-perception and global self-assessment. Perhaps, the improved social interaction and reciprocal action and higher physical skills of the sport engaged children are foundation of their higher global self-assessment, independently from the fact that they esteem their cognitive competence relatively lower.

## CONCLUSIONS

The data analysis of competence self-assessment of institutionalized children show that participation in extracurricular forms of sport activities helps to improve peer communication skills through such actions, as well as physical capacity and the global personal self-confidence. However, it does not have any significant impact over their cognitive competence.

The Inquiry outcomes indicate that the sport-engaged boys and girls from the institutions are enjoying higher popularity within the peer and friend groups, they know how to behave in order to get more likes around themselves. They are more inquisitive when choosing the playing game, more reactive and inclusively faster. The sport practiced in the free of school curriculum time enhances their self-confidence and spirits and their willingness not to imitate and resemble the others, but to be innovative and unique.

Carefully elaborated competencies give chance to the children successfully to develop interpersonal communication, help them to strengthen their ability for decision making process and, finally, to come to adequate decisions.

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# MATERIAL SPACIOUS CONDITIONS OF PRESCHOOLS AND PRIMARY SCHOOLS FOR THE REALISATION OF PHYSICAL EDUCATION TEACHING

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## SUMMARY

**Introduction:** All children have the right to have physical education, so that in the curricula of general educational systems, physical education is an obligatory subject in 89,0% of the primary schools in the world. Physical education, as planned and creative activity with the clearly defined goal, starts in the institutional education of the Republic of Serbia with preschool education, and it ends with the end of the education in secondary schools. One of the most demanding periods is the preschool and the younger primary school age. The goal of this work was to explore the contemporary state of the material spacious conditions of the preschool and school buildings for the realization of the physical education programme contents.

**Methods:** For the categorization of the preschool and school buildings the Petrovic et al., (1995) six grade scale was applied. The sample consisted of 40 preschool institutions with 178995 preschoolers and 48 primary schools with 30083 students from Podunavski, Branicevski, Sumadijski, Pomoravski, Raski and Rasinski regions. The instrument was fulfilled by the preschool teachers during the directed motor activities and physical education teachers during the regular physical education lessons.

**Results:** Out of 40 preschools 32 (80%) do not have a big gym, and out of 48 primary schools 27 (56,25%) primary schools do not have the gym with the dimensions of the basketball court. The small gym is more frequent in the preschools (75%) in relation to the primary schools (29,17%). The courts with the dimension of the handball court are more present in the primary schools and they are in 56,25% made of concrete. Free spaces are present in all the preschools and in 65% the ground is grassy. The circular athletic lane is present in a small number of the preschools (15%) and primary schools (16,67%). In the preschools the presence of dressing rooms is very small (15%). In the schools that do not have locker rooms the students use a regular classroom for the changing of clothes before and after the physical education lesson. The rooms for equipment are with 85% more present in the preschools. It is usual that the teacher's office is at the same time the room for the equipment which is not present in 22, 2% of the primary schools.

**Conclusion:** The general ascertainment indicates that the situation in the preschools and the primary schools is almost identical and that it has not been changed in relation to the data from 1995 and 2005. The material spacious conditions apart from the content and the teachers are the most decisive for the realization of physical education.

**Key words:** buildings, physical education, preschools, primary schools

## INTRODUCTION

The origin of the problem of physical education teaching dates back to the first organized physical education systems, and that is, for example, the absence of the organized and planned work in the preschools and the lower grades of the primary school, which represents one of the weakest points of the complex process of school physical education and upbringing (Konstatinovic, 1981, 131). The inefficiency of physical education is primarily represented by the weak influence on the transformation of the motor ability, because of the small density of exercising, that is, short active time of exercising (Markovic and Ignjatovic, 2015).

The basic conditions for the successful realization of the programme contents of physical education lessons are good teaching stuff, spacious conditions and equipment (Brajkovic, 1998, 45). The knowledge of the preschool teachers and primary school teachers on the present level does not enable the realization of the planned contents when the abilities of the child for the acquiring of new forms of motor movement and versatile development of motor potential are the greatest, when the interests and the attitudes are subject to positive influence. Incompetence and superficiality, especially in this field, if they are more prominent, will negatively reflect in later phases of educational work. The space for the realization of physical education lessons is an equipped space or a surface which has to maximize the satisfaction of the user. In such a space, all hygienic-building conditions should be respected, like: the necessary lights, the heating, the ventilation and the other. Besides, the equipment and the educational tools should fulfill hygienic, pedagogical ad technical demands (Nikolic, 2008).

The physical education lessons are held in very different conditions, and thus with very different results. Teachers are more directed to group sports, while gymnastics and athletics are neglected. Most of the physical education lessons are held in the presence of several classes (Budja, 1996). Material situation of physical education is getting worse year by year. The existing equipment is worn out, broken down or stolen, and for the new ones there is no money (Acovic, 1994, 271).

The incitement of the preschoolers to accept body movement-exercising as a part of their daily routine is the essence of every physical education teacher and each of them should aspire to naturalize each student in physical education, that is (perhaps more important) naturalization of physical education itself, in preschools, in primary schools, in the family, in the broader social community – in the minds in general (Matic, 1992, 131).

Apart from numerous health hygienic conditions which preschool teacher and primary school teacher should take care of the floors for the realization of the planned contents are very important. Beside safety reasons for which the organizer is personally responsible, the different floors influence different results for the evaluation of the speed (Markovic & Visnjic, 2008a,b). By the analysis of the findings about the school buildings for physical education in 90 primary and secondary schools of Severnobacki and Zapadnobacki regions Petrovic et al., (1995), formed six categories of the buildings. The teachers from ten towns in Serbia (67,92%) think that the classification of schools and physical education programmes according to material spacious conditions would have positive effects (Radojevic et al., 1997).

The goal of this work was to look into the contemporary condition of material spacious conditions of the preschools and primary schools for the realization of the physical education contents.

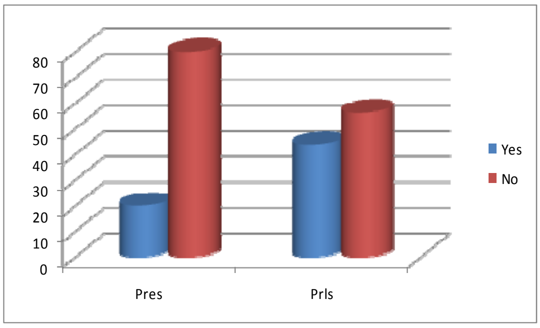
# METHODS

The research had transversal character and it was realized in the second term of 2015/2016 school year. It was realized in 40 preschools, with 17895 preschoolers and 48 primary schools with 30083 pupils. The preschools and the primary schools are in Podunavski, Branicevski, Sumadijski, Pomoravski, raski and Rasinski regions. For the research of material spacious conditions the instrument of Petrovic et al., was applied (1995). The instrument was fulfilled by preschool teachers during directed motor activities and physical education teachers during the regular physical education lessons. In quantitative analysis of the data the percentual research of frequencies was applied.

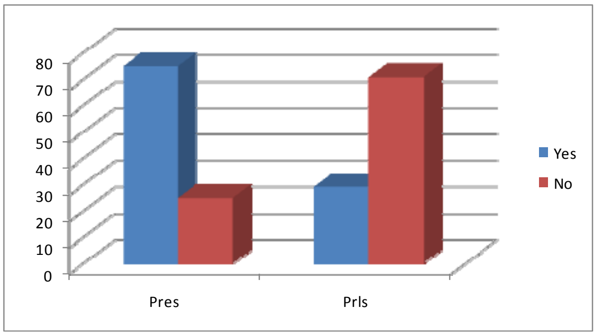
# RESULTS

On the basis of the results it can be stated that out of 40 preschools 8 preschools have the gym with the dimensions of a basketball court (20%), and out of 48 primary schools 21 schools have a big gym (43,75%), which indicates that there is higher frequency of big gyms in primary schools for 23,75%. According to the norms for school gyms minimal surface for the exercising per one student is 12-16$m^2$ (Graph 1).

30 preschools (75%) have small gym or adapted space (minimal dimension 150$m^2$) and 14 primary schools (29,17%), which indicates bigger frequency of small gyms in preschools than in primary schools for 45,83%. The bigger frequency of small gyms in preschools can be partly explained by insufficient number of big gyms, while in primary schools the contemporary situation can be explained by the frequency of village schools with 15% in the sample of primary schools.



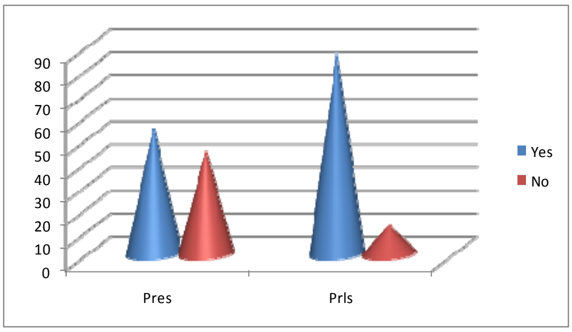

Graph 1. Hall- whose minimal basketball court (min. 450m $^{2}$ )



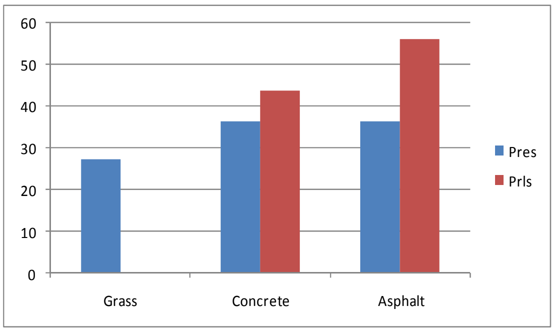

Graph 2. Small hall (min. 150m $^{2}$ ) or adapted spaces with dimensions

***Legend:*** Pres – Preschools, Prls – Primary schools

The fact that 56,25% of primary schools do not have a gym, and more than 60% of the physical education lesson programme is connected with the use of the gym which indicates that physical education programme will not be realized and the students will not be in the situation to learn a great percentage of sport technical knowledge, especially for exercising on gymnastics equipment and on the floor. The gyms are usually neglected because of irregular use and overuse, which leads to the diminishing of their functionality and unhygienic conditions influence badly students' health. The maintenance of the gyms means regular cleaning, washing, disinfection in certain time intervals, checking of the correctness of the space, equipment, tools and timely repair that is, changing of broken parts. For all mentioned in the preschools the teacher is responsible, and in primary schools physical education teachers.



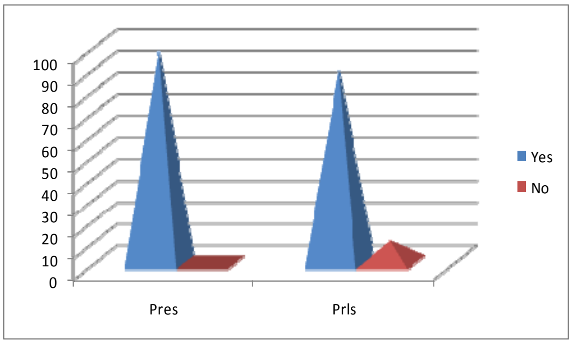

Graph 3. Handball court



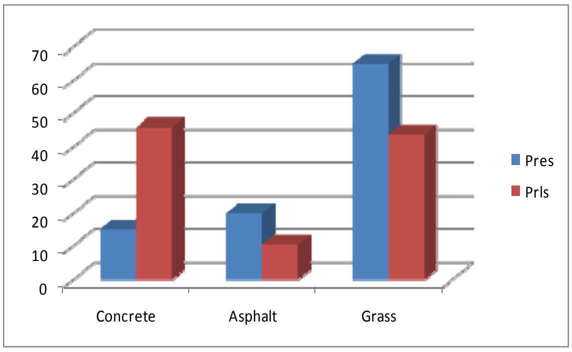

Graph 4. Floors courts

The handball court and pitch court with dimensions 40x20m in preschools are preferable. In primary schools these court dimensions are necessary for the realization of the physical education plan and programme. The big court is present in 55% of preschools and in 87,5% of primary schools (Graph 3).The courts should have at least 15m$^2$ per child and they should be properly equipped with the equipment which suits the children's age. More developed primary schools should have apart from one big court also one grass court for the playing of younger school age pupils, with the dimension 30x15m. Insufficient space and material abilities of preschools and primary schools diminish children's playing which is necessary for them for proper growth and development.

The concrete floor is more frequent on primary school courts (43,75%) in comparison to the courts in preschools (36,36%). The grass floor is only present on preschool courts in 27,27% of the cases. Asphalt floor is present in preschools with 36,36% and 56,25% of primary school courts (Graph 4). The thing that does not make anyone happy is that there is a high percent of concrete floors on primary school courts. The worn concrete floors are frequent cause of injuries during physical education lessons. It is encouraging that a big number of preschools have grass floors, which are good for undisturbed, directed motor activities.

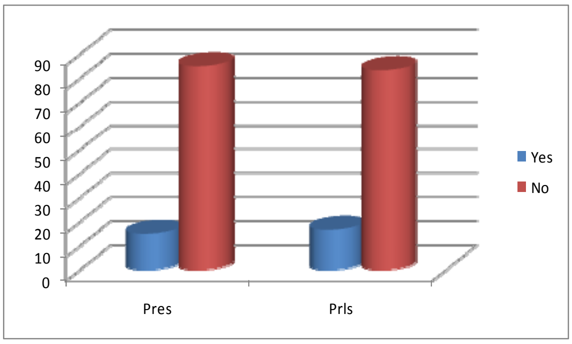



Graph 5. Free space

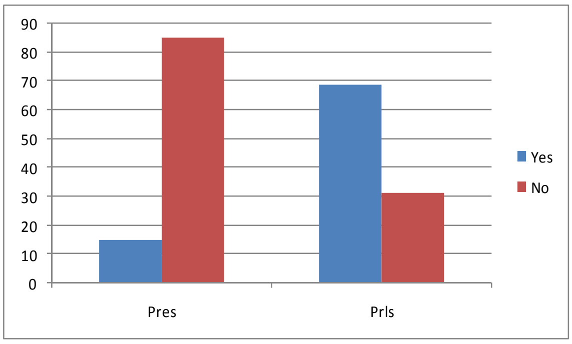



Graph 6. The floors of free space

By looking into Graph 5 we can see that all preschools have free surface and it is in 15% concrete, 30% asphalt and 65% grassy (Graph 6). 89,58% of primary schools have free surface or school yard. Free surface is for 10,42% more frequent in preschools. In primary schools free surface is in 45, 83% of the cases made of concrete, in 43,75% it is grassy and in 10,42% of the cases it is made of asphalt. Free surface or school yard with paths for resting and recreation of the pupils has dimension of $5m^2$ per pupil for complete primary schools, that is $1.000m^2$ for detached classes of primary schools and incomplete primary school from the first to the fourth grade.




Graph 7. Circular 200m lane



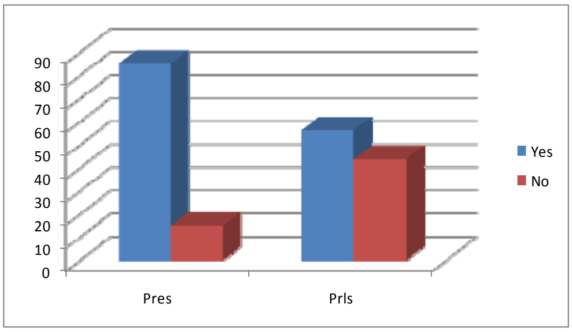

Graph 8. Two dressing rooms

15% of preschools and 16,67% of primary schools have the circular track of 200m or 400m (Graph 7). In cases without circular tracks, by the Book of rules about the norms of school space, equipment and educational facilities, the school should have four athletic tracks with the length of at least 80 metres.

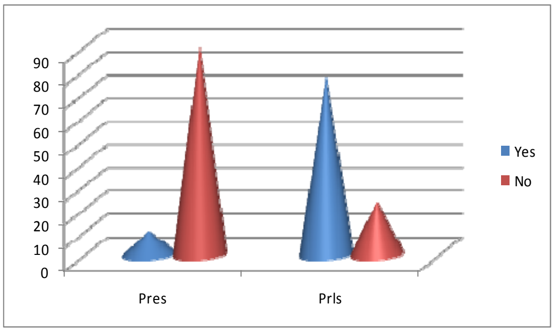
The contents of the directed motor activities are often with natural forms of movement, and elements of athletics are present in the programme of physical education from the first grade of primary school. This situation in preschools will not enable undisturbed planning and realization of the directed motor activities, and in schools planning and processing of athletics lesson units (Graph 7).

By looking into the Graph 8 it can be seen that a very small number of 15% of preschools has two dressing rooms and 68,75% with two dressing rooms. Most of the dressing rooms in primary schools are connected with the big gym. There is a number of schools that have adapted rooms which serve as dressing rooms, so that pupils would not change their clothes in classrooms, while in preschools preschoolers change clothes in their rooms.

In preschools we cannot talk about equipment rooms like school equipment rooms. The programme contents of the directed motor activities do not demand a big number of equipment as physical education teaching. The equipment rooms are not directly connected with the gym. We can see that 85% of preschools and 56,25% of primary schools have the equipment rooms (Graph 9). It is not only the space for gymnastics equipment in schools, but the space for all tools that school possesses for the realization of teaching.




Graph 9. Equipment room




Graph 10. Teacher's office

The minimal space for the equipment room for small gyms is 30m$^2$, and for the big gyms it is 50m$^2$. The material spacious conditions allow that only 10% of preschools have a special room like the teachers cabinet, and in primary schools 77,08% of the teachers have their own cabinet (Graph 10). In numerous schools the teachers within the equipment rooms and other adapted rooms have room for themselves for undisturbed work. The room for the teacher should be 16m$^2$ big with the special space for the wardrobe, shower and toilet.

**Table 1.** Categorization of preschools and primary schools according to material-technical conditions

| Space | Preschools | | Primary schools | |
|---|---|---|---|---|
| | *n* | % | *n* | % |
| I Category | 2 | 5,0 | 1 | 2,08 |
| II Category | 8 | 20,0 | 13 | 27,08 |
| III Category | 12 | 30,0 | 13 | 27,08 |
| IV Category | 15 | 37,5 | 14 | 29,04 |
| V Category | 3 | 7,5 | 6 | 12,50 |
| VI Category | 0 | 0 | 1 | 2,08 |

The data about the material spacious conditions show that the first category is present only in two preschools. The most frequent is the fourth category in 37,5% of the schools, then the third category with 30%, then the second one and the fifth one, and the sixth category were not found in preschools. In primary schools the most frequent is the fourth category with 29,04%, then with the same frequency are the second and the third category with 27,08%. On the fourth place is the fifth category with 12,50%. On the fifth and the sixth place are the first and the sixth category, which were found in one school each.

The first two categories of the buildings enable planning, programming and realization of all physical education contents. In the third category of the buildings certain contents of physical education do not have appropriate material basis. In the fourth category of the buildings material spacious conditions provide only the realization of the reduced contents; in the fifth category of the buildings it is possible to realize very limited programme contents, and in the sixth category the building for physical education does not exist. Eventually there is some kind of adapted building. The realization of the programme contents in such a building is not possible.

# DISCUSSION

By the analysis of the data from 40 preschools and 48 primary schools we got diverse picture about the material spacious conditions for the realization of the physical education programme contents of the directed motor activities and extracurricular activities. It is worrying that 85% of preschools and 56,25% of primary schools do not have the gym with basketball court dimensions. The same situation is on the territory of the city of Belgrade where 47,90% of schools have gyms (Nikolic, 2005). The results in preschools and primary schools of the first and the second category are almost identical to the results of Petrovic et al., (1995), where in the total sample of preschools and primary schools there were 2,2% of schools in the first category, and in this research there were 2,08%. 32,2% belonged to the second category, and in this research 27,08%. The norms are one gym per school with sixteen classes, and for schools with more than sixteen classes the norm is two gyms, i.e. the gym and the smaller room from gymnastics and corrective pedagogical work. There are no smaller gyms in 25% of preschools and 70,83% of primary schools. The schools gyms were built as an annex to the school building, so that they have access from the communication of the school and a special access from outdoors for the eventual use of the people when the school does not work. Some schools make public calls for the collecting of offers for the renting of gyms, in spite of the fact that schools are not allowed to rent gyms without the consent of the Ministry. The Law about the public possession directs schools to transfer to the Ministry all the money from renting the gyms.

The situation is a bit worse with the preschools' outdoor playgrounds, where 45% of them do not have a playground. The asphalt and the concrete floor with 36, 36% are evenly present in preschools, while the asphalt floor with 52,25% is the most frequent floor on the primary schools' playgrounds. Beside planned contents of physical education teaching, the courts are used for the realization of the extracurricular activities, as well as the activities before, after and between the lessons. Boys and girls achieved approximately the best results on the asphalt floor in dash running and running with the change of direction, and on the parquet floor the worst results (Markovic and Visnjic, 2008a,b). The load that the foot arch suffers is dispersed differently depending on the floor (Tessutti et al., 2007). The results of the measurements of the plantar pressure distribution while running on different floors also influence on the economics of running (Kerdok et al., 2002). The thing that encourages is the fact that all preschools, which is not the case with the primary schools, have free surface and it is in most of the cases (65%) grass. In primary schools with the frequency of 45,83% free surface is made of concrete, then grassy with 43,75% and asphalt with 10,42%. A small number of preschools (15%) as well as primary schools (16,67%) are equipped with circular track for running. The circular tracks around the courts with the length of 200m or 400m are necessary for the realization of programme contents of the directed motor activities and contents from athletics present in the physical education programme from the first grade of primary school to the third grade of secondary school.

In preschools the presence of dressing rooms is very small (15%), so that preschoolers before their morning exercising and directed motor activities leave some of their clothes in their rooms. In schools that do not have dressing rooms, the pupils use classrooms for changing clothes before and after physical education lesson. The equipment rooms with 85% are more frequent in preschools. It is usual that the teacher's office is at the same time the equipment room, which is not present in 22,92% of primary schools.

# CONCLUSION

The goal of this work was to look into the contemporary state of the material and spacious conditions of preschools' and primary schools' buildings for the realization of physical education programme contents.By the use of the six grade scale the categorization of 40 preschools and 48 primary schools was made. The results indicate that a big gym is more frequent in primary schools, and a small gym in preschools. The big courts are more frequent in primary schools and the concrete floor is predominant, the free surface is present in all preschools and it is in 65% of the cases grassy. The circular tracks are insufficiently present; the dressing rooms are more frequent in primary schools because of the regular lessons of physical education of older and younger school age children. The situation is different with the equipment rooms, which are present in 85% of preschools. The teacher's office is more frequent in primary schools. The situation is versatile and it can be stated that the situation in schools and preschools is almost identical and that it has not changed in relation to the data since 1995 and 2005. The material spacious conditions apart from the contents and the teachers are decisive for undisturbed realization of programme contents of physical education in preschools and primary schools. It is necessary to invite all interested parties, starting with parents, local governments up to the Ministry of Education, Science and Technological Development, the Ministry of Youth and Sport and the Ministry of Finance.

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# PEDAGOGICAL COGNITION – STATUS AND CHALLENGES

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UDC 37.01

## SUMMARY

The objective of the present development is to follow up the development, state, perspectives and challenges of the pedagogical knowledge in historical aspect. Special attention shall be paid to some tendencies in its development within the conditions of the modern civilization process. It is known that the beginning of the pedagogical knowledge can be traced back in the deepest antiquity. It accompanies the complete phylogenetic and ontogenetic development of men and society.

Pedagogical knowledge is an exceptionally dynamic process. It follows both its own logical perfection and the changes in the development of society. They lay an imprint on both the schooling and education. Society is more and more devoted to men so that to come to the rise by particular strength to the idea about its harmonious development as the main objective of the education; as well as to the appearance of the great philosophical schools of the antiquity which are individuated as centers of scientific thought. More over it is necessary to underline that physical and aesthetic education are paid greatest attention.

One of the most important periods in the development of the pedagogical knowledge is related to the appearance of a new humanistic culture during the epoch of the Renaissance which by great historic accent takes to the front the issue of man and the new attitude towards him. Raised is the idea about an education of more humanistic, more democratic and realistic character.

The new stage in the development of the pedagogical knowledge is related to the so-called reformatory pedagogy. Word goes about a powerful movement, an exceptionally reach variety of schools, directions, theories, conceptions, names, related to the striving towards renewal and perfection of the schooling, teaching and education. That is the reason why special attention shall be paid to the c h a l l e n g e s to the pedagogical science, as theory and practice, reasoned by the deep changes of the society at the beginning of the 21st century as well as their dynamics; important in that direction are the vehement development of the computer technique, the informational technologies, internet and the satellite communications. That takes to the front the necessity of swift mobility and reset of the educational system which has to answer the needs of life. That shall be also one of the important accents of the present report.

**Keywords:** upbringing, teaching, knowledge, humanism

## INTRODUCTION

The beginning of the pedagogical cognition can be traced back to antiquity. It arises together with human society and is an inseparable part of its social and historical development. It is an exceptionally dynamic process which follows both its own logical perfection and the incessant changes occurring in the objective reality.

It is known that at the beginning of human history the pedagogical cognition have been rather primitive; containing information both from the everyday, direct observation and the generalization about the reality as an authoritative knowledge.

Gradually with the development of the society, with the great evolution of literacy, schooling and teaching become a function of the state. That reasons the appearance of the first schools from the time of the Sumerian and Babylon civilization, known as "E.Duba". Pedagogical activity is undertaken by people of sufficient knowledge, wisdom of life and the skill to work with children. More special care is put about the l a b o u r, p h y s i c a l and m o r a l schooling of the growing up young people. The fist examples of "upbringing" and "education" appear, on the base of which the development level of the young people is evaluated as well as their preparation about a wholesome participation in life.

It is a fact that from antiquity yet the great "philosophic" and "cogitative" schools appear – the "Academy" of Plato / 427 – 347 BC /, the "Academy" of Aristotle / 384 –322 BC / and others which become centers of the scientific thought.

The ancient Roman philosophers L.A.Seneca and M.F.Quintilian have as well greatly contributed to the development of the pedagogical science. Affirmed is the thesis that the objective of the upbringing is the benignity and the moral perfection.

With the development of the crafts and trade, with the appearance of the towns, the enlargement of the economic relationship between the countries in Western Europe /12th, 13th century/ the need of a new type of upbringing and education, of a new type of schools appear – for craftsmen and traders. The first Universities arise /during the 12th – 14th century/ - in Italy /Salerno, Bologna/; France /Paris/; England /Oxfort, Cambridge/; Chekia /Prague/. The idea of even greater awareness, immersion and life application of the knowledge, larger freedom of the thought and humanism when teaching and educating is imposed. All that contributes for enlarging the horizon of knowledge and human abilities. It is an important precondition for the development of the pedagogical cognition, development of the science, for teaching and educating of secular nature. The humanistic breath in science about an upbringing and education of more humanistic, democratic and realistic nature is also of importance.

Pedagogical science is affirmed with the authority of an independent science during the 17th century. The well known Check pedagogue I.A.Komenski /1592–1670/ has mostly contributed to this fact. He is the author of the "Great didactic", the first fundamental book in the field of the pedagogical theory and practice. It is with it that the new period in the development of the pedagogical science is related – its independent "disciplinary" differentiation. The new ideas of life are reflected in the book – democracy, humanism, cheerfulness, optimism, deep sympathy towards man , as a creator of all beautiful and sublime in life. For the author, man is "the most perfect and sublime creation on earth", "beautiful micro cosmos", "harmony in relation both to the body and sole". It is namely here that for the first time basic issues related to the teaching and upbringing, actual till today, are developed. For instance, about the class – lesson system, known as well as a mass, collective, group system for teaching; about the environmental upbringing and teaching; etc.

Important contribution to the affirming of the pedagogy as independent science have got:

- the well known English philosopher John Lock / 1632 – 1704 /. He pleads about a system physical education, develops in details the physical education theory, he is particularly interested in the issues related to the moral education, etc.
- Jean Jacques Russo / 1712 - 1778 /, an outstanding representative of the enlightening movement in France during the 18th . He develops in details the theory related to the environmental and free education which is to help the development and to contribute to the opening of the natural strength and abilities of the child.
- J.H.Pestolozzi / 1746 – 1827 /, well known Swiss pedagogue, creator of the famous theory about the "elementary education"; etc.

A great deal of the ideas of the progressive pedagogical thought can be found in the works of the representatives of the so-called Reformatory pedagogy. Word goes about a powerful pedagogical movement having arisen at the end of the 19th and the beginning of the 20th century in a range of European countries. The objective is the renewal and perfection of the teaching and education of the growing up generation, about greater deal of democracy and humanism, better adaptation of man to the new realities and tendencies in the society. Not less important are their ideas about the defense of the children and their rights; about environmental, free development of the personality of the child; about such a pedagogy which shall open a horizon for the natural manifestations of the personality; about endless love towards the child; about multimedia education n; etc.

At the beginning of the 21st century pedagogical theory and practice faces a series of *serious challenges.* They are closely linked both to the nature of the profound changes in society and their dynamics. It may not be exaggeration to say that at the moment the world is in a state of significant changes which have not yet been well explored regarding their scale and intensity of expression as well as the consequences of their implementation.

All this is related to the rapid development of computer technology, information technologies, Internet and satellite communications which made public awareness, including the awareness of adolescents, in all matters an "instantaneous" process. Undoubtedly, the global changes in the field of modern communications are a prerequisite for the emergence of various phenomena: from *the most negative consequences* for life, health and education of the younger generation and processes such as internet addiction, replacement of communication in the "face to face" system by technical devices or "intermediaries"- mainly mobile phones etc. to *the extremely positive ones* - emergence of a new type of literacy, obtaining the necessary information in the fastest way, modern and powerful teaching tools (such as the distance learning) etc.

In the context of the shared opinion it can be assumed that the traditional forms and means of education, while not having lost their meaning and significance, are just part of the possible ones. This puts in front of the some modern pedagogy in theoretical and practical aspects the requirement for a detailed study and best use of their multiple opportunities. Furthermore it should be taken into consideration that this process has to be performed in conditions of constant counteracting the negative effects of the development of electronic media and means of communication.

The rapid development of modern technics and technologies, the economic situation as well as the dynamics of the highlights of the market and business are yet another challenge to pedagogical science. Undoubtedly these processes inevitably lead to rapid obsolescence of educational content in many disciplines, to the emergence of new professions and the need for frequent retraining of personnel. An important challenge for pedagogical science is to determine the change in the proportion of interaction in the system "family – school" concerning the education of adolescents. Indisputably these are problems that contemporary pedagogy has to handle in the process of designing and steering the educational system.

It is obvious that we live in a new world that requires from the pedagogical science and practice large-scale fundamental research, deep analysis of the changes, European exchange of good practices (including physical education and sport). In this respect there are major benchmarks that provoke reflection and it is about them that the discussions have to be led during the exchanges, practical - and applied scientific forums.

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# THE CORRELATION BETWEEN MORPHOLOGICAL CHARACTERISTICS AND MOTOR ABILITIES IN EIGHT-YEAR-OLD GIRLS

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## SUMMARY

The aim of this research was to determine whether there is a connection between morphological characteristics and motor abilities in normal and overweight eight-year-old girls. The sample consisted of 82 second grade girl students of elementary schools in the town of Niš. After measuring body height and weight and calculating BMI according to Cole et al. (2000), two sub-samples were formed: normal weight (n=53) and overweight (n=29). The morphological characteristics were determined by measuring 16 parameters of longitudinal, transversal, circular dimensionality and body mass, and subcutaneous fatty tissue by measuring skin fold thickness. For the assessment of motor abilities (explosive strength, coordination and speed), a battery of nine tests was applied. Relations between morphological characteristics and motor abilities were assessed by a canonical correlation analysis. The results indicate that the correlations were statistically significant only in the group of overweight girls ($p < .01$). In general, we can conclude that the level of motor abilities in normal weight girls is largely independent of morphological characteristics, while in overweight girls due to higher development of adipose and lower development of muscle tissue, negative correlation between these two areas is present.

**Keywords:** nutritional status, morphological characteristics, motor abilities, correlation.

## INTRODUCTION

Prepubescent age is a very sensitive developmental period. Although this is a period of slower growth, one calendar year in this ontogenesis period can be considered as developmental stage, when changes in child's body directly affect individual motor abilities (Turek, 2006).

Within the growth and development and the mutual relations between morphological characteristics and motor abilities in children, certain rules can be defined that depend on the endogenous and exogenous factors, such as gender, age and physical activity (Bala, Jašić, & Popović, 2009). Defining the rules is based on the fact that individual differences among children influence different body constitutions and types of motor abilities. Knowledge of these rules, which are being manifested by relations between the anthropological dimensions, is necessary for understanding the efficiency of any motor ability. The manifestation of motor abilities depends on the morphological characteristics. Motor abilities in children are quantitatively lower, and structurally different than in adults. Accordingly, the relations between morphological characteristics and motor abilities in children are different compared to those of adults.

The biological development of children is manifested through changes in physical and motor development. One of the important aspects of the development, which is associated with physical and motor development, is the level of nutritional status. The nutritional status of children is one of the important indicators of the health, mental and physical capabilities and potential for normal and healthy growth and development. It is assumed that bigger deviation from optimal body weight is one of the indicators of health disorder symptoms.

In the modern life conditions, anthropological status of children is exposed to many risk factors (lack of physical activity, irregular and calorific diet etc.). It is notable that great attention of the scientific community is focused on the physical status of children, pointing to a worrying prevalence of overweight and obese children. Obesity in children is defined as an increase in body weight over the reference value determined by age, sex and body height (Antić, 2009).

Special interest in scientific research is related to the relations between nutritional status and motor abilities in children of different age. Excess mass and higher development of subcutaneous fatty tissue in children, are associated with lower levels of functional motor abilities (Ara, Moreno, Leiva, Gutin, & Casajús, 2007; Casajús, Leiva, Villarroya, Legaz, & Moreno, 2007; Esmaeilzadeh & Ebadollahzadeh, 2012; Leskošek, Strel, & Kovač, 2007; Malina et al., 1995; Ostojić, Stojanović, D., Stojanović, V., Marić, & Njaradi, 2011). Compared to normal weight children, overweight and obese children had more problems in activities that required lifting and projecting body mass through space (Ara et al., 2007; Casajús et al., 2007; Leskošek et al., 2007; Malina et al., 1995). Obesity in childhood is often associated with physical inactivity (Stettler, Signer, & Suter, 2004; Bukara-Radujković i Zdravković, 2009). Level of physical activity in these children is significantly lower than in normal weight children (Trost, Kerr, Ward, & Pate, 2001; Ara et al., 2007). Some authors believe that obesity represents an obstacle for motor development and generation of motor habits (Bala, 2007; Cawley & Spiess, 2008; Graf et al., 2004a, 2004б; Wrotniak, Epstein, Dorn, Jones, & Kondilis, 2006).

The aim of this research is to determine whether there is a connection between morphological characteristics and motor abilities in normal and overweight eight-year-old girls.

# METHODS

## Subjects

The research was conducted on the sample of 82 second grade elementary school students attending "Ratko Vukićević," "Car Konstantin" and "Sveti Sava" elementary schools in Niš, ages 8.06 (± 0.21). The sample included those girls whose parents had given signed consent for their participation, and who were healthy on the day of the testing. The measuring took place in the school facilities which met the necessary requirements.

After measuring body height and body weight and calculating body mass index (BMI), two sub-samples were formed, according to children's BMI and in accordance with the work of Cole, Bellizzi, Flegal & Dietz (2000). The first sub-sample consisted of 53 girls with normal body weight and an average BMI value of 16.00 (±1.69) and age of 8.07 (±0.40). The second sub-sample consisted of 29 overweight girls and an average BMI value of 19.40 (± 0.66) and age of 8.06 (± 0.02).

## Procedure

Morphological characteristics were determined by measuring 16 parameters of longitudinal, transversal, circular dimensionality and body weight, and subcutaneous fatty tissue by measuring skin fold thickness. Within the longitudinal dimensionality of the skeleton the following parameters were determined: body height, leg length and arm length; within the transversal dimensionality: shoulder width, pelvic width, and hip width; within the body mass and circular dimensionality: thorax volume, upper arm volume, thigh volume and calf volume; within the subcutaneous fatty tissue: sub-scapular skin fold, abdominal skin folds, thigh skin folds and medial calf skin folds.

The measuring technique for the morphological characteristics followed the guidelines of the methodology recommended by the International Biological Program (Weiner & Lourie, 1969).

Basic parameters of the motor abilities were determined by using the battery of tests used in the study by Kostić et al. (2010): plyometric jump (Nazarenko, 2000), hyperextension, twist, and throw (Kostić et al., 2009), standing depth jump (Kurelić et al., 1975), 20 sidesteps with a baton (Kurelić et al., 1975 ), horizontal jump rope (Kurelić et al., 1975), running and rolling (Kostić et al., 2009), hand tapping (Kurelić et al., 1975), 5×10 meter run (Kurelić et al., 1975), and foot tapping against a wall (Kurelić et al., 1975).

## Statistical analysis

For all the parameters of the morphological characteristics and motor abilities, mean arithmetic values and standard deviations were calculated, while the connection between the morphological characteristics and motor abilities was determined by using a canonical correlation analysis. The bi-orthogonal method of canonical correlation analysis was used. For each isolated canonical function the following parameters were given: extent of the canonical correlation (R), canonical root of determination ($R^2$), Bartlett's Chi-square test ($H^2$), degree of freedom (df) and significance level (p). All of the analyses were carried out with help of the SPSS 16.0 program.

# RESULTS

Table 1 shows the arithmetic mean values and standard deviations of all the variables of morphological characteristics and motor abilities for both sub-samples. The descriptive statistical parameters indicate that the group of normal weight girls is superior in almost all tested motor abilities, while the values of almost all morphological characteristics are higher in overweight girls.

**Table 1.** Basic descriptive statistical parameters

| Morphological characteristics | | | Motor abilities | | |
|---|---|---|---|---|---|
| | Normal weight (n=53) Mean±SD | Overweight (n=29) Mean±SD | | Normal weight (n=53) Mean±SD | Overweight (n=29) Mean±SD |
| Body height | 133.12 ± 6.80 | 133.93 ± 5.57 | Plyometric jump | 14.57 ± 5.64 | 14.69 ± 5.23 |
| Leg length | 74.29 ± 4.49 | 73.85 ± 4.54 | Hypertension, twist, and throw | 48.77 ± 15.08 | 46.37 ± 14.29 |
| Arm length | 55.83 ± 3.32 | 56.09 ± 3.36 | Standing depth jump | 108.44 ± 31.5 | 96.93 ± 29.91 |
| Shoulder width | 28.77 ± 2.02 | 29.67 ± 1.53 | Horizontal jump rope | 4.91 ± 3.72 | 4.28 ± 2.95 |
| Pelvic width | 20.60 ± 1.40 | 21.86 ± 1.26 | 20 sidesteps with a baton | 24.17 ± 6.86 | 23.78 ± 7.07 |
| Hip width | 22.25 ± 1.39 | 23.77 ± 1.49 | Running and rolling | 20.36 ± 2.54 | 22.17 ± 4.45 |
| Body weight | 28.50 ± 4.60 | 34.87 ± 3.38 | Hand tapping | 28.42 ± 5.45 | 27.07 ± 6.08 |
| Thorax volume | 61.10 ± 7.05 | 66.99 ± 3.75 | Foot tapping against a wall | 14.51 ± 2.22 | 13.62 ± 2.29 |
| Upper arm volume | 18.62 ± 1.97 | 20.87 ± 1.41 | 5×10 meter run | 18.37 ± 1.73 | 19.85 ± 2.63 |
| Thigh volume | 37.74 ± 4.18 | 41.81 ± 3.66 | | | |
| Calf volume | 26.94 ± 2.23 | 28.91 ± 1.79 | | | |
| Triceps SF | 11.32 ± 3.97 | 14.86 ± 3.42 | | | |
| Sub-scapular SF | 8.25 ± 5.69 | 12.51 ± 3.87 | | | |
| Abdominal SF | 10.73 ± 6.90 | 15.63 ± 4.64 | | | |
| Thigh SF | 14.09 ± 4.76 | 19.19 ± 5.04 | | | |
| Medial calf SF | 12.66 ± 3.88 | 16.14 ± 3.18 | | | |

*Legend: Mean - average value; SD - standard deviation; SF - skin fold; n - number*

**Table 2.** The cross-correlation matrix between morphological characteristics and motor abilities in normal weight girls

| | Plyometric jump | Hyperextension, twist, and throw | Standing depth jump | Horizontal jump rope | 20 sidesteps with a baton | Running and rolling | Hand tapping | Foot tapping against a wall | 5×10 meter run |
|---|---|---|---|---|---|---|---|---|---|
| Body height | 0.18 | 0.33* | 0.30* | -0.10 | -0.14 | -0.18 | 0.19 | -0.02 | -0.37** |
| Leg length | 0.10 | 0.28* | 0.27* | -0.05 | -0.12 | -0.15 | 0.25 | -0.06 | -0.23 |
| Arm length | 0.02 | 0.35** | 0.10 | -0.11 | -0.18 | -0.22 | 0.33* | -0.08 | -0.29* |
| Shoulder width | 0.13 | 0.25 | 0.12 | -0.26 | 0.00 | -0.08 | 0.29* | 0.04 | -0.31* |
| Pelvic width | -0.04 | 0.17 | 0.16 | -0.14 | -0.14 | -0.19 | 0.21 | 0.12 | -0.14 |
| Hip width | 0.00 | 0.31* | 0.09 | -0.17 | -0.11 | -0.17 | 0.33* | 0.02 | -0.18 |
| Body weight | 0.03 | 0.35** | 0.21 | -0.14 | -0.05 | -0.14 | 0.23 | -0.01 | -0.23 |
| Thorax volume | -0.12 | 0.11 | 0.02 | -0.17 | -0.05 | -0.10 | 0.23 | 0.10 | -0.17 |
| Upper arm volume | -0.10 | 0.13 | -0.00 | -0.24 | 0.01 | -0.07 | 0.14 | -0.01 | -0.12 |
| Thigh volume | -0.08 | 0.19 | -0.07 | -0.25 | -0.14 | -0.13 | 0.29* | 0.11 | -0.10 |
| Calf volume | -0.00 | 0.35** | 0.11 | -0.17 | -0.07 | -0.11 | 0.28* | -0.04 | -0.12 |
| Triceps SF | -0.27* | 0.05 | 0.01 | -0.22 | 0.07 | 0.15 | -0.02 | -0.12 | 0.08 |
| Sub-scapular SF | -0.19 | -0.04 | -0.48** | -0.17 | -0.02 | 0.06 | -0.05 | -0.05 | 0.07 |
| Abdominal SF | -0.40** | 0.03 | -0.27* | -0.25 | 0.07 | 0.11 | -0.12 | -0.10 | 0.08 |
| Thigh SF | -0.33* | 0.04 | -0.18 | -0.20 | 0.14 | 0.13 | -0.16 | -0.12 | 0.11 |
| Medial calf SF | -0.08 | 0.22 | 0.18 | 0.04 | 0.07 | 0.11 | 0.03 | -0.10 | -0.01 |

*Legend: SF - skin fold; level of significance ** p < .01; * p < .05*

**Table 3.** The cross-correlation matrix between morphological characteristics and motor abilities in overweight girls

| | Plyometric jump | Hyperextension, twist, and throw | Standing depth jump | Horizontal jump rope | 20 sidesteps with a baton | Running and rolling | Hand tapping | Foot tapping against a wall | 5×10 meter run |
|---|---|---|---|---|---|---|---|---|---|
| Body height | -0.24 | -0.01 | 0.13 | -0.14 | 0.11 | 0.28 | 0.10 | -0.22 | 0.03 |
| Leg length | -0.48** | -0.39* | -0.09 | -0.30 | -0.06 | 0.60** | -0.20 | -0.35 | 0.25 |
| Arm length | -0.26 | 0.06 | 0.16 | -0.10 | 0.14 | 0.38* | 0.17 | -0.12 | 0.13 |
| Shoulder width | -0.46* | -0.22 | -0.04 | -0.28 | 0.18 | 0.48** | -0.05 | -0.25 | 0.27 |
| Pelvic width | -0.17 | -0.07 | -0.02 | -0.29 | 0.24 | 0.43* | -0.04 | -0.38* | 0.24 |
| Hip width | -0.32 | -0.03 | 0.15 | -0.04 | 0.04 | 0.34 | 0.10 | -0.17 | -0.01 |
| Body weight | -0.17 | 0.15 | 0.25 | -0.01 | 0.04 | 0.17 | 0.26 | -0.02 | -0.06 |
| Thorax volume | -0.11 | 0.21 | 0.17 | 0.08 | 0.18 | 0.24 | 0.31 | 0.31 | 0.22 |
| Upper arm volume | -0.29 | 0.47* | 0.20 | 0.23 | -0.14 | -0.02 | 0.39* | 0.35 | -0.04 |
| Thigh volume | -0.14 | 0.39* | 0.33 | 0.30 | -0.32 | -0.07 | 0.64** | 0.35 | -0.08 |
| Calf volume | -0.20 | 0.19 | 0.16 | 0.22 | -0.12 | 0.06 | 0.44* | 0.09 | -0.03 |
| Triceps SF | -0.24 | 0.19 | -0.33 | 0.04 | 0.19 | 0.11 | -0.12 | 0.17 | 0.14 |
| Sub-scapular SF | -0.30 | -0.19 | -0.09 | -0.14 | 0.34 | 0.52** | -0.10 | 0.12 | 0.43* |
| Abdominal SF | -0.30 | -0.20 | -0.16 | -0.22 | 0.37 | 0.59** | -0.27 | -0.22 | 0.42* |
| Thigh SF | -0.17 | 0.27 | 0.01 | 0.05 | 0.02 | 0.10 | 0.13 | -0.02 | 0.18 |
| Medial calf SF | -0.09 | -0.19 | -0.53** | -0.16 | 0.08 | 0.36 | -0.34 | -0.32 | 0.28 |

*Legend: SF – skin fold; level of significance ** p < .01; * p < .05*

The cross-correlation matrix between morphological characteristics and motor abilities for the group of normal weight and overweight participants are shown in Table 2 and 3. Based on the results shown in Table 2 and 3, it is evident that there weren't extremely high correlations, but that the total number of statistical significant correlation was considerable. The course of the relationship varies, which is evident in the trend of the correlation coefficients, which may be the result of the correlation essence, but also the result of the method used for measuring and assessing some time-related motor abilities. It is noted that in both subject groups there were no significant correlations between morphological characteristics and tests for the assessment of arm and leg coordination.

Based on the application of canonical correlation analysis for the group of participants with normal body weight, statistically significant correlation coefficients between morphologic characteristics and motor abilities were not found. Thus, these results will not be analyzed.

**Table 4.** The canonical correlation between morphological characteristics and motor abilities in normal weight girls

| | R | $R^2$ | Chi-Sqr. | df | p |
|---|---|---|---|---|---|
| 0 | 0.83 | 0.69 | 161.97 | 144 | .146 |
| 1 | 0.73 | 0.53 | 116.81 | 120 | .565 |
| 2 | 0.72 | 0.51 | 87.01 | 98 | .779 |
| 3 | 0.63 | 0.40 | 59.07 | 78 | .946 |
| 4 | 0.63 | 0.39 | 39.38 | 60 | .982 |

The results of the canonical correlation for the group of overweight girls (Table 5) indicate that the areas of morphological characteristics and motor abilities are interrelated with four pairs of statistically significant canonical factors ($p< .01$). The first pair of canonical factors explains 99% ($R^2=$

.99) of the common variability, second pair 98% ($R^2$= .98), third pair 96% ($R^2$= .96) and fourth pair partially explains remaining variability of these two areas with 88% ($R^2$= .88).

**Table 5.** The canonical correlation between morphological characteristics and motor abilities in overweight girls

| | R | $R^2$ | Chi-Sqr. | df | p |
|---|---|---|---|---|---|
| 0 | 0.99 | 0.99 | 308.96 | 144 | .000** |
| 1 | 0.99 | 0.98 | 224.02 | 120 | .000** |
| 2 | 0.98 | 0.96 | 160.27 | 98 | .000** |
| 3 | 0.94 | 0.88 | 109.78 | 78 | .010** |
| 4 | 0.90 | 0.81 | 77.55 | 60 | .063 |

In order to explain the structure of canonical dimensions, the isolated canonical factors were defined in the observed areas (Table 6).

On the first isolated canonical factor in the area of morphological characteristics, the highest projections are present in the abdominal skin fold (-.53), pelvic width (-.42) and medial calf skin fold (-.39). In the area of motor abilities statistically significant correlations are present with all the variables. The highest projections are determined for the hand tapping (.84), horizontal jump rope (.66), foot tapping against a wall (.62) and 20 sidesteps with a baton (-.62).

On the second isolated canonical factor in the area of the morphological characteristics, the highest projections are present with upper arm volume (-.65), thigh skin fold (-.55) and thigh volume (-.50), and in the area of motor abilities with hyperextension, twist and throw (-.85), running and rolling (.55) and hand tapping (-.37).

The third canonical factor in the area of morphological characteristics is defined by the all variables, while the highest projections are in upper arm volume (.56), thigh volume (.48) and leg length (.48). The highest projections in the area of motor abilities are recorded in running and rolling (.49), plyometric jump (-.44) and 20 sidesteps with a baton (-.39).

**Table 6.** The canonical factor of the morphological characteristics (left) and motor abilities (right) in overweight girls

| | Root 1 | Root 2 | Root 3 | Root 4 | | Root 1 | Root 2 | Root 3 | Root 4 |
|---|---|---|---|---|---|---|---|---|---|
| Body height | -.20 | -.10 | .20 | .55 | Plyometric jump | .53 | -.10 | -.44 | -.27 |
| Leg length | -.38 | .23 | .48 | .42 | Hypertension, twist, and throw | .27 | -.85 | -.11 | -.08 |
| Arm length | -.25 | -.24 | .39 | .57 | Standing depth jump | .47 | -.17 | -.16 | .20 |
| Shoulder width | -.33 | .02 | .34 | .50 | Horizontal jump rope | .66 | -.30 | .27 | -.30 |
| Pelvic width | -.42 | -.16 | .18 | .51 | 20 sidesteps with a baton | -.62 | .04 | -.39 | -.03 |
| Hip width | -.20 | -.06 | .38 | .52 | Running and rolling | -.50 | .55 | .49 | .18 |
| Body weight | -.06 | -.22 | .25 | .52 | Hand tapping | .84 | -.37 | .14 | .33 |
| Thorax volume | -.02 | -.35 | .41 | .22 | Foot tapping against a wall | .62 | -.29 | .35 | -.42 |
| Upper arm volume | -.02 | -.65 | .56 | .25 | 5×10 meter run | -.36 | .26 | .29 | -.08 |
| Thigh volume | .28 | -.50 | .48 | .46 | | | | | |
| Calf volume | .13 | -.29 | .38 | .49 | | | | | |
| Triceps SF | -.25 | -.30 | .31 | -.15 | | | | | |
| Sub-scapular SF | -.25 | .03 | .41 | .04 | | | | | |
| Abdominal SF | -.53 | -.03 | .38 | .12 | | | | | |
| Thigh SF | -.26 | -.55 | .34 | .17 | | | | | |
| Medial calf SF | -.39 | .09 | .18 | -.05 | | | | | |

The highest projections on the fourth isolated canonical factor in the area of the morphological characteristics are recorded in arm length (.57), body height (.55), hip width (.52) and body weight (.52). The highest, and also the only projections of motor variables are recorded in foot tapping against a wall (-.42), hand tapping (.33), horizontal jump rope (-.30) and plyometric jump (-.27).

## DISCUSSION

The growth and development of children, as well as their morphological characteristics, influence the realization of various motor tasks (Pate, 1989; Taylor & Baranowski, 1991; Malina et al., 1995; Turek, 2006; Matić, 2006). However, this phenomenon does not always hold true. The results of the cross-correlation in normal weight girls indicate that the execution of motor tasks designed for the evaluation of coordination and frequent movement speed of legs is not related to morphological characteristics. By analysing statistically significant coefficients, it is concluded that subcutaneous fatty tissue is impeding factor in the manifestation of explosive leg strength. It is expected that greater development of adipose tissue will have a negative impact on the realization of standing depth jump and plyometric jump, which is consistent with previous research (Milanese, Bortolami, Bertucco, Verlato, & Zancanaro, 2010; Raudsepp & Jürimäe, 1997; Malina et al., 1995; Suchomel, 2005). It is noted that the measures of longitudinal dimensionality of skeleton are in positive correlation with hypertension, twist, and throw, standing depth jump and 5×10 meter run. Longer extremity length in subjects enables better execution of these tasks, which is manifested through longer footsteps in running, longer length of jump or further throw of the medicine ball. When it comes to frequent movement speed of arms, its performance is positively determined by arm length, shoulder and hip width, as well as thigh and calf volume. Previous studies confirm that the arm length is an essential factor in the effectiveness of performing this task, while increased voluminosity and body mass do not impose disturbing factors (Pejčić, 2007; Malacko, Pejčić, & Tomljenović, 2014; Ara et al., 2007; Leskošek et al., 2007; Podstawski & Boryslawski, 2012). The results of canonical correlation analysis indicate that the connection between morphological and motor areas in normal weight subjects isn't statistically significant. Thus obtained results suggest that the level of motor abilities in normal weight subjects doesn't depend on their morphological characteristics. Identical results were obtained in seven-year-old normal weight girls in the research made by Đorđević, Pantelić, Kostić & Uzunović (2014).

On the other hand, in the group of overweight subjects, the cross-correlation results indicate that subcutaneous fatty tissue is a disturbing factor in the realization of motor tasks that require lifting and projecting body mass through space (standing depth jump, running and rolling and 5×10meter run). These results are directly or indirectly connected with other studies (Ara et al., 2007; Milanese et al., 2010; Suchomel, 2005; Raudsepp & Jürimäe, 1997; Yusof, Aiman, Zawi, Hasan, & Radzi, 2013; Yavuz, 2013). Unlike normal weight, the results of canonical correlation analysis in overweight subjects indicate that the areas of morphological characteristics and motor abilities are connected with four pairs of statistically significant canonical factors ($p< .01$). Relations between the first pair of canonical factors indicate that the subjects with higher measures of longitudinal and transversal dimensionality, and obvious excess of subcutaneous fatty tissue, achieve lower results in all motor abilities. In fact, emphasized adiposity (excess mass) in girls with massive body constitution has a negative impact on the manifestation of explosive strength, coordination and speed. Thus obtained results are directly or indirectly connected with other studies (Milanese et al., 2010; Suchomel, 2005; Raudsepp & Jürimäe, 1997; Yusof et al., 2013; Yavuz, 2013).

Relations between the second pair of canonical factors indicate that subjects with higher voluminosity and body mass and with more subcutaneous fatty tissue in thigh and upper arm achieve better results in explosive arm strength, coordination and speed. Obtained relations can be interpreted on the basis of some other factors that are beyond the control of this study (previous motor experience, neurological, functional and mental development of subjects etc.).

Relations between the third pair of canonical factors indicate that subjects with quantitative higher values of all morphological characteristics, especially body voluminousity, achieved lower results in explosive leg strength, running speed, as well as in running and rolling. They achieved better results in tasks designed for the assessment of arm and leg coordination (20 sidesteps with a baton, horizontal jump rope) and frequent leg speed. It is concluded that higher values of morphological characteristics, alongside with high body voluminosity (that originates mostly from subcutaneous fatty tissue), have a negative impact on the manifestation of power in jumping, and also make it difficult to perform tasks which involve more movement or require lifting and transferring body mass through space in short time intervals. Thus obtained relations are consistent with other studies (Biskanaki et al., 2004; Suchomel, 2005; Ara et al., 2007; Tokmakidis, Kasambalis, & Christodoulos, 2006; Brunet, Chaput, & Tremblay, 2007; Leskošek et al., 2007; Casajús et al., 2007). Movement structures in motor tasks used for the assessment of coordination (20 sidesteps with a baton and horizontal jump rope) and frequency speed of legs do not require large body movements through space. Primarily, for the successful execution of these tasks timing and movement synchronization is important, which largely depend on the maturity of the central nervous system.

Relations between the fourth pair of canonical factors indicate that the subjects with higher values of longitudinal and transversal dimensionality, higher voluminosity and body mass, achieve lower results in explosive leg strength, coordination and frequent movement speed of legs, and better results in frequent movement speed of arms. Subjects with higher body mass and soft tissue volume, which means more fatty and less muscle tissue, have less success in tasks that require lifting and transferring body mass through space, which is consistent with other studies (Biskanaki et al., 2004; Suchomel, 2005; Ara et al., 2007; Tokmakidis et al., 2006; Brunet et al., 2007; Leskošek et al., 2007; Casajús et al., 2007). The exception is the variable for the assessment of frequent movement speed of arms, which confirms that increased volume and body mass do not represent disrupting factors for the successful execution of this task (Ara et al., 2007; Leskošek et al., 2007; Runhaar et al., 2010; Esmaeilzadeh & Ebadollahzadeh, 2012; Podstawski & Boryslawski, 2012; Casajús et al., 2007).

# CONCLUSION

Based on the results, it can be concluded that in normal weight girls level of motor abilities isn't largely influenced by morphological characteristics. On the other hand, the morphological structure of overweight girls showed a significant negative correlation with motor abilities ($p< .01$). In fact, pronounced body voluminosity and subcutaneous fatty tissue in overweight girls are the ballast mass, which leads to the negative relation between these two areas. Negative influence of morphological characteristics was particularly pronounced in motor tasks that have higher overall movement that involves lifting and projecting body through space and have frequent changes of direction in short periods of time.

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# THE INCIDENCE OF LORDOTIC DEFORMITY IN CHILDREN UNDER THE AGE OF 15 IN THE REPUBLIC OF SERBIA: A SYSTEMATIC REVIEW

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## SUMMARY

The objective of this study is to determine the incidence of lordosis in children aged 15 years and under in the Republic of Serbia. The following electronic databases were searched in order to collect the relevant studies conducted to date: PubMed, SCIndeks, KOPSON, and Google Scholar. Only studies conducted between 2005 and 2015 were included in the review. In order for a study to be included for analysis, the following criteria had to be satisfied: the study had to include participants assessed for lordosis, and the participants in the study had to be of pre-school and elementary school age in Serbia. A significant number of studies (195) were excluded based on the pre-set criteria, and the remaining 13 studies met all the criteria agreed upon. The studies reviewed in the present paper assessed a total of 8,528 children. Lordosis as a deformity was diagnosed in 1,673 children, yielding an incidence of 19.617%. Recommendations, based on the results obtained, include a reduced Napoleon Volanski method, insprection, somatometry, and somatoscopy, as well as the "Spinal mouse" instrument for lordosis assessment. Studies have found a very high incidence of lordotic deformity in children aged under 15 years.

**Keywords:** Deformity, lordosis, preschool age, elementary school age, postural status.

## INTRODUCTION

Physical activity is an important factor in the development and maintenance of human physical abilities; however, we are currently witnessing an ever increasing neglect on the part of modern humans toward their bodies. Adults and children in particular have adapted to the contemporary global changes that have effected a growing incidence of hypokinesia, as a result of unprecedented scientific and technological developments. Physical activity from birth is of utmost importance for adequate formation of children's skeletal, muscular, and ligament systems and for optimal body development, as well as for minimizing the risk of deformity occuring.

Body deformity in children is a postural disorder mainly caused by muscle weakness in the region of the back, chest, or abdomen, as well as legs and feet (Živković, 1998). Additionally, abdomen and lower extremity muscle weakness can lead to secondary disorders in the upper body. Primary changes usually first emerge in the muscular system, followed by the ligaments, and finally skeletal system (Babjak, 1984). Lordosis manifests in the sagittal plane as an abnormal curvature of the spine toward the left, primarily due to muscle weakness in one side of the body or in the abdomen.

Lordotic bad posture and structural lordosis are a postural disorder in the lumbar area of the back, characterized by excessive lumbar curvature with a forward convexity. This postural deformity has the following clinical characteristics: head leaning toward the back, beyond the vertical axis, a flat or somewhat convex chest, increased lumbar curvature, pelvis tilted, to the front and downward, increased pelvic tilt, abdomen saggy and convex, hips shifted forward overall, knees hyperextended, and feet passive and insufficient, characterized to a greater or lesser degree by pes planus (Koturović & Jeričević, 1988).

Detecting lordosis as a postural deformity is of considerable importance, especially up to 15 years of age, for the reason that early formation of "good posture patterns", especially "if formed in early childhod, not only contributes to adequate growth and development of children, but also reflects positively on their health and overall quality of life later in life" (Protić–Gava, & Krneta, 2010). Accordingly, the objective of this study was to assess the incidence of lordotic deformity in children under the age of 15 in the Republic of Serbia.

# METHODS

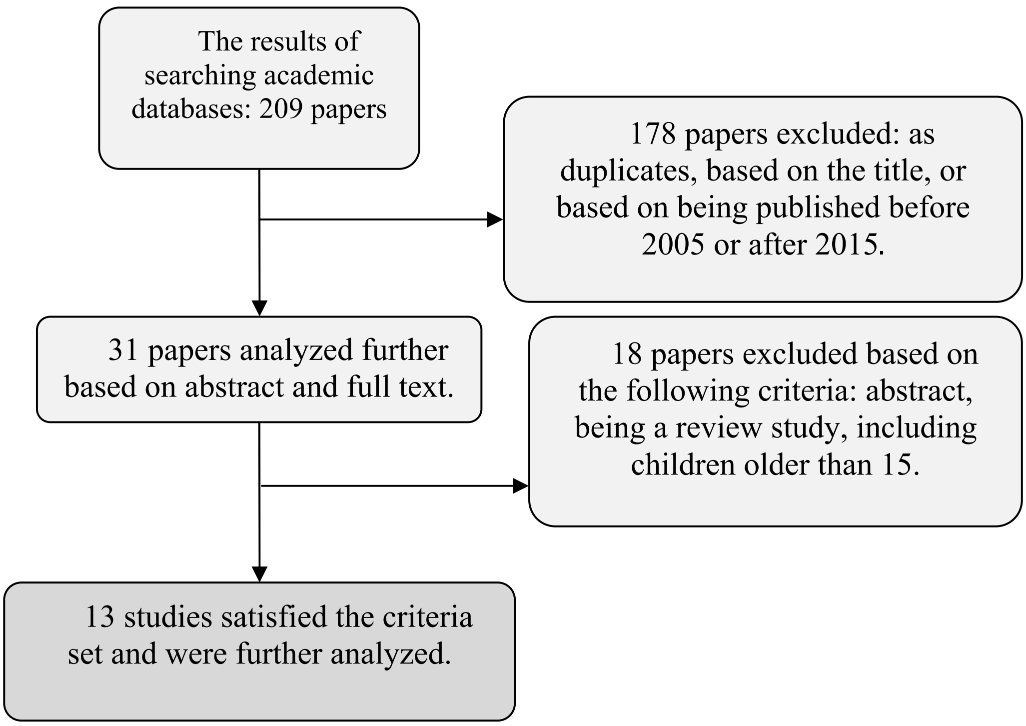
The following electronic databases were searched in order to collect the studies conducted to date on the incidence of lordotic deformity in children under the age of 15: PubMed, SCIndeks, KOPSON, and Google Scholar. Only academic papers published between 2005 and 2015 were included in the review. The following keywords were used to search the databases: deformity, lordosis, pre-school age, elementary school age, postural status. The retrieved academic paper titles, abstracts and full texts were then read and analyzed. In order for a study to be included in the final analysis, two criteria had to be satisfied: the paper had to include participants assessed in the Republic of Serbia for lordotic deformity and the participants had to be under 15 years of age. Academic studies that met these criteria were then further analyzed and presented according to the following parameters (Table 1): reference (author initial, and year the study was published), participant sample (participant age, total number, and subgroups), testing method, and study results.

# RESULTS

The procedure for academic study collection and selection

The procedure followed with the aim of collecting, analyzing and eliminating the academic studies retrieved is presented in Figure 1. A total of 209 papers were identified based on the keywords used. The number of studies immediately excluded based on title, study repetition, or period when the study was published (i.e., prior to 2005) was 178, leaving 31 studies for further analysis. Further analysis of these 31 studies eliminated 18 papers based on multiple criteria, such as the abstract identifying the paper as another systematic review, as well as incompatibility in terms of study participants' age (i.e., high school or older).

The remaining 13 academic studies satisfied the criteria set, namely: these were studies published between 2005 and 2015, the studies included participants assessed for lordotic deformity, and the paricipants in the study were of pre-school or elementary school age.




***The procedure for collecting, anayzing and elimination of retrieved papers***

| Reference | Age | Participant number | Testing method | Study results |
|---|---|---|---|---|
| Sabo, E. (2006). | 3.5-7 years | 1,259 subjects (603 females and 656 males) | Napoleon Volanski method | Total number of subjects with lordotic bad posture diagnosed was 828. |
| Bogdanović, Z., & Milenković, S. (2008) | 11 years | 299 participants | Measured by the somatometric method using a plummet and ruler | Lordotic bad posture diagnosed in 30.43%, or 91, of the participants. |
| Milošević, Z., & Obradović, B. (2008). | Subjects' mean age was 6.92±0.2 years | 377 participants (193 females and 184 males) | Napoleon Volanski method | Lordotic bad posture found in 250 subjects (I-235, II-35 subjects). |
| Obradović, B., & Milošević, Z. (2008) | 6,05±0,02 years | 242 subjects with equal numbers of males and females | Napoleon Volanski method | 168 subjects diagnosed with lordotic bad posture. |
| Djokić, Z., & Stojanović, M. (2010) | 9-12 years | 1,523 subjects, of whom 775 males and 748 females | Somatoscopy and somatometry methods | Incidence of lordotic deformity was 1%, or a total of 16 subjects. |
| Hadžić, Z., Gerdijan, N., Mikić, B., & Katanić, N. (2010). | 7-10 years | 125 male participants | Insprection, and using a plummet and ruler | 7.2% (a total of 9) of participants diagnosed with lordotic deformity. |
| Đokić, Z., Međedović, B., & Smiljanić, J. (2011) | 9-12 years | 810 participants (406 males and 404 females) | Somatoscopy and somatometry methods, using a plummet and ruler | Lordotic bad posture diagnosed in a total of 28 subjects of both sexes. |
| Simov, B.S., Minić, M.S., & Stojanović, O.D. (2011) | 6-7 years | 968 subjects of both sexes | Somatometric method using a plummet and ruler | Lordotic bad posture diagnosed in 20 participants. |
| Dragić, B., Midić, D., & Midić, M. (2012) | 7-14 years | 1,309 subjects of both sexes | Test battery for assessment of lordotic, kyphotic and kypho-lordotic posture | Testing showed that 9 sujects had lordotic bad posture, and 110 subjects had kypho-lordotic bad posture. |
| Pavlović, S. (2012) | 6-7 years | 638 participants of both sexes | Observation, measurement and comparison method | Lordotic bad posture diagnosed in only 2 children. |
| Protić-Gava, B., Šćepović, T., & Batez, M. (2013) | Subject mean age was 8.52 years | 63 subjects (35 males and 28 females) | Modified Napoleon Volanski method | Lordotic bad posture found in 61,3% or 17 of female subjects, and 38,7%, or 14, of males. |
| Jorgić, B., et al. (2015). | 6-14 years | 515+162 subjects of both sexes | “Spinal Mouse“ instrument | Lordotic bad posture found in 93 participants |
| Milić, Z., Lepeš, J., & Halasi, S. (2015). | 10-11 years ± 6 months | 67 participants | Sometometric method, using a plummet and ruler | Lordosis diagnosed in 18 subjects |

***A review of the studies which satisfied all search criteria***

# DISCUSSION

Table 1 presents the academic studies retrieved in an academic database search for papers looking into the incidence of lordotic deformity or lordotic bad posture in children under 15 years of age in the Republic of Serbia. The table presents and analyzes the studies according to five groups of parameters: reference, participant age, participant number, participant groups, testing methods and instruments, and testing results. Children participating in the studies were aged betwen 3.5 years (Sabo, 2006) and 14 years (Petrovski, 2015; Jorgić et al. 2015; Dragić, Midić, & Midić, 2012). The total number of participants assessed in the reviewed studies was 8,528, with the fewest subjects, a total of 63, in the paper by Protić-Gava, Šćepović, & Batez (2013), and the most stubjects, 1,523, in the study conducted by Djokić and Stojanović (2010). Diagnosing lordotic deformity was performed by means of the reduced Napoleon Volanski method (Sabo, 2006; Milošević, & Obradović, 2008; Obradović, & Milošević, 2008; Protić-Gava, Šćepović, & Batez, 2013), via inspection (Petrovski, 2015; Hadžić, Gerdijan, Mikić, & Katanić, 2010), using the “Spinal mouse“ instrument (Jorgić et al. 2015), as well as by the somatometric and somatoscopic methods (Milić, Lepeš, & Halasi, 2015; Simov, Minić, & Stojanović, 2011; Đokić, Međedović, & Smiljanić, 2011; Djokić & Stojanović, 2010; Bogdanović, & Milenković, 2008). The total number of assessed participants was 8,528, with lordotic deformity or lordotic bad posture found in 1,673 subjects, or 19.617%. This indicates a high level of lordotic deformity in children aged under 15 in the

Republic of Serbia, with one in five children under 15 presenting with lordotic bad posture or lordosis.

Based on the results obtained, the reduced Napoleon Volanski method is recommended, as well as insprection, somatometry, somatoscopy, as well as the “Spinal mouse“ instrument for lordotic deformity assessment.

The data obtained in this study is indicative of insufficient involvement of those in the chain responsible for guiding children so that they can have normal growth and development, not only in terms of physical health, but also in terms of social and psychological aspects of being. A great majority of subjects in each of the reviewed studies who had a diagnosis of lordosis in fact had the first stage of the deformity, namely functional lordosis. Finally, although the state observed may seem alarming, there are mitigating factors at work, too, such as the deformity observed being mostly in the early, or functional, stages, providing those bearing the greatest responsibility in this matter, namely parents and education and health professionals, the opportunity to assume a more responsible and more involved approach so as to eradicate this problem sooner rather than later.

# CONCLUSION

By reviewing the relevant studies and taking into account the results therein obtained pertaining to the Republic o Serbia, we wish to draw attention to the alarming situation regarding postural status, more precisely to the fact that on average one in five children under the age of 15 presents with lordotic deformity.

This review contributes to the academic literature on the subject, as well as to raising awareness of the need for directed and adequately distributed physical activity for improving postural status in preschool- and elementary-school age children with lordotic deformity. The range of studies analyzed indicates a dearth of information arising out of academic study of lordosis in preschool- and elementary-school age children in Serbia. Given the lack of interest from academics and from the people who are in practice in charge of children's physical engagement, namely parents and physical education teachers, more attention is needed in terms of methods of prevention regarding postural status in children under 15 years of age. It is only through a concerted effort and dedication from parents, P.E. teachers, and children that strong and healthy children can emerge, paving the way to a happier and healthier life, and the only path to success in life is via happiness.

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# POSTURAL STATUS OF THE SPINAL COLUMN IN THE SAGITTAL PLANE IN A STUDENT POPULATION

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## SUMMARY

The objective of this study was to determine the postural status of the spinal column in the sagittal plane in undergraduate students of the Niš and Veliko Turnovo Universities who are studying to become physical education teachers and coaches. The sample comprised a total of 135 students of both sexes, or, according to university attended: 58 participants from the Department of Physical Education at the Faculty of Pedagogy, University of Veliko Turnovo, Bulgaria, and 77 students from the Faculty of Sports and Physical Education, University of Niš, Serbia. The device used to measure the postural status of the spinal column in the sagittal plane was the "Spinal mouse". In order to establish any differences within each individual group in terms of deformity and normal posture incidence, as well as to establish differences between the two university groups, a Chi Square test was used. Based on the results obtained, it can be concluded that there is no statistically significant difference in the number of students with and without postural disorders in the sagittal plane at the Faculty of Sports and Physical Education in Niš (sig=0.425), and, similarly, no such statistically significant difference was found among the students of the Department of Physical Education attending the Faculty of Pedagogy in Veliko Turnovo (sig=0.599). In terms of percentages, the students of the Faculty of Pedagogy had a greater incidence of postural disorders (53.4 % versus 45.5%), yet this difference was not statistically significant (sig=0.456). The results obtained in this study indicate a high incidence of bad postural status of the spinal column in the sagittal plane in students of both faculties, and provide an opportunity for further research in this area in order to help arrive at a solution to this problem.

**Keywords:** kyphosis, lordosis, kypho-lordosis, differences, incidence

## INTRODUCTION

Correct spinal column postural status refers to a position of the body, namely a relevant positioning of bodily segments while stationary or active (Demeši-Drljan, & Mikov, 2012). However, nowadays there is an increase in incorrect body posture in children and adolescents, and an attendant rise in postural disorders. Spinal postural disorders refer to malalignments from the correct body posture in the sagittal and frontal (or coronal) planes (Milenković, 2007). The most common resultant disorders in the sagittal plane are kyphosis, lordosis, kypholordosis and flatback syndrome (Živković, 2009). Determining spinal postural status is equally important in school-age children and in university students, in order for appropriate corrective gymnastics programs to be designed and administered with the aim of removing the functional deformity or spinal postural disorder. The most common initial cause of incorrect postural status in the sagittal plane in children and adolescents is insufficient physical activity, or hypokinesia which emerges due to intensive technological development resulting in an increasingly sedentary work and life style (Medojević, & Jakšić, 2007). Since physical inactivity is considered a major cause of postural disorders, we were interested to find out what the state of postural disorder was in students of sport and physical education. In accordance with the above, the **objective** of this study was to determine whether any sagittal plane spinal postural disorders were present in students of the Niš and Veliko Turnovo Universities studying to become physical education teachers and coaches, as well as any differences in postural disorders between the two groups.

# METHODS

## Subjects

A total of 135 participants took part in the study. 77 subjects were undergraduate students of the Faculty of Sport and Physical Education, University of Niš, Serbia, whereas 58 subjects were students of the department of physical education at the Faculty of Pedagogy, University of Veliko Turnovo, Bulgaria.

## Procedure

The "Spinal mouse" testing instrument was used to determine spinal postural status in the sagittal plane (Idiag, Fehraltdorf, Switzerland, www.idiag.ch). "Spinal Mouse" is part of a group of invasive instruments for determining the sagittal plane spinal status. The validity and reliability of the "Spinal Mouse" as an instrument was established in the studies by Mannion, Knecht, Balaban, Dvorak & Grob (2004), and by Post & Leferink (2004). The instrument was also used on subjects of various ages (Bubanj, Živković, Živković, Milenković, Bubanj et al., 2012; Jorgic, Milenković, Ždrale, Milenković, Stanković et al., 2015; Jorgić, Milenković, Milenković, Stanković, & Bubanj, 2015). Based on the data obtained using this instrument regarding spinal postural status in the sagittal plane, the following variables were singled out: KIF – kyphotic postural disorder, LOR – lordotic postural disorder, and KL - kypholordosis.

## Statistical analysis

The results obtained by the measurement are presented as a frequency and percentage. To determine differences in terms of deformity and correct posture incidence within each individual subject group, we used the Chi Square test for assessing the quality of fit, whereas the Chi Square test of independence was used to determine any differences in terms of deformity incidence between the two student groups.

# RESULTS

**Table 1.** Sagittal plane postural status in students of the Faculty of Sport and Physical Education, University of Niš.

| Variable | Frequency | Percent |
|---|---|---|
| N | 42 | 54.5 |
| KIF | 24 | 31.2 |
| LOR | 8 | 10.4 |
| KL | 3 | 3.9 |
| Total | 77 | 100 |

N – no deformity, KIF – kyphotic disorder, LOR – lordotic disorder, KL - kypholordosis, Total – total number of subjects

Based on Table 1, namely the representation of basic descriptive statistics parameters, provided as numbers and percentages, regarding spinal deformity incidence in the sagittal plane for students at the Faculty of Sport and Physical Education in Niš, the following results were obtained: kyphotic disorder in 24 participants (31.2%), lordotic disorder in 8 subjects (10.4%), and kypholordotic bad posture in 3 subjects (3.9%).

**Table 2.** Chi Square test results for the Faculty of Sports and Physical Education, University of Niš

| Variable | Frequency | Percent (%) | Chi Square Test | |
|---|---|---|---|---|
| N | 42 | 54.5 | Chi-Square | 0.636 |
| DEF | 35 | 45.5 | df | 1 |
| Total | 77 | 100.0 | Asymp. Sig. | 0.425 |

N – no deformity, DEF – total postural disorders, Total – total number of participants

**Table 3**. Postural status in the sagittal plane among students at the department of physical education at the Faculty of Pedagogy, Universty of Veliko Turnovo

| Variable | Frequency | Percent |
|---|---|---|
| N | 27 | 46.6 |
| KIF | 13 | 22.4 |
| LOR | 8 | 13.8 |
| KL | 10 | 17.2 |
| Total | 58 | 100 |

N – no deformity, KIF – kyphotic disorder, LOR – lordotic disorder, KL - kypholordosis, Total – total number of subjects

The results obtained indicate there is no statistically significant difference (sig=0.425) in the numbers of students at the Faculty of Sport and Physical Education in Niš with and without spinal postural disorders in the sagittal plane.

Based on Table 3, namely the basic descriptive statistics parameters, provided as numbers and percentages, regarding spinal deformity in the sagittal plane, in students from the Veliko Turnovo department of physical education the following results were obtained: kyphotic disorder in 13 subjects (22.4%), lordotic disorder in 8 participants (13.8%), and finally kypho-lordotic bad posture in 10 subjects (17.2%).

**Table 4**. Results of the Chi Square test of postural status in the sagittal plane of students at the department of physical education, Faculty of Pedagogy, Veliko Turnovo .

| Variable | Frequency | Percent | Chi Square test | |
|---|---|---|---|---|
| N | 27 | 46.6 | Chi-Square | 0.276 |
| DEF | 31 | 53.4 | df | 1 |
| Total | 58 | 100.0 | Asymp. Sig. | 0.599 |

N – no deformity, DEF - total postural disorder (kyphotic disorder, lordotic disorder, and kypholordosis), Total – total number of subjects

**Table 5.** Statistical significance of differences between the two faculties.

| Chi-Square Tests | | | | | |
|---|---|---|---|---|---|
| | Value | df | Asymp. Sig. (2-sided) | Exact Sig. (2-sided) | Exact Sig. (1-sided) |
| Pearson Chi-Square | .846[a] | 1 | .358 | | |
| Continuity Correction[b] | .556 | 1 | **.456** | | |
| Likelihood Ratio | .847 | 1 | .358 | | |
| Fisher's Exact Test | | | | .388 | .228 |
| Linear-by-Linear Association | .840 | 1 | .359 | | |
| N of Valid Cases | 135 | | | | |

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 28.36.
b. Computed only for a 2x2 table

The results obtained indicate no statistically significant difference (sig=0.599) in terms of the number of students at Veliko Turnovo with and without spinal postural disorders in the sagittal plane.

Based on the results presented in Table 5, it can be discerned that there is no statistically significant difference (sig=0.456) between the proportion of students of the Faculty of Sport and Physical Education in Niš with no postural disorder in the sagittal plane and the relevant proportion of students at the group for physical education at the Faculty of Pedagogy in Veliko Turnovo .

# DISCUSSION

The results obtained in the present study indicate a high incidence of spinal column postural disorders in students of both universities. Regarding the individual faculties, the Niš University group had a number of participants with no spinal column postural disorder in the sagittal plane higher by 9% compared with Veliko Turnovo. Given that the study participants were students of the faculty of sport and physical education undergoing organized physical activity as part of their practical classes, the expectation was for the percentage of those with no postural disorders in the sagittal plane of the spinal column to be much higher than 54.5%. Among the Veliko Turnovo students, the percentage of students with some form of postural disorder in the spinal column's sagittal plane was even higher, with the percent of students with deformity at 53.4%. Considered separately, kyphotic bad posture was the most common in both student groups (31.2% and 22.4%, respectively). Among the Niš University students, the two next most common postural disorders were lordosis and kypholordosis, whereas among the Veliko Turnovo students these were, after kyphosis, kypholordosis and lordosis.

The results herein obtained are in accordance with the results in studies to date into student postural status, indicating high deformity incidence in the spinal column's sagittal plane (Milenković, & Bogdanović, 2008; Krsmanović, Krulanović, & Andrašić, 2010). Physical inactivity is extremely common in the student population, and may be one cause of the alarming results regarding levels of physical ability and postural status (Stojanović, Višnjić, Mitrović, & Stojanović, 2009). However, taking into account the fact that the present study was conducted with students of the faculty of sport and physical education, it would seem that physical inactivity is not the the sole culprit for bad posture observed in the student population, but is part of a complex cluster of diverse causes. Practicing one sport or engaging in regular physical activity, on their own, do not seem to contribute to postural status improvement, especially taking into account the fact that some sports may actually cause postural disorders unless certain compensatory exercises are included at the end of each practice. This indicates that, in order to eradicate spinal column deformities, clusters of corrective gymnastics exercises should be administered to the student population as well. No statistically significant difference was found between the students of the two faculties in terms of spinal column postural disorders in the sagittal plane (sig=0.456). In terms of percentages, a slightly higher sagittal plane postural disorder incidence was found in the Veliko Turnovo students of the department for physical education, which may be a consequence of the somewhat less rigorous faculty entrance examination and selection.

The insights and findings set out above can serve as a recommendation both for physical education teachers working in elementary and high schools, as their input is crucial given that it occurs during the impressionable developmental phases, formative of correct posture later in life, and for future research, given the new avenues of study revealed for the given area.

# CONCLUSION

The results obtained in this study indicate a surprisingly high incidence (around 50%) of postural disorders in the sagittal plane in students opting for their future profession to be physical education teachers or coaches. In addition to indicating that it is not mere physical inactivity that causes postural disorders, this finding also points out the need for administering postural status tests among students who are physically active in order that corrective gymnastics exercise programs may be planned. Finally, the results obtained also indicate a need for further research into the student population's postural status.

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# ATTITUDES AND NEEDS OF ELEMENTARY SCHOOL STUDENTS TOWARDS OUTDOOR ACTIVITIES CURUCULLUM

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## SUMMARY:

The analysis of the positive prophylactic effects of nature doubtlessly bring about the need for organizing particular models of outdoor activities, and their further development with the aim of including them in further practice. The sample in this study consisted of 146 (M=70; F=76) fourteen-year-old students from three Belgrade elementary schools. The data were collected using a questionnaire consisting of 15 items and were analyzed by appropriate statistical procedures: percentages and frequencies. The results of our study showed that students have positive attitudes towards particular models of outdoor activities. The data analysis of the feedback from the students regarding particular models of outdoor activities referred to the effects, quality and further need for their organization. Furthermore, the aim of this study was to gather precise information and to develop certain models of outdoor activities which would meet the actual needs of the students.

**Keywords:** positive attitudes, education, nature, physical activity, extracurricular activities.

## INTRODUCTION

Outdoor activities represent a series of sports and other types of content which take place in a natural environment, with the involvement of scientific disciplines, with the goal of a safer stay outdoors while adhering to all types of natural laws and showing respect for the preservation of nature (Miletić, 2012). Outdoor activities contribute to the building of a more positive attitude of students towards physical education. By taking part in these outdoor activities, children develop abilities of cooperation, they learn about each other while developing the norms of socially acceptable behavior. Skills which are needed in everyday life are learnt and the limits of one's own abilities determined (Nedić, 1997). On a day-to-day basis we are able to, in a variety of places, hear individuals point out the importance of children spending time outdoors. There is proof that students who have attended schools whose programs included outdoor extracurricular activities achieved higher scores on tests for the evaluation of academic knowledge (reading, science, math, attendance and GPA) when compared to students attending traditional schools (SEER, 2000). On the other hand, having completed a week-long outdoor course, a group of students built strong positive attitudes towards staying outdoors, as well as an understanding of its positive influence on human health (Mittelstaedt, Sanker, & Vanderveer, 1999). More and more often we find ourselves in the situation that we can note an increase in the number of people who spend pleasant leisure hours by the river, on hillsides, or the shores of lakes or seas. Nature and physical activity motivate us to develop and maintain the necessary life vitality (Krsmanović & Berković, 1999).

The task for any outdoor stay is for the students to become familiar with and learn about natural laws, the way nature functions, to learn survival skills for staying outdoors, to gain ethnographic knowledge on the traditions and culture of the place where they are staying. All this has the aim of acquiring the habit of regular stay outdoors and optimum balance in maintaining the wellbeing of every individual (Manojlović, 2005). Outdoors, both adults and children act in accordance with natural laws, which is why nature always needs to be studied, observed and protected (Savić, 2007). The program content of the outdoor activities included in the curriculum for elementary and high schools has the aim of brining students closer together, but also everyone interested in the possibilities and content which an organized stay out of doors could offer, with the aim of using the acquired knowledge in practice and combining it with daily life and work (Savić & Miletić, 2012).

At a time of globalization, industrialization and computerization, which is seriously affecting human health, it is necessary to return to the original way of life, traditional ways of living out of doors and reconnecting with outdoor activities (Đurić, 2005). Data on the physical and functional abilities of schoolchildren, as well as the results of full physical examinations over the past decade indicate their constant decline. Many of these data indicate that a great number of school children have impaired health of the locomotor apparatus. The main task of our profession is to motivate a proper, harmonized development of students, ranging from the physical and intellectual to the spiritual and esthetic. In order for this type of upbringing and education to be achieved, we need the help of children who with their cooperation, ideas and desires will help us achieve our common goals. The most important and key thing is to teach children to love nature, since naturally stimulating factors such as the sun, air, water are the most important means of increasing general biological wellbeing, and cannot be replaced by any chemical or modern sports hall (Đurić, 2005).

Extracurricular activities are sorely neglected, especially at the high school level, despite the fact that students like them very much. They actually have a greater value than physical education classes (which are obligatory for everyone) since students voluntarily participate in them. They will be very beneficial to anyone who has even slightly, or not at all participated in these types of activities. They will benefit from extracurricular activities since they offer a break from regular classes, filling the students with positive emotions, which is all the more reason for developing these kinds of programs in schools (Gajić, 2006). A great number of outdoor activities can be realized, with no need for props or equipment. We will only cite the ones which are most popular in our surroundings: outings, treks, sleeping outdoors, camping, cross country running, general physical education classes, games and outdoor sports activities. All these activities have a positive effect on the human body (Savić et al., 2012).

The outdoor lifestyle is just as important and interesting as the activities offered in an urban environment, which is why it should be developed early on life, so that children could learn about the benefits of nature and thus enrich their lives and activities (Savković, 2013). Thus the aim of this study was to use data obtained in a survey to analyze the attitudes of elementary school students towards certain models of outdoor activities. Based on the results, we could draw certain conclusions, as well as form a more realistic image on the needs of the students in terms of activities, which might be useful when planning outdoor activities.

# METHODS

## Subjects

The sample of participants in this study was selected from a population of male and female students from Belgrade elementary schools. These included the following elementary schools: Duško Radović, Ivan Gundulić and Dragan Lukić from Belgrade. The sample was randomly extracted from a population of seventh-grade students and will in quantitative terms meet the requirements of this study. The sample included 146 students aged 13-14. Their number has satisfied the condition for a quantitative analysis considering the number of variables. All of the students voluntarily participated in the anonymous survey.

## Procedure

The survey was carried out in three Belgrade elementary schools once the Faculty of Sport and Physical Education approved the project: Duško Radović, Ivan Gundulić and Dragan Lukić, during regular physical education classes at those schools. All of the students were given a questionnaire with previous explanations on how to fill them out, but without directly influencing the answers. This survey was already used in 2012 in certain cities (Niš, Zaječar and Knjaževac), and was designed in accordance with the needs of this study, adapted to the topic and aim of the study.

During this survey data were collected on the attitudes and needs of students regarding the model of outdoor activities. In order to collect data, the questionnaire was used as the measuring instrument, consisting of 15 items. When designing the questionnaire, care was taken to take into consideration the age of the children to be surveyed, whether the questions would be ambiguous or too personal, and special attention paid so that the questions would be understandable to the target population, and that the children actually had the information that was asked of them.

Three variables were used:

1. The first variable includes three questions or items which refer to the daily activities of the students (how many classes do they have each day?

how much studying do they do every day? how many physical education classes do they have every week?).

2. The second variable includes the following seven question, or items, and defines the attitudes and needs of the students regarding the model of outdoor activities, such as field trips, summer holidays, winter holidays, outdoor schools, camping,...).
3. The third variable includes the final five questions (items) which refer to the effects of the abovementioned activities on the body of the students (proper growth and development, collective spirit, discipline and responsibility, violence, learning).

## Statistical analysis

The results presented in this research were obtained by means of the appropriate nonparametric statistical methods. Due to the specific nature of the research, we calculated the frequencies and percentages for each item. The data were processed using the STATISTICA 7.0 package for Windows (StatSoft, Inc., Tulsa, OK).

# RESULTS

The first variable (table no.1) in the study includes the first three items included in the survey and is defined as the *daily physical activities of the student*.

The general analysis of the results in the table led us to conclude that most of the students spend six classes a day at school (75.3%), which was expected considering their age (seventh-grade), while the number of responses for five or six classes ranges from (8.9%) to (15.8%). For the following item the order of the answers was interesting, since it divides the population provisionally into two parts when it comes to studying daily. What is disturbing is that the majority of seventh graders, namely (61.6 %) of them, studies for only 2 hours, while the remaining (38.4 %) study 3 or more hours every day. In terms of the third item, the majority of students 84.9% have indicated that they have three physical education classes every week, and a smaller percentage circled the answer that they had two classes (13.0%), and only (2.1%.) indicated they had more than three classes. When we take into consideration the fact that the students spend a lot of time attending classes in a seated position (are not physically active) and that only (38.4%) studied three or more hours during the day, and if we add to that the time they spend in front of their tv screens, in front of the computer and sleeping, we undoubtedly reach the conclusion that three physical education classes per week is quite insufficient for this population.

**Table no.1** The items of the first variable

| No. | Clame | Answer | Fr. | % |
|---|---|---|---|---|
| 1. | How much time at average do you spend at school on working day? | Five classes | 13 | 8.9 |
| | | **Six classes** | **110** | **75.3** |
| | | More then six | 23 | 15.8 |
| 2. | How much time a day do you spend on learning? | **Two hours** | **90** | **61.6** |
| | | Three hours | 37 | 25.3 |
| | | More then three | 19 | 13.0 |
| 3. | How many classes of PE do you have per week? | Two classes | 19 | 13.0 |
| | | **Three calsses** | **124** | **84.9** |
| | | More then three | 3 | 2.1 |

The second variable (table no.2) of the study was defined by the following seven items and they define the **attitudes and needs of students based on the models of outdoor activities.**

Even though all the surveyed schools have a gym (99.3%), the students believe that they should spend more time outdoors every week (56.8%); however, as many as (13%) stated they should not. As far as walking daily is concerned, (29.5%) of the students indicated that they felt the need to walk, and as many as (46.6%) answered (***depends***), while (24%) of them said they did not feel the need to walk. Based on this we could conclude that there is greater interest among students for some other types of outdoor activity models than for walking. In terms of items seven and eight, the schools through their programs most often organize field trips (69.9%), recreational classes (15.8%), outdoor classes (8.9%) and other models of outdoor activities. Fieldtrips are the most frequent with (52.7%), cross country runs with (21.9%) and summer holidays (15.8%), while winter holidays (3.4%) and walking tours (0.7%) were the most infrequent. In addition, a high percentage of students (72.6%) expressed a desire for outdoor activity models to be included in these new school plans and programs, while a smaller percentage of students (19.2%) circled the response (*depends*), and (8.2%) stated they did not want these models of activities to be included in the plans and programs of their schools. Most of the students opted for: camping (31.5 %), summer holidays (21.9 %), outings involving water activities (19.9%) and winter holidays (18.5%), while walking tours (4.1%), field trips (2.7 %) and cross country runs (1.4 %) were the least popular.

**Table no. 2** The items of the second variable

| No. | Clame | Answer | Fr. | % |
|---|---|---|---|---|
| 4. | Does your school have a gym? | **Yes** | **145** | **99.3** |
| | | No | 1 | 0.7 |
| 5. | Do you think that you should spend more time in nature per week? | Yes | 83 | **56.8** |
| | | Depends | 44 | 30.1 |
| | | No | 19 | 13.0 |
| 6. | Do you feel the need to go hiking during the day? | Yes | 43 | 29.5 |
| | | **Depends** | **68** | **46.6** |
| | | No | 35 | 24.0 |
| 7. | Which of the following activities from the school programmes are organized by your school? | **Excursions** | **102** | **69.9** |
| | | Outdoor classes | 13 | 8.9 |
| | | Recreacional classes | 23 | 15.8 |
| | | Neither one | 8 | 5.5 |
| 8. | Does your school organizes some of the following models of outdoor activities? | Winter holidays | 5 | 3.4 |
| | | Summer holidays | 23 | 15.8 |
| | | **Field trips** | **77** | **52.7** |
| | | Cross country runs | 32 | 21.9 |
| | | Hiking tours | 1 | 0.7 |
| | | Nither one | 8 | 5.5 |
| 9. | How would you like your school to include some of the above activities? | **Yes** | **106** | **72.6** |
| | | Depends | 28 | 19.2 |
| | | No | 12 | 8.2 |
| 10. | Which one of the following activities would you like being organized by your school? | Winter holidays | 27 | 18.5 |
| | | **Summer holidays** | **32** | **21.9** |
| | | Field trips | 4 | 2.7 |
| | | Cross country runs | 2 | 1.4 |
| | | Hiking tours | 6 | 4.1 |
| | | **Camping** | **46** | **31.5** |
| | | **Field trips on water** | **29** | **19.9** |

The third variable (table no. 3) was defined by the five remaining items which define the effects and influences of the cited **activities on the traits and development of the students' bodies**.

We can note that there were perceptually different responses based on categories (*yes, in part, no*) on the items of the third variable. Most of the student responses, of both male and female students, indicated high evaluations of the positive effects and influence of the aforementioned activities on the personality features of the individual. We especially point out the positive evaluations of the cited activities on the proper growth and development of the body (66.4%), with the answer *partly* selected by (28.1%), while (5.5%) of the students indicated that these activities do not affect proper growth and development. In addition, the responses on the influence of the activities on certain personality traits were also positive: collective spirit and sociability (65.8%), and discipline and responsibility somewhat less (55.5%). In terms of the next to last item which refers to the reduction in aggression and violence, only (34.9%) of the students consider that outdoor activity models reduce violence and aggression, (41.1%) of the students selected the response *partly*, while (24.0%) considered these activities did not reduce violence and aggression among students. What is also interesting are the positive responses of the students on whether the outdoor activity models offer new knowledge and can be applied in practice (66.4%). All this indicates the positive emotional maturing of the surveyed population and their adequate education on the aforementioned extracurricular outdoor activity models.

**Table no.3** The items of the third variable

| No. | Clame | Answer | Fr. | % |
|---|---|---|---|---|
| 11. | Do above mentioned activities affect the proper growth and development ? | **Yes** | **97** | **66.4** |
| | | Pratly | 41 | 28.1 |
| | | No | 8 | 5.5 |
| 12. | Do above mentioned activities develop team spirit (sociability) ? | **Yes** | **96** | **65.8** |
| | | Partly | 42 | 28.8 |
| | | No | 8 | 5.5 |
| 13. | Do above mentioned activities affect discipline development and responsibility ? | **Yes** | **81** | **55.5** |
| | | Partly | 50 | 34.2 |
| | | No | 15 | 10.3 |
| 14. | Do above mentioned activities affect the reduction of the violence among students ? | **Yes** | 51 | 34.9 |
| | | Partly | **60** | **41.1** |
| | | No | 35 | 24.0 |
| 15. | Do above mentioned activities offer new knowledge and have a practical application ? | **Yes** | **97** | **66.4** |
| | | Partly | 37 | 25.3 |
| | | No | 12 | 8.2 |

In terms of percentages, there were fewer responses which indicate a negative attitude toward the influence and effects of the cited models of outdoor activities on personality traits. We can explain this by the affinities of individuals towards some activities which were not offered in the survey *(schools: language, computer science, music, sports clubs),* as well as insufficient levels of information on and interest in the offered outdoor activity models.

# DISCUSSION

When discussing the results we have to be cautious, considering the fact that these conclusions cannot be applied on the entire territory of the Republic of Serbia, since the survey only took place in Belgrade. We know the fact that certain parts of the country are economically and materially developed to different extents in comparison to Belgrade, so we can conclude that a many schools do not have the means necessary to organize outdoor activity models. Generally speaking, most schools in Serbia do not even have the means to organize physical education classes in general, and these cases can even be found in Belgrade, but to a much smaller extent (Nikolić, 2002). However, in addition to the current situation there is a high level of motivation among physical education teachers to collaborate with their colleagues to organize outdoor activity models and work on their affirmation.

The results of this survey indicate the fact that the students mostly have positive attitudes towards outdoor activities, and most of them would like these extracurricular activities to be included in the curriculums of their schools. It should be mentioned that a study which included a sample of students form several cities in Serbia (Niš, Zaječar and Knjaževac) indicated similar results (Savić, Bratić, & Stojiljković, 2012). When speaking of the answers of the students from different parts of Serbia and Belgrade, differences can be noted. What is interesting are the differences for item no 5 where the students from South East Serbia feel a greater need to spend time outdoors (68.2%) and 56.8% of the students from Belgrade. Also, in the case of item 6 the situation is similar since the students from the interior feel a greater need for walking 52.3%, unlike students from Belgrade 29.5%. In terms of the activities which are most frequently organized in the schools, the students from all the cities are in agreement and most of them selected field trips. Of the other activities which the schools organizes, there are differences since the schools in Belgrade mostly organize field trips 52.7%, while in the other three cities cross country runs were selected with a high 72.8%. Of the activities which were organized least, walking tours were selected both in Belgrade and South East Serbia. What is positive is that most of the students from the cited cities wanted outdoor activities be included in the plans and programs of their schools. For the tenth item, "Which outdoor activities would you like to see organized in your school?" the students from the interior indicated summer holidays first, while the students from Belgrade opted for camping.

In the case of the third variable, the attitudes are very similar for students from all four cities, and what is interesting is that a large percentage of the students showed positive attitudes and consider that extracurricular activities influence the proper growth and development of the body (Frumkin & Louve, 2007; McCurdy, Winterbottom, Mehta, & Roberts, 2010), develop collective spirit and encourage sociability (Darst & Armstrong, 1980; Ewert, 1989; Canadian Parks/Recreation Association, 1997), and influence the development of discipline and responsibility among the students (Ewert, 1989; American Camping Association, 2005). In addition, most of the surveyed students from all the cities are of the opinion that these outdoor activity models offer new knowledge and can be applied in practice (Neuman, 2004). Only in the case of item 14 "Do these aforementioned outdoor activities decrease violence among students" did the students not give positive answers.

In the work of Savković (2013), the author studied the attitudes of students regarding the practical classes as a part of outdoor activity courses. The results indicated that most of the students were coming into contact with certain activities for the first time and that they would be going through the training for practical classes for the first time. The students had positive attitudes towards the activities which were carried out during practical classes, and the importance of camping as well as the organization itself was evaluated by the students with very high grades. They consider that the knowledge and experience acquired during the practical courses related to camping would be of great importance in their future work with students, which indicates that practical classes related to camping cannot be neglected. A great number of students consider themselves to be ready to organize and participate in these types of classes, so that we could conclude that they have acquired the necessary knowledge during their theoretical courses and practical courses. Even though our study did not include the attitudes of students towards their practical courses, we consider this item to be very important since the students represent future professionals that will be involved in the immediate realization of these types of courses.

All this indicates the need that children have for these types of activities, and also the requirement of physical education teachers to work on the affirmation of these contents in their schools. All types of activities which enable longer stays outdoors and maximum use of natural factors contribute to the proper development of the human body, encourage psycho-physical development and develop a sense for a more creative life and work which the students certainly need.

## CONCLUSION

A sample of 146 participants, male and female schoolchildren from Belgrade, with a chronological age of 14, completed a questionnaire in December, which consisted of 15 items divided into three variables focusing on the attitudes and needs of students regarding certain outdoor activity models in the form of extracurricular activities. The obtained data were processed using statistical procedures which were appropriate for this type of study.

The students believe that extracurricular outdoor activities have a positive effect on the bodies of the students (proper growth and development of the body, development of a collective spirit, a decrease in violence, increase in a sense of discipline and responsibility) and are aware that through extracurricular outdoor activities they acquire new knowledge which can be used in practice. Extracurricular activities have significantly been neglected, especially in high schools, despite the fact that the students like them very much. They actually have a greater value than physical education classes (which are obligatory for everyone), since the students voluntarily take part in these types of classes. Extracurricular activities will make a great contribution to everyone who might have had small or no experience dealing with these types of activities. They will benefit from stepping out of the school environment, since it represents a true change for them, filling them with positive emotions, which is reason enough to include these programs in schools.

We can also conclude that our country in the upcoming period will be facing changes in the laws on education. We expect elementary school education to undergo extensive change. This means that this study could contribute certain facts and evidence, sublimated in the form of new models of extracurricular outdoor activities in elementary school programs. The results of this study will certainly represent a significant contribution to the formation of a rational, effective and high quality school system, especially in terms of education and upbringing involving content from a new curriculum which could be realized outdoors. They only partly reflect the need of schoolchildren who live in urban environments, and which are susceptible to hypokinesis. Naturally, it is the responsibility of the physical education teacher in collaboration with their colleagues to work on the affirmation of the aforementioned and similar content in their schools.

This somewhat indicates the need to change extracurricular activities in schools in terms of suggesting these or similar activities which do not require equipment (since this is precisely one of the reasons and main problems because of which many students do not opt for this type of class), and have an adequate health and social effect (for example, field trips, walking tours, orienteering competitions and orienteering cross country runs).

Outdoor activities have a special educational value and help a person get to know nature much better, use and change it creatively, which gives unique importance to the development of creativity among children. In these activities we find various hereditary and acquired natural forms of movement, walking, orienteering, scouting skills, traditional forms of competition, basic, relay and sports games. Outdoor activity models represent a special form of socialization and enable a far broader, more complete and higher quality realization of educational tasks.

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# EFFECT OF MORPHOLOGICAL CHARACTERISTICS ON STRENGTH OF PRESCHOOL CHILDREN ENGAGED IN DIFFERENT PHYSICAL ACTIVITIES

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## SUMMARY

The morphological structure of children must be taken into account in studies of motor efficiency of preschool children. The main objective of this study was focused precisely on the analysis of the effects of morphological characteristics on the manifestation of strength in preschool children, who are physically differently engaged. In the Ex post facto study, the experimental sample consisted of 58 children (5.03 ± 0.57), who had, in the previous eight-month period, additional physical activity organized, and control group of 46 children (5.13 ± 0.29), who had physical activities organized in the preschool institution they attended. The effect of the system of seven anthropometric measures on the efficiency of manifestation of explosive strength (Standing long jump), repetitive strength (Sit-ups in 60s) and static strength (Chin-up endurance) was analyzed. Moderately high and statistically significant effect of the predictor system on the efficiency of showing explosive and repetitive strength was found in both groups of children, where the effect was visibly higher in the group of children who did not have additional physical activity. In that group, a statistically significant effect on the expression of static strength of arms and shoulders was determined. The variables Body height and Forearm circumference showed the largest positive effect, while the variables Body mass, Upper arm skinfold and Abdomen circumference showed negative effect direction. These findings confirmed the view that anthropometric measures should be included as mediating variables in assessing the efficiency of the manifestation of strength in children, especially Body height and Body mass.


**Keywords**: children, exercise, strength, body type, effect

## INTRODUCTION

Preschool age is an extremely sensitive period for motor abilities development in children, especially when it comes to learning and adopting extensive repertoire of motor skills. Preschool children who are not involved in some form of organized physical activity are more likely to be less successful in motor abilities during childhood and adolescence (Hardy, King, Farrell, MacNiven, & Howlett, 2010). Children are less physically active and spend less and less time playing outside (Biddle, Gorelyn, & Stensel, 2004; Boreham & Riddoch, 2001). This was demonstrated in a 2012 study on a sample of 9.000 American children, which showed that more than half of the children do not go out with parents at least once a day to play (Tandon, Zhou, & Christakis, 2012).

Daily participation in various forms of physical activity has a positive impact on the growth and development of the organism (Hennessy et al., 2010; Eathern, Morgan, & Lubans, 2013). The importance of physical activity is particularly emphasized in the preschool age. Preschool children, unlike others, are still in the process of forming the habits that will continue to reflect on their quality of life.

When we talk about physical exercise, especially of children, it is important that it is dominated by natural forms of movement and that it can be adapted to each child's abilities, in order to influence the growth of its capabilities. Also, one of the criteria is whether that activity affects the development of all body segments and in what way. The aim of this study was to determine whether engaging in additional physical activity positively affects the quality of morphological status of preschool children, as well as their motor abilities, especially strength. Within the main objective, the extent and direction of the influence of morphological characteristics on the strength of two groups of children of preschool age were analyzed, children who have additional physical activity and children who did not have any additional physical activity.

# METHODS

## Subjects

The control group of subjects, who did not engage in additional physical activity, consisted of 46 boys and girls with mean age of 5.13 ± 0.29 decimal years. The experimental group of subjects, who had an organized additional physical activity, consisted of 58 boys and girls with mean age of 5.03 ± 0.57 decimal years. All subjects were healthy and regularly participated in the work of the preschool institution they attended. The parents had given a written consent for the children who have been subjected to the process of measuring.

## Procedure

Assessment of the status of strength of children was carried out using the standardized motor tests according to Bala, M. V. Stojanović and M. Stojanović (2007). The used tests: Standing long jump (cm) - for the evaluation of explosive strength of the lower extremities; Sit-ups in 60 seconds (freq.) - for the evaluation of repetitive strength of the flexor muscle of abdomen; Chin-up endurance (0.1sec) - for the evaluation of static strength of the upper extremities. All the tests have shown a high reliability in application with preschool children (Bala et al., 2007).

Anthropometric measures applied in the study were: Body height (mm), Body mass (0.1 kg), Circumference of the thorax (mm), Circumference of the upper arm (mm), Circumference of the forearm (mm), Abdominal skinfold (mm), and Upper arm skinfold (mm). Anthropometric measurements were conducted in accordance with the IBP standard.

Children of the experimental group had additional physical activity twice a week for 60 minutes within the sports school, which lasted at least 8 months before the measurements were taken. Children of the control group had organized physical activity under the program of preschool institutions they attended.

## Statistical analysis

The arithmetic mean (AM) and standard deviation (S) for all analyzed variables were determined, and testing normality of distribution was performed using the Kolmogorov-Smirnov test (KS). Analysis of different morphological characteristics of boys and girls was done as preliminary analysis, using the independent samples t test. Linear regression analysis was used to determine the relation between morphological characteristics and motor abilities. Within the regression analysis were calculated: the coefficient of multiple correlation (R), coefficients of determination (R2), standardized partial regression coefficients (β), t-test (t), statistical significance of regression coefficients (p), size of F-relationship (F) and level of statistical significance of multiple correlation coefficients (P). A set of anthropometric variables consisted of predictor system, while the criterion variables consisted of results of motor tests. Processing the obtained data was performed using the statistical software package SPSS 20.0, by applying the statistical significance of level $p <= 0.05$.

# RESULTS

Testing the differences of morphological characteristics of boys and girls showed that there were no statistically significant differences between children of different sexes. Based on these findings, the sample of subjects is treated as homogeneous with respect to gender in further analysis.

Comparative overview of arithmetic means of the analyzed groups results (Table 1) showed that the experimental group had lower average measure values of subcutaneous fat, abdomen circumference and body mass. In motor variables, the experimental group had higher average value in *Standing long jump* and in the remaining two variables, the control group had higher average values. Differences between the analyzed groups had no statistically significant level.

Analysis of the data distribution of the applied variables showed that there is a statistically significant deviation from the normal distribution for the variables *Abdomen skinfold*, *Chin-up endurance*, *Sit-ups* and *Body mass*. Expressed variability of results is present in these variables, which might be expected in preschool children given the results of some previous studies (Bala, 2004).

Based on the results of regression analysis (Table 2) in subjects who were involved in additional physical activity, a statistically significant effect of the system of predictor variables on the criterion variables *Sit-ups* and *Standing long jump* was determined. Percentage of explained variance of the criterion variable *Sit-ups* was 28.3% and for *Standing long jump* the percentage was visibly higher - 38.9%. In the criterion variable *Chin-up endurance,* a statistically significant effect of the system of predictor variables was not determined.

**Table 1** Basic descriptive statistics of morphological and motor variables in children engaged in (N = 59) and not engaged in (N = 46) organized physical activity (PA).

| VARIABLES | Children engaged in additional PA | | | Children not engaged in additional PA | | |
|---|---|---|---|---|---|---|
| | AM1 | S1 | KS1 | AM2 | S2 | KS2 |
| Body height (mm) | 1136.07 | 61.25 | 0.200 | 1133.93 | 54.28 | 0.200 |
| Body mass (0.1 kg) | 204.93 | 30.31 | 0.187 | 212.46 | 39.63 | 0.002* |
| Chest circumference (mm) | 570.60 | 32.88 | 0.200 | 565.57 | 45.01 | 0.182 |
| Abdomen circumference (mm) | 540.71 | 38.31 | 0.186 | 542.43 | 50.63 | 0.007* |
| Forearm circumference (mm) | 171.74 | 11.08 | 0.200 | 174.09 | 14.93 | 0.095 |
| Abdomen skinfold (mm) | 68.93 | 30.83 | 0.014* | 74.57 | 37.16 | 0.000* |
| Upper arm skinfold (mm) | 92.00 | 22.40 | 0.200 | 98.96 | 30.04 | 0.200 |
| Standing long jump (cm) | 97.24 | 18.94 | 0.200 | 96.39 | 16.84 | 0.013* |
| Chin-up endurance (0.1s) | 76.14 | 88.28 | 0.000* | 77.26 | 68.66 | 0.001* |
| Sit-ups (freq.) | 14.52 | 9.97 | 0.016* | 15.46 | 9.31 | 0.200 |

Legend: AM - arithmetic mean; S - standard deviation; KS - significance of Kolmogorov-Smirnov test; * - present deviation from the normal distribution

**Table 2** Results of regression analysis in children who are engaged in some form of organized physical activity

| VARIABLES | Sit-ups | | Standing long jump | | Chin-up endurance | |
|---|---|---|---|---|---|---|
| | β | p | β | p | β | p |
| Body height (mm) | -0.295 | 0.385 | **0.814** | **0.012** | 0.173 | 0.659 |
| Body mass (0.1 kg) | **1.617** | **0.016** | -0.484 | 0.421 | -0.276 | 0.714 |
| Average chest circumference (mm) | -0.186 | 0.539 | 0.347 | 0.217 | 0.106 | 0.762 |
| Abdomen circumference (mm) | **-0.834** | **0.007** | -0.369 | 0.187 | -0.270 | 0.439 |
| Forearm circumference (mm) | -0.014 | 0.957 | 0.037 | 0.875 | 0.063 | 0.831 |
| Abdomen skinfold (mm) | -0.198 | 0.461 | 0.259 | 0.297 | -0.021 | 0.947 |
| Upper arm skinfold (mm) | -0.107 | 0.625 | **-0.411** | **0.045** | 0.131 | 0.602 |
| | **R = 0.532<br>$R^2$ = 0.283<br>F = 2.881<br>P = 0.013** | | **R = 0.624<br>$R^2$ = 0.389<br>F = 4.637<br>P = 0.000** | | **R = 0.209<br>$R^2$ = 0.044<br>F = 0.332<br>P = 0.936** | |

*Legend: β (beta) - standardized regression coefficients; p - significance of beta coefficient; R - multiple correlation coefficient; $R^2$ - adjusted value of the squared multiple correlation coefficient; F - value of F-relationship; P - statistical significance*

The variable *Body mass* had statistically significant and great influence on the results of the test *Sit-ups,* in a positive direction, while all measures of subcutaneous fat had negative, but not statistically significant, influence on these results. The variable *Abdomen circumference* showed visibly larger and statistically significant negative influence. The most positive influence on the criterion variable *Standing long jump* had the variable *Body height,* while the variable *Upper arm skinfold* had statistically significant and negative influence.

The results of regression analysis in children who were not engaged in some additional form of organized physical activity (Table 3) showed a statistically significant effect of the system of predictor variables in all three criterion variables. In the variable *Sit-ups,* statistically significant and positive influence had the variable *Body height* and *Forearm circumference,* while the variable *Upper arm skinfold* showed a negative influence. *Body height* showed positive influence on *Standing long jump,* and negative on *Abdomen circumference*. In the variable *Chin-up endurance,* statistically significant and positive influence had the variable *Forearm circumference,* while the variable *Upper arm skinfold* showed a negative influence.

**Table 3** Results of regression analysis in children who are not engaged in some form of organized physical activity

| VARIABLES | Sit-ups | | Standing long jump | | Chin-up endurance | |
|---|---|---|---|---|---|---|
| | β | p | β | p | β | p |
| Body height (mm) | **0.609** | **0.037** | **0.803** | **0.004** | 0.451 | 0.128 |
| Body mass (0.1 kg) | -1.002 | 0.235 | 0.205 | 0.794 | -0.587 | 0.494 |
| Average chest circumference (mm) | 0.149 | 0.675 | -0.159 | 0.634 | -0.149 | 0.682 |
| Abdomen circumference (mm) | -0.117 | 0.813 | **-1.226** | **0.012** | -0.228 | 0.655 |
| Forearm circumference (mm) | **1.087** | **0.005** | 0.447 | 0.205 | **0.862** | **0.028** |
| Abdomen skinfold (mm) | 0.035 | 0.909 | 0.457 | 0.119 | 0.016 | 0.959 |
| Upper arm skinfold (mm) | **-0.537** | **0.027** | -0.257 | 0.249 | **-0.556** | **0.026** |
| | R = 0.607<br>$R^2$ = 0.368<br>F = 3.162<br>P = 0.010 | | R = 0.664<br>$R^2$ = 0.441<br>F = 4.283<br>P = 0.001 | | R = 0.579<br>$R^2$ = 0.335<br>F = 2.737<br>P = 0.021 | |

## DISCUSSION

Preschool period is marked with stable and not so turbulent growth and development of the child's body, which positively affects the formation and development of motor abilities. The annual growth rate of height and weight is not strongly pronounced, which means that children are in a relatively stable stage of development, which is very important in achieving better results in motor manifestations (Đorđić et al., 2006). With that in mind, the contribution of additional physical activity to morphological characteristics of children can be quite reliably estimated in this period.

Comparative analysis of the basic descriptive statistics of morphological characteristics of children in the experimental and control group showed that the children of the experimental group had lower average values of the subcutaneous fat, body mass and abdomen circumference. It can be assumed that in these children, additional physical activity that included medium-intensive and highly intensive moving activities, contributed, to some extent, to the reduction of the mentioned indicators and reduced the risk of increased body mass. Such an assumption is consistent with the findings of Janssen and Leblanc (2010), who point out that high levels of physical activity in young children largely prevent obesity in childhood.

The effect of anthropometric measures on the efficiency of performance of certain motor tasks, for which the manifestation of strength is characteristic, is different in the two groups of analyzed subjects. The results of this study suggest a greater influence of morphological characteristics on the efficiency to manifest the strength in children who are not involved in any additional physical activities. This is particularly pronounced in the manifestation of static and explosive strength. In the test of static strength of arms and shoulders Chin-up endurance, which was quite difficult for children of preschool age, in the control group of subjects the system of anthropometric measures explained 33.5% of variance of this criterion variable, while in the experimental group it amounted to only 4.4%. It can be directly correlated with increased body mass and subcutaneous fat that was present in the control group of children (Kukolj et al., 2006). In the test Standing long jump, statistically significant influence of anthropometric measures system was found for both analyzed groups, which coincides with the findings of the research Kondrič, Mišigoj-Duraković and Metikoš (2002). A greater influence was observed in the control group compared to the experimental (44.1%; 38.9%, respectively) for this variable too. Large influence of the longitudinal dimensionality of the body on the results of the Standing long jump was confirmed in children (Đorđević, Pantelić, Kostić and Uzunović, 2014). The research also confirmed the significant impact of morphological characteristics in manifestation of repetitive strength. In both analyzed groups of preschool children, we obtained a statistically significant influence of the anthropometric measures system on the results in a test Sit-ups (23.8% and 36.8% of the variance). These findings are also emphasized by De Privitellio, Caput - Jogunica, Gulan & Boschi (2007) in the study on the influence of sports activities on the change in motor abilities of preschool children. It can be said that the manifestation of children's motor abilities largely depends on the morphological dimensions, and anthropometric characteristics. (Bala, Jakšić i Popović, 2009; Turek, 2006).

# CONCLUSION

The results of this study point to two main conclusions:

1. For preschool children engaged in additional form of organized physical activity, the influence of morphological characteristics on the expression of strength is less obvious compared to children who do not have organized additional physical activity, primarily due to the reduction of subcutaneous fat and body mass as disruptive factors.
2. In studies of motor abilities of preschool children, especially of all types of strength, it is necessary to include anthropometric characteristics as mediating variables, primarily body height and body mass. Influence of morphological characteristics in some basic motor abilities tests which are applied on preschool children can be very high, which has been proved in this study.

Influence on the motor development of children should be implemented in such a way where the exercising leads to qualitative changes (Findak, Mraković and Delija, 2001). Sure, children should be directed to regular physical exercise in order for them to develop motor abilities, and thus contribute to reducing or preventing the formation of large amounts of adipose tissue, ie. Obesity. This is particularly important because nowadays, obesity is increasingly taking on the characteristics of an epidemic.

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# DIFFERENCES IN MOTOR AND FUNCTIONAL ABILITIES BETWEEN ATHLETE AND NON-ATHLETE STUDENTS

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## SUMMARY

The objective of this research was to determine the differences in motor and functional abilities between active athlete and non-athlete students. A sample of 52 subjects, seventh grade students of primary school "Vožd Karađorđe" in Niš, was divided into two subsamples - a subsample of athletes and a subsample of non-athletes, each with 26 participants. Students from both subsamples regularly attended Physical Education classes, but the students from the subsample of athletes were also actively engaged in sport in sports clubs in Nis, whereas the students from the subsample of non-athletes did not train any sports. In accordance with the appropriate protocols, standardized motor and functional testing was conducted. Three measuring instruments were applied for each assessment of motor and functional abilities. The results of the multivariate analysis of variance (MANOVA) and the univariate analysis of variance (ANOVA) showed that statistically, students athletes differ significantly from students non-athletes in motor abilities. In functional spaces, MANOVA analysis showed statistically significant intergroups differences, while, at univariate level, ANOVA showed statistically significant differences in two of three applied functional abilities tests.

**Keywords**: primary school students, motor and functional abilities, differences

## INTRODUCTION

In physical education curriculum, one of the priorities is the development and the maintenance of pupils' motor abilities. The harmonious development of students' motor abilities creates real prerequisites for the successful implementation of the remaining tasks in this educational area as defined by the documents, which also include the acquisition of sport-technical education curriculum contents in accordance with the students' age and gender.

Numerous recent studies (Findak, 1995; Krsmanović, 2000; Višnjić et al., 2004; Perišić & Knjaz, 2005; Krsmanović et al., 2008) point to the conclusion that physical education classes, neither with weekly teaching hours (2 + 1) nor with the content and the applied loads, can fully respond to the defined objectives and tasks. School physical education is realized with a relatively low energy component, insufficient to generate adaptive changes in motor and functional abilities of students, primarily because of both inadequate intensity and scope of work and insufficient number of weekly teaching hours devoted to physical exercise. Furthermore, the material base, which is an important condition for curriculum implementation, is becoming more and more an aggravating factor, either due to the lack of equipment and props, or their obsolescence and lack of functionality, thus reducing the possibilities for proper students' development concerning both motor and functionl abilities.

Sport-technical education should be based on previously well grounded "motor basis" i.e. on physical fitness, which implies harmonious development of all motor abilities (Krsmanović et al., 2008; Višnjić et al., 2008). Motor abilities are the basis of efficient execution of motor tasks in everyday life, play, physical education, sports and recreational activities and professional sports. Because of their importance, the development of motor abilities in physical education is defined as a specific topic area.

Motor (physical) abilities refer to a set of innate and acquired skills that enable successful performance of motor activities. They represent a system of movement manifestations by means of which a man, in order to meet the needs of life and work, by moving the body or its parts, interacts with his environment. They are developed by the application of adequate training stimuli (means of physical exercises, methods and load), by means of which, together with appropriate exercise frequency, the desired effects or adaptations are exerted (Milanović, 2007; Malacko & Doder, 2008).

Capabilities and characteristics of school children can be most successfully developed during so-called 'sensitive periods', which are objectively the most favorable ones. These are periods of ontogenesis when, based on the principles of nature, the most significant pace of development of certain abilities and characteristics of an individual is achieved, the adaptive features in relation to exogenous factors are increased and special favorable conditions for the formation of certain skills and habits are created (Stegeman, 1991; Malacko, 2000). Between the age of 11 and the age of 14 years old, a child's organism is very susceptible to external influences (transformations), if they by their orientation correspond to the basic tendencies of the natural flow of motor, morphological and functional changes.

Functional abilities of man imply unity of functional body structures and its mutual functioning (Wilmore & Costill, 1994). The majority of studies of functional abilities were directed to analyze behavior of cardiovascular and respiratory system influenced by different training stimuli, applied in Physical Education, sports and recreation. Functional abilities are highly complex and depend on variable and numerous factors, first of all on the vegetative nervous and endocrine system (Mraković et al., 1996). Due to the fact that functional abilities are very important for sports success, these athletic attributes are of special interest for coaches, Physical Education teachers, instructors and psychologists. They have a major impact on the results of motor behavior of students, since in an appropriate correlation with motor abilities they positively contribute to the achievement of sports results.

The impact of training load on the functional adaptation of the organism fluctuates and depends on many factors, including the nature of sports activities, training orientation, individual reactions of the organism, the effectiveness of the applied means and methods of recovery, etc. During training – the application of different training loads the first, initial part of the so-called rapid adaptation of the organism to the applied load takes place, characterized by functional adaptive changes in the existing functional systems. Adaptive changes, starting during the implementation of training loads continue over the next 12-24-48 hours during the recovery (Whelton et al, 2002). This means that training loads only launch a number of functional adaptation mechanisms, which after training and during recovery, continue and grow into a number of adaptive structural changes that by optimal repetition and frequency of training loads result in stable, long-term adaptable changes.

According to the degree of the increase of functional capabilities, certain training loads will induce fewer and fewer adaptive changes, which means that the recovery period will be followed by a lower and lower supercompensation level. Hence, training load will cease to exert the training effects after a while. This means that the training load should be gradually increased in accordance with the level of training increase (Heimar and Medved, 1997). Therefore, the necessity of the optimum load application in order to create the greatest possible supercompensation (progress and benefit from training) and thus achieve maximum adaptation that implies maximum utilization of genetic potential, basically lies in the principle of adaptation in the training process.

An increasing number of children and youth get involved in training work in sports clubs or as a part of school sports sections. In this way, owing to the increased intensity and scope of the exercise, a statistically significant increase in certain parameters of anthropological characteristics is often detected in them when compared to their peers who are not involved in sports.

A good knowledge of the internal structure and differences in dimensions of anthropological characteristics of student athletes and non-athletes is important to structure curriculum and training content aimed to optimize the results of physical education curriculum and training process, which would contribute to the coordinated development of students.

The aim of this study was to determine differences in motor and functional abilities between athlete and non-athlete students. By realizing such an objective, the establishment of more rational procedures for optimal planning and programming in physical education and sports clubs would be enabled and purposeful guidelines for their further desired anthropological development would be determined.

# METHOD OF RESEARCH

## Sample of participants

The sample of 52 subjects, the seventh grade students of primary school "Vožd Karađorđe" in Niš, aged 13 ± 6 months, was divided in two sub-samples: the subsample of athletes (N=26) and the subsample of non-athletes (N=26). The participants from the subsample of athletes, took part in training processes in collective sports: soccer (N=11); basketball (N=9); handball (N=6), for at least two years in a club. The second subsample of non-athletes (N=26), included students who apart of regular Physical Education classess, were not involved in any training process.

All subjects gave consent and voluntarily participated in the survey. They were explained the protocols for the evaluation of functional and motor abilities.

## Sample of measuring instruments

The sample of measuring instruments for the assessment of participants' motor abilities was composed by dimension of repetitive strength estimated by standard tests: squats (MČUČ), chin-ups (MZGI) and sit-ups in 60 seconds (MSU60). The applied set of motor tests was taken from the site Topend sport, http://www.topendsports.com/testing/tests/index.htm.

Functional abilities were evaluated by using the following tests: Pulse frequency after the load (FPPO), Margaria test (FMARG) and Vital lung capacity (FVKPL). Functional tests were selected according to the research of Heimer & Medved, 1997.

All measurements were performed in the first semester of 2015/16 school year, in accordance with the standard methodological requirements.

## Data Processing

In order to determine the intergroup differences in motor and functional abilities between the subjects who are athletes and those who are non-athletes, the multivariate analysis of variance (MANOVA) was used, while the differences between the groups for each individual variable were determined with the use of the univariate analysis of variance (ANOVA). Data processing was conducted with the use of the software package Statistica for Windows, version 8.

# RESULTS

**Table 1** The multivariate analysis of variance (MANOVA) between the group of athletes and the group of non-athletes in terms of motor abilities

| Wilks' Lambda | Rao'F | P-level |
|---|---|---|
| .782 | 6.42 | .000** |

Legend: Wilks' Lambda – the value of the coefficient of Wilks' Lambda test for centroid group equality; Rao'F – the value of the F-test coefficient for the significance of Wilks' Lambda; P – the coefficient of significance of the differences between the centroids of groups. * - statistically significant difference.

In Table 1, the data of the multivariate analysis of variance of motor abilities between the groups of students - athletes and those who are non-athletes, are presented.

From this table can be noticed that at multivariate level, groups of athletes and non-athletes statistically significantly differ in motor abilities, since Wilk's Lambda has a value of 0.782, which gives with the Rao'F coefficient of 6.42, the level of significance P = .000.

The results show that pupils who are athletes have statistically significantly better values of the motor abilities than the pupils who are non-athletes.

**Table 2** The univariate analysis of variance (ANOVA) between the group of athletes and the group of non-athletes in terms of motor abilities

| Variable | Mean (SP) | Mean (NS) | F-relation | P |
|---|---|---|---|---|
| MČUČN | 57.91 | 39.40 | 11.82 | .001* |
| MZGIB | 8.53 | 6.48 | 8.30 | .004* |
| MSU60 | 32.53 | 24.48 | 19.49 | .000* |

Legend: Mean – arithmetic means SP – students athletes NS – students non-athletes F-relation – value of the F-test, the significance of the difference in means; P – the coefficient of significance of the differences between the arithmetic means; * - statistically significant difference

In table 2, the univariate level of analysis of variance, between subjects athletes and non-athletes in motor abilities tests, is present. On the bases of the F - relation coefficients and their signifficance P-Levels, it can be concluded that there are statistically significant differences between athletes and non-athletes in all the applied motor tests: squats, chin-ups and sit-ups in 60 seconds.

**Table 3.** The multivariate analysis of variance (MANOVA) between the group of athletes and the group of non-athletes in terms of functional abilities

| Wilks' Lambda | Rao'F | P-level |
|---|---|---|
| .748 | 4.35 | .003** |

Legend: Wilks' Lambda – the value of the coefficient of Wilks' Lambda test for centroid group equality; Rao'F – the value of the F-test coefficient for the significance of Wilks' Lambda; P – the coefficient of significance of the differences between the centroids of groups. * - statistically significant difference.

Based on the results obtained by a multivariate analyses of variance (MANOVA), which show the significance of the differences in means of the two groups of participants – students who are athletes and non-athletes, it can be noticed that a statistically significant difference in functional abilities does exist, since Wilk's Lambda has a value of .748, which gives with the Rao's F- coefficient of 4.35, a statistically significant difference at the P = .003 level.

**Table 4** The univariate analysis of variance (ANOVA) between the group of athletes and the group of non-athletes in terms of functional abilities

| Variable | Mean (SP) | Mean (NS) | F-relation | P |
|---|---|---|---|---|
| FFPPO | 138.20 | 142.54 | 2.52 | .126 |
| FVKPL | 2652.00 | 2470.00 | 5.68 | .003* |
| FMARG | 3.85 | 4.15 | 4.54.82 | .002* |

Legend: Mean – arithmetic means SP – students athletes NS – students non-athletes F-relation – value of the F-test, the significance of the difference in means; P – the coefficient of significance of the differences between the arithmetic means; * - statistically significant difference

By analyzing the data presented in the table 4, we can notice that in the functional abilities, at univariate level, statistically significant differences between the athletes and non-athletes were noticed in two of three applied functional tests. Students athletes achieved statistically significantly better results in Margaria test (FMARG) and Vital lung capacity (FVKPL), while for the Pulse frequency after the load test (FFPPO) no statistically significant difference between athletes and non-athletes was noticed.

# DISCUSSION

The present research was designed to study the differences between motor and functional abilities in athletes and non-athletes students, age 13.

The MANOVA results (Table 1 and 3), show that there are statistically significant intergroup differences between athlets and nonathlets in both motor and functional research spaces.

The results of the univariate analysis of variance – ANOVA (Table 2), show that there are statistically significant intergroup differences in all the applied motor tests for the estimation of repetitive strength: squats (MČUČN), chin-ups (MZGIB) and sit-ups in 60 seconds (MSU60). It can be assumed that training process in sport clubs was properly methodologicaly shaped in all its segments, bigining of planning and programming, chosing operators of works, dosing, distribution and control of applied loading, fully adjusted to suit the needs and interests of the subjects. Intergroup differences in these tests, acording to some researchers (Malacko & Rađo, 2004; Bompa, 2006; Stefanović, 2006; Prahović & Protić, 2007), can be explained by increasing of muscle mass and decreasing of body fat in sportsmen. For performing strength tests, fat is non-functional tissue, so it won't contribute to the higher number of performance and will simply weigh athlets down. The fact is that, the higher the muscle mass and the lower the body fat, the result in repetitive strength tests will be better. If we compare two individuals with the same body weight, the leaner one is expected to win out in strength tests.

Accordingly, students athlets have an optimal body composition - more muscle mass and less body fat and that is why there are statistically significance differences in repetitive strenght tests between athletes and nonathletes. In order to achieve better result in all applied motor tests, students nonathletes should improve and maintain muscle mass and strength while decreasing body fat.

But, these are not the only factors that influence result efficiency in strenght tests. When it comes to chin-ups, a strong grip is also an asset. Besides, building arms, shoulders and back strength will help in achieving better results in chin-ups. Improvement of the muscle capacity indices depends on the nature of the physical load: muscle strength indices increased more in the cyclic sports group.

Besides in chin-ups, students athlets achieved better results in test squat. For performing this exercise, dominant muscles are frontal thigh muscle, gluteus, lateral and straight abdominal muscles, than back extensor and calf muscle. Thus, not only does this exercise build muscle in lower body, it also strengthens upper half as well. The main force is coming from the buttock muscles. This exercises is beneficial to bild core muscles, i.e. the belly and lower back. Extensor muscles as well as lateral and straight abdominal muscles stabilize the movement and are being worked with each squat. In order to improve results in squats test, students should dial in their technique first, because, as with any other exercise, the technique is crucial. Athletes also achieved better results in sit-ups test for 60 second, due to their stronger belly muscles.

In this paper, the results of MANOVA analysis (Table 3) also showed statistically significant intergroups differences between athletes and non-athletes in functional abilities tests. At univariate level, the results of the ANOVA analysis (table 4), show statistically significant differences in two of three applied functional abilities tests - Margaria test (FMARG) and Vital lung capacity (FVKPL), in favour of athletes, while in test Pulse frequency after the load (FFPPO), intergroup comparisons showed no statistically significant difference.

It is well known that regular sport training is an important external factor affecting the functional parameters of accelerated changes in the cardiovascular system, so that students athletes have well –developed functional capacity. A number of studies have already highlighted the positive effects of physical exercise, in the conditions of long-term adaptation to physical loading, on the functional state of cardiovascular system (Fox et al, 1993; Heimar & Medved, 1997; Whelton et al., 2002; Duraković, 2008; Radovanović et al., 2005; Branković et al., 2009). Long-term physical load results in heart and vascular system adaptation changes and lead to enhanced CVS functional capability.

During the period of intensive growth of the human body in the first ten to fifteen years of life, heart rate has the main role in increasing the efficacy of the heart during physical exercise. Exercising on a regular basis can reduce athlets resting heart rate and is considered a healthy and beneficial adaptation.

Within the possible endogenous factors influencing the heart rate at the studied age, there could be maturation processes related with neuro-humoral influences and changes of the sympathetic and parasympathetic influences on the cardiac function (Duncker & Bache, 2008), and at least they are parts of the intrinsic modifications.

It is necessary to take into account the fact that the athletes' physical maturity and functional ability indicators are also the outcome of a selection process and adaptation dynamics (Wilmore & Costill, 1994).

# CONCLUSION

The multivariate and univariate analysis of variance (MANOVA-ANOVA) revealed statistically significant intergroup differences between the two groups of athletes and non-athletes in all of the the studied variables for repetitive strength evaluation.

In functional spaces, MANOVA analysis showed statistically significant intergroups differences, while, at univariate level, ANOVA showed statistically significant differences in two of three applied functional abilities tests.

It can be concluded that there are significant differences between athletes and non-athletes in variables of repetitive strength and funcional abilities in favor of athletes.

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# SOME PSYCHOLOGICAL CORRELATES OF ACADEMIC SUCCESS AT THE FACULTY OF SPORT AND PHYSICAL EDUCATION

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## SUMMARY

The aim of this study was to determine the psychological correlates which affect the average mark during the studies and the duration of studies at the Faculty of Sport and Physical Education in Nis. The sample consisted of 77 students who have completed undergraduate studies at this faculty, the measured psychological variables being intelligence, emotional competence and achievement motivation. All three variables significantly correlate with the average mark, and the last two with academic efficiency as well. A set of predictor variables comprised of intelligence, emotional competence and achievement motivation explains even 66.7% of the average mark criterion variable during studies. The same set can explain 48.4% of the variability of duration of studies criterion variable.

## INTRODUCTION

It is a common notion that academic achievement is influenced by numerous factors the most important of which are abilities, motivation and certain personality traits. Kvaščev and Radovanovic (1986) say that the success in learning can be best predicted by the interaction of personality traits and abilities. The survey conducted on students of psychology show that there is a statistically significant correlation between intelligence and the average mark, but not between intelligence and a period of studying (Hanak, 1999). The study shows that the conscientiousness as a personality trait is significantly correlated with the period of studying.

There are many factors that influence the (in) efficiency of studying in Serbia, which can be divided into two groups: the extra-systemic (individual, family and general social) and intra-systemic (relating to universities and colleges) (Jarić, 2009). This paper deals with individual factors of academic success, namely its psychological correlates with students of the Faculty of Sport and Physical Education. Studying at the faculty has specific characteristics compared to other faculties, the most distinguishing of which is the one related to the abilities required to acquire the course successfully. Unlike the other faculties, at the Faculty of Sport it is necessary to have not only intellectual but also motor skills which, to a large extent, determine academic success.

The aim of this study was to determine the correlation between certain psychological variables and the academic success at the Faculty of Sport and Physical Education. Academic success criterion is determined by average mark and duration of studies, and psychological variables are academic (classical) intelligence, emotional intelligence and achievement motivation.

The definition of emotional intelligence has been changing over time. First, Salovey and Mayer, who made the first hierarchical model of emotional intelligence (Salovey & Mayer, 1990), defined it as the ability to monitor one's own and other people's emotions and the implementation of the information obtained by such monitoring in one's thinking and behavior. Such an ability, according to that definition, included assessment and expression of one's own and other people's emotions, control of these emotions and their use in adaptation. The same authors (Mayer, Caruso & Salovey, 1999), completed the definition and specified four skills that emotional intelligence is comprised of.

The greatest concern related to emotional intelligence is whether it is an ability or a personality trait. This concern primarily comes from the operationalization of the subject of measurement. Authors who are committed to observing the emotional intelligence as a trait, operationalize it through self-assessment questionnaires (like most personality tests) and also refer to it as a trait of emotional self-efficacy (Petrides, 2011). Takšić (1998, 2002) assumes tri-factor structure of emotional intelligence (or emotional competence, as he also calls it) consisting of the following factors: the ability to identify and understand emotions, the ability to express and name emotions and the ability to manage emotions. Students of the Faculty of Sport and Physical Education, who do or prefer martial arts and gymnastics, have a more prominent overall emotional intelligence and are better at managing their emotions (Todorović, Marković, Mitic, Mitrovic, 2013). The ability to express and name emotions is higher in students of sports high schools compared to students of 'normal' high schools (Takšić et al., 2005). The importance of emotional intelligence for sports performance is also discussed in transparent studies (Stanimirović & Hanrahan, 2010).

Achievement motivation is intrinsic social motive. McClelland defined achievement motivation as 'a tendency to make an effort to achieve and accomplish something considered valuable by means of which the person will distinguish oneself from the others'(McClelland, 1953, according to Roth, 2010, p. 289). According to Atkinson (Atkinson, 1964), achievement motivation consists of two components:

1. a motivation to succeed and subjective probability of achieving success,
2. a motivation to avoid failure and subjective probability of experiencing failure.

People who have developed achievement motivation show a habit of making long- term plans and formulating their objectives more clearly (Roth, 2010). Female students at the Faculty of Sport and Physical Education had a higher expression of the general achievement motivation compared to male students of the same faculty (Lazarevic & Trebješanin, 2007). A recent achievement motivation research in our country (Franceško, Mihic & Bala, 2002) indicates the existence of four first-order factors: persistence in achieving goals, competition with others, goal accomplishment as a source of satisfaction and planning orientation. However, these factors are not independent and significantly correlate with the total score.

# METHODOLOGICAL PART

The aim of this paper is to examine the connection between psychological variables with the academic success at the Faculty of Sport and Physical Education. The academic success criterion is determined by average mark and duration of studies psychological variables being academic (classical) intelligence, emotional intelligence and achievement motivation.

In a sample of 77 students who have completed a four-year undergraduate studies and enrolled Master studies in 2015/16 academic year, the following instruments were applied:

1. In order to assess the cognitive abilities we applied KOG 3 (Wolf, Momirović and Džamonja, 1992) which consists of the following tests: IT-1 – a test for assessing the effectiveness of perceptual processing; AL-4 - test for assessing the efficiency of serial processing; S-1 - test for assessing the efficiency of parallel processing. The answers to the test are transposed on the z-scale and IQ was determined for each respondent.
2. Emotional competence questionnaire (UEK-45) (Takšić, 2000) is a shortened version of the UEK-136 questionnaire and consists of 45 statements to which the respondent replies by circling one of the numbers offered on a five-point Likert scale. The replies represent the respondent's assessment of the development of their own abilities related to emotional competence.
3. Instrument for determining achievement motivation is MOP2002 (Franceško, Mihic & Bala, 2002) which consists of 55 items that are formulated as statements, and respondents assess the level of agreement on a five-point Likert scale.

# RESEARCH RESULTS

**Table 1.** Correlation of intelligence (IQ), emotional competence, motivation achievement with the average mark during studies and duration of studies

| | | IQ | Emotional competence | Achievement motivation | Average mark during studies | Days of studying |
|---|---|---|---|---|---|---|
| IQ | Pearson Correlation | 1 | .064 | .281(*) | .286(*) | -.173 |
| | Sig. (2-tailed) | | .583 | .013 | .012 | .132 |
| | N | 77 | 77 | 77 | 77 | 77 |
| Emotional competence | Pearson Correlation | 064 | 1 | 412(**) | .544(**) | -.678(**) |
| | Sig. (2-tailed) | .583 | | .000 | .000 | .000 |
| | N | 77 | 77 | 77 | 77 | 77 |
| Achievement motivation | Pearson Correlation | .281(*) | .412(**) | 1 | .784(**) | -.459(**) |
| | Sig. (2-tailed) | .013 | .000 | | .000 | .000 |
| | N | 77 | 77 | 77 | 77 | 77 |
| Average mark during studies | Pearson Correlation | .286(*) | .544(**) | .784(**) | 1 | -.579(**) |
| | Sig. (2-tailed) | .012 | .000 | .000 | | .000 |
| | N | 77 | 77 | 77 | 77 | 77 |
| Days of studying | Pearson Correlation | -.173 | -.678(**) | -.459(**) | -.579(**) | 1 |
| | Sig. (2-tailed) | .132 | .000 | .000 | .000 | |
| | N | 77 | 77 | 77 | 77 | 77 |

The results showed that there is a positive correlation between intelligence (IQ) and achievement motivation, where a statistically significant correlation was found ($r = .281$; $p < 0.05$).

It was shown that students who have higher intelligence also achieve higher average marks during studies ($r = .286$; $p < 0.05$).

It was found that there is a positive correlation between the level of emotional competence and achievement motivation ($r = .412$; $p < 0.05$), but also that students who have a higher emotional competence have better marks during studies ($r = .544$; $p < 0.05$) .

In accordance with the aforementioned findings there is also the fact that a negative correlation exists between the level of emotional competence and achievement motivation on the one hand, and the average duration of study on the other, and that emotionally more competent students who have highly expressed achievement motivation complete given academic programs in a shorter period of time. The resulting correlations are statistically significant ($p < 0.05$).

Considering the findings mentioned above, the procedure of the linear regression analysis was conducted in order to check whether, on the basis of the students' expression of intelligence (IQ), emotional competence and achievement motivation, average mark achieved during studies can be predicted.

**Table 2a.** Prediction of average mark achieved during studies based on intelligence, emotional competence and achievement motivation expression

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .825(a) | .680 | .667 | .42810 |

**Tabela 2b.** Prediction of average mark achieved during studies based on intelligence, emotional competence and achievement motivation expression

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 28.459 | 3 | 9.486 | 51.762 | .000(a) |
| | Residual | 13.379 | 73 | .183 | | |
| | Total | 41.837 | 76 | | | |

**Tabela 2c.** Prediction of average mark achieved during studies based on intelligence, emotional competence and achievement motivation expression

| | | Unstandardized Coefficients | | Standardized Coefficients | | |
|---|---|---|---|---|---|---|
| Model | | B | Std. Error | Beta | t | Sig. |
| 1 | (Constant) | -4.481 | 1.089 | | -4.113 | .000 |
| | IQ | .010 | .008 | .086 | 1.250 | .215 |
| | Emotional competence | .015 | .004 | .272 | 3.739 | .000 |
| | Achievement motivation | .049 | .006 | .648 | 8.560 | .000 |

**Table 3a.** Prediction of average mark achieved during studies based on intelligence, emotional competence and achievement motivation expression

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .710(a) | .505 | .484 | 285.139 |

**Tabela 3b.** Prediction of average mark achieved during studies based on intelligence, emotional competence and achievement motivation expression

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 6044017.761 | 3 | 2014672.587 | 24.780 | .000(a) |
| | Residual | 5935192.057 | 73 | 81304.001 | | |
| | Total | 11979209.818 | 76 | | | |

**Tabela 3c.** Prediction of average mark achieved during studies based on intelligence, emotional competence and achievement motivation expression

| | | Unstandardized Coefficients | | Standardized Coefficients | | |
|---|---|---|---|---|---|---|
| Model | | B | Std. Error | Beta | t | Sig. |
| 1 | (Constant) | 6536.489 | 725.589 | | 9.009 | .000 |
| | IQ | -4.904 | 5.154 | -.082 | -.951 | .345 |
| | Emotional competence | -17.136 | 2.612 | -.594 | -6.560 | .000 |
| | Achievement motivation | -7.716 | 3.804 | -.191 | -2.028 | .046 |

The results obtained by regression analysis (shown in tables 2a, 2b and 2c) indicate that, on the basis of the obtained model, 66.7% (Adjusted R square = .667) of the variability criterion variable (average mark achieved during studies) can be explained based on a set of predictor variables comprised of intelligence (IQ), emotional competence and achievement motivation. The resulting model is statistically significant (P = .825; p <0.05).

The possibility of achieving a good prediction of the average duration of study on the basis of a set of predictors (intelligence, emotional competence and achievement motivation) was also tested.

The research findings presented in tables 2a, 2b and 2c indicate the possibility that on the basis of a set of predictors, expressed through the students' intelligence (IQ), emotional competence and achievement motivation, 48.4% of the variability criterion variable (R square = ADJUST. 484) can be explained, which in the case of our study is the average duration of studies. The aforementioned model, on the basis of which the indicated prediction is realized, is statistically significant (P = .710; p <0.05).

# DISCUSSION AND CONCLUSION

The results obtained in this study are consistent with theories (Kvaščev & Radovanovic, 1986), which point out the fact that academic success can be viewed only through the interaction of students' abilities and personality traits. Intelligence as an ability is in a statistically significant correlation with the average marks during studies which is a similar finding to the results obtained in studies dealing with similar issues on a sample of students from other faculties (Hanak, 1999). However, the level of intelligence is not significantly correlated with the duration of studies. It should be noted here that, unlike other faculties, intellectual skills are not the only ones that are required for successful studies. Motor skills, which are not included in this study, are also, to a great extent, necessary for it. An interesting finding is that the expression of achievement motivation and emotional competence is in a statistically significant correlation with the average mark and a period of study. The difference is that the achievement motivation correlates most intensively with the average mark (even 0.784), whereas emotional competence has the strongest correlation with the duration of studies (-0.678).

A set of predictor variables comprised of intelligence, emotional competence and achievement motivation explains even 66.7% of the variable criterion of the average marks during studies. The same set can explain 48.4% of the variability of duration of studies variable criterion. The limitation of this study lies in the fact that it is a sample that consists of one generation of master students. The extension of the sample and the introduction of two more variables that could be significant: motor skills and personality traits according to a five- or a six-factor model, can be proposed for future research.

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# MOTOR ABILITIES OF BOYS AGED 7-8 YEARS OF DIFFERENT RESIDENTIAL STATUS

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## SUMMARY

A sample of 87 pupils - boys, first-grade of primary school, from the municipality of Vukovar, was divided into two subsamples on the basis of the place of residence (50 from primary schools in the city of Vukovar as urban place of residence, and 37 from rural primary schools, as rural areas of this municipality). A battery of eight tests for the area of motor abilities was used in this study (polygon backwards, standing long jump, hand tapping, 20 m standing start running, 60 sec sit-ups, three-balls slalom, chin-up endurance, sitting wide-legged forward bend). After the testing, the results in the refered area of motor abilities of male pupils showed statistically significant differences between the groups on multivariate, collectively observed level. The analysis of individual variables used in the research revealed statistically significant differences in the variables polygon backwards,standing long jump, hand tapping, 20 m standing start running and 60 second sit-ups, in favor of pupils with the place of residence in rural parts of the municipality of Vukovar. In the variable three-balls slalom, used to evaluate the coordination, statistically significant difference was found in favor of pupils with the place of residence in urban area of the municipality of Vukovar. Based on these results, the contribution of the specificity of place of residence to distinguishing the groups of first-grade primary school pupils can be assumed, in the area of their motor abilities.

**Keywords:** motor abilities, boys, place of residence

## INTRODUCTION

Particularly important for proper overall growth and development of a young person is an optimal level of motor abilities, exogenous and endogenous factors. Lately, we can talk about phenotypic impact on development of motor abilities of school children (Umstattd Meyer et al., 2014). The residential status can be one of the factors that lead to differences in motor functioning of primary school children (Bathrelloue et al., 2007; Tinazci, Emiroğlu, 2010; Mitrović, 2012). A sustained and systematic physical activity of structured or unstructured type is required for motor development of children. Therefore, the quality of teaching in schools, as well as creating the habit to properly use free time, by dedicating significant attention to organized physical exercise and movement is, from kinesiology perspective, the primary pedagogical and educational task in both urban and rural areas. Physical education is a complex educational process that begins in preschool institutions and lasts until higher education institutions.

In the last few decades, motor abilities have been one of the frequent objects of study in the field of physical culture. The level of development of motor abilities in pupils is significantly conditioned by their proper overall growth and development. In the last two decades the researchers are indicating the more pronounced decrease in physical activity of children in our country (Bala, G., Popović, B. 2007), neighboring countries (Strel, Bizjak, Starc and Kovač, 2009), as well as in developed countries (Wedderkopp, Froberg, Hansen & Andersen, 2004). The results speak about the insufficient extent, but also about the teaching quality for primary school children, even about the way of organizing, as subject or classroom teaching (Stamatović, 2001). In addition to organized activities within the educational institutions of different levels, very important are the activities within the so-called free time. Current status of children and young people is characterized by a negative trend in motor and functional abilities, and instead of growth of these abilities with the child's age, they decrease, and the possible cause is, also, increased limit of muscular exertion (Cvetković, Obradović and Krneta, 2007).

The belief, and the results of not a large number of researches, point to the distinction of children of different status on the basis of the place of residence, in the area of motor abilities. This issue is addressed by several researchers (Eiben, Barabás, & Németh, 2005; Badrić and Petračić, 2007; Bathrellou, Lazarou, Panagiotakos, Sidossis, 2007; Petrić, 2009; Tinazci & Emiroğlu, 2010), and they pointed to the existence of differences in motor area of children of different residential status. By comparing the motor abilities of young school children of different residential status, different results were obtained, from the higher levels of the same in children from rural areas, children from urban areas, undetermined differences or, most often, differences only in certain motor abilities (Čeleš, Hadžikadunić, Hadžikadunić and Kozić, 2007; Badrić and Petračić, 2007; Tinazci & Emiroglu, 2010).

Subject of the current research were motor abilities (explosive leg strength, flexibility, repetitive strength of the torso, static strength of arms and shoulders, coordination, speed of movement and speed of alternate arm movements) in first-grade primary school boys from urban and rural areas of the municipality of Vukovar (Republic of Croatia). The aim of the research was to determine the difference in the area of motor abilities of boys aged 7 - 8 years of different residental status, ie. urban and rural areas of the municipality of Vukovar. The hypothesis of the research is defined by belief of existence of statistically significant difference in the level of motor abilities between the groups of boys, first-grade primary school pupils, with a place of residence in urban or rural areas of Vukovar municipality.

# METHODS

## Subjects

Determination of motor abilities was carried out on a sample of 50 subjects, boys attending the first grades of primary schools (aged 7 - 8): Primary school "Nikola Andrić" and Primary School "Siniše Glavaševića" in Vukovar, who were subjects with urban place of residence and 37 boys - subjects, PS "Čakovci" from Čakovci, PS "Ilača-Banovci" from Ilača and Banovci, PS "Negoslavci" from Negoslavci and PS "Markušica" from Markušica, as a group of pupils from rural areas of the municipality of Vukovar.

## Procedure

Standardized motor tests were used for the assessment of motor abilities in young school children

I To evaluate the factors of movements structuring:

1) Polygon backwards (0.1 s),
2) Standing long jump (cm)
3) Three-balls slalom (0.1 s),
4) 20 m standing start running (0.1 s),

II To evaluate the factors of functional synergy and muscle tone control:

5) Hand tapping (freq.),
6) Sitting wide-legged forward bend (cm),

III To evaluate the factors of motor units excitation duration:

7) 60s sit-ups (freq.),
8) Chin-up endurance (0.1 s).

Before the begining of the research, the questionnaires were handed to the parents of the children, while respecting the ethical principles, and the parents (guardians) approved, with their signature, the testing of their children (Declaration of Helsinki). Assessment of motor abilities was carried out in the halls for physical education in schools in Vukovar, Čakovci, Banovci, Negoslavci and Markušica (Republic of Croatia) at the beginning of April 2014. The realization of the research took place in school halls of the mentioned primary schools. The research was helped by trained measurers.

## Statistical analysis

Basic descriptive statistics were determined for all variables, both subsamples in the study: arithmetic mean (AM), standard deviation (S), minimum (MIN) and maximum measurement results (MAX) and the coefficient of variation (CV%). Normality of distribution was found by Kolmogorov-Smirnov test. To determine the existence of differences at the level of motor abilities between groups of pupils of different residential status, we used the multivariate (MANOVA) and univariate (ANOVA) analysis of variance to determine the individual differences.

# RESULTS

The results of descriptive statistics for subjects from urban areas (Table 1), indicate a remarkable variability of motor abilities of boys in most of the analyzed variables, which may be the result of a different level of development of these abilities in the given sample and the age of the boys, and conditions in which they develop and live. The largest variability of results was observed in the variable for the assesment of factors of motor units excitation duration, *chin-up endurance*, in both subsamples of subjects. The greatest variations of the results were observed, with the emphasis that there were the subjects who did not manage to stay up even for one second. (Minimum recorded score was 0 seconds in both subsamples).

Taking into account the results of descriptive statistics of motor variables for subjects from rural areas (Table 1), in variables for evaluation of factors of movements structuring, *Standing long jump* and *20 m standing start running*, there was a homogeneity of results, while in other variables we observed an increased variability.

By observing the results (Table 1) it can be concluded that statistically significant deviations of obtained distribution of results from the normal distribution in subjects from urban and rural areas (p> 0.05) were not recorded.

**Table 1** Descriptive statistics of the motor variables in subjects from **rural** areas

| Variable | Group | AM | S | MIN | MAX | CV (%) | pKS |
|---|---|---|---|---|---|---|---|
| Polygon backwards (0.1 s) | Urban | 261.21 | 89.90 | 137 | 650 | 34.42 | 0.13 |
| | Rural | 163.22 | 28.82 | 119 | 270 | 17.35 | 0.43 |
| Standing long jump (cm) | Urban | 128.43 | 14.59 | 87 | 157 | 11.36 | 0.30 |
| | Rural | 144.70 | 14.79 | 95 | 173 | 10.22 | 0.62 |
| Three-balls slalom (0.1 s), | Urban | 374.56 | 77.62 | 242 | 601 | 20.72 | 0.77 |
| | Rural | 453.63 | 104.52 | 325 | 710 | 23.04 | 0.07 |
| 20 m standing start running (0.1 s) | Urban | 50.96 | 4.39 | 43 | 62 | 8.61 | 0.88 |
| | Rural | 44.70 | 3.72 | 41 | 59 | 8.32 | 0.26 |
| Hand tapping (freq.) | Urban | 20.41 | 3.63 | 14 | 28 | 17.79 | 0.20 |
| | Rural | 21.67 | 3.21 | 16 | 28 | 14.81 | 0.97 |
| Sitting wide-legged forward bend (cm) | Urban | 35.89 | 8.36 | 17 | 58 | 23.29 | 0.08 |
| | Rural | 38.48 | 6.63 | 26 | 56 | 17.23 | 0.98 |
| 60s sit-ups (freq.) | Urban | 22.97 | 8.04 | 4. | 42 | 35.00 | 0.65 |
| | Rural | 31.33 | 6.74 | 20 | 51 | 21.51 | 0.90 |
| Chin-up endurance (0.1 s) | Urban | 98.97 | 83.14 | 0 | 337 | 84.00 | 0.18 |
| | Rural | 158.59 | 111.51 | 0 | 430 | 70.31 | 0.54 |

*Legend: AM - arithmetic mean; S - standard deviation; MIN - minimum recorded measurement result; MAX - maximum recorded measurement result; CV (%) - coefficient of variation; pKS - level of statistical significance of Kolmogorov-Smirnov test*

**Table 2** Differences in motor variables between the groups of pupils depending on the place of residence

| Variable | f | p | F | p |
|---|---|---|---|---|
| Polygon backwards | 30.69 | **0.00** | 9.20 | **0.00** |
| Standing long jump | 24.06 | **0.00** | | |
| Three-balls slalom | 16.54 | **0.00** | | |
| 20 m standing start running | 42.87 | **0.00** | | |
| Hand tapping | 2.46 | 0.12 | | |
| Sitting wide-legged forward bend | 2.13 | 0.15 | | |
| 60 second sit-ups | 22.95 | **0.00** | | |
| Chin-up endurance | 8.22 | 0.01 | | |

*Legend: f - univariate F-test; p - level of statistical significance of the F-test; F - multivariate Wilkis' F-test; p - statistical significance of the multivariate F-test*

By observing the results of the multivariate Wilks' Lambda F-test (Table 2), it can be concluded that there are statistically significant differences (P = 0.00) in terms of motor abilities of boys from urban and rural areas with the value of F=9.20. It is concluded, by individual observation of motor variables, that these differences exist in the variables (Table 2):

1. *Polygon backwards (p=0.00),*
2. *Standing long jump (p=0.00),*
3. *20 m standing start running (p=0.00),*
4. *60 second sit-ups (p=0.00),*
5. *Chin-up endurance (p=0.01) in favor of boys from rural areas and variables*

6. *Three-balls slalom (p=0.00) in favor of boys from urban area.*

## DISCUSSION

Physical activity of boys aged 7-8 years is largely determined by their sex, structure of movement, morphological characteristics and level of motor abilities. When analyzing the situation and differences, we should not ignore the influence of residential status (families, schools and environment). Social standards, cultural level of environment, place and role of physical education in it, are just another factors of the social environment, which can indirectly influence the overall development, including the level of motor abilities of all its members, therefore the boys, first-grade primary school pupils from the municipality of Vukovar.

Analyzing the results in terms of neurophysiological mechanisms defined by the studies on older children and adolescents, it can be concluded that the functioning of mechanism for movement structuring is very pronounced in boys, which manifests itself in motor abilities: body coordination and reorganization of movement stereotypes, as well as the mechanism for regulation of the motor units excitation duration. In the less complex movements, such as jumping, or moving backwards without additional means, statistically significant differences were in favor of the subjects from rural areas, while in the movements of increased complexity, where the coordination eye-hand and eye-foot is necessary, the domination of subjects from urban areas is observed. In more complex movements in which dominates the strength, especially of arms or legs, the subjects from the rural areas were more dominant, due to the fact that their movement is of the similar type in their spare time. By moving freely in space, playing, boys from rural areas enriched their motor skills, strengthened certain muscle groups by climbing trees, which significantly strengthened their whole body muscles, which contributed to the existence of significant difference in their favor. Maybe the life in more urban environment, faster pace, a number of information helped that children from urban areas (boys) achieve more significant and better results in more complex movements comparing to children from rural areas who live more peaceful lives. Daily engagement in certain type of activity that stimulates higher parts of the cerebral cortex, could affect the more complex coordination activities of boys from urban areas.

Results obtained in this study, between subjects from urban and rural area of the municipality of Vukovar, in the level of motor abilities, may also be explained by different socialization processes that take place within the family and the immediate environment of children – first-grade pupils. Certain differences in motor abilities manifested in this study may have been incurred in accordance with the place of residence and customs prevailing in certain parts of the populated areas or rural settlements. Therefore, we must point out that the difference in child's growing up in rural and urban areas can produce differences in motor behavior, because the impact of growing up in these areas is reflected in the behavior of individuals, and thus in their motor abilities. Subjects from rural areas were at a higher level of manifestation of strength and movement structuring, which were of less demanding and complex coordination type. Better coordination of children from rural areas, and higher level of manifestation of strength can be connected with the fact that they had more space for playing, which is prevalent in rural settlements of the municipality of Vukovar (meadows, pastures, fields where it was possible for children to develop, in accordance with their needs for movement). It can not be said that in the town of Vukovar itself there are no playgrounds or space for children to play, it is just possible that children in rural areas, unlike those in urban areas, are still less interested in video games and computers, and therefore they still have larger motoric engagement in relation to children who live in the city of Vukovar. Sedentary lifestyle is omnipresent, but maybe the children who live in rural areas of the Vukovar municipality are more involved in chores, perhaps they spend more time in the open, and thus they play more, developing their motor skills and enriching their motoric experience. Boys from smaller towns of the municipality of Vukovar have enough space to engage through playing, to gain and enrich their motor skills through activities such as climbing, running through a variety of natural obstacles during childhood, as opposed to the children who live in the city of Vukovar, with a different way of life, where their free time is differently organized. It is possible that the movement and playing in a less limited space provided the opportunity for the boys in rural areas of the city of Vukovar to more significantly enrich their motor skills, strengthen certain muscle groups and also the muscles of the whole body, which, possibly, contributed to the existence of statistically significant difference in relation to the monitored motor abilities of pupils of urban areas. At the same time, it is possible that the life of pupils in more urban environment, as is the city of Vukovar, with the faster pace of life and rapid flow of a large number of information, helped that children from urban areas achieve better statistically significant results in more complex movements in relation to the children from rural areas. Daily engagement in a certain type of activity that stimulates higher parts of the cerebral cortex, could affect the more complex coordination activities of boys from urban areas, as the city of Vukovar.

Comparing the results of the study on differences in motor area between children from urban and rural environments, many similarities with foreign authors can be found - Čeleš, Hadžikadunić, Hadžikadunić and Kozić (2007), where the differences in the type of strength were determined in favor of children from rural areas, which is described by a greater desire of the children from rural areas to compete, to prove themselves, and who were very happy about the testing. The moment of desire to prove themselves in younger school children could play a crucial role, because watching the child's motor skills, as motor skills of general type, where it reacts with its whole being, we can recognize the connection between the voluntary moment and the achieved result of measurements. In younger school children, especially first-grade pupils, motoric behavior is variable, as indicated by the results of the homogeneity of distributions in the research, so it can happen that a child does the test great one time, and it totally fails the second time, as a result of unsteady motor functioning (unstable motor skills) and moment of willingness to compete.

The influence of different anthropological factors on the efficiency of various motor tasks is complex, it depends on the level at which these factors are, and on mutual relations of all the features within the anthropological status. Since the physical activity of children should be considered as a regular, integral part of growing up, then the studies on motor abilities, on conditions and circumstances in which those develop, are becoming very important. This importance is reflected in better understanding of the development of motor abilities, as in children who are active, so in children who are passive or do not engage in physical activity.

## CONCLUSION

Results of the study have shown that there are statistically significant differences between the groups of first-grade primary school pupils in the city of Vukovar and its rural schools, in the area of the monitored motor abilities.

Based on these results, the following can be concluded:

Group of subjects - first-grade primary school pupils from the town of Vukovar showed better statistically significant results in the part of monitored motor area defined by a single variable *Three-balls slalom*, and the group of subjects - pupils from rural areas, showed better statistically significant results in the same, motor area, defined by the following individual variables: *Polygon backwards, Standing long jump, 20 m standing start running, 60 sec sit-ups, Chin-up endurance.*

In further research it would be necessary to observe the socio-economic factors and the range of morphological characteristics, which could possibly have a particular stake in the manifestation of motor abilities of younger primary school boys, and therefore the first-grade primary school pupils from the municipality of Vukovar.

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# THE EFFECTS OF AN ADDITIONAL MOTOR STRENGTH PROGRAM ON STUDENTS WHO PARTICIPATED IN CAMPING

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796.5

## SUMMARY

The sample consisted of 48 male participants, 22 to 24 years old, taken from the population of third year students from the College of Physical Education and Sport in Banja Luka. From the sample defined in this way, two subsamples were formed. The first subsample was the experimental group which included 22 participants and implemented the program of practical camping exercises and an additional motor strength program lasting 60 minutes on a daily basis. The second subsample was the control group consisting of 26 participants which engaged only in the program of practical camping exercises. The work in both groups lasted 15 days. The main goal of this research was to determine the influence of practical camping exercises and the additional motor strength program on transformational processes of certain motor abilities (repetitive strength, explosive strength and flexibility). Nine motor tests were run for evaluation of motor abilities. At the end of the experimental procedure, the results of multivariate analysis of covariance showed that the experimental group, as compared to the control group, achieved statistically better results in the observed motor abilities in initial and final measuring.

**Keywords**: students, kinesiological experiment, explosive strength, repetitive strength, flexibility, multivariate and univariate analysis of covariance.

## INTRODUCTION

Outdoor activities have a great significance in education of future professors of physical education. Technical and tactical knowledge acquired at camping trips make an effective preparation for higher quality and more independent life functioning. One of the goals of these activities is to bring camping in nature closer to students as they will be the future promoters of these kinds of stays.

Camping is a group and organized stay in nature, which typically happens in summer at a temporary placement (usually tents), with planned purpose and program, and ways of organizing life in mostly 10 to 20 days' time frame. Essentially, it is a temporary stay in nature lasting several days, near some body of water, most commonly in tents, but also in camp houses, village houses, schools, and such.

Programmed and applied training exercises during camping should first and foremost serve as obligatory education of students, and then these should also be interesting and applicable in education institutions, that is, adapted to different age groups and abilities of children and youth.

The analysis of effects of the additional motor strength program is becoming a frequent topic in scientific research (Bowerman, Freeman & Gambetta, 1998; Stanojlović & Stanojević, 1999; Malacko & Rađo, 2004; Miletic & Savić, 2006).

For the training effects to be successfully analyzed, it is important to solve the issue of programing and control of the training procedure as well as the choice of methodological procedures which are appropriate for the analyzed problem.

Organization of camping is one of the key questions when it comes to realization of education in the realm of outdoor activities, because it should contain both obligatory educational content and a recreational part, as well as the process of creating interest in that kind of school activity which is included in curricular and extracurricular programs in primary and secondary schools (Kurelić & i saradnici, 1975; Dragosavljević, 2002; Bjekovic & Dragosavljevic, 2002; Ilić, 2003; Bijelić, 2005; Stojanović, Savić, Miletic & Vukić, 2009).

Generally, every organized stay in nature that lasts longer than two days can be categorized as camping. Therefore, the main purpose of physical education and sport for students, who are the future teachers that will work with children and youth, is to educate them for life in nature via acquisition of the basic knowledge and experience during their stay in simple life conditions.

The goal of the research was to determine the differences in the level of motor abilities at the end of the experimental time between the participants of the experimental group, who were involved in the program of practical camping exercises and the additional motor strength program of exercising, and the participants of the control group who were only engaged in the program of practical camping exercises.

# METHODOLOGY

The sample consisted of 48 male participants, 22 to 25 years old, taken from the population of third year students from the College of Physical Education and Sport in Banja Luka who were participants of the practical part of examination of the camping subject.

From the sample defined in this way, two subsamples were formed. The first subsample included 22 participants that were included in the program of practical camping exercises and the additional motor strength program lasting 60 minutes every day. The second subsample consisted of 26 participants which engaged only in the program of practical camping exercises. The first subsample was the experimental group, while the second subsample was the control group. The work in both groups lasted for 15 days.

Before the beginning of the training work and after its ending after 15 days in both groups, nine tests were run to evaluate repetitive strength, explosive strength and coordination.

For evaluation of the repetitive strength, the following tests were run: sit ups on a bench (MDTŠV), pull ups (MMZGB) and squats with 30% of the load (MČUČN). For evaluation of the explosive strength: standing long jump (MSDSM), standing triple jump (MTRSK) and standing quintuple jump (MPTSK). For evaluation of flexibility: deep forward bending from the bench (MDPKL), wide leg stretches (MŠPAG) and stretching with a stick (MIPAL). These tests were chosen based on instructions and recommendations from the research performed by Kurelić and others in 1975.

The results from the applied tests at the beginning and at the end of the experimental period were processed via multivariate and univariate analysis of covariance method.

The work in the experimental group contained morning gymnastics, two walking tours in nature ranging from 6 to 24 km, orientation in nature with maps and a compass, orienteering – overcoming obstacles on a course, rowing a boat or kayak, freediving, organization and preparation of camping, learning to tie knots with a rope, sports and recreational activities, organization of entertaining activities or some form of competitions next to a fire.

The additional motor strength program in the experimental group consisted of selected exercises such as jumping while alternately lifting left and right leg with different swing amplitudes; jumping off two feet over a hurdle of 30 to 50 cm height; jumping on a lifted object with two feet or one foot take off (30–40–50 cm); long jump and high jump with explosive speed; high jump and long jump from half-squatting position, zig-zag, backward, variations of jumps with a jumping rope and similar exercises.

The research of the effectiveness of the program of practical camping exercises in the control group was performed based on the realization of the previously outlined curriculum. The structure of the program content had transformational impact on development of anthropological characteristics and increase of the technical and tactical knowledge.

# RESULTS

**Table 1.** Multivariate analysis of covariance between the experimental and control group in motor abilities at the final testing with neutralization of differences from the initial testing.

| Wilks' Lambda | F | df1 | df2 | P-Level |
|---|---|---|---|---|
| .643 | 5.35 | 9 | 48 | .000** |

Table 1 shows multivariate analysis of covariance which determines achieved effects of the experimental treatment on development of motor abilities in the experimental group as compared to the control group in the final testing with neutralization of the observed differences from the initial testing. There is a statistically significant difference on a multivariate level between the participants from the experimental group and those from the control group at the level of significance higher than 0.01 (P-level = .000), which is confirmed by the value of Wilks' Lambda test (.643) and F-test

(5.35). The existing difference is a result of the experimental treatment of practical camping exercises and the additional motor strength exercising program lasting 60 minutes every day, which positively influenced development of motor abilities in the experimental group.

**Table 2.** Univariate analysis of covariance between the experimental and control group in motor abilities at the final testing with neutralization of differences from the initial testing.

| Motor tests | GROUPS | MEAN | F-relation | N | P-Level |
|---|---|---|---|---|---|
| MDTŠV | EX. | 30.82 | 12.64 | 22 | .000** |
| | CO | 24.31 | | 26 | |
| MMZGB | EX | 13.80 | 10.53 | 22 | .001* |
| | CO | 9.07 | | 26 | |
| MČUČN | EX | 42.05 | 5.21 | 22 | .018* |
| | CO | 36.24 | | 26 | |
| MSDSM | EX | 259.40 | 7.82 | 22 | .004* |
| | CO | 246.25 | | 26 | |
| MTRSK | EX | 725.12 | 7.54 | 22 | .007* |
| | CO | 652.91 | | 26 | |
| MPTSK | EX | 986.28 | 2.26 | 22 | .041* |
| | CO | 872.47 | | 26 | |
| MDPKL | EX | 48.31 | 6.41 | 22 | .013** |
| | CO | 39.25 | | 26 | |
| MŠPAG | EX | 178.16 | 11.56 | 22 | .000** |
| | CO | 162.47 | | 26 | |
| MIPAL | EX | 52.00 | 4.04 | 22 | .047* |
| | CO | 81.43 | | 26 | |

Univariate level of analysis of covariance between the experimental and control group in evaluative tests of motor abilities at the final testing with neutralization and partialization of results at the initial testing (table 2), indicates that there is a statistically significant effect in the following exercises: sit ups on a bench (MDTŠV.000), pull ups (MMZGB.001), squats with 30% of the load (MČUČN.018), standing long jump (MSDSM.004), standing triple jump (MTRSK.007) and standing quintuple jump (MPTSK.041) deep forward bending from the bench (MDPKL.013), wide leg stretches (MŠPAG.000) and stretching with a stick (MIPAL.047) at the level of reliability of 99%.

# DISCUSSION AND CONCLUSION

This research confirmed that there are effects of the additional motor strength program on development of motor abilities in students from the experimental group that participated in camping.

The applied program of motor strength contributed positively toward transformation of tested abilities in the experimental group (table 1 and 2). At the initial testing there weren't any statistical differences for the tested abilities between the experimental and control group because all the participants had similar level of motor abilities.

At the end of the experimental period, it was proven that with the right intensity, duration and frequency of motor strength trainings, they provide an effective way of continually improving motor abilities.

The results of the research enable shedding light on and innovation of complex relations that exist in the training work on development of motor strength (methods, instruments, volume and intensity of load, individualization, relaxation intervals) significant for rationalization, optimization and effective development of motor abilities in students.

Aside from this, the research results offer a practical way for evaluation of motor abilities as they present a scientifically verified thesis to be used for planning and programming, realization and control of realization of camping trips. This approach produced positive changes in participants' organism, which resulted in higher level of motor abilities.

Validity of these results is confirmed by some other researchers (Weineck, 2000; Duraković, 2007; Memagić et al., 2011) that emphasize that a motor strength program that is properly formed affects the increase of the level of tested abilities.

Some researchers (Bompa, 2006; Milanović, 2007) explain such forms of transformatonal processes by adaptive processes that cause internal redistribution in an organism and thus cause an increase in muscular system which contributes to development of levers and ligaments.

Theoretical value of this research will be in the fact that the teachers in professional schools who deal with the realization of practical exercises within Activities in nature - subject, students of the College of Physical Education and Sports and other entities will acquire knowledge about the adaptive processes of motor strength, and this will contribute to achieving better results in realization of practical and theoretical instructions.

The results of this research can serve as a model for further researches and acquisition of scientific answers about purposefulness of the additional motor strength program. This first and foremost relates to the choice of data processing methodology and interpretation of results, methodical formation of training work, especially when it comes to application of exercising methods, and organizational and work forms.

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# RELATIONS BETWEEN MOTORIC ABILITIES ON THE RESULTS OF THE PRACTICAL EXAM IN ARTISTIC GYMNASTICS

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## SUMMARY

The aim of this research was to determine a relation between motor abilities on the results of the practical exam in Artistic gymnastics. A sample was femail students (n=41; mean ± SD age: 21 ± 6) why attended Artistic gymnastic course on the six semester at the academic year of 2013/14. in Sports science Faculty at the University of Niš. Motoric abilities (Table 1) consist of package of tests proposed by Veličković, Petković & Ilić (2010).The Bologna Process in Serbia has caused the evaluation of achievement in classes from grade 1-5, with criteria for evaluation are clearly given in the references book by Veličković, Petković & Ilić (2010), where in the pre-exam the is expected to present proper technique performance of certain elements on the gymnastic disciplines: Vault, Un. bars, Beam and Floor.A working hypothesis (H) - a statistically significant relations of motor abilities on the results in pre-exam in gymnastic course was confirmed, and proposed gymnastics curriculum is effective because it helts students to realize curriculum easier and to overcome the pre-exam in Artistic gymnastics.

**Keywords:** motoric abilities, gymnastics, pre-exam, students

## INTRODUCTION

The education system in the Republic of Serbia in the last decade has undergone major changes since school system has had to adapt to modern trends used by universities in Europe. As part of Europe but not yet as part of the European Union, the process of contemporary studies in Serbia issued the "Bologna way of collecting loans," which allows the mobility of students and studying in several universities in Europe. System of collection points during the study exists for more than 10 years in the system of higher education in the Republic of Serbia, but curricula are still continued to supplement and change. One of the subjects that are still modernize is Artistic gymnastics, which students is attending as a course curriculum at the Faculty of sport in Serbia. As an Olympic sport with a long tradition and a serious organizational structure at the top of the International Gymnastic Federation (FIG), as a curriculum for students at universities are still adjusting. Artistic gymnastics is classified as a sport of complex structures of movements (Milanović, taken from Petković et all., 2010), conventional sport that values aesthetic component of movement. Artistic Gymnastics is polystructural sports dominated by the complex structure of movement (Matveev, 1977). Due to the complex structure of movements and exercises which are made in top gymnastics program, at the universities for students should combine basic exercises that have to overcome and certain exercises with high requirements that FIG prescribes according to the Code of Points. It is very difficult for students to overcome, because this subject are attending as a course during one semester, which lasts four months. During that semester time it has to be adopted a lot of new complex elements on the various gymnastic disciplines.

The Bologna Process in Serbia has caused the evaluation of achievement in classes from grade 1-5, with criteria for evaluation are clearly given in the references book by Veličković, Petković & Ilić (2010,14), where students in pre-exam has to performe proper technique of gymnastic elements, which are connected together and form the composition. Curriculum for Aristic gymnastics course on Faculty of sport in Nis for women consists of exercises on the gymnastic disciplines: Vault, Un. bars, Beam and Floor. Gymnastic curriculum is designed and accredited study program adopted at the Faculty of sport in Nis and given a description at the references for practical training for gymnastic course by Veličković, Petković & Ilić (2010). Many studies have been conducted in order to check the given curriculum for students and their applicability. Konstataki (2015) investigated the effectiveness of problem based learning (PBL) in improving the student learning experience in sports science. Findings showed overwhelming student support of PBL as an alternative method of teaching and learning. Šibanc (2013) researched how future Slovenian physical education teachers evaluated gymnastics according to their gender and sport knowledge. Results has shown that female students gymnastics like it more than mail students. The aim of this study is to determine whether there is a relation of motor abilities on the success in the performance of exercises on different gymnastic disciplines on the practical exam in Artistic gymnastics. A working hypothesis (H) - a statistically significant relations of motor abilities (as a set of predictor variables) on the results in pre-exam in practical gymnastic course. Than it should be determined whether the proposed gymnastics curriculum is effective.

# METHODS

A sample of of this research study was femail students (n=41; mean ± SD age: 21 ± 6) why studied in Sports science Faculty at the University of Niš. They attended Artistic gymnastic course in six semester at the academic year of 2013/14. The students were all academic members and for first time attending a course in Artistic gymnastics. This module was delivered for three hours practical work every week over a period of 15 weeks. This delivery period included 12 weeks of teaching followed programm by two weeks of assessment and one week to provide feedback on assessed work. The three hour block was arranged to include a one-hour practical work for motor abilities and two hours practical session for learning given gymnastic exercises. The study was approved by the Ethics Committee of the Faculty of Sport and Physical Education, University of Niš according to the Helsinki Declaration. The statistical analysis was performed using the statistical package SPSS 18. A significance criterion was defined at the level of $p < .05$. Testing procedures for measuring of gymnastics skills was indoors at the temperatures between $16^0$-$20^0$C. Motoric abilities (Table 1) consist of package of tests proposed by Veličković, Petković & Ilić (2010). Standardization of tests determined Kurelić et all. (1975).

**Table 1.** Motoric abilities by Veličković, Petković & Ilić (2010, 64)

| N$^o$ | Codes | *Term of motor abilities* | *Description of motor abilities* |
|---|---|---|---|
| 1. | **MSDLJ** | Standing broad jump | a reflection of both feet to determine the explosive power of the lower extremities |
| 2. | **MUZM** | Jump to front support | uplift the body of the parallel bar to determine repetitive strength of arms and shoulders |
| 3. | **MODT** | Upper body liftings | Lower body is set on an elevation where the uplift is carried to the upper body in a horizontal position and determines the strength of the lower part of the back muscles |
| 4. | **MODN** | Leg lift | body from the hanging position is rising feet to $90^0$ determines the abdominal repetitive strenght |
| 5. | **MUSC** | Bodyweight squat | deep squat to the right and left leg defining leg strength |
| 6. | **MOKR** | Turns for $360^0$ | Balance of the body |
| 7. | **MPIZ** | L-sit on the bar | raising outstretched legs on bar whot determines abdominal static strength |
| 8. | **MSKL** | Push up on the bench | raising the whole body through the arm front position of the hands whot determins repetitive strenght of arms and shoulders |

The results of the evaluation of practical exam in Artistic gymnastics are described in references book by Velickovic, Petković & Ilić (2010). The scoring of tests and their transition points were described in the Standards motor abilities Veličković, Petković & Ilić (2010). People who have evaluated the performane on the gymnastic disciplines were two academic professors who are gymnastic judges national level and one academic professor with international level. Final score is presented by given the average score of all three professors. This motoric tests is taken from the battery of tests that have adopted some European countries in the selection process in gymnastics and used to verify certain motor skills, by various authors Veličković, Petković & Ilić (2010) suggested as one of the conditions for a necessary successful completion of the program in teaching gymnastics course.

Respondents had one attempt in the period which was designed curriculum to check the motor skills, while the cumulative total credits included in the pre-exam students in teaching gymnastics. Gymnastics curriculum given in course is presented as a proposal of a group of authors Veličković, Petković & Ilić (2010), which consists of a series of related gymnastic elements on four disciplines. The total number of points is designed for maximum value for performing the practical part of the course are 24. The maximum number of points that is designed to determine the value of the motor abilities is 8 points. The Bologna Process in Serbia has caused the evaluation of achievement in classes from grade 1-5, with criteria for evaluation are clearly given in Table 2.

**Table 2.** Criteria evaluation for description of performance

| Mark | ***Description of performance*** |
|---|---|
| **5** | ***Excellent*** – student performs the skill individually, without technical and aesthetic errors |
| **4** | ***Very good*** - student performs the skill individually, with minor technical and aesthetic errors |
| **3** | ***Good*** - student performs the skill individually, with midlle size technical and aesthetic errors |
| **2** | ***Sufficient*** - student performs the skill individually, with great technical and aesthetic errors |
| **1** | ***Nonsuficient*** - student is not able to perform the skill |

The model of delivery period students were attending in period of 15 weeks. A motor abilities test was implemented in the week 13, while checking an acquired knowledge of gymnastics skiils was followed at the 14 week of teaching course.

# RESULTS

In Tables 3. – 4. has shown the central and dispersion parameters of basic statistics for variables in the the space of motor skills (Table 3) and for the variables in the space of success on individual disciplinaman (Table 4).

**Table 3**. Basic statistics for motoric abilities

| Variables | Mean | Min | Max | Range | SD | Error | Skew | Kurt |
|---|---|---|---|---|---|---|---|---|
| MSDLJ | 204.88 | 165.00 | 210.00 | 45.00 | 10.154 | 1.586 | -2.2998 | 5.5265 |
| MUZM | 8.05 | 2.00 | 10.00 | 8.00 | 3.146 | 0.491 | -1.2829 | -0.1244 |
| MODT | 25.98 | 2.00 | 28.00 | 26.00 | 6.843 | 1.069 | -3.3670 | 9.9027 |
| MODN | 12.59 | 2.00 | 13.00 | 11.00 | 1.816 | 0.284 | -5.3426 | 30.5178 |
| MUSC | 10.49 | 2.00 | 15.00 | 13.00 | 5.980 | 0.934 | -0.6500 | -1.5609 |
| MOKR | 6.00 | 1.00 | 10.00 | 9.00 | 3.776 | 0.597 | -0.2918 | -1.5972 |
| MPIZ | 11.63 | 5.00 | 16.00 | 11.00 | 4.876 | 0.771 | -0.3830 | -1.7393 |
| MSKL | 21.27 | 10.00 | 23.00 | 13.00 | 3.912 | 0.611 | -2.0614 | 2.6526 |

In Table 3. based on the value of the standard deviation it can be concluded that the sample are more or less homogeneous. The highest homogeneity of the results expressed at variable Leg lift (MODN), while the results of Standing broad jump (MSDLJ) is heterogeneous.

In Table 4, which shows the basic statistics of the success rate of students in Artistic gymnastics, on the basis of the value of the standard deviation (SD), it can be concluded that the student of the success at the end of the course had roughly consistent results in all disciplines.

**Table 4.** Basic statistics for practical exam

| Variables | Mean | Min | Max | Range | SD | Error | Skew | Kurt |
|---|---|---|---|---|---|---|---|---|
| Vault | 2.52 | 0.10 | 4.00 | 3.90 | 1.280 | 0.200 | -1.0337 | -0.1962 |
| UnBars | 2.79 | 0.10 | 5.00 | 4.90 | 1.998 | 0.316 | -0.4535 | -1.6607 |
| Beam | 5.05 | 0.10 | 6.90 | 6.80 | 1.882 | 0.294 | -1.8103 | 2.5685 |
| Floor | 6.25 | 0.10 | 8.00 | 7.90 | 1.582 | 0.247 | -1.7986 | 4.5854 |

**Table 5.** Canonical analysis - isolated common factors

| | Canonicl - R | Canonicl - R-sqr. | Chi-sqr. | df | p |
|---|---|---|---|---|---|
| **0** | 0.803242 | 0.645197 | 66.84151 | 32 | **0.00** |
| **1** | 0.776095 | 0.602323 | 35.23761 | 21 | **0.03** |

Table 5. shows the common factors canonical variables mobility and success on the gymnastics course. Total kinesiology space was reduced to two canonical factors, where the first factor can be explained by the 80% and the second with 77%. The significance level of relations between the first canonical factor is explained by 100% (.00) and the second canonical factor explained 98% (.02).

Table 6. shows the Croskorelative matrix, which explains the relation of motoric abileties with success in each individual discipline among students on the gymnastics course. The results indicate that the proposed package of tests has statistical significance relations on all gymnastic desciplines with 5 motoric abilities, while the other three do not.

**Table 6.** Croskorelative matrix

| Variables | Vault | UnBars | Beam | Floor |
|---|---|---|---|---|
| **MSDLJ** | 0.39 | 0.19 | 0.15 | 0.28 |
| **MUZM** | 0.14 | 0.62 | 0.17 | 0.26 |
| **MODT** | 0.11 | -0.08 | -0.06 | 0.29 |
| **MODN** | -0.09 | -0.10 | 0.01 | -0.05 |
| **MUSC** | 0.16 | 0.40 | 0.23 | 0.61 |
| **MOKR** | 0.16 | 0.49 | 0.03 | 0.31 |
| **MPIZ** | 0.17 | 0.23 | 0.18 | 0.29 |
| MSKL | 0.15 | 0.39 | 0.08 | 0.22 |

## DISCUSSION

The results at Table 6. shows that Standing broad jump (MSDLJ) has a significant relations with the discipline Vault (.39). This is understandable because for Vault is very important leg bounce for springboard, resulting in a strong explosive leg strength, which was presented this variable. In Floor exercises there are statistically significant relations for Bodyweight squat (MUSC, .61), which explains explosive power of the lower extremities, very important for all the hops, leaps, jumps and acrobatics that is in the program exercises on the Floor.

There are no statistically significant relations between motoric abilities and success in performing exercises on pre-exam on the Beam. This can be explained that in order to maintain the balance position for exercising on the beam is necessary, MOKR was applicable, but in addition to the turns $360^0$ who were taken on the floor, it is necessary to perform a turn for $360^0$ on the beam. The exercises which are given at the beam must be modified or some of motoric abilities must be complement to affect the maintenance of the balance.

At Ubars there are statistically significant relations with four variables: MUZM ( .62), MSKL ( .39), MOKR ( .49) and MUSC ( .40). The variables MUZM and MSKL estimate the static strength of arms and shoulders, which is essential for performing exercises on Ubars. Other variables is necessary for performing mounts (MUSC) and hip circles (MOKR).

Other motor skills which had no statistically significant relation among the gymnastic disciplines doesn mean that they are not important for performing exercises. For certain motoric abilities students were physically more prepared so that the overall success on the pre- exam had more accomplishments (MSKL, MOKR, MUSC, MUZM, MSDLJ), but others didn't (MPIZ, MODN, MODT). This motoric abilities are represents static and repetitive strength of abdomen and the power of the lower part of back limb. How students are physically active because of the nature of studies that attend, these regions muscles have no relations with success in thepre-exam because the lower part of the back muscles and abdominal muscles were strong and they easier have mastered the curriculum.

## CONCLUSION

Results of analysis of individual disciplines may concluded that no one of chosen motor ability have no relation with the Beam, indicating that it is necessary to modify the other tasks that affect balance. Similar investigations was analyzed Hruša &

Hrušova (2012) where gymnastics was a subject with practical applications in the field of sports management at selected universities in the Czech Republic and to compare practical entrance exams and subjects of curricula. They analysed and compared curricula of full-time bachelor's studies of sports management, and they concluded that gymnastics is essential for body strengthening and stabilization of spine. Relationship between the function of motion system and gymnastic exercises were recommended as a basis for other sports.Curriculum generate a positive contribution to the total, which means that they are properly selected and to have relations with mastering gymnastics programs at the Faculty of sport in Nis. A working hypotheses in our research may be accepted because there are statistically significant relations of motor abilities on the success in pre-exam in practical gymnastic course. The curriculum that was proposed by a group of authors Veličković, Petković & Ilić (2010) is applicable and effective ( Table 5), because it helps students with motoric tests to realize curriculum easier and to overcome the pre-exam in Artistic gymnastics.

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# PLYOMETRIC TRAINING IN THE MUSCLE EXPLOSIVE STRENGTH DEVELOPMENT

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## SUMMARY

The aim of actual study was to determine influence of the plyometric training on the muscle explosive strength of lower extremities, during the nine month period. Totally 60 students of male and female sex, aged 17 years ± 6 months, consisted an experimental group and were involved in programmed plyometric training during the physical education classes through 11 designed polygons. Initial measurement had been done just before the start of the program and the final one upon its completion. The experimental program had been realized throughout the entire school year and performed twice a week during a physical education classes, while measurements have been made using a device Myotest. After the statistical data analysis a positive effect of the program on all tested variables of the muscle explosive strength was determined.

**Keywords:** Plyometrics, muscle strength, students, athletes

## INTRODUCTION

Only thirty years ago it was considered that the strength training, especially training with an additional load, is significant for a small number of sports (Radcliffe, Farentinos, & Schwarz 2003).

The participation of science in greater extent to the systematization, structuring, planning, programming, implementation and recognition of the impact of the training, allowed the kinesiologists to discover the many of the secrets of the human body, its needs and function. The findings that have been reached, made it possible to realize that strength training is an absolute essential in developing the fundamental skills of an athlete. In the last two decades, athletes, football players, basketball players, volleyball players, tennis players, skiers, swimmers, ... and almost all the other athletes, are considering strength training as the core of their preparation (Idrizović, 2001).

Power is a basic motor ability that has always attracted people's and expert's attention, who have attempted to adequately explain it: Opavsky (1975) identifies power with force and states that the force is an ability to transform muscle strain within the motor units into kinetic or potential form of mechanical energy. Branković & Bubanj (1997) define power as motor ability of an athlete which is being manifested in a one-off, acyclic peak muscle strain and depends on the physiological section, the length of muscles, biochemical processes that occur during the work and metabolism. Finally, they state that the mobilization and regulation of muscle strength application significantly depend on the central nervous system activity, cerebral cortex, and to a great extent on the mental functions with the domination of motivation. Power is actually a combination of force and velocity (Radcliffe, Farentinos, & Schwarz 2003), significant in performing of almost all sports skills.

Power is multidimensional motor ability, and there are many types of forces, including the muscle explosive strength. According to Herodek (2006) explosive strength is the ability of short term maximum mobilization of muscular forces, in order to accelerate the movement of the body, while Radovanović & Ignjatović (2009) state that the maximum value of the force or power that can be developed by specific muscle or muscle group in the shortest period of time referres to as the explosive force or explosive power.

According to Nejić, Herodek, Živković, & Protić (2010) jumping ability is a specific example of the explosive strength in the eccentric-concentric conditions occurring in different cyclic, acyclic and combined motor situations. When the development of explosive strength is being programmed within the physical preparation of the athletes, it is necessary to define the objectives strived. Before all, it is necessary to analyze the structure of the sport discipline and determine what type of jumping ability is dominant. Age is a very important factor for the development of explosive strength. It is known that abilities in the field of muscle power increase with age. So shall the explosive strength, both in absolute and in relative terms obtain greater value in the age of 18 years, than, for example, in the the age of 12. When it comes to the development of motor skills, at the very beginning there is a problem selecting the correct exercises, that will be most rational and efficient in development of the ability desired. There are many exercises for the development of explosive strength, and their effectiveness depends on the correctness of their performance, motivation of players, but the creativity of coaches, as well.

The aim of actual study was to determine the effect of plyometric training in duration of 9 months on the muscle explosive strength of lower extremities.

# METHODS

## Subjects

Actual research included 60 of 240 subjects, the participants of the national project OI 179024 „The differences and the influences of the maximum muscle strength on the bone mineral density between athletes and non-athletes of high school population“. High-school students of the third year of the High School of Economics in Niš, aged 17 ± 6 months (Mean ± St. Dev.), of male (N = 40) and female (N = 20) sex, were included in the following programmed training processes (sports): martial arts (N = 13), football (N = 12), volleyball (N = 9), dance (N = 6), basketball (N = 4), bodybuilding (N = 4), table tennis (N = 4 ), tennis (N = 3), handball (N = 3), swimming (N = 3). As part of the experimental group, they have conducted a special programmed plyometric training at the physical education (PE) classes.

## Procedures

Explosive strength expressed through the Countermovement jump (CMJ) is defined as the individual's ability of the subject's neuromuscular system to express muscle strain in the shortest period of time. CMJ represents plyometric exercise for the lower body. The purpose of the application of CMJ is to improve the reactivity and of explosive strength of the lower body. In order of assessment of the lower extremities muscle explosive strength, accelerometer Myotest was used (Myotest SA, Sion, Switzerland).

The muscle explosive strength measurements were conducted in a PE gym of the High School of Economics in Niš, in the morning. Immediately prior the measurement of explosive strength of the lower extremities the warming protocol was implemented. Subjects approached to the measurement in the column, one after the other. The measurement was carried out with two measurers (project realizators). Measuring instruments for assessing the muscle explosive strength of the lower extremities through CMJ were: HEIGHT (in cm), POWER (in W/kg), FORCE (in N/kg) and VELOCITY (in cm/s).

In order to determine the values of the variables of explosive strength, a special Velcro belt was placed around the vaist of subject, with device Myotest safely attached to the belt.

Experimental program duration was 9 months, and its implementation was carried out through 11 designed polygons. Initial measurement was performed before the start of the program, while final one after its completion. The experimental program covered whole school year and was performed twice a week during PE classes, under the supervision of the PE teachers and project realizators.

The program is divided into three parts (Table 1), depending on the intensity of the load during the exercise: the first part consists of the exercises of the low and low to medium load intensity such as jumps with both feet with and without a medicine ball, with the aim of developing self-confidence of the examinees (from the 1st to 6th week); the second part is comprised of the exercises of medium, low-medium and medium-high load intensity such as hurdle jumps with both feet with and without a medicine ball (from 7th to 26th week); the third part consists of high and medium high load intensity exercises such as single foot hurdle jumps with and without a medicine ball (from 27th to 36th week). Within the second and the third part of the program, a one to two week rest was planned (Bubanj et al., 2014).

**Table 1.** Guidelines for exercise dosing within plyometric program during a school year.

| Week | Intensity of load | Average number of exercises, series and repetitions during one school class |
|---|---|---|
| 1-3 | Low | 3-4 x 2 x 4-8 |
| 4-6 | Low/medium | 3-4 x 2-3 x 4-8 |
| 7-9 | Medium | 3-4 x 2-3 x 4-10 |
| 10-12 | Low/medium | 4 x 2-3 x 6-10 |
| 13-14 | Holiday/Rest | |
| 15-16 | Medium | 4-5 x 2-3 x 6-10 |
| 17-19 | Medium/high | 4-5 x 2-3 x 6-12 |
| 20-22 | High | 5 x 2-3 x 6-12 |
| 23-25 | Medium/high | 5 x 2-3 x 8-12 |
| 26 | Measurements/rest | |
| 27-29 | High | 4 x 2-3 x 10-12 |
| 30-32 | Medium/high | 3-4 x 2 x 10-12 |
| 33-35 | High | 2 x 2 x 10-12 |
| 36 | Rest | |

Each of the polygons contains exercises for speed and agility development through acceleration, deceleration and sudden direction of movement changes, then, the explosive strength of the upper, middle and lower parts of the body with the corresponding recovery and rest between exercises and series. It has been anticipated that during different exercises girls should use medicine balls weighing 4 kg and boys 5 kg.

With the purpose of conducting the effective plyometric program in PE classes, the procedures within a school class were set in the following way: 1) the introductory part of the class consisted of a five-minute warm-up activity, which implied rectilinear running, 4x30 m of forward skipping, 4x30 m of lateral skipping, 4x30 m of backward skipping, and then 5 minutes of stretching in pairs; 2) in the preparatory part of the class, the examiners had 5 minutes to explain the examinees the exercises that would be conducted in the polygon; 3) in the main part of the class, the examinees underwent the 25-minute long polygon; 4) in the final part of the class, the examiners planned muscle relaxation and the whole body recovery through light running, walking and 5-minute-long stretching in pairs (Bubanj et al., 2014).

## Statistical analysis

Explosive strength of lower extremities, i.e., performances of the vertical jump were determined by a wireless Myotest device. For the statistical analysis and interpretation of the results, the statistical package SPSS version 11.0 was used. The results were expressed by means of descriptive statistics, whereas t-test, ANOVA method was used (Pallant, 2007), with the aim of determining statistically significant difference in the explosive strength of lower extremities among subjects, regarding their gender.

# RESULTS

**Table 2**. Descriptive statistics

| Variable (Unit) | Measurement | Males | | | Females | | |
|---|---|---|---|---|---|---|---|
| | | Mean | SD | p | Mean | SD | p |
| HEIGHT (cm) | Initial | 31,49 | 2,30 | ,938 | 21,05 | 1,14 | ,787 |
| | Final | 36,83 | 5,26 | ,840 | 25,36 | 3,46 | ,665 |
| POWER (W/kg) | Initial | 34,09 | 7,74 | ,513 | 23,70 | 5,17 | ,858 |
| | Final | 39,36 | 7,79 | ,830 | 27,91 | 6,04 | ,860 |
| FORCE (N/kg) | Initial | 17,60 | 1,79 | ,400 | 16,20 | 1,28 | ,873 |
| | Final | 21,76 | 2,14 | ,513 | 18,78 | 1,61 | ,620 |
| VELOCITY (cm/s) | Initial | 226,33 | 30,12 | ,916 | 162,90 | 17,68 | ,665 |
| | Final | 230,40 | 33,16 | ,993 | 185,80 | 27,20 | ,922 |

Legen: Min - Minimum value; Max - maximum value; Mean - Arithmetic mean; SD - standard deviation; p value - Statistical significance of the Kolmogorov-Smirnov test

Table 2 shows the results of the arithmetic mean of the tested variables (HEIGHT, POWER, FORCE and VELOCITY) of the CMJ at the initial and final measurement. Standard deviation of the tested variables are also shown. Finally, based on the significance of Kolmogorov-Smirnov test (all values are greater than 0.05), it is concluded that the distribution of the observed measurements is normal both in the male and in the female part of the sample. It justified the use of method ANOVA for Repeated Measurements (Table 3 and the Graph 1), that tested differences in the values of the muscle explosive strength in male and female students, between the initial and final measurement.

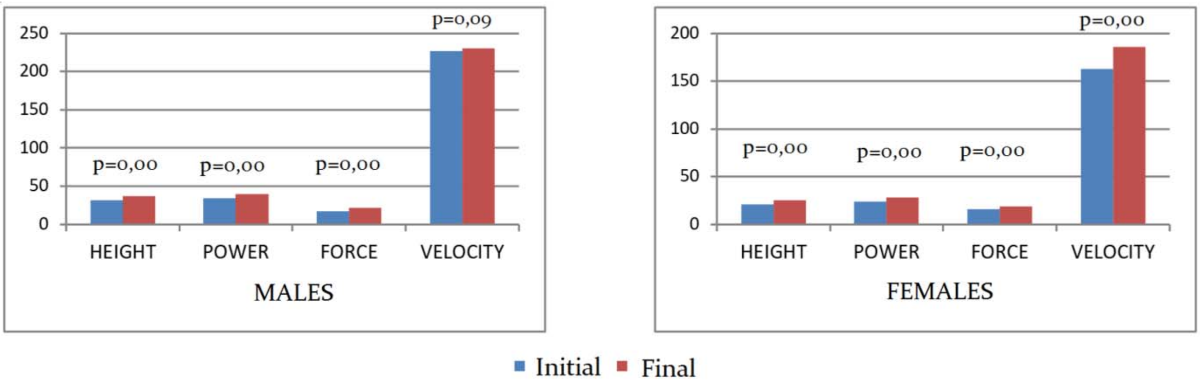
**Table 3.** Results of the method ANOVA for repeated measures– male and female students

| | Males | | | Females | | |
|---|---|---|---|---|---|---|
| Variable (Unit) | Wilks' Lambda | F | Sig. | Wilks' Lambda | F | Sig. |
| HEIGHT (cm) | ,37 | 64,72 | **,000** | ,23 | 46,21 | **,000** |
| POWER (W/kg) | ,20 | 148,62 | **,000** | ,15 | 101,76 | **,000** |
| FORCE (N/kg) | ,20 | 155,86 | **,000** | ,33 | 37,02 | **,000** |
| VELOCITY (cm/s) | ,92 | 2,97 | ,092 | ,33 | 37,36 | **,000** |

Legend: Wilks' Lambda – Wilks' Lambda statistics; F – F statistics; Sig. – statistical significance

Based on the results of the method ANOVA for repeated measurements, it is evident that in male students there are statistically significant differences in the three variables (HEIGHT, POWER and the FORCE) of the CMJ, while in the fourth variable (VELOCITY), there is a difference, but not statistically significant. In female subjects statistically significant differences were determined in all studied variables.

**Graph 1.** Display of mean values of the measured variables from the initial and final measurement and the significance of differences




significance level set at $p < 0.005$

## DISCUSSION

Results of actual research are in accordance to research results of Kukric, Petrović, Dobraš, & Guzina (2010), in which the plyometric program lasted 10 weeks. There was a significant improvement in explosive strength of the lower extermities, i.e., the height and power of the jump.

Similar results were obtained in the research of Fatouros, Jamurtas, Leontsini, Taxildaris, Aggelousis, Kostopoulos, & Buckenmeyer (2000), in which plyometric program lasted 12 weeks. The subjects trained three times a week. There was a significant improvement in explosive strength of the lower extermities, i.e., improvement in the vertical jump performance.

In the research of Milenkovic (2013), plyometric program was implemented with football players in duration of 6 weeks, three times a week. There was a significant improvement in explosive strength of the lower extermities in all tested variables.

Meylan & Malatesta (2009) also conducted a plyometric program with football players aged 13 years, in duration of 8 weeks. All the children were playing in the same league and trained twice a week for 90 minutes. There was also a significant improvement in explosive strength of the lower extermities in all tested variables.

## CONCLUSION

The results of actual research suggests that a special programmed plyometric training organized in the framework of PE classes, had a positive impact on the muscle explosive strength of the lower extremities in students who are actively involved in different sports. This research points to the possibility of alternative forms of PE teaching, through specially designed polygons for the development of muscle explosive strength. Of course, in order to to be effective, plyometric training method needs to be implemented technically correctly, with a gradual increasement in the load and the application of periodization. Otherwise it may cause poor results, and even injuries.

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***Interdisciplinary***

# HAND GRIP CONTRACTILE CHARACTERISTICS AND FUNCTIONAL DIMORPHISM IN THE ANTI-TERRORISM SPECIAL POLICE FORCE[1]

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## SUMMARY

The objective hereof was to determine numerical standards and a level of functional dimorphism for maximal and explosive force of the hand muscles. One of the reasons for which these characteristics are of great importance for professional performance and a good level of physical fitness is that human hand represents a main manipulative organ. The study included 36 members of the Anti-terrorism Special Police Force (ATSPF) of the Republic of Serbia. A function of the hand was determined by using a standardized "Hand Grip" test. The results showed that the average measured value of maximal hand grip force for the left hand was 474.7 ± 98.8 N, while the right hand result was at the level of 530.4 ± 100.1 N. The average measured value of explosive hand grip force realised by the subjects for the left hand was 803.6 ± 323.4 N / s, while for the right hand the result was at the level of 843.0 ± 353.7 N / s. When compared with the results obtained for the dimorphism index for maximal force, it was determined to be at the level of 0.902, meaning that maximal force of the left hand amounted to 90.2% of maximal force of the right hand. We found that the results of the dimorphism index of explosive force were at the level of 95.3%, that is, the difference between the right, dominant hand and the left, non-dominant hand was only 4.7%. Overall, it can be noted that the results obtained in this study can be used as initial criteria for testing physical fitness of the members of the ATSPF of the Republic of Serbia, as well as for training methodologies in the Specialized Physical Education.

**Keywords:** Anti-terrorism Special Police Force members, motoric testing, dynamometry, maximal force, explosive force, hand grip test.

## INTRODUCTION

An adequately prepared police officer has to be trained to handle a physical task with adequate speed, intensity, power and force, in a precise and coordinated manner. All of that has to be realised in various, familiar or unfamiliar situations and conditions of acting (Blagojevic, Vuckovic and Dopsaj, 2009). Police job, among other characteristics, also involves actions that are taken in relatively unfamiliar surroundings and for the purposes of resolving incidental offence situations. This is precisely why police officers must be physically prepared to meet all such professional requirements. Therefore it is important that capable candidates are chosen during selection and their ability developed during their professional career, because the insufficiently developed ability, even the physical one, represents a limiting factor in performing educational processes, professional assignments, and might render professional advancing difficult or even impossible. Also, it can lead to lowered work productivity, or even injuries, various forms of disabilities, the consequence of which can also be loss of human resources and undesired management and economics costs. (Veljkovic, 2014).

This paper is the result of the research on project: "Management of police organization in preventing and mitigating threats to security in the Republic of Serbia", which is financed and carried out by the Academy of Criminalistic and Police Studies, Belgrade - the cycle of scientific projects 2015-2019.

A good selection is of general interest for public safety, and police officers, and particularly special forces, are expected to possess a high level of physical abilities and specific skills, based on which they can overpower and deprive a person of freedom in the situations dangerous for themselves and for others, be able to control the safety of violation of public order, or to overpower the individuals or groups attacking or resisting physically, actively and passively (Vuckovic, Blagojevic and Dopsaj, 2011). Due to all the above mentioned facts, in the police work selection system, both globally and locally, one of the parameters of quality staff is a developed system of checking, testing, and constant monitoring of the level of development of physical and motoric skills (Anderson, Plecas, Segger, 2001; Jankovic, Vuckovic, Blagojevic, 2014).

The preparedness of special police forces is based on their fast action, which in most cases happens in complex technical-tactical and safety situations that require extreme physical efforts. That fact directly implies the need for all members of the given forces to possess an extreme preparedness regarding all the parameters required by all potentially possible given professional situations. A unity of mental and physical preparedness is something insisted on in members of Special Forces when facing the given situations. A physical preparation includes general and specific part of the training. The general one implies raising the level of gross motor skills, while the specific one is related to the situations emerging in the field (close encounter with other persons, use of weapons and means of use of force, various demanding motor assignments, running, climbing, and jumping with equipment, and other).

During physical training we need to take into account all the circumstances met by members of Special Forces. In such situations, gross motor skills or general physical training will make a necessary background that contributes to undisturbed mastering of techniques and equipment at their disposal, as well as a basis for upgrading of the capabilities for specific situations they deal with.

Basic muscle functional ability is an ability to perform contraction, or an ability to perform mechanical shortening or stretch of the muscle tissue under adequate physiological conditions. The given physiological shortening or stretch consequently leads to the manifestation of an increased tissue tension which further leads to development of muscle force. Muscle force is measured under the conditions of isometric or static tension (Amanovic, Milosevic, Mudric, 2004). With regards to the current theoretical standings, there are the following characteristic dimensions of muscle force, and these are: maximal muscle force, explosive muscle force, and endurance in muscle force.

The Ministry of Interior of the Republic of Serbia (MOI) and the system of testing and monitoring of physical abilities in respect of testing of muscle force use the tests on the following muscle groups: back extensor muscles, leg extensor muscles, and hand flexor muscles (Blagojevic, 2002; Amanovic, Milosevic, Mudric, 2004; Vuckovic, Blagojevic, Dopsaj, 2011). The indicators of the flexor muscle force of the hand, as important and basic manipulative organ, and especially in respect of means of use of force, personal weapons, as well as realisation of the techniques of the Specialized Physical Education (SPE), are very important in the MOI officers, and particularly in special force members (Vuckovic, 2002).

Determining of the hand grip force, as well as of the characteristics of its endurance, is applied in various research areas. Many studies examined the connection of the hand grip with morphological characteristics, age and sex, as well as with type of work and type of sport (Ertem et al., 2005; Koley & Singh, 2010). The area hereof is studying of physical abilities of the members of the Anti-terrorism Special Police Force (ATSPF) of the Republic of Serbia. The subject hereof is determining of the characteristics of force of the flexor muscles on both hands, measured by the standardised "Hand Grip" test, as well as defining of the given force ratio between the dominant and non-dominant hand, and the dimorphism index of both measured extremities. The objective hereof is to determine numerical standards for the given test based on the analysis of condition of the measured test subjects, and to determine a functional ratio between the dominant and non-dominant hand in the reference population of top professionally prepared MOI officers.

# METHODS

## Subjects

The study sample comprised of 36 members of the ATSPF. **The average age of the subjects was 37.4 with the age range from** 24.0 to 49.0. The average number of the subjects' service years in the MOI was 15.3, ranging from 5.0 to 30.0. All subjects were healthy, with no acute and chronic diseases, as well as with no other interference that would affect the test results.

## Procedure

With a view to determining the muscle force characteristics, a standardised procedure with the standardised measuring gear utilized in the system for testing physical abilities in the MOI, as well as at the Academy of Criminalistic and Police Studies, was applied, namely the "Hand Grip in Standing Position" test. The finger flexors' muscle force is measured through the isometric dynamometry method (Figure 1). All the subjects had an individual 5-minute warm-up, and they also got familiarized with the testing procedure prior to the test and performed the test trial as a specific warm-up. After a 5-minute break, the test began by measuring one maximal effort of the hand grip per hand, at the subjects' own discretion (the subjects chose by themselves whether they would start with the left and follow with the right hand, or vice versa).

**Figure 1**. *Hand grip apparatuses*

The variables examined in this study were the following:

Two variables representing a developed value of the hand grip maximal force –

1. Maximal force of the right hand grip – FmaxR, expressed in Newton (N),
2. Maximal force of the left hand grip – FmaxL, expressed in Newton (N).

Two variables representing a developed value of the hand grip explosive force –

3. Explosive force of the right hand grip – FexplR, expressed in Newton / second (N/s),
4. Explosive force of the left hand grip – FexplL, expressed in Newton / second (N/s).

Two variables representing a developed value of the dimorphism index, for maximal force and for explosive force of the hand grip –

5. Maximal hand grip force index dimorphism – IDFmax, expressed in index number,
6. Explosive hand grip force index dimorphism – IDFexpl, expressed in index number.

Dimorphism index is calculated as a mathematical ratio, i.e. an index relation between the measured results of maximal force of the non-dominant and dominant hand, or as an index relation of the result of explosive force of the non-dominant and dominant hand.

## Statistical analysis

The results were initially analysed by using the descriptive statistical procedures for the calculation of the basic measures of central tendency and measures of dispersion: Arithmetic mean (AM), Standard deviation (SD), limit values of range tolerance (Min and Max), and coefficient of variation (cV%). Defining of the difference was determined by the Student T-test for a dependent sample. The level of significance was at the level of 95%, respectively, $p \leq 0.05$ (Hair et al., 1998).

# RESULTS

Table 1 shows descriptive indicators of the examined variables for both hands.

**Table 1.** Results of descriptive indicators

| | FmaxL | FmaxR | IDFmax | FexplL | FexplR | IDFexpl |
|---|---|---|---|---|---|---|
| **Mean** | 474.7 | 530.4 | 0.902 | 803.6 | 843 | 0.953 |
| **SD** | 98.8 | 100.1 | 0.193 | 323.4 | 353.7 | 0.446 |
| **Min** | 296 | 349 | 0.689 | 235.9 | 356.2 | 0.308 |
| **Max** | 751 | 735 | 1.28 | 1586.1 | 1694.6 | 2.186 |
| **cV%** | 20.8 | 18.9 | 15.44 | 40.2 | 42 | 42.76 |

Table 2 shows the results of the T-test for all observed variables.

**Table 2.** Results of T-test

| | t Stat | P one-tail | t Critical one-tail |
|---|---|---|---|
| **Fmax** | -2.377 | 0.010 | 1.667 |
| **Fexpl** | -0.493 | 0.312 | 1.667 |
| **IDF** | -1.804 | 0.038 | 1.667 |

# DISCUSSION

The examination of the muscle contraction quality of the hand, as a principal part of the human body for object manipulation, is of great significance for science and practice. Good characteristics of the hand muscles are in correlation with general body strength indicators, and can be used as screening test even in evaluating general state of health, or general physical fitness in humans (Bohannon, 2001; Dietz, Fouad, Bastiaanse, 2001). For optimal functioning of the arm and hand in daily activities, and especially in the professional activities of police officers and members of special forces, it is necessary to maintain and train the scope and diversity of all movements in all joints of upper extremities, such as a grip function.

The measured average value of maximal hand grip force realised by the subjects in this study was 474.7 ± 98.8 N for the left hand, while the result for the right hand was 530.4 ± 100.1 N. If we compare the results hereof with the standards used in the USA, one can see that the results of the examined police officers fall under the category of normally strong men, close to the upper limit comparing to the standard (the average value of both hands of our sample is 501.55 N, or 51.23 kg (474.7 + 530.4 = 1005.10; 1005.10 / 2 = 502.55; 502.55 / 9.81 = 51.23). When we perform the analysis of the average results of maximal force for both hands, as many as 12 tested police officers, or 33.34%, had the result falling under the class of strong people. In other words, 1/3 of the tested members of the ATSPF belonged under the category of the people of above average preparedness, and in them the average result of maximal force for both hands was 61.22 N.

The results of the Student T test for dependent samples showed that there was a significant statistical difference between the average results of maximal force in the left and the right hand at the level of p = 0.010, as well as T values of -2.377. Such results were expected because in other authors had been determined that the dominant hand (in the case of our sample, all subjects were right-handed) was stronger by approximately 10% comparing to the non-dominant one. An almost identical result was determined in this study as well, where the dimorphism index of maximal force was 0.902, which means that the right hand, as stronger extremity, is stronger by 9.8% comparing to the left hand. In comparison to various top athletes, it was determined that the dimorphism index of maximal hand grip force was 95.79% in weightlifters, 94.37% in judokas, 93.95% in basketball players, 93.54% in volleyball players, 91.55% in water polo players, and 87.57% in handball players (Ivanovic et al., 2009).

The measured average value of the hand grip explosive force realised by the subjects for the left hand was 803.6 ± 323.4 N/s, while the result for the right hand was 843.0 ± 353.7 N/s. There are few studies examining explosive force in the “Hand Grip” test, so the results hereof have great significance with regards to the mentioned physical ability. Comparing to the result of one of the previous studies, in which the level of the hand flexor muscle explosive force was examined in men with different levels of training, it was determined that the given explosive force was the biggest in weightlifters 762.95 N/s (for the left hand) and 794.04 N/s (for the right hand), in well-trained young persons it was

594.19 N/s (for the left hand) and 658.55 N/s (for the right hand), while the control group of healthy men had 542.89 N/s (for the left hand) and 772.95 N/s (for the right hand)(Dopsaj et al., 2009). Unlike maximal force, where the results of 2/3 of our subjects were in the group of average persons and the results of 1/3 of them were in the group of persons of above average strength, when it comes to explosive force, the results of our subjects showed that they were significantly higher than the results of normally and well-trained population, by some 30.0% on average (by 28.63% bigger explosive force than in the control group and by 31.63% bigger explosive force than in the well-trained group). They were also better than the results of explosivity determined in weightlifters by 5.76% (Dopsaj et al., 2009). That only means that the tested members of the ATSPF had probably reached a high level of specific hand muscle adaptation in order to develop muscle force very intensively, or to achieve maximal force very fast. The necessity to react very quickly, to produce an intensive grip, movement of the hand clench, as well as high intensity of force development in the upper extremities, i.e. arms and hands, is a very important physical and motor ability which is a must-have for the members of special police units. Namely, the utilisation of the means of use of force, weapon handling, frequent situations and close encounter trainings with the application of the SPE techniques, led to the muscle adaptation at the level of extremely high values of explosive force manifestation in the arms, i.e. hands, that was even bigger than in top athletes competing in strength sports.

The results of the Student T test for dependent samples showed that there was no significant statistical difference between the average results of explosive force in the left and the right hand, because p value was 0.312. These results prove that, unlike maximal force, where a statistically significant difference between the left and the right hand was determined, the adaptation and level of training of symmetrical explosive force manifestation in both hands is an important physical ability. It was determined that the results of the dimorphism index of explosive force were 95.3%, or that the difference between the right, dominant hand, and the left, non-dominant hand, was only 4.7%.

Also, the results of the Student T test showed that there was a significant statistical difference between the dimorphism index regarding maximal and explosive force produced in the "Hand Grip" test at the level of t = -1.804, and p = 0.038. With regards to the dimorphism index results for explosive force, the results of the previous studies showed that the dimorphism index for explosive force in the control healthy untrained population was 70.24%, in the well-trained young persons it was 90.23%, and in weightlifters it was 96.08% (Dopsaj et al., 2009). As the same index in our examined sample is 95.3%, one can conclude that it is very similar to highly trained persons with regards to strength. The most probable reason of great similarity of explosive force production in the examined subjects from the ATSPF, as well as in weightlifters, is symmetrical load on both hands during exercising, which conditioned equalising of the mentioned ability in respect of the non-dominant and dominant hand.

# CONCLUSION

This study had the objective of determining numerical standards for the given test based on the analysis of the condition of the measured subjects, members of the ATSPF, as well as of determining the functional ratio between the dominant and non-dominant hand in the reference population of top professionally prepared members of the ATSPF. Based on the results obtained, one can see that the results of the examined police officers fall under the category of normally strong men and close to the upper limit comparing to the standard. When the analysis of the result structure is performed, one can see that 33.34% of them had the result in the category of strong persons, while 2/3 of them were in the class of average values. When it comes to explosive force, it was shown that the results of our subjects were significantly above the results of normally and well-trained population by 30.0% on average (by 28.63% bigger explosive force comparing to the control group, and by 31.63% bigger explosive force comparing to the well-trained group), and that they were also better comparing to the explosivity results of weightlifters, by 5.76%. When it comes to the results obtained for the dimorphism index for maximal force, it was determined to be 0.902. Such results prove that, unlike maximal force, where a statistically significant difference was determined between the left and the right hand, the adaptation and training of symmetrical manifestation of explosive force of both hands are important physical abilities. When it comes to the results obtained for the dimorphism index for explosive force, it was determined to be 0.953, which means that the right hand, as stronger extremity, is more explosive than the left one by only 4.7%. As this index is 95.3% in our examined sample, one can conclude that it is very similar to the one in highly-trained persons in strength, i.e. weight lifters (96.08), but rather different than the one in untrained (70.24) or well-trained persons (90.23). Generally speaking, one can emphasize that the results obtained herein can be used as starting criteria for testing of physical preparedness for the members of the ATSPF of the R. of Serbia, as well as for the needs of improvement of the SPE work methodology.

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# THE HISTORY OF THE ORGANISATION OF THE SUMMER OLYMPIC GAMES THROUGH ECONOMIC AND FINANCIAL EFFECTS

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## SUMMARY

In its core this paper is about the organization of the Olympic Games through history as well as an overview of the Olympic Games through its financial and economical effects. Based on the systematization of research gathered it will be determined that organization of mega events such as the Olympic Games has both positive and negative financial effects. The goal of this paper is to determine the economic and financial effects while hosting the Olympic Games, the financial influence of the Olympic Games on the hosts, meaning the city which is the host of the Olympic Games, as well as the influence of the Olympic Games on the host countries economy. The Olympic Games are the biggest and most prestigious sports event of its kind, which are attended by the presidents, prime ministers, members of royal families with millions of citizens from across the globe. However, today it is getting harder to become the host of the Olympic Games besides a county with strong influence huge funds are necessary in order to organize the Olympic Games. The influences of Olympics might be long lasting , as well as positive and negative. The Game themselves in its nature are more than just sport and sport events and that makes them different from any other sport competition.

**Keywords**: Olympic Games, history, organization, economy, financial effect.

## INTRODUCTION

The Modern Olympic games, aside from being a reawakening of the Greek Olympic games, have been started in order to promote sport, sport values, a healthy lifestyle and a positive competitive spirit. As the Olympic games have started to gain more and more countries as contestants and as media have massively started to broadcast the Olympic games , so has their potential been noticed. Every host county has tried to make the Olympic games as modern, spectacular and memorable as possible. Over the years it has become apparent that the Olympic games bare with them much more than just sports and that they have a greater role in promoting the host county (Skoko & Vukasović, 2008).

Back in ancient Olymp, where the ancient Olympic games were held, treasuries were constantly being filled by voluntary donations of wealthy individuals and cities whose athletes competed in the games. They did so to honor the Gods, as well as themselves. It is quite clear without the Games that money would not finds its way into the treasuries of Olymp. Which means, that the games made good profit, acquired primarily as gifts. ( Zivanovic, Randjelovic, Stankovic & Pavlovic, 2010).

It is know that the organization of a great sporting event is quite expensive. The greatest expenses are the infrastructure, the accommodation of the athletes as well the securing of the event alone. Three types of benefits can be distinguished from these types of events, and those are the economic growth, the infrastructural heritage and the promotion of the image, whereby the economic benefits are responsible for justifying mega events – the Olympic games.

However, the economic influence is very hard to asses and predict before a sporting event. Therefore not every sporting event can be successful, which means that not all the economic influences are positive. The expenses of being the host of a mega sporting event such as the Olympic games, might beat out the positive benefits for some of the residents, who can reduce or withdraw their support for the event. (Roche. 2000).

Throughout this paper the questions whether the economic and financial effects when organizing the Olympic games have positive or negative influence on the county apropos the host city of the Olympic games will be answered, and all of that is based on the influence that the Olympic games have left on the previous host of the games.

# METHODS

Descriptive method and theoretical analysis were used for gathering, classifying and analyzing the relevant related researches found via Google, Google Scholar, SCI indeks, PubMed and Kobson. Additional references, such as course books, were also used. The limits to the web browsing were set to papers and article published from 2000 to 2016. All the analyzed scientific researches were published in the magazines with the impact factor. The following key words were applied: Organisation of Olympic games, history of Olympics, economic and financial aspect, impact of the Olympic games on economy.

## Olympic values

However, today it is getting harder to become the host of the Olympic games., except for the ability of the country to carry out the Olympic games some benefits are wanted, new ideas and values which the Olympic games will bring. The Olympic games carry curtain values which are associated with all its contestants, both sportsman and sponsors. Those values help the Olympic games to attract a large number of spectators who are interested in the Olympic games even in the modern age. The Olympic Games- which take place once every four years in various cities thought the world- are a sporting spectacle that consists of some 10,500 athletes from more than 200 countries who compete in 28 sports over a period of 17 days. (Oldenboom, 2006).

In the principles of IOC one can recognize main values of OG for which Coubertin fought when he was explaining that he “revived” OG in order “to ennoble and strengthen sports, to ensure their independence and duration, and thus to enable them better to fulfill the educational role incumbent upon them in the modern world” (IOC, 2002, p. 1). We can see that according to the Olympic Charter one of the principles is that OG are in its nature more than sport and sport event and that makes them different then any other sport event. Olympic Games are according to them „sport festival“ which implys that inseparetly component of OG, its goals and its values, are art and education trough sport.

The possibility of OG is immense. People follow OG based on their personal, sport and many other reasons. According to research on OG in Beijing 2008, MEC Acces find out that some resons why people follow OG are: „national pride, individual spirit, global harmony, excitement, because they love to watch and follow the sport, they love to watch competition of different countries on one place, it’s a collection of different sports, chance to see sport that they normally don’t see, it’s exciting, dedication of the athletes, etc.“ (MEC Access, 2008, p. 7).

## The economic effects of organizing the Olympic games

In the last few decades, scientific workers and the broad population have been interested in the economic effect on the organizing country apropos the host city. One of the most important reasons behind the decision of becoming a host of a big sporting event is the positive influence of the event on the local economy, which can improve the overall social status of the local community.

The economic influence of the event can be defined as „ the net worth of the economic changes in the local host comminity, which is a result of the money spent in connection with the specific event“ (Crompton, 1995). The host city can utilize the unique potentional which follows a big sporting event so that it could chance its structure, which will enable them to initiate a cetain self-sustained proces thorugh constant income from tourism, industiral areas, event that will follow the primary sporting event or even through the creation of new economic relations with other regions or countires. (Preuss, 2004).

## The economic effects from the aspect of the time of occurrence

From the aspect of the time of occurrence alone the following division can be made:

1. The economic effects expressed in short terms- mainly connected to the influx of a great amounts of money which is a direct consequence of the hosting of the event, but determined by the number of visitors, contestants, media representatives, officials –
2. The economic effects observed as a long-term benefit- may be divided into three categories:
   a) The construction of the sports facilities
   b) National and international recognition of the host city and the county through great medical exposure
   c) Social benefits expressed through job creation, volunteerism, educational programs intended for the younger population, and as always current cultural programs (Jevtic 2013).

Big events of international character are simply great in the sense of the ability to broadcast promotional messages to millions of viewers by TV or other means of modern methods of communication. (Roberts, 2004).

## The economic effects from the aspect invoked changes

Economic effects consist of direct, indirect and invoked effects. Direct effects represent the increased demand for curtain products as well as curtain services, and are caused by the number of visitors of the event. Direct income bring a tempting amount of money, which helps the enlargement of fiscal revenue for the government , host cities, the Olympic committee of the host city, the IOC and sponsors.

Indirect effects include the turnover of money which initially originates from the previous effects. In the period between 1991. Up until 1997, indirect effects in Atlanta 1996 are estimated to be 1,3 billion US dollars. (Jevtic, 2013).

Indirect revenue motivates the growth of economic performances and stimulate the development of the industry. The influence of indirect revenue is much larger than that of the direct one. These effect have three phases of influence. In the phase before the Games. the main factor which influences the economic performances depend on the amount of direct and indirect revenue. In the phase during the Games, the economy will be motivated by the outside demand such of the consumption of food and tourism. In the phase after the Games, the following influence will not only enlarge the reputation of the host city, but will also accelerate the primary construction and economic growth. (Trkulja, 2008). The invoked effects represent the increase of employment and income per household, which are the result of the economic activities of the two previous effects.

## Physical changes of the host city during the organization of big sporting events

Mega sporting events, such as the Olympic games may create opprotunities to construct new sporting object sports objects, as well as the betterment of the physicial surroundings of the host city. (www.olympic.org/uk.) The organization of the Olympic games frequently envolves the construction of new sports objects or the reconstruction of existing ones primairly because the requriments of the organizator to meet the needs of organizing a competiton in various sports in a short period of time.

The Olympics might create a number of other benefits for urban surroundings of the host city, depening on their circumstances and general state. In Tokyo, during the Olympic preparation the water supply system was bettered, the levels of sewer collectors were builts, the Olympics games had an influence on the improvment of the public health standard for garbage colleting, cleaning of the streets, public toilets and food hygiene. In Seoul, as well, now programs were introduced for better waste managament, better control of the water quality as well as the reduction of air pollution.

Big investments were made in the telecommunications infrastructure in Barcelona, Atlanta and Sidney. Thus all the three cities were in a better possition to compete on the global level of city networks.

The scale of the urban investment required to stage an Olympic Games has obviously increased as the number of sports and athletes, the global media interest and the level of commercial sponsorship has grown. Since 1960, the Games have involved large-scale urban transformations, which have acted as tools of regional development. These phases outlined in (Table 1) are a useful guide to the main patterns and changes, although they are obviously a generalised model from which individual Games have sometimes deviated (Essex and Chalkley, 1998; Chalkley and Essex, 2003).

Table 1. The changing infrastructural impact of the Summer Games, 1896-2000

| | |
|---|---|
| **Phase 1**. 1896-1904 | Small scale, poorly organised and not necessarily involving any new development |
| **Phase 2**. 1908-1932 | Small scale, better organised and involving construction of purpose built sports facilities |
| **Phase 3**. 1936-1956 | Large scale, well organised and involving construction of purpose built sport facilities with some impact on urban infrastructure |
| **Phase 4**. 1960- 2000 | Large scale, well organised and involving construction of purpose built sports facilities with significant impacts on urban infrastructure |

## City development caused by the organization of the Olympic games

Substantial infrastructural investments necessary for big sporting events may have a positive and long lasting effect on the community, if they are carefully planned and realized. The infrastructure necessary for big sporting events would in any case be built, but it would take up a lot more time to develop. For example, big projects such as the Munich metro finished within a five year deadline during the Olympics, as that is a project that would normally take 10 to 15 years to complete. (liu,2006)

The infrastructure includes the sporting infrastructure for competing and training, but also a general infrastructure of the city such as the airport, telecommunications, hotels, accommodation ( for the athletes, media representatives and officials), entertainment content, trade fairs, parks and related infrastructure. The infrastructure which is being built purposely must imbed with the urban city plan and its development strategy. The influence of the Olympic games on the physical environment includes the construction of new sporting events, accommodation capacities, the change the cities apparel and transport links, as well as the rearrangement of the industrial zone. (Whitson & Macintosh, 1996).The hosting of the Olympic games might create additional problems in the environment, especially the temporary building which must be demolished after the Games. (Hamakawa, & Elam, 2011). These days it is common practice to build object with recyclable materials, with the intention of preserving and reducing the pollution of the living environment .

Up until today, the most successful Games, from the infrastructural perspective, were those who have followed the clear plan and who did not necessarily build object used only for the specifically for the Olympic games.

## Positive and negative legacy of hosting the Olympic games

The main thing that a great number of cities candidates themself to organize these events are the economic benefits for the city and county host. The influences of these events might be long lasting , as well as possitive and negative. (Table 2). From the economic and financial point of view the most cost-effective Olympic were held in Los Angeles 1984. , furthermore the Olympic games in Seoul 1988. , Barcelona 1992., ( Pellegrino & Hancock, 2010)., Sidney 2000., And London 2012 had all achieved great financial success. Using these cities as examples we can see the positive financial heritage of the Games, however if we look to the Montreal 1976. , Athens 2004. (Aravossis, Tziralis, Tolis & Tatsiopoulos, 2006)., And Moscow 1980. Olympic games , we can conclude that the negative side effects of the Olympic game can be quite huge.

| Positive impact of hosting Olympic games | Negative impact of hosting Olympic games |
|---|---|
| **Construction of general infrastructure (roads, telecommunications networks). Constructions of new facilities. Incresed number of tourists. New jobs. Quality of life. Creation of new cultural values. Restoring the spirit of the local community.** | **Large construction costs. Borrowing the economy and the public sector. New tax. Increase investments in projects that are not on primary importance. The increase in real estate prices.** |

## CONCLUSION

Big sport events such as the Olympic games represent a high stakes game and can have a successful long-term result, but require close consideration and an informed approach. However, there exists a curtain number with the so called unsuccessful long-term result, consequenly the candidacy, preparation and realisation of the event are of great importance.

But the part that follows is what brings or does not bring success in the end. For the maximum of advanages to be extracted, the cities and host county are in need of a clear vision for the heritage that remains after the event and the exsistance of the commitment to the goal in making the vision reality. That is the only way for the expected benefits to be achieved and for a possitive and long lasting heritage to be made.

The Olympic games might represent a good initiator for many possitive changes, but will only be successful if the chances from hosting are exploited well and if a strategy is well thought out which is not universal, but specific to each host city. The Olympic games alone if they are well organized bring in a great profit in economic as well as other aspects ( the improvment of the imidge of the county, the expression of political strength, the improvement of the living environment ) and their benefit can be felt for a long period of time after the Games have ended. The main recommendation when organizing the Olympic games is that their size should be diminished, so that the focus of the Olympic games can again be „athletism" as its main purpose.

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# AGGRESSIVENESS AND ANGER DISPLYED BY YOUNGSTERS, DEPRIVED OF PARENTCARE ATTENDING TO VARIOUS SPORT ACTIVITIES

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## SUMMARY

The purpose of this research paper is to estimate the impact of aggression and anger expressed by growing-ups, deprived of parents cares, in sports contests. During the fieldwork we implemented The Competitive Aggressiveness and Anger Scale, shortly CAAS (Maxwell & Moores, 2007) while questionnaired 66 teenagers (25 girls and 41 boys), aged 12-18, who were practicing various sports – athletics, football, badminton, basketball as a single discipline and in combination as more than one sport as well. The results demonstrate that the anger levels are higher than the aggression levels and have different intensity in the different sports games. We compared the sport anger and sport aggression that are raising in the two sex groups; however, this was done only in the athletics games and among the teenagers training more than one sport discipline.

**Keywords:** aggression, anger, deprived of parents cares, sports

## INTRODUCTION

Anger is a natural mechanism. It forces man as a human being to catch that his/her interests are in danger. Anger is a strong emotion. Quite often it was stirred up by fear, offense, discrepancy, injustice behavior (Fakirska, Y., 2014). Usually, the feeling of anger raises a head as an effect of some kind of a frustration that has been provoked.

Aggression is a sort of behavior caused by the sense of anger. It could be expressed physically, verbally or in any other type of reversed exerted influence on the object, as the subject that has caused frustration.

Anger and aggression in the sports field are usually provoked by a bad refereeship which may be expressed by maltreatment of the player or the team, because of game lost, as a response to a verbal or physical aggression from the other players or provoked by the fans' behaviors, etc.

To be sure, the child motor development is of great importance because it has a very influential impact over children emotional, intellectual and social progressive development.

According to the researches done, the institutional care is negatively impacting on the physical health of the child, on its social (Tharp-Taylor A., 2003; Pantuikhina E., 2009; Shakhmanova A., 2010) and cognitive developments (Sloutsky V., 1997; MacLean K., 2003), on the sense of loneliness and anxiety. Most frequently these complications may and usually occur in the adolescence time period, because of the intensive cognitive, social and emotional transformations of the growing-up child, itself, that are accompanying them (Kingery J. et al., 2011).

The changes that take place in the time of child's growth, especially between the $7^{th}$ and $14^{th}$ year after the birth, bring forth the creation of identity feeling and sense. During the so-called middle childhood while comparing themselves with the peers, they develop a perception of self-respect and individuality. Impetuous physical and psycho-social transformations occur in the beginning of the adolescence; these transformations accompany the specific puberty time period and may become reasons the youngsters to envisage many various problems. If the teenagers are surrounded or in environment (school, home, institution) not adapted to their specific-age demands and emerging necessity to feel independently, they may lose their self-credibility and to give in to negative behavior models such as loafing, dropping out of school, aggressive behavior, etc.

Research data show that adolescence as a transition age accumulates all adequate and non-adequate trends of the psychic development during the childhood. The adolescence is a time period when the person, the young person approbates and confirms his/her self-image in front of the others, in front of the rest of the world, he or she cultivates and promotes his/her self-dependence and strong-mindedness, sets up his/her self-estimation and self-confirmation. In this transition age-period usually appears a lack of enough self-reliance and self-confidence and this situation opens into the necessity of buildup a new type of adherence and attachment to the peers/the group. The teenagers estimate themselves and their personal behavior through the reactions of their equals, i.e. the persons of the same age, coevals, and not through the eyes of the adults, i.e. non-equals, the group of the persons not of the same age group. To be accepted by the peers group is of paramount importance and the rejection may be rather destructive. In combination with the scanty, quite limited life-experience they have and not well developed decision-making skills, it is not a rare case they to be vulnerable to a friendly negative pressures and precarious behaviors. On the other hand, the teenagers are emotionally unstable and often change their moods. Thus, in combination with more complex social interrelations and interactions, it may sharpen; intensify the negative emotional mind frame of the growing-up teenagers.

It is well known that sport is of benefit for the human health status but also it is an important factor for the enhancement of the psycho and social progress of the person. The sport is a chance for children to communicate with friends, to meet new people and to build up contacts and relations. It creates environment of identical interests and thus builds up the feeling of self-trust and self-confidence. The sport activities exert shaping impact on the sportive type person. This occurs to be a significant factor for the one who is growing up. Participation in sport exercises and events is related to such positive results as peer relations improvement, increase of self-confidence, spirits and decrease of the anxiety levels (Kirkcaldy B. et al., 2002; Marsh H., 1998; Smith A., 2003).

The findings of Page R. et al. (1992) announce that the children, 6 to 11 olds, who have achieved higher physical results, are less lonely. The sport may become an instrument to improve the risk behavior and aggression as well as even to diminish them.

Importantly to mention, the instrumental aggression that is usually appearing during the sport training or competition is a rational form to oppose the rival. However, in the case of children-teenager sport both, the excitement and anger are quite often converting the team into an uncontrollable aggregation of children, lost their moral face and lacking their sense of justice (B.Breidemeier, 1955, after Mutafova, 2004). Unlike the other social spheres, in the sport field being a victor or a looser means increased levels of thrill, excitement and frustration, and because of this usually provokes aggressive behaviors ( Berkovitz's frustration-aggression theory, 1965,1969 and 2001). However, to have knowledge on the aggressive behavior acts may sketch the directions, outline the trends of how such behaviors could be liable to training and upbringing, and be regulated in such a manner that to be converted from a destructive into a constructive aggression with respect to the tangible activity (Geron, 2006).

**The aim** of this research is to describe the specific characteristics of the sport aggression and anger and to shape their manifestations in the teenager groups of children, deprived of parentcare, attending to various sport activities.

# METHODS

## Subjects

The observation subject of this research were 66 graduates of the homes for children deprived of parents' care in Bulgaria, aged between 12$^{th}$ and 20$^{th}$ and practicing various sport activities. The time period was one month - April, 2016. The apportionment of the group observed by variables such as sex, age and sport is shown in Table 1:

**Table 1:** Students Shares by Sport Activities

| Sex/Average age | Girls - 15,27 | Boys - 14,71 | Total |
|---|---|---|---|
| Athletics | 14 | 15 | 29 |
| Football | - | 13 | 13 |
| Badminton | 6 | - | 6 |
| Basketball | - | 5 | 5 |
| More than one sport | 5 | 8 | 13 |
| **Total** | **25** | **41** | **66** |

## Procedure

Research method: To esteem the sport aggression and anger we used a common questionnaire CAAS – The Competitive Aggressiveness and Anger Scale (Maxwell & Moores, 2007; cited after Visek, A., Maxwell, J.,Watson II, J, Hurst, J. 2010). CAAS may be used to delimit and differentiate the aggressive from non-aggressive sportsmen. The questionnaire is of self-descriptive type and the respondent answers in Likert's 5-level format: *"practically never", "rarely", "on occasion", " often"* and *"practically always".* Only fully complete questionnaires were respected. The scale consists of 12 items: six - to report aggressiveness; and six more –anger.

The authors of the scale have discovered positive correlations between the CAAS points and the 5-subscale Aggression Questionnaire of Bus&Perry (BPAQ; Buss & Perry, 1992, по Visek, A., Maxwell, J.,Watson II, J,Hurst, J. 2010). The scale is not adapted to the Bulgarian environment but is translated by Kaltchev in the year of 2012. The sportive aggression and anger fieldwork was conducted in different collective sports and among young football players, athletes in rugby and grass hokey. The results show significant difference between the anger and aggression in the 3 groups (in respect to the sport practiced); the highest values are registered in the group of the football players (Gencheva N., 2015). Then, we compared the results of this current research with the 2015 research data.

## RESULTS AND DISCUSSION

The results concerning sport anger and aggression in the group of the athletes, boys and girls, are shown in Fig.1

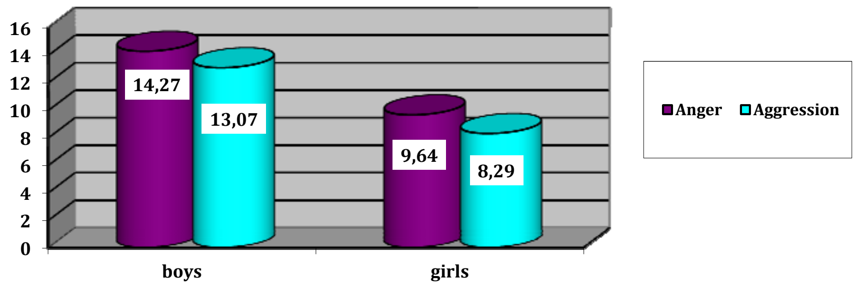


**Fig.1** Sport anger and aggression in athletics, boys and girls

The results from Fig.1 demonstrate higher anger levels in comparison to the verbal and physical aggression in both sexes but statistically these are insignificant differences. In this sample we did not find any statistically important distinction between the boys age (n=15, average age of 15,3) and the age of the girls (n=14, average age - 14,7 ). As expected, the statistical data for both factors – anger and aggression – are significantly lower. This concerns the total final result of the test in the girl group of the athletes. However, there is no data available in order to compare the variables included in the research. This will be an interesting aspect as far as the field sports are individual and not collective and during the whole process – training and race - the athletes have no direct contact. Figure 2 gives us information about the comparison of the indices on sport anger and aggression in the both sexes observed groups, practicing more than one sport:

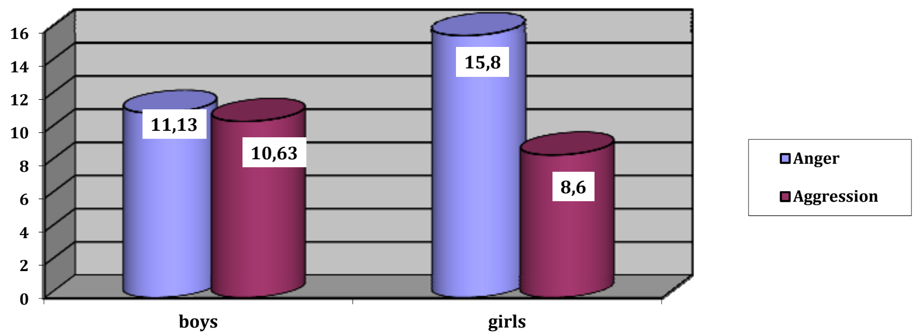


**Figure 2** Sport anger and aggression when more than one discipline is practiced, boys and girls

The average aggression levels in the both groups, either boys or girls, that are training more than one sport discipline, are lower than the average aggression levels of the teenagers who practice just fields athletics. Similar tendency is observed in the realm of boys' anger. Only the group of the girls training more than one sport discipline registers anger results, almost equal to the results registered in the field athletics. The data are interesting because the teenagers, practicing more than one sport are involved either in individual or in collective disciplines. The measured average levels of anger and aggression in the group of the boys, playing football, are presented in Fig. 3

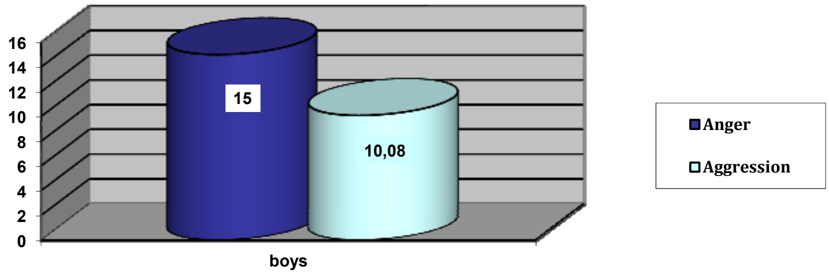


**Figure 3** Sport anger and aggression in the boys' group, playing football.

The findings in the group of the boys playing football (n=13) show the highest average levels of anger, while the aggression levels are almost equal, compared to the levels of the boys who train more than one sport discipline (n=8). In respect to the factor *anger* the levels of the statistic data are considerably higher in the group of the boys, football players, if compared to those that practice more than one sport, while in respect to the factor *aggression* there is no considerable difference in the total result and the age. It is interesting to notice that the aggression levels in the field athletics are higher than those for the football game.

Figure 4 reflects the average levels of anger and aggression in the group of boys, basketball players.

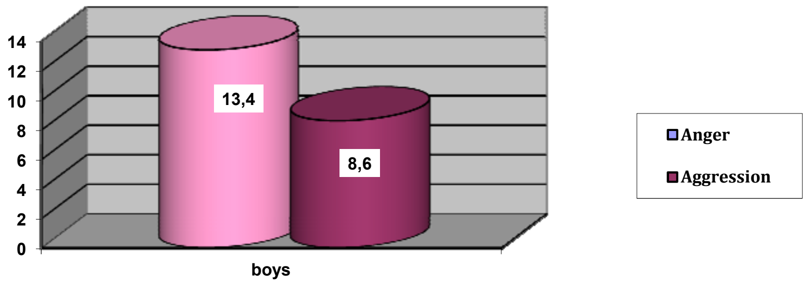


**Figure 4** Sport anger and aggression among the boys practicing basketball.

The results registered for sport anger and aggression in the boys' group of the basketball players do not differ essentially from the reported data about the group of the football players. The results of the studied anger and aggression in the group of the girls training badminton are presented in Figure 5:

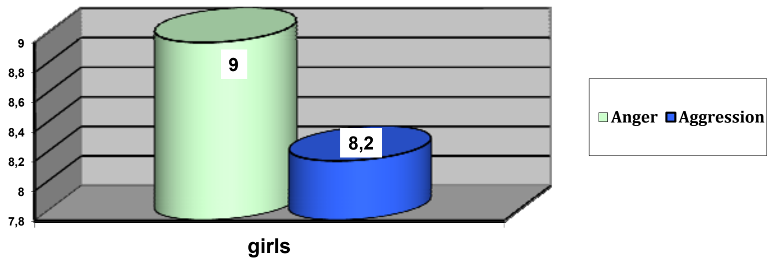


**Figure 5** Sport anger and aggression in the group of girl players of badminton.

The results reported show that the lowest average levels of aggression and anger were registered in the group of the badminton training girls.

In the whole sample of sporting children and teenagers that are deprived of parentcare (n=66), we observed normal distribution of the test data among all types sport disciplines as well as among both sexes. We also registered a statistically considerable correlation between the sex affiliation (the girls have lower final scores) and the test results, as the dependency is quite strong (r = -0,355) in respect of the final test result, and the aggressiveness (r = - 0,354) and it is weak in respect of anger (r = - 0,297). The outcomes are close to the findings of another research conducted in 2015 by N. Gentcheva.

# CONCLUSION

In respect to sex as a variable, the findings of this research again confirm that the aggressive trends are higher in the group of the teen boys than in the group of the teen girls. Probably, this is a reflection of the influence of various social and biological factors. We compared the data for the sport anger and the sport aggressiveness in both sexes only between the groups training field athletics and more than two sports disciplines. The achieved results in the field athletics are interesting because they are very close to the results of the football players' group and also may become a subject matter of any further in-depth studies of the individual sports.

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# DIGITAL INCLINOMETER AS AN INNOVATION IN THE FUNCTIONAL DIAGNOSTIC IN CHILDREN

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UDC 796.01-053.3

## SUMMARY

The purpose of this study was to investigate the application of a digital pelvic inclinometer (DPI) for measuring sagittal plane (lumbar spine) pelvic tilt in healthy children from primary school. This will help us to refine functional diagnostics in this field.

**Keywords:** Digital Pelvic Inclinometer, Pelvic tilt, Physiotherapy

## INTRODUCTION

The postural disorders in children are a wide-spread problem. To precise the functional diagnostic in children is the most important part of the prevention. The key point in this aspect is the utilization of the devices. Unfortunately, the literature and the results on the problem are very scant.

The pelvis tilt is an important index in assessment of the postural disorders, especially in children with lumbar lordosis. Usually in practice the difference between an anterior superior iliac spine and a posterior superior iliac spine is visual assessed. Debruner H., V. Hep (1996) indicated that the asymmetry in anterior superior iliac spine and posterior superior iliac spine is indicative of problem in pelvis and to incorrect diagnostic for difference in length of the lower extremities. In this aspect we think that the Digital Pelvic Inclinometer will be contribute to additional information.

THE AIM of the research is to make literature revue and to study the possibilities for implementation of Digital Pelvic Inclinometer (DPI) in functional diagnostic of the postural disorders in children.

## METHODS

In accessible literature we didn't find any information about application of the Digital Pelvic Inclinometer in children.

## The device

The Digital Pelvic Inclinometer (DPI) developed by Sub-4 Technologies, is a precision measuring device used to quantify innominate bone inclination. Using the described technique, the DPI can be used to assess pelvic behaviour by using the specialize protocols. The Digital Pelvic Inclinometer (DPI) allows the physiotherapists to understand and measure the role of the pelvic in development of repetitive injury including lower back.

Data is captured by the DPI via a tiny three-axis accelerometer attached to a small electronics board. The accelerometer measures the static acceleration of gravity in the three directions. The electronics use this data to calculate the angle of tilt. This data is then shown in numerical form on the LCD.

The DPI is only as accurate as it's user and has high inter/intra physiotherapists reliability if used in the correct manner, following the guidelines below. The anterior superior iliac spine (ASIS) and pubic symphysis are aligned vertically. In this position the pelvis is in 'neutral' and is described by Kendal et al (2005) "as an ideal position for the pelvis". Kendal also describes the normal sagittal plane inclination between the posterior superior iliac spine (PSIS) and ASIS as being approximately 5° +ve (Innominate inclination is considered +ve when the PSIS is higher than the ASIS, and –ve when the PSIS is lower than the ASIS). Others have described average inclination at around 11.3° +ve and 8.8° +ve 3,5.2° Kendall, F., E. McCreary, et al.

However, variations as much as twelve degrees have been found in cadaver studies. This author describes the normal inclination of the average adult innominate to be around 8 to 10° +ve, based on clinical experience.

- The DPI is an easy to use hand-held instrument designed to allow the physiotherapists to measure innominate inclination and establish pelvic torsion.
- The two moveable arms with sensory finger grips increase proprioception and therefore accurate measuring.
- The precision arms pivot about a main body, which houses a digital inclinometer and a spirit level. The spirit level allows the main body to be kept level during measurement.
- The DPI allows the physiotherapists to record quantitative data both before and after treatment. Kendall, F., E. McCreary, et al.

# THE PROTOCOLS

1. Basic Pelvic Torsion Measurement

Start on one side of your patient and take an innominate bone inclination. Record this data.

Then repeat the innominate bone inclination measurement, but this time on the contralateral side. Any difference in the values between each side is described as a pelvic torsion, which may require corrective treatment (table 1).

**Table 1** An example of a basic pelvic torsion measurement

| | |
|---|---|
| Right Innominate Inclination | 15° |
| Left Innominate Inclination | 8° |
| **Pelvic Torsion** | = 7° |

2. The Pelvic Equilibrium Theory

The Pelvic Equilibrium Theory' is an exciting new explanation of pelvic adaption in the presence of leg length inequality (LLI). Discovered by specialist podiatrist Clifton Bradeley this new theory is fast becoming the most popular MSK assessment protocol used in clinical biomechanics across the world (fig. 2).

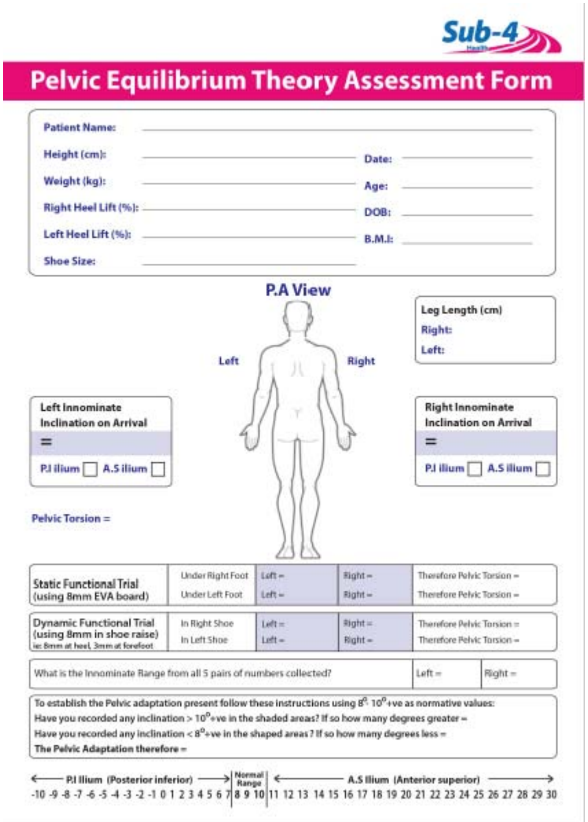


**Fig. 2** Pelvic Equilibrium Theory Assesment form

## Subjects

In our preliminary research we applied the DPI in 25 children from the beginning classes (from I to III classes) in the school "Iordan Iovkov" – Sofia during the period April - May 2016. The average age was 8.6 years (from 7 to 9). Was measured left and rigth pelvic inclination and therefore - torsion.

## RESULTS

The results are presented in Table 2.

**Table 2** Results from inclination measurement

| | |
|---|---|
| Average- left side | 10.78º |
| Average- right side | 10.28º |
| Average of Torsion | 2.108º |

The results show that the pelvic inclination in children are average for left 10.78º and for right 10.28º.

Torsion is the difference between left and right inclination of innominate bones. Mean value of torsion is 2.108º this indicate potential for developing progression Lordosis in children it 1 to 3 class.

## DISCUSSION

During normal standing the head is upright and facing forwards, the neck is slightly extended, the upper back is in slight flexion, and the lower back is in slight extension. The slightly extended inward curve of the neck (cervical spine) and lower back (lumbar spine) is referred to as lordosis. There are several researches about lordosis and the concomitant dysfunctions. The screening examination involved 83 children with the average age from II and III classes at the School at Sofia in October - November 2012 shows result from hamstring lenght test. – Tasheva R, & Kolev, K. (2014). In 25,30% (21 children) of the groupe was indicated lordosis. The hamstring was shortened in 20 (95%) of them with average 61, 1º (minimal value 45º to maximal 75º ). Only 20 children were free of spinal deformities. Their average hip flexion was 75º (minimal value 60º to maximal 90º).

The rate for adults described by Kendall, F., E. McCreary, et al is 8+ve +10$^0$+ve. In the same time there are no standards for children about measuring of the pelvis inclination by DPI.

Our results show averages slightly above normal for pelvic inclination (Left 10.78, right 10.28).

A basic pelvic torsion measurement will clearly identify whether there is a twist (torsion) between each innominate bone, which can be quantified and recorded prior to intervention. If a pelvic torsion is identified and the physiotherapists implements their preferred treatment program to reduce the torsion, the DPI can then be used again after treatment to quantify the improvement / correction.

The functional diagnostic of the postural disorders in children plays the important role regarding the prevention of the structural spine deformities and chronic musculesceletal problems.

## CONCLUSION

This new and innovative methodology allows asymmetry, dysfunction and adaption to be quantified, allowing instant evidence based diagnosis and treatment. The DPI subsequently allows the physiotherapist to record normative values after treatment interventions have been implemented. In short this means that:

- Dysfunction can be quantified.
- Treatment becomes more directive and accurate.
- Improvement can be quantified.
- The effects of orthotics, heel-raises and other treatments can be quantified.

All these indices lead to more precise physiotherapy for prevention and correction.

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# CORRELATION BETWEEN RESULTS OF FUNCTIONAL LORDOSIS TEST AND DIGITAL PELVIC INCLINOMETER TEST

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UDC 615.825::796

## SUMMARY

This article present testing of new method to funtional diagnostic and correlation it with functional test for lordosis in lumbar spine. The Digital Pelvic Inclinometer (DPI) help to do precise screening diagnostics of lumbar spine in children at primary classes. The study confirmed that the applying of the Digital Pelvic Inclinometer contribute very important data and give an opportunity to precise the diagnostics of lumbar lordosis in children at primary classes.

**Keywords:** Digital Pelvic Inclinometer, Lordosis, Physiotherapy

## INTRODUCTION

Postural disorders of the spine are significantly prevalent among children. A large percentage of them are in the sagittal plane and with localization in lumbar spine. Usually we apply the functional test for the assessing lordosis (Tasheva, R., Kolev, K., 2014). In the last years, our research found that the functional lordosis is not predominantly a feature of female children and this postural problem is extended also among primary schoolboys. Early and detailed functional diagnostics of lordosis with digital pelvic inclinometer (DPI) will help to precise the diagnostic and programming physiotherapy. This is the rationale for our study.

**The aim** of this study is to precise the diagnostics of lumbar lordosis in children at primary classes through applying the Digital Pelvic Inclinometer (DPI) and to correlate the results with the Functional Test.

## METHODS

### Subject

The screening examination involved 132 children (62 girls and 70 boys) with the average age 8, 7 (from 7 to 9 years) from the beginning classes (from I to III classes) at the School "Iordan Iovkov" – Sofia. We assessed the lumbar lordosis through the Fuctional Test in all children. The DPI was applied for preliminary investigation in 25 children of measuring left and rigth pelvic inclination and therefore - torsion

### Procedure

First we check the lower back in the sagittal plane for the presence of excessive lordosis - this is view of the back. After this, a bilateral Test in standing position with hip and knee flexion in 90̊ was applied to determine the type of lordosis. Finally, the inclination of innominate bones and torsion of the pelvic in standing position was evaluated with DPI. Both lower limbs were examined.

The next indexes were registered in: surgery; pulmonary disorders; infectious diseases; cardiovascular disease, scars, congenital anomalies and more.

### Tests

1. <u>Inspection</u>

During normal standing position with heels brought together, fingers pointing outward, knees are extended and upper limbs are freely granted to the body. Body and head are in the normal upright position without the additional stress of back and abdominal muscles. The level of superior anterior iliac spine and superior posterior iliac spine were inspected from the front, side and back. (Tasheva, R., 2008), (Fig. 1).

**Fig. 1** Inspection of the lumbar back from side

2. Functional Test determining the type of Lordosis

Standing is a start position. When running the test the leg of the evaluated children is placed in 90° hip and knee flexion and holds this position for a few seconds. Screen whether lumbar lordosis by hip flexion is flattened. If the arch smooth define as a functional lordosis, if does not as a structural lordosis (Fig. 2). The test is performed consecutively with both lower limbs. (Tasheva, R., 2008).

**Fig. 2** Determining the type of lordosis

3. Basic Pelvic Torsion Measurement – DPI test

Start on one side of the child and take an innominate bone inclination. Then repeat the innominate bone inclination measurement, but this time on the contralateral side. (Fig. 3) Any difference in the values between each side is described as a pelvic torsion, which may require corrective treatment (Table 1). (Clifton Bradeley, 2013).

**Fig. 3** Pelvic torsion measurement – DPI test

**Table 1** An example of a basic pelvic torsion measurement

| | |
|---|---|
| Right Innominate Inclination | 15° |
| Left Innominate Inclination | 8° |
| **Pelvic Torsion** | = 7° |

The center of mass (CoM) passes anterior to the sacral base and ankle joint, slightly posterior of the acetabulum but just anterior to the thoracic spine and knees. The anterior superior iliac spine (ASIS) and pubic symphysis are aligned vertically (Fig. 4). In this position the pelvis is in 'neutral' and is described by Kendal et al "as an ideal position for the pelvis". This author describes the normal inclination of the average adult innominate to be around 8 to 10 ° +ve, based on clinical experience. (Kendall, F., E. McCreary, et al., 2005).

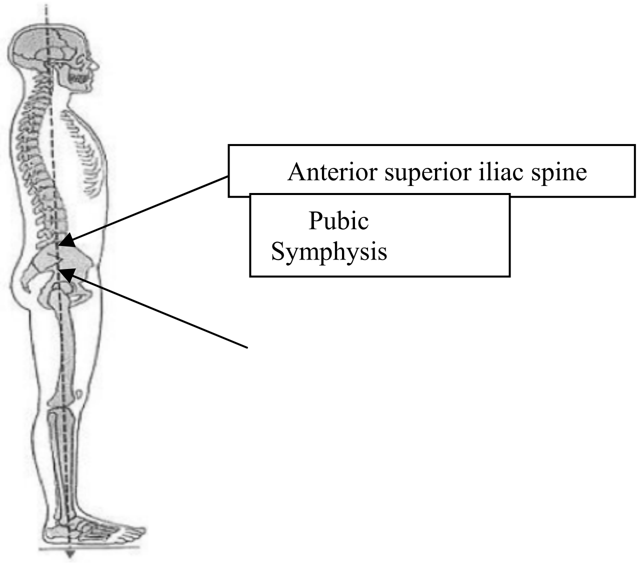


**Fig. 4** The normal standing upright posture

# RESULTS

**Table 2** Results from lordosis functional test

| Gender | N | Children with lordosis | Healthy Children |
|---|---|---|---|
| Females | 15 (60%) | 11 (73.35%) | 4 (26.6%) |
| Males | 10 (40%) | 6 (60%) | 4 (40%) |
| Total | **25 (100%)** | **17 (68%)** | **8 (32%)** |

From the totally tested 25 children 15 are girls and 10 boys. Children with indicated lordosis are 17 (68%) - 11(73.35%) girls and 6(60%) boys. Then healthy children are 4 (26.6%) from the 15 girls and 4 (40%) from the boys (Table 2).

**Table 3** Descriptive statistic for pelvic tilt

| Index | Side | N | Xmin | Xmax | R | x̄ | S | V | As | Ex |
|---|---|---|---|---|---|---|---|---|---|---|
| Children with lordosis | Left | 17 | 4.20 | 22.50 | 18.30 | 11.02 | 4.22 | 17.80 | 1.16 | 2.51 |
| | Right | 17 | 3.50 | 18.00 | 14.50 | 10.95 | 3.63 | 13.20 | -0.10 | 0.67 |
| | Torsion | 17 | 0.50 | 9.30 | 8.80 | 2.78 | 2.43 | 5.93 | 1.51 | 1.06 |
| Healthy children (children without lordosis) | Left | 8 | 4.50 | 11.70 | 7.20 | 8.76 | 2.41 | 5.79 | 0.40 | -0.79 |
| | Right | 8 | 3.50 | 10.60 | 7.10 | 8.14 | 2.41 | 5.80 | -0.05 | -1.08 |
| | Torsion | 8 | 0.00 | 1.10 | 1.10 | 0.62 | 0.4 | 0.16 | -0.80 | 1.5 |

From the data in Table 3 we can draw the following conclusions:

- Children with lordosis innominate inclination values range from left side - 4.20° to 22.50° and right side - 3.50° to 18°
- Healthy children innominate inclination values range from left side – 4.50⁰ to 11.70⁰ and right side – 3.50⁰ to 10.60⁰
- Pelvic torsion range in lordosis children – 0.50⁰ to 9.30⁰ and Healthy children range is 0.00⁰ to 1.10⁰
- The study groups are sufficiently uniform performance DPI test, as the coefficient of variation (V) is 17.80% of left side and 13.20% of right side for children with established functional lordosis and 5.79% of left side and 5.80% of right side for healthy children. Torsion variation in children with lordosis is 5.93% and 0.16% for healthy children. Coefficients are close to those of highly homogeneous sample (Table 3).
- Coefficients of skewness (As) and kurtosis (Ex) are, respectively, for children with lordosis As 1.16(left) -0.10(right)- Ex 2.51 (Left) and Ex 0.67 (right) at α = 0,05 and healthy children – As 0, 40 (left) -0.05 (right )and Ex -0.79 (left) -1.08 (right) at α = 0,05 are below critical, which means that the criterion has a normal distribution.
- Torsion values: Children with lordosis – As 1.51, Ex 1.06; Healthy children – As-0.80 Ex 1.5 at α = 0,05
- The correlation with standards on the left and right side is presented in Table 4.

From this analysis we can see the percentage of values according to the standards both groups from left and right side measured in children. (Fig. 5)

**Table 4** Values according to norms

| | N | In standards | | Excess (+) | | Subnorm (-) | |
|---|---|---|---|---|---|---|---|
| | | Left | Right | Left | Right | Left | Right |
| **Children with lordosis** | 17 (100%) | 6 (35,3%) | 1 (5,9%) | 8 (47,05%) | 13 (76,47) | 2 (11,76%) | 3 (17,64%) |
| **Healthy children** (children without lordosis) | 8 (100%) | 2 (25%) | 2 (25%) | 1 (12,5%) | 1 (12,5%) | 5 (62,5%) | 5 (62,5%) |
| **Totall** | 25 (100%) | 8 (32%) | 3 (12%) | 9 (36%) | 14 (56%) | 7 (28%) | 8 (32%) |

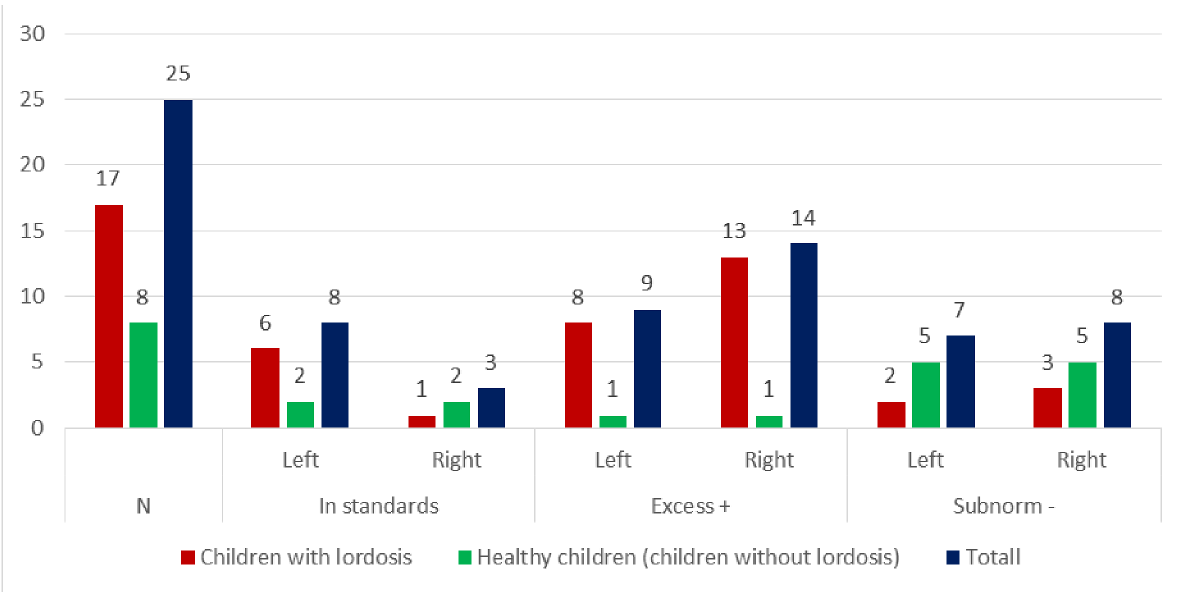


**Fig. 5** Diagram of values according to norms

**Table 5** Dependence between the type of lordosis and pelvic inclination

| Index | Sign | Healthy children | | | Functional lordosis | | | Statistical | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | n1 | X1 | S1 | n2 | X2 | S2 | t | P(t) | d | rpb |
| Lordosis | Left inclination | 8 | 7,1 | 2,4 | 16 | 10,9 | 3,7 | 2,63 | 98,5 | 3,8 | 0,489 |
| | Torsion | 8 | 0,7 | 0,4 | 16 | 2,2 | 1,7 | 2.44 | 97,7 | 1,5 | 0.461 |

By IBM SPSS statistic analysis, we made correlation between parametric and nonparametric values from both tests. (Damyanova, R., V. Gigova, 2000).

In 8 persons test lordosis shows that healthy, while 16 have functional lordosis. The mean value of the test with DPI - left sided, for healthy is 7.1 degrees, and in children with functional lordosis - 10.9 degrees. The difference of 3.8 degrees statistically significant due to the value of T-Student criterion (t) of 2.63 at a critical value of 2.07 (24 respondents) and warranty probability is 98.4%. Biserialniyat factor (rpb) is above the critical value of 0.39, which means that belonging to groups "healthy children" and "children with functional lordosis" influences signs "left-sided inclination of the pelvis" (Table 5).

Torsion in healthy (without lordosis) children means 0.7 degrees and in the other with functional lordosis is 2.2 degrees. The difference (d) from 1.5 degrees statistically significant because the value of the T-criterion (t) of 2.44, which is above the critical value - 2.07 and guaranteed probability of 97.7% and the value of biserialniya factor - 0.461 above critical of 0.39, which means that belonging to groups "healthy persons" and "persons with functional lordosis" influences signs "left-sided inclination of the pelvis".

# DISCUSSION

If we consider the author Kendall, and its values for standard inclination of the pelvis, then our studies DPI average group of children with established lordosis are left $11.02^0$ – right $10.95^0$, and the group of healthy children - $8.76^0$ left side and $8.14^0$ for right side. (Table 3)

As it means that, if $10^0$ for the maximum value of the norm, it is from these results it is clear that the group of children with lordosis are $1.02^0$ above the norm of the left side, and $0.76^0$ on the right side. From the results in healthy children establish normal values for the inclination of the pelvis.

# CONCLUSION

This study confirmed that the applying of the Digital Pelvic Inclinometer contribute very important data and give an opportunity to precise the diagnostics of lumbar lordosis in children at primary classes. The results showed the correlation between the Digital Pelvic Inclinometer Test and the Functional Lordosis Test.

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# CRITICAL THINKING - STRATEGIC LEARNING AND METACOGNITIVE STRATEGIES IN SPORTS CLASS

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## SUMMARY

The reform in teaching and curriculum involves not only the teaching content, but even more so the teachers' methodology, the students' learning strategies and the changed relationship between students and teachers in the classroom settings. The purpose of this paper is to suggest that what is needed for ESP is a different orientation to English study. There is a shift of the focus of attention from the grammatical to the communicative properties of language. Difficulties students encounter arise not so much from a defective knowledge of the system of language but from unfamiliarity with English use. It is suggested that in teaching ESP learning strategies and strategic learning should play an important role. Accordingly, autonomous-strategic learning and metacognitive strategies are suggested as basic essentials for teaching and learning ESP in sport.

**Keywords:** Strategic learning, Metacognition, Product, Process, ESP-sport

## INTRODUCTION

English for specific purposes (ESP) is a movement based on the proposition that all language teaching programs should be tailored to the specific learning and language use needs of identified groups of students. Whereas English had previously decided its own destiny, it now became subject to needs, and demands of people other than language teachers. Dovey (2006) states courses which prepare students for the workplace in specific ways can be expected to have purposes quite different from those of discipline- based courses and can also be expected to introduce new questions. ESP also became an important part of English probably as a direct result of the introduction of communicative teaching curricula. Its main drive was practical, driven by the increasing numbers of people around the world who needed English for clearly defined reasons such as reading academic textbooks, developing writing skills, or transacting business (Hutchinson and Waters, 1987).

It is suggested that ESP could easily be outlined based on the sorts of texts that learners need to become familiar with, or the needs-related nature of the teaching (Swales, 1985). The early analyses of ESP texts took the form of frequency counts of structures or verb forms. These limitations led to researchers using rhetorical or discourse analysis methods to discover the main characteristics of texts in different academic fields, e.g. sport, business (e.g. Widdowson, 1979). During the late 1970s ESP course designers started to carry out needs analysis of their students' future linguistic requirements. These needs analysis were often expressed in terms of notions and functions (Wilkins, 1976) and the most celebrated model of such a needs analysis are described by Munby (1978) in his communicative syllabus design. These profiles included the purposes of communication, the communication settings, and the language skills, functions and structures required. It is evident that ESP is not equal for producing sub-technical and technical textbooks.

## METHODS

The burning question is:

1. Whether an English teacher courses or the specialists from the field should teach ESP course.
2. Some students think that ESP is a new label for GPE and nothing else. For them this is invented by English teachers to make students interested in English programs.

They believe that their instructors in their field will be more successful to teach ESP courses even not being familiar with English teaching and learning theories. For some others having knowledge in the field is not sufficient for an ESP Instructor, they should have a good command in general English and they should be familiar with the basic principles and teaching and learning theories.

**Review of previous research**

To pave the way, it is better to have a brief look at some definitions and explanations by some specialists in the field to support the idea that ESP is not the same as EGP. What is the difference between the ESP and General English (EGP) approach? Hutchinson and Waters 1987:53) answer this quite simply, "… in theory nothing, in practice a great deal". This definition by Hutchinson and Waters raises one important question. If in theory there is no difference between ESP and EGP, what is the theoretical justification for ESP? It seems that without a theoretical justification to ESP there will be no acceptable rational for such a course. But Widdowson (1983) attempts to theorize ESP and this can be followed in his works under two interrelated headings: Learning purpose and Language use. For Widdowson GPE is no less specific and purposeful than ESP. What distinguishes them is the way in which purpose is defined, and the manner of its implementation.

Based on this definition there are two interpretations from learning purpose. One might be regarded as objective-oriented learning and the other as aim-oriented one. In ESP Specification of objective is equivalent to aim that is a training operation and deals with development of restricted competence, whereas, in GPE Specification of objective is not equivalent to aim but it leads to aim that is an educational operation and deals with development of general capacity (Widdowson, 1983):

ESP is essentially a training operation which seeks to provide learners with a restricted competence to enable them to cope with certain clearly defined tasks. These tasks continue the specific purposes which ESP course is designed to meet. The course, therefore, makes direct reference to eventual aims. GPE, on the other hand, is essentially an educational operation which seeks to provide learners with a general capacity to enable them to cope with undefined eventualities in the future. Widdowson (1983) criticizes the two models of idealization, registers analysis and needs analysis and suggests his own model of idealization.

**Methods**

1. **Register analysis approach** is a kind of idealization that involves the dissociation of linguistic forms from their communicative function in discourse. In fact the specification based on register analysis does acknowledge the pedagogically necessary distinction between aims and objectives. It rests on the assumption that a definition of objectives in terms of linguistic terms will provide for the subsequent satisfaction of communicative aims. That is to say that the imparting of linguistic competence will enable the learner to develop communicative capacity under his own steam.

2. **Needs analysis approach** is a kind of idealization that seeks to retain the communicative value of linguistic elements and analyses language into its notional and functional. What this needs analysis approach seeks to do is to bring aims into closer approximation to objectives. Here, findings that emerge from needs analysis characterize aims. Richards and Rogers (2001) state that a notional functional syllabus would include not only elements of grammar and lexis but also specify the topics, notions, and concepts the learner needs to communicate about. The English for specific Purpose (ESP) movement likewise begins not from a structural theory of language but from a functional account of learner needs. Widdowson challenges this orthodox view of ESP and suggests

3. **A discourse approach to ESP.** We must look for is a model of language which does not simply atomize the user's behavior into components of competence, but accounts for the essential features of the discourse process. The model therefore has to lend support to the concepts of training and education, of competence and capacity, of aims and objectives, and so give us a theoretical basis for ESP (Widdowson 1983:34). Hutchinson and Water (1987) challenge this view and claim that ESP must be seen

4. **As an approach not as a product**, ESP is not a particular kind of language or methodology, nor does it consist of a particular type of teaching material, it is an approach to language learning, which is based on learners needs. It seems that in the three approaches stated earlier the idea of what to learn plays an important role and how learn is not the main concern. …. But our concern in ESP is not with language use –although this will help to define the course objectives our concern is with language learning. We cannot simply assume that describing and exemplifying what people do with language will enable someone to learn it. If that were so, we need to do no more than read a grammar book and a dictionary in order to learn a language. A truly valid approach to ESP must be based on an understanding of the processes of language learning." (p.24)

There is a need to seek possibilities of fostering learner autonomy in ESP course design in any teaching context. This importance can be followed by applying metacognitive strategies for ESP learning. In fact, an autonomous learner should be able to manage or regulate the process of learning which involves making decisions as to what to learn, how to learn, when to monitor, and in what way to evaluate success or failure of learning (Wenden 1987; Holec 1987; Cotteral 2000).

**Goal-oriented and Process-oriented Syllabuses**

Generally speaking, the process of deciding what to teach is based on consideration of what the learner should most usefully be able to communicate in the foreign language. In ESP, According to Mackay and Mountford (1978) when needs are clear, learning aims can be defined in terms of these specific purposes to which the language will be put, whether it be reading scientific papers or communicating with technicians on an oil rig. The result is that almost immediately, teaching can be seen to be effective in that the learner begins to demonstrate communicative ability in the required area. What Mackay and Mountford suggest is only the realm of Goal-oriented syllabus and there is no place to processes-oriented one in such an interpretation of the learner needs.

We know goal-oriented approach focuses on the selection of language by reference to the ends of learning, but the process-oriented approach focuses on the presentation of language by reference to the means of learning and allows the ends to be achieved by the learner by exercising the ability he or she has acquired. The first approach assumes that the completion of a course of instruction marks the completion of learning and that all that is left for the student to do is to apply this ready-made knowledge. The second approach assumes that learning will continue beyond the completion of instruction since the aim of such instruction precisely is to develop a capacity to learn: it does not itself realize any special purpose but provides the learner with the potential for its realization. In practice, syllabuses in which the selection and grading of items was carried out on a grammatical basis fell into disfavor because they failed adequacy to reflect changing views on the nature of language.

In addition, there was sometimes a mismatch between what was taught and what was learned. Some SLA researchers have claimed that this mismatch is likely to occur when the grading of syllabus input is carried out according to grammatical rather than psycholinguistic principles, while others suggest that the very act of linguistically selecting and grading input will lead to distortion. Moreover it seemed that functional-notional principles would result in syllabuses which were radically different from those based on grammatical principles. However, in practice, the new syllabuses were rather similar to those they were intended to replace. In both syllabuses, the focus tended to be on the end products or results of the teaching/learning process.

According to Widdowson (1983) the absence of distinction between aims and objectives leads to an ambiguity in the expression "learner needs". On the other hand, it can refer to what the learner has to do in order to learn: in this sense, it relates to pedagogic objectives. If one follows a goal-oriented approach one needs to take one's bearing from models of linguistic description, since these will define the units of course content. A process-oriented approach, on the other hand, can only be pursued by reference to some idea about how to learn. In this regard, according to Atay (2007) the interest in the strategies has paralleled a movement away from a dominantly teaching –oriented perspective to one that emphasis the learner's active role in the learning process. Thus, if ESP is an approach not as a product, it must be an approach to language learning. And here, Learning strategies and activities should play more important role than selecting and grading appropriate materials to meet the students' needs.

**Learner Autonomy**

Holec (1987) defines Learner autonomy as the ability to take charge of one's learning.

It is good for teachers introduce such key concepts as "learner-centeredness" and learner autonomy" and their theoretical underpinning, and stress the importance of learning how to learn so that students would be psychologically prepared and are likely to cooperate. As learner-centeredness is one of the tendencies that supports autonomous language learning, students should be given a clear explanation as to what it means, how it is conducted, and what benefits could be gained through this approach. Aebersold and Field (1997) define the term" student-centered:

Courses in which the students have some degree of control over what goes on in the course and how it occurs are considered to be student-centered. Giving students some control over their learning process has many benefits: It makes them feel confident; it puts some of the decision making in their hands; it puts the responsibility for learning in their hands; and over the long term it builds independence and self-reliance so that they can read on their own without being dependent on teacher direction and supervision. It activates the students' own learning spirals. (p. 37).

Even giving students' freedom to choose materials is not only compatible to the theory, but also satisfies learners' needs. A better understanding of the theory would stimulate learners' interest and motivation to practice autonomous learning.

Thus consciousness raising was chosen as the first measure to implement the innovation. To transfer the responsibility of selecting materials to learners is supported by (Hollec, 1987, Vitori, 1995), because it stimulates their interest, enhance the do-it-yourself ability. Engaging learners in activities of selecting, preparing and presenting materials could be considered creative because these activities involve problem–solving and decision making.

**Cognitive Strategies**

The term cognitive strategy refers to specific measures or steps that learners take in order to fulfill learning tasks (O'Malley and Chamot 1990). Literature in reading research has shown that cognitive strategy use can facilitate understanding and successful learners seem to be differentiated from less successful ones in terms of strategy use. Similarly learners who possess summarizing skills (Kintch and Van Dijk 1978) have improved comprehension on the texts and increased recalls.

**Monitoring**

Monitoring refers to both learners' identifying learning difficulties and pointing out shortcomings of the program so that decision could be made as to what to do about it (Rubin 1987). As the shift of responsibilities from the teacher to the learners takes place, it is important for the learner to do self-evaluation and provide feedback to the program in order to regulate learning process. Nunan (1997) suggests that monitoring plays an important role in informing the learner of the problems encountered during the course of learning. Thus the course should intend to raise learners' consciousness to monitor their learning process.

**Metacognitive Strategies**

One can probably figure out from analyzing the term itself, metacognition is cognition about cognition or thinking about thinking. Thinking can be of what the person knows and what the person is currently doing. Metacognition is deliberate, planned, intentional, goal directed and future-oriented mental processing that can be used to accomplish cognitive tasks (Flavell, 1971). Metacognition involves active monitoring and consequent regulation and orchestration of cognitive processes to achieve cognitive goals. As metacognition involves an awareness of oneself as an actor , a deliberate storer and retriever of information, it may be reasonable to reserve the term metacognitive for conscious and deliberate thoughts that have other thoughts as their objects (Hacker, 1998). According to Block (2004) metacognition can be defined as a reader's awareness of (1) what he or she is thinking about while reading, (2) what thinking processes he or she initiates to overcome literacy challenges, and (3) how a reader selects specific thinking processes to make meaning before, during, and after reading.

Auerbach and Paxton (1997), define metacognition as "knowledge of strategies for processing texts, the ability to monitor comprehension, and the ability to adjust strategies as needed" (pp. 240-41). Research studies (Duell, 1986) seem to confirm that as children get older they demonstrate more awareness of their thinking processes. Metacognition is relevant to work on cognitive styles and learning strategies in so far as the individual has some awareness of their thinking or learning processes.

Cognitive strategies differ from metacognitive strategies in that they are likely to be encapsulated within a subject area (e.g., EFL), whereas metacognitive strategies span multiple subject areas (Shraw, 1998). Cognitive strategies are, for example, making a decision, translating, summarizing, linking with prior knowledge or experience, applying grammar rules and guessing meaning from texts (e.g., O'Malley and Chamot, 1990). Metacognition refers to awareness and control of cognitive activities. Empirical studies show that successful learners differ from less successful ones in both the quantity and quality of cognitive and metacognitive strategy use (e.g., Oxford, 1989). The literature of metacognitive strategies in reading comprehension reveals that poor readers in general lack effective metacognitive strategies and have little awareness on how to approach to reading. They also have deficiencies in the use of metacognitive strategies to monitor for their understanding of texts. In contrast, successful L2 readers know how to use appropriate strategies to enhance text comprehension (e.g., Pitts, 1983).

## DISCUSSION

Feedback from the students on their impressions and thoughts of the strategies covered during the terms and students' retrospective comments on the efficiency of these strategies at ESP-sport class are following.

1. Now, I think my brain is more active in reading as if, I read with my brain rather than my eyes.
2. After previewing I can decide how I will deal with any particular text, and which other strategies I am going to follow to have better comprehension.
3. The strategies you applied made me conscious and active I used to read a text word for word until then, being afraid to misunderstand the contents. Now I'm trying to skip as many words as possible even when I am going to read about something not familiar, and I am going to deal with the text I have already had quite a few knowledge.

4. There are many positive aspects of using predictions:

Firstly, immediately thinking about the topics help us to understand contents of articles.

Secondly, we can improve our reading speed by predicting the following contents.

Thirdly, we can associate our knowledge we have concerning the topics and it can help make our learning much easier.

5. Finding key words in any text was an interesting technique. I think relying on Key words is more helpful than relying on the structure in reading a text.

6. I think it is easier to ask question when I read something I have prior knowledge with because I have something to base in to ask question.

7. Now, I have a critical reading and I can use my background knowledge.

## CONCLUSION

We conclude that ESP is an approach to language teaching which aims to meet the needs of particular learners. This means in principle that much of work done by ESP teachers is concerned with designing appropriate courses for various groups of learners, for example PE and sports students. In fact, with ESP (in sports) and content-based syllabuses, an obvious means of grading content is with reference to concepts associated with the subject in question.

It seems reasonable enough to assume that a specification of language needs should define the language content of a course designed to meet such needs. Here "learner needs" is open to question. In fact two different interpretations may be extracted from learners needs. It may refer to targeted behavior, the ends of learning or it may refer to what the learner needs to do to actually acquire the language.

Over recent years some applied linguists have shifted focus from the outcomes of instruction, i.e. the knowledge and skills to be gained by the learner, to the processes through which knowledge and skills might be gained. Although specification of language needs is necessary for ESP course and selecting and grading materials, in teaching ESP in sport, learning strategies should play an important role.

Accordingly, autonomous learning and metacognitive strategies are suggested as the two basic essentials for teaching and learning ESP in sport. Finally, if we limit teaching ESP to what to learn and forget how to learn, it will be safe to claim that familiarity with teaching and learning theories is not an essential for ESP teacher, otherwise it should be regarded as a sin qua non for ESP teacher.

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# THE BENEFICIAL EFFECTS OF PHYSICAL-COGNITIVE TRAINING TECHNIQUES FOR PHYSICAL AND BRAIN HEALTH

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## SUMMARY

The 15 randomly selected healthy late-middle-aged and old-aged participants (64,36 ± 4,65 years of age; body mass 69,71 ± 10,34 kg; height 159,64 ± 8,37 cm) from Center for daily activities for elderly people of Municipality of Koper filled out a participant satisfaction questionnaire after 3 months of combined cognitive training and physical activity training techniques. Also the self-reported mental/physical benefits of these techniques by elderly participants were identified. The self-reported benefits of the program and satisfaction with the training techniques are important starting points for further program development.

**Keywords:** physical-cognitive training techniques; physical health; cognitive health;

## INTRODUCTION

The aging process begins at birth and people change through all stages of life, only that at a young age they are not even aware of these changes (Požar, 1996; Miloševič, 2003). The period after thirty years of age is a turning point, after which it comes to additional changes that lead to a slow deterioration of functional capacity (Miloševič, 2003). A fundamental change in old age, which relates to the aging of the musculoskeletal system is a reduction in muscle strength, which is more pronounced in women than in men (Požar, 1996), and the maximum loss of power in elderly women is shown on the legs, and the smallest in the arms and shoulder girdles (Dolenc, 2007). Also Macaluso and de Vito (2004), Reeves, Narici and Maganaris (2006) claimed, that strength loss appear to be the greatest in the lower limbs, but on the other hand, some authors argued, that this can hold true both for women or men (Camiña Fernández, Cancela Carral and Romo Pérez, 2001; Janssen, Heymfield, Wang and Ross, 2000).

Furthermore, it is well established that loss of muscle mass results in functional limitations and disabilities associated with aging (Leenders, 2003; Rouvenoff, 2001) and it is the leading cause of reduced strength among adults 15–80 years of age (McArdle, Katch and Katch, 2001), particularly marked in highly sedentary (hypokinetic) subjects (Rodríguez-Ruiz et al., 2013).

The relationship between muscle mass and physical activity levels is not easy. The following well-known risk factors for bone thinning and osteoporosis adversely affect on the metabolically active bone tissue: the loss of estrogen during menopause, certain medications and diseases, smoking, too much alcohol, reduced use of muscle power and poor nutrition (Hind, 2015). Regular physical activity with correct safety precautions has the small risk of complications and a number of benefits, such as prevention of loss of bone and muscle mass, improvement in muscle strength, coordination and balance, what consequently prevents falls and osteoporotic fractures (Pfeifer and Kogoj, 2014).

Important issues associated with aging are also memory problems and question is, are these problems normal or serious? It often happens that we forget, for example, where are the glasses. This happens to us all the time, so it is important to say that any disturbance of memory is not dementia, but it can be a good sign for the early detection of this disease.

There are many different definitions of dementia. For example, Graham and Warner (2013) defined the concept of dementia as a situation, when the operation of the brain function gradually worsens and does not coincide with the criteria of normal mental decline in old age.

The numbers show, that 3-11% of people above 65 years suffer from dementia and morbidity is higher with further aging. It can be expected, that 20 to 50% of older people, who are 85 years old will be diagnosed with dementia. The possibility of the occurrence of dementia in people, who are 100 years old, is lifted onto 60-90% (Denišlič, 2002). In the population aged 65 and above, approximately one in twenty individuals suffer from dementia. Among elderly, that are 85 years old or older, there is one in six people with this disease (Graham and Warner, 2013).

Due to the increasing number of those suffering from dementia, is necessary to increase investment in healthy aging. One of these investments is regular physical and cognitive training in early, mid and late life. Several studies have found that this kind of activity is associated with a lower risk of cognitive decline and dementia (Yoon, et al. 2014; Bahar-Fuchs, Clare and Woods, 2013; Tardif and Simard, 2011).

# METHODS

The 15 randomly selected healthy late-middle-aged and old-aged participants (64,36 ± 4,65 years of age; body mass 69,71 ± 10,34 kg; height 159,64 ± 8,37 cm) from Center for daily activities for elderly people of Municipality of Koper filled out a participant satisfaction questionnaire after 3 months of training, because if participants are unhappy with the service provided, they will not continue to participate, and therefore they will not be able to benefit from what the program has to offer. Questionnaire was brief, tailored to these specific exercises and focused on aspects of the program that are in our power to change or improve.

Also the self-reported mental/physical benefits of these techniques by elderly participants were identified. The self-reported benefits of the program and satisfaction with the training techniques are important starting points for further program development.

The subjects participated voluntarily and were familiar with the goals and purpose of the study. The possibility of refusal to cooperate and the anonymity were both guaranteed. All data obtained were used only for research purposes.

Two main types of techniques were used during the training program: (a) identification of the position of a certain character- for example a fisherman, a knight, a golf player etc. in combination with different exercise tools- golf balls, fitness sticks and 1kg fitness dumbbell; (b) exercises with certain elements of choreography in order to improve muscle strength, endurance, postural control, balance and to improve cognitive function, also in combination with above mentioned exercise tools.

# RESULTS

**Table 1**: Participant Satisfaction Questionnaire

| Question | Answer | Proportion |
|---|---|---|
| An overall satisfaction with the program | Very satisfied<br>Satisfied<br>Quite satisfied | 71 %<br><br>18 %<br>11 % |
| Satisfaction with the implementation of techniques twice a week | Yes<br>No | 82 %<br>18 % expressed the desire for program implementation 3 times weekly |
| Satisfaction with the way of implementing the program | Yes<br>Quite | 94 %<br>6 % |
| Satisfaction at the end of the one-hour program | Pleasant tiredness | 100 % |
| The desire for recommendation of physical training to relatives, friends, acquaintances and others. | Yes | 100 % |
| The desire for continuation of the program | Yes | 100 % |

**Table 2:** Self-reported mental/physical benefits of training techniques

| Mental/physical benefits | Proportion |
|---|---|
| I feel less stressed | 67 % |
| My mood is improved | 72 % |
| I feel happier | 55 % |
| My short-term memory increased | 44 % |
| I am less afraid of falling- I feel more secure | 58 % |
| Improved muscle strength | 100 % |
| Improved balance | 85 % |
| Improved indurance | 90 % |
| Improved flexibility | 84 % |

# DISCUSSION

The aging process begins at birth and people change through all stages of life, only that at a young age they are not even aware of these changes (Požar, 1996; Miloševič, 2003). The period after thirty years of age is a turning point, after which it comes to additional changes that lead to a slow deterioration of functional capacity (Miloševič, 2003). Life extension is a global trend and a result of changing lifestyles and new findings in the field of medicine and pharmacy. According to the World Health Organization it is projected, that till 2050, two billion people will be older than 60 years (Facts about aging, 2014) and according to the Statistical Office of the Republic of Slovenia, which summarizes the data of Eurostat, in 2060 we can expect that a third of Slovenian citizens be over 60 years old. In 2010, the proportion of older people in Slovenia was 16.5%, in 2050 will probably grow to 31.6%. Longevity and the increase in elderly population also means an increase in aging-associated diseases (Brnot and Peršin, 2013).

The American College of Sports Medicine (ACSM) recommends all adults over the age of 65, who have no physical activity limitations, to have a specific plan for physical activity which includes "aerobic, muscle-strengthening, and flexibility activities (and possibly balance exercises)" and these activities need to meet the standards of being both preventative and therapeutic (Nelson et al., 2007).

Several studies examined the beneficial effects of physical activity and some of them also explored the influence of combined physical and cognitive training in older adults, which have differential positive effects on cognition, but have been rarely applied in combination. It is important, that after 30 minutes of physical activity, the brain begin to release the endorphins, which are most popular of so-called happiness hormones (McGovern, 2005). Exercise improves the overall mood and is a natural anti-depressant (Roy, 2014). Generally, anything that is good for the heart is great for the brain, which indirectly means it is also very important to find ways to enjoy physical/ cognitive training or combination of both and stick to it.

Many medical conditions are improved with physical-cognitive training, including above mentioned dementia, and that type of training has beneficial effect on muscle strength, balance, endurance and flexibility.

This study shown that (a) the majority of elderly participants expressed great satisfaction via the questionnaire, (b) all of them expressed desire for the program to continue, (c) physical-cognitive exercise provides many health benefits and (d) older adults can gain a lot by staying physically/mentally active.

# CONCLUSION

Assessing satisfaction of participants and checking self-reported mental/physical benefits of training techniques is a necessary but not sufficient part of evaluating that type of training programs. There are also other methods for careful progress monitoring and analysis of elderly training performance, for example TMG, which is a non-invasive measuring method, based on the selective and simple measurement of muscle contractile properties on the basis of the muscle belly response and it is reproducible and valid method for the estimation of muscle composition (Šimunič et al., 2011; Šimunič, 2012; Šimunič, 2015). The combination of these methods is the key for the effective evaluation of training programs.

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# DIFFERENCES IN MEDIA REPORTING ON FEMALE AND MALE ATHLETES DURING THE OLYMPIC GAMES

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## SUMMARY

As an integral part of the culture of any society sport plays a key role in achieving social cohesion, overcoming gender stereotypes and prejudices, empowerment of women and promotion of gender equality. The aim of this study was to collect, classify and analyze the papers dealing with gender representation in media during the Olympic Games, and to draw some conclusions. More than 50 papers were analyzed, but only 11 met all the required criteria. The papers dealt with the representation of both gender athletes in media, from the summer Olympic Games in 1948 until 2008, and the Winter Olympic Games in 2010. Analyzing research results we can conclude that: larger number of articles in the print media are focused on male athletes; larger number of words are dedicated to male athletes than to the female athletes; television media also gives preference to male athletes regarding the duration of the television reports; male athletes photographs are more frequent than female athletes ones, large number of female photographs are situated in non-sport environments. It has been observed that recent studies report on a more balanced picture, primarily referring to the internet media.

**Keywords:** sport, Olympic Games, gender, media.

## INTRODUCTION

As an integral part of the culture of any society sport plays a key role in achieving social cohesion, overcoming gender stereotypes and prejudices, empowerment of women and promotion of gender equality. This potential of sport has been recognized in numerous international documents which define the institutional framework for the advancement of women and gender equality in sport. Why is it important to research media reporting in relation to women and sport? The main reason is that mass media — which are an essential feature of modern social life — preserve, transmit and create important cultural information. One of the central assumptions within media studies is that how members of society see themselves, how they are viewed and even treated by others, is determined to a great extent by their media representation (Dyer, 1993). Women take more participation in sports, even in sports which men have always dominated. However, media coverage of the competition in which female athletes compete in most cases is not satisfactory (Wensing, 2003; Duncan, 2005; Messner, 2003). According to Lee (1992) imbalances in reporting on male and female sport activities are rooted in generally shared ideas on the relationship between gender and sport. These include physiological, social psychological, and performance myths concerning the consequences of gender on sport participation. These myths have been accepted and perpetuated by the influential groups who control the structure of sports, including the number of participants for each gender and the number of events (Lee, 1992). The first group of myths is concerned with the harmful physical effects of sport participation on women. The social psychological myths involve ideas on certain sports enhancing or threatening femininity. These ideas include prevailing social definitions of specific sports women should or should not participate in.

In almost any society a traditional social definition for females is one of the subservience and subordination to men. Therefore, women are expected not to compete in sports demanding competitiveness and self-exertion (Leonard, 1980). Lee (1992) also argued that participation in certain individual and team sports allows for the demonstration of characteristics such as power, control, influence, and domination. In team sports, power and control are exercised through the combined efforts of team members in the quest for victory. Team sports involving female participants are, therefore, often disregarded by media.

Duncan and Hasbrook (1988) have emphasized that this exclusionary practice is a symbolic denial of power for women. Similarly, certain individual women sports (some track & field events, weightlifting, boxing, etc.) demand strength and endurance and/or may involve some risk. Such sports are considered unfeminine, and consequently, inappropriate for women. On the other hand, there are other sports such as tennis, swimming, synchronized swimming, gymnastics and figure skating which are considered to be traditionally female (Pirinen, 1997). Pirinen argued that traditionally male sports such as boxing, ski jumping, hammer throwing, triple jump and pole vault when performed by women are likely to get much less media representation than traditionally male or traditionally female sports. Women`s involvement in competitive sport was at first restrected to several "female appropriate" sports such as: tennis, golf and swimming. Now, when women are competing in almost every sport, deviding sports into male and female appropriate is outdated.

According to Smith (2016) there are several theories explaining mediated viewing experience related to gender differences. Most frequent theoretical frameworks are agenda setting, framing, and the hegemonic masculinity theory. Hegemonic masculinity theory can explain different ways stereotypes about women in sport are created and perpetuated. Smith (2016) quoted Gramsci (1971) "*notion of cultural hegemony centers on ideas of winning, power, and domination of a ruling class portrayed through the media and accepted as normal and natural*".

Despite increasing worldwide numbers of women participating in athletics, sport is still considered a male-dominated field (Crolley, 2007).When either gender deviates from those norms, such as women in "power" sports like boxing or hockey, the balance of power in hegemonic masculinity shifts. If principles of hegemonic masculinity are observed in sports media, consumers can expect to see male athletes portrayed in powerful and athletic contexts, while female athletes draw attention for their emotions and femininity. Scholars have shown that sports media often reinforce hegemonic masculinity (Kian, Mondello, & Vincent, 2009). Previous research studies have concluded that a hegemonic masculinity is reinforced through sports media production through language and commentaries, defining which sports are "appropriate" for men and women to participate in and different forms of visual production.

The Olympic Games can serve as a clear example both of the changes in attitudes towards women athletes and of their increased participation in sport. When modern Olympic Games were revived they were reserved for men only, as they had always been in the ancient times. In the first modern Olympics, in 1896, there were no female participants but from the 1900 to nowadays, women are competing equally as men, therefore, it is time for them to be equally represented in media.

# METHODS

There are numerous studies which investigate the portrayals of female athletes in sports magazines, newspapers, or television. The aim of this paper is to present and systematize current knowledge in this field. More than 60 papers were analyzed, but only 11 qualified as papers consisting research about women competing in the Olympic Games represented in media.

# RESULTS

All scientific papers were published in relevant scientific journals. The papers were related to the representation of athletes in media, from the summer Olympic Games in 1948 until 2008, and the Winter Olympic Games in 2010. Sources in the works were the most widely read dailies. The research material included following countries: USA, UK, Canada, Belgium, Denmark, France, Spain and Australia.

**Table 1**. Presentation of collected papers

| Author, year | OG | Source | Sport | State | Number of articles; minutes of air time | Number of male articles; minutes of air time | Number of female articles; minutes of air time | % of articles; minutes of air time (neutral gender) | % of male photographs; athletic and non athletic | % of female photographs athletic and non athletic | % of photographs devoted to neutral gender |
|---|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| King, 2007 | 1948–2004 | The Times; Daily Mail | Track&field | GB | 222; 256 | 59; 58 | 28; 36 | 13; 6 | Times 99; 4 nonathl. DM 97; 10 nonathl. | Times 53; 8 nonathl. DM 81; 9 nonath. | |
| Jones, 1999 | 1996, 1998 | Sport Illustrated, USA Today, LA Times, NY Times (9 in total) | Basketball, Gymnastics, Hockey, Soccer, Softball | USA | 67 | NA | 67 | NA | NA | NA | NA |
| Vincent 2002 | 1996 | Daily Mail, The Times; NY Times, USA Today; Toronto Star, Globe and Mail | all | USA, Canada, Great Britain | 1425 | 458 | 302 | 565 | 55,9 | 43,4 | 0.7 |
| Capranica, 2005 | 2000 | 20 National newspaper from four countries | 25 sports, 132 events | Belgium, Denmark, France, Italy | 5557 | 51,8 % | 29,3 % | 18,9 % | 56,2 % total 3011 | 33,5 % total 3011 | 10,3 % total 3011 |
| Tuggle, 2002 | 2000 | NBC’s prime-time Olympic coverage | all | USA | 41:06:50 | 55.2 % | 44.8 % | 0 | NA | NA | NA |
| Davis, 2012 | 2008 | NBC’s prime-time Olympic coverage | all | USA | 44:46:44 | 52.9 % | 46.3 % | 0,8% | NA | NA | NA |
| Bissell, 2013 | 2008 | several networks | Volleyball | USA | NA | NA | NA | NA | NA | NA | NA |
| Capranica, 2002 | 2000 | Rai 3 | all | Italy | NA | 71% | 29% | 0 | NA | NA | NA |
| Smith, 2014 | 2010 | NBC | Ice hockey | USA | 4,540 total camera shots | 45% | 55% | 0 | NA | NA | NA |
| Jones, D., 2004 | 2000 | ABC News Online | all | Australia | NA | 50.5 % words | 49.5 % words | 0 | NA | NA | NA |
| Jones, D., 2009 | 2008 | ABC News Online | all | Australia | 702 stories | NA | NA | NA | 228 | 172 | 100 |

Legend: OG= Olympic Games, NA=not available.

Number of analyzed articles in the papers ranged from 67 to 5557 in printed media and the number of video material ranged from 41 to 45 hours in televised media. Representation of the female athletes in print media texts ranged from 29.3% (Capranica, 2005) to 30.6% (King, 2007).

As for the visual display of the photographs, it was observed that female athletes were represented in ranges from 33.5 (Capranica, 2005) to 43.4% (Vincent, 2002). Analysis of television news gave mixed results. Share of the female athletes ranged from 29% (Capranica, 2002) to 55% (Smith, 2014). Female athletes share 55% of the data obtained from the analysis of the Winter Olympics in 2010 and that is the most favorable percentage of female athletes in collected research in all television broadcasters.

The data obtained in the survey of sports internet portals show an almost balanced representation of the male and female athletes in terms of the number of words. The photographs in the sports internet media are more often representing men, in 228 photos, while women are represented in 172 photos (Jones, 2009).

The aim of media research in sport in Italy (Capranica, 2002) was to determine gender differences in sports reporting during the Olympic Games in Athens. The percentage of television coverage of the female athletes (29%) was close to the proportion of the Italian women's participation in the Games (international 38%, Italy 28%). Women's competition was followed by 26% of the average audience, which included 40% of women. Men with a share of 31% followed all competitions. Coverage of women accompanied by the national team of Italy ranged from 4% (TV operators) to 33% (staff), while the female representatives of the Italian Olympic Committee - delegates, ranged from 0 to 19.2% (doctors), indicating a strong men's numerical superiority in terms of the professional engagement in the Italian sport.

When it comes to displaying an athlete on the front pages of the sports newspapers, it is worth noting that women are rarely depicted as active participants in sport, and they will more likely be displayed in passive or traditionally female positions (King, 2007).

The above mentioned studies emphasize that the language used in media is a powerful tool for highlighting gender differences. Comments involving sports skills are often lacking in descriptions of women athletes. Instead, the description of women athletes emphasizes more aesthetic attributes and/or focuses on femininity, or lack of it. Male athletes are on the contrary, generally described as energetic, strong mentally and physically. Women athletes are instead presented according to the cultural stereotypes which suggest that they are physically and even emotionally weak.

From the analysis of the presented research we can conclude that:

- Male athletes are getting higher number of articles in the print media;
- Number of words dedicated to male athletes is greater than the number of words devoted to the description of the female athletes;
- Recent studies give a picture that is more balanced, primarily referring to the internet media;
- Television media also give preference to male athletes regarding the duration of the television reports and coverage;
- Male athletes are shown in photos more often than female athletes, whereas it was observed that a large number of female photos are focused on the environments which are not directly related to sport.

## CONCLUSION

Results of the research on the media images of women in sports are significant because they show whether the image of women in sports media is balanced, whether it affects or breaks the stereotypical images of women in sport, and whether and to what extent it contributes to the affirmation or the marginalization of women in sports. It is assumed that if female athletes are more represented in major sporting events, their media coverage will increase over the year. Of course, achieving significant results, holding national and world records significantly increases the interest of journalists in individual sports and athletes. It is therefore expected that the coverage of female athletes will significantly increase in the future.

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# USE OF MOTOR IMAGERY PRACTICE IN REHABILITATION PROCESS OF ORTHOPEDIC PATIENTS

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## SUMMARY

The aim of present narrative review is to determine effects of motor imagery (MI) on human performance and more specifically in orthopedic patient following surgery or immobilization. After overview of literature on this topic we found that MI practice have a beneficial effects in both healthy and patients population. MI along with physical practice has a positive impact on strength, flexibility and muscle activation. However, when combined with common physical therapy, MI have beneficial effects on knee range of motion in both anterior cruciate ligament (ACL) and total knee arthroplasty (TKA) patients, while following ACL surgery significant improvement were also found for knee strength, pain managing and voluntary muscle activation. Unfortunately, due to only a few existing studies on this topic, we cannot draw firm evidence of clinically significant effects of MI practice in rehabilitation of orthopedic patients. More applied studies should be conducted to investigate this issue.

**Keywords:** mental practice, effects, immobilization, surgery, TKA, ACL

## INTRODUCTION

Research has shown that prolonged physical inactivity has marked a negative impact on both, skeletal muscle structure (Pišot, Narici, Šimunič, De Boer, Seynnes, et al. 2008; de Boer Seynnes, Di Prampero, Pišot, Mekjavić, et al. 2008) and function (Pišot, Marusic, Biolo, Mazzucco, Lazzer, et al. 2016, Lundbye-Jensen & Nielsen, 2008; Bloomfield, 1997; Berg, Larsson, & Tesch, 1997). LeBlanc, Gogia, Schneider, Krebs, Schonfeld, et al. (1988), reported decrease of 12% and 26 % in cross sectional muscle area (CSA) and muscle strength of the plantar flexors, respectively, after five weeks of bed rest. This results are similar with those in other studies (Pišot et al. 2008, De Boer et al. 2008; Stillwell, McLarren & Gersten, 1967). Decrease in muscle function, e.g. force output is usually followed by lower electromyography (EMG) amplitude, which represents neural adaptation due muscle disease and/or disuse. Pisot, et al. (2008) showed decrease in bilateral deficite of 18 % which was accompanied by lower EMG amplitude of knee extensors (−17.0 %) and gastrocnemius medialis (−11.7 %).

In period of hospitalization, following injury (Hortobágyi, Dempsey, Fraser, Zheng, Hamilton, et al. 2000) or orthopedic operation, like total knee arthroplasty (Stevens, Mizner & Snyder-Mackler, 2003) quadriceps strength could decrease up to 47% and 62% respectively. Mizner, Petterson, Stevens, Vandenborne & Snyder-Mackler (2005) showed decrease in postoperative muscle strength by 62 %, while voluntary activation was decreased by 17%, and maximal cross-sectional area was decreased by 10% in comparison with the preoperative values. They concluded that failure of voluntary muscle activation (VMA) and atrophy explained 85% of the loss of quadriceps strength ($p < .001$), while VMA contributed nearly twice as much as atrophy did to the loss of quadriceps strength. After prolonged muscle disuse, depending on the age and health status of subjects, this alterations can last up to 1 year after surgery (Mizner, Petterson & Snyder-Mackler, 2005), while bilateral voluntary activation deficit can be, at least in part, reversible within 3 years (Berth, Urbach & Awiszus, 2002).

However, while overt movement cannot be executed in full manner or not at all, due to immobilization, timely basis rehabilitation is necessary as a prevention tool against greater decadence of performance, especially those exercise regimens that facilitate muscle activation (Stevens, et al., 2003). In this regard in last two decades there is a rise of researchers that investigates new treatment approaches which relies on mirror neurons existence, such as action observation, use of virtual reality or mental representation of motor action e.g. motor imagery (Carrasco & Cantalapiedra, 2016).

Studies of MI in rehabilitation have been conducted mainly on people with neuromuscular conditions (Dickstein & Deutsch, 2007). Excesive evidence support effectivenes of MI in improved performance after stroke, spinal cord injury or in Parkinson's disease patients (Park, 2015; Carrasco & Cantalapiedra 2016; Cramer, Orr, Cohen & Lacourse, 2007; Tamir, Dickstein & Huberman, 2007; Abbruzzese, Avanzino, Marchese & Pelosin, 2015). However, to date there is no review which aim to investigate motor imagery use in orthopedic patients. Therefore, aim of this paper is to present works that covers this issue, and to present motor imagery as mental practice method which might be efficiently used by both healthy and injured subjects.

## MOTOR IMAGERY (MI)

As a mode of mental training, MI has become a major focus of research during last three decades. Imagery by itself is the process in which an individual recalls or creates sensory experiences in the absence of external stimuli usually associated with these experiences (Murphy, 1994). Based on activated senses imagery may have different modalities like visual, auditory, olfactory, gustatory, tactile and motor. However, motor imagery represents mental simulation of a specific action without any corresponding motor output e.g. overt motor execution, hence requiring a representation of the body as the generator of acting forces (Jeannerod, 1994). MI thus enables one to practice movements without needs to physically perform them.

Efficiency of MI practice relays on fact that MI and motor execution (ME) shares common neural substrates which is showed elsewhere (Jeannerod, 1994; Porro, Francescato, Cettolo, Diamond, Baraldi et al. 1996; Gerardin, Sirigu, Lehéricy, Poline, Gaymard, et al. 2000). Jeannerod (2001) made a ''simulation theory'' that predicts that there should be a neural overlap between imagining actions and executing actions and that this may be a reason for facilitation of motor performance following mental training. This phenomenon is defined in literature by Jeannerod (1994), as functional equivalence which is further improved by Holmes & Calmels (2008). Explanation of this relies on three facts: First one is that executed and imagined tasks like writing the same letters or walking of the same distances show the same durations (Decety and Michel, 1989), second is that both processes follows Fitts' law, which states that more difficult movements take more time to produce physically than do easier ones (Fitts, 1954), and/or third is that the subjective rating of the mental effort to imagine a task correlates with the amount of force which is needed for the task execution (Decety, 1996).

Functional MRI studies have illustrated that the same cortical areas of the brain are engaged when performing motor imagery as they are during a motor task (Lotze, Montoya & Erb, 1999). For example, Grezes and Decety (2001) showed that there is good overlap between action execution and imagined movements in the supplementary motor area (SMA), the dorsal premotor cortex, the supramarginal gyrus, and the superior parietal lobe, which makes sense in regard to their role for generating a motor plan appropriate to an intended goal based on theory of motor representation. Study of Gerardin, et al. (2000) showed activation of motor cortex during imaging of action, same as during ME, which represents central mechanism of MI efficiency. Task-oriented motor program may promote neuroplasticity, increase functional capacity, generate greater cortical changes, and promote better motor learning to improve motor skills in daily functions (Santos, 2013).

## EFFECT OF MI PRACTICE ON FUNCTIONAL PERFORMANCE AT HEALTHY INDIVIDUALS

MI has proven valuable in a variety of circumstances, such as athlete's (Olsson, Jonsson & Nyberg 2008; Battaglia, D'Artibale, Fiorilli, Piazza, Tsopani, et al. 2014) or musician's (Brown & Palmer, 2013) training and training of surgical skills (Sanders, Sadoski, Bramson, Wiprud & Van Walsum, 2004). There is ample evidence that motor imagery practice improves strength, as does physical practice (Yue & Cole, 1992; Shackel & Standing, 2007; Sidaway & Trzaska, 2005) or even to greater extent compared with low intensity resistance training (Zijdewind, Toering, Bessem, van der Laan & Diercks, 2003). For example, Yue & Cole (1992) showed that following strength training of left hypothenar muscles for 4 weeks, five sessions per week leads to improvements in MI and ME group, but not in control. Average abduction force of left fifth digit increase 22% of MI group and 30% for the ME group, while mean increase for the control group was 3.7%. Other study, of Shackel & Standing (2007) showed improvements ($p = .008$) in hip flexor muscles strength following both MI (24%) or ME (28%) without significant difference between groups.

However, this results are variable, where beneficial effects on performance output were shown after both training modalities but with greater increase after ME (Ranganathan, Siemionow, Liu, Sahgal & Yue, 2004).

MI training may help improve range of motion (ROM). Flexibility of both the hip and ankle joints increased in young female swimmers after combined MI training with muscle stretching compared to the control group (Guillot, Tolleron & Collet, 2010). Vergeer & Roberts (2006) investigated effects of combined stretching and two different modalities of MI on passive and active ROM of hip joint. First modality included movement imagery, where participants imagined moving the limb they were stretching and another one were stretching imagery, where they imagined physiological processes which occurred while stretching the muscle. Results showed significant increases in flexibility over time ($P < .001$) for both, passive and active ROM, but without differences between groups. Although there were no significant differences between groups in scope of physiological effects, they found that MI groups had higher values of perceived comfort, compared to controls, were movement imagery group had higher scores than stretching imagery. These findings support the notion that MI training combined with motor practice or muscle stretches improves flexibility. For surely, there is no any negative physiological effect on flexibility, while there are some indications that an indirect positive effect may be possible due to overall better relaxation which could help to extend the ROM or increase the duration of the single stretch (Vergeer & Roberts, 2006).

## USE OF IMAGERY IN ORTHOPEDIC PATIENTS

Cooper (1985) showed that MI can facilitate learning and acquisition of motor skills, as well as maintain and retain previously acquired skills. Therefore, Imagery is often recommended as one of the most effective psychological skills for sport injury rehabilitation (Weise & Weiss, 1987). Survey studies reported that many athletes are already using imagery during injury rehabilitation (Sordoni, Hall, & Forwell, 2000; Driediger, Hall & Callow, 2006; Monsma, Mensch & Farroll, 2009).

Driediger, Hall & Callow, (2006) provided extensive information about athletes use of imagery during injury rehabilitation and it was clear that they believed imagery served cognitive, motivational and healing purposes in effectively rehabilitating an injury. Cognitive imagery was used to learn and properly perform the rehabilitation exercises, eventually it was concluded that the implementation of imagery alongside physical rehabilitation should enhance the rehabilitation experience and, therefore, facilitate the recovery rates of injured athletes (Driediger, et al., 2006). Furthermore, when mental practice was added to conventional physical therapy, there were functional and clinical improvements (Santos, 2013).

## INTERVENTIONAL STUDIES

When physical training can’t be performed to full capacity due to musculoskeletal injury, there is evidence that MI training has beneficial effects on ROM (Cupal & Brewer,2001; Mahmoud, Razzano & Tischler, 2016) pain managing (Cupal & Brewer), knee strength (Cupal & Brewer) and VMA (Lebon, Guillot & Collet, 2012), in combination with common physical therapy.

Study of Cupal and Brewer, (2001) aimed to investigate effects of MI during rehabilitation period following successful reconstructive surgery of ACL at thirty individuals. Participants ranged from recreational to competitive athletes of various sports like basketball, alpine downhill skiing, soccer, volleyball, hockey, rodeo and other activities. MI treatment consisted of 10 sessions with frequency of 1 session per 2 weeks. After intervention results showed greater ($p < .05$) knee strength, as well as less re-injury anxiety and pain for treatment group participants at 24 weeks post surgery, compared to placebo and/or controls. Variance effect size calculations revealed that the treatment accounted for approximately 35 %, 62% and 76 % of the variance for knee strength, less injury anxiety, and pain, respectively which has great clinical effect.

Christakou & Zervas, (2007) aimed to examine the effectiveness of imagery on pain, edema, and ROM in athletes who have sustained a grade II ankle sprain. Study included 18 active male athletes, aged from 18 to 30 years who were equally divided into MI and control groups. Following 12 individual sessions of imagery practice along with normal course of physiotherapy there were no significant differences between two groups, although there were noted positive progress in all outcomes parameters after intervention period. Researchers stated that reason for non significant results of this study might be found in low sample size and different measurements tool used for pain evaluation compared to other studies which showed positive results (Baird & Sands, 2004; Moseley, 2004; Moseley 2006; Cole, 2015). This might be reasonable explanation, because Baird & Sands, as well as Moseley in their studies used other pain scales, like Arthritis Impact Measures pain scale and Neuropathic pain, respectively, while Christakou & Zevas (2007) used Visual Analog Scale.

Only study that investigating effects of MI on VMA patterns after orthopedic surgery was study of

Lebon, et al. (2012). They aimed to investigate electromyography activity of the quadriceps, pain and anthropometrical data throughout a 12-session therapy after ACL injury, on 12 patients who are randomly assigned to MI or control group. Study showed that muscle activation increased from pre to post test greater ($P = .02$) in the MI group, compared to control. Imagery practice did not result in pain decrease. Although both group significantly decreased their pain level pre to post, there were no differences between groups, as well as for ROM ($P > .05$), where the effect size was large ES (d) = 0.8, ranging from -0.4 to 1.9. However, Due no changes in thigh circumference after MI practice it is concluded that muscle activation increase might originate from redistribution of central neuronal activity. Those changes are reflected through increased brain signals and muscle activity caused by increased neural drive, which denotes the magnitude of efferent neural output from the CNS to active muscle fibers. Underlying alterations in muscle activity are explained through changes in motor unit firing patterns and also motor unit synchronization, measured by surface electromyography (Gabriel, Kamen & Frost, 2006). This concept of the important role of neural adaptations following practice is supported by other MI studies (Ranganathan et al., 2004; Shackell & Standing, 2007; Yue & Cole, 1992) and also of those one that investigating early stages of neuromuscular adaptation on resistance training (Moritani & Devries, 1980; Häkkinen & Häkkinen, 1994; Häkkinen, Kallinen, Linnamo, Pastinen, Newton, et al. 1996; Häkkinen, Kraemer, Newton, & Alen, 2001). Therefore, it seems that same patterns are present during MI and physical practice (Di Rienzo, Blache, Kanthack, Monteil, Collet, et al. 2015; Yao, Ranganathan, Allexandre, Siemionow & Yue, 2013) where greater motor unit recruitment and activation leads to greater muscle output.

Recent study of Mahmoud, et al, (2016) also aimed to investigate effects of MI training practiced along with common physical therapy on ROM, pain and function of patients after total knee replacement surgery. Results showed that motor imagery group demonstrated greater increase in knee ROM ($p < 0.029$) and function ($p < .043$), while there is no differences for pain reduction ($p < .726$), when compared to the control group. However, this study has a lot of possible limitations, which could be explained through insufficient overall sample size ($n = 10$), and/or intervention group ($n=4$). Also, due to rigorous inclusion criteria regard requirements of acute postoperative ROM of patients which must ranged between 60-90 degrees of knee flexion. This inclusion condition is reasonable as it is known that ROM of less than 60 degrees could indicate complications with the surgery, while above 90 degrees may be high enough not to show a significant difference in the results after intervention, which was also noted by authors (Mahmoud et al., 2016). Regard to all above mentioned studies and measurements of ROM, there could be great chance of human error, because all of those measurement were taken manually. Not counting ROM, only in study of Mahmoud et al., 2016 there were noticed improvements in functional assessments, which was measured with questionnaire Lower Extremity Functional Scale, although this scale was not on the list of the most used one in evaluation of patient function following TKA (for review see: Ramkumar, Harris & Noble, 2015). Also, more contemporary assessments should be included in evaluation of outcomes of MI following rehabilitation after musculoskeletal injuries, rather than questionnaire based one.

## Conclusion

Aim of this narrative review was to clarify effects of MI practice on orthopedic patients. In healthy subjects there is ample evidence of MI efficiency in improving functional performance, while there is only a few studies that aimed to investigate possible effects in orthopedic patients. We found that MI practice, when combined with common physical therapy, have beneficial effects on knee range of motion following both ACL reconstructive and total knee replacement surgeries, respectively, while beneficial results of MI practice on knee strength, pain managing and voluntary muscle activation have found only after ACL surgery.

Unfortunately, due to the few existing studies on this topic, we can not draw solid evidence of clinically significant effects of MI practice in rehabilitation of orthopedic injuries. More applied studies should be conducted to investigate this issue.

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# HISTORICAL DEVELOPMENT OF SCIENTIFIC PUBLICATIONS IN SPORT AND PHYSICAL EDUCATION

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## SUMMARY

Scientific journals are already more than two centuries, the basic medium of scientific communication. Their history begins with two journals: *Journal des sçavans* (Paris) and the *Philosophical Transactions of the Royal Society* (London). The first scientific journals in the field of sport and physical education have appeared in the late 19th century on USA. Since then, they have undergone significant changes both in the structure of the works and in the choice of subjects of investigation, the application of research methods, the selection of the sample, the method of citation literature etc. In Serbia first scientific journal in the field of sport and physical education is the issue of the Faculty of Sport and Physical Education in Belgrade, which was at the very beginning of its existence, carried the title of “Fiskultura” (1947 to 1949). And then “Physical Culture” (1950 to present) . This paper aims to present the historical development of scientific publications in the field of sport and physical education in the world and in our country and to give a brief overview of the features of the first scientific papers published in these journals.

**Keywords:** scientific article, research, scientific journal

## INTRODUCTION

Although the term journal can be used to describe the various types of publications, if we define the term journal from the academic standpoint it would wear the epithet of scientific and marked the publication that comes out several times a year and contains scientific articles with the latest scientific achievements in certain scientific fields (Gratton & Jones , 2010). Papers are published in scientific journals only after peer review by experts from the field that deals with the work. In this way, they check the quality of submitted papers, the validity of the presented results, their originality and modernity which all together provides high quality journals. Most scientific journals are highly specialized and publish only articles from one field, while there are those, including some of the oldest scientific journals such as *Nature* and *Science*, which publish the prestigious papers from various scientific fields. Although scientific journals in appearance are very similar to professional journals they are actually very different. Publications of scientific journals are rarely read as leisure literature, as they would be able to read the professional journal. Publication of research results is an essential part of the scientific method. If the paper describes an experiment or method of calculation it has to be described in detail that another researcher could repeat the experiment and thus confirm the results.

History of scientific journals begins with a French journal published in 1665 in Paris under the title *Journal des sçavans* and one English journal published the same year in London under the title *Philosophical Transactions of the Royal Society* (Kronick, 1976). Form of serial issues in science became very soon an effective medium of scientific communication that goes beyond books and monographs that have previously only existed. Model of scientific journals rapidly expanded during the 17th century, various scientific journals begin to publish in Leipzig (*Acta eruditorum*), Amsterdam (*Nouvelles de la République des Lettres*), Rome (*Giornale de 'letterati d'Italia*). Until 1700 in the world of science there was about 35 scientific journals, but during the 18th century number of the serial scientific publications in the world has grown to over 1000. Many of these journals were of ephemeral nature and were published only a few numbers, after which they cease to exist (Kronick , 1976). Gascoigne (Gascoigne, 1985) in his study expressed the fact that in spite of such a large number of scientific journals only 63 scientific publications had a significant scientific impact until 1793. The study of Derek de Sole Price's (De Solla Price, 1961) was found that since 1665, when the first scientific journals appeared, issues annually increased by an average of 7%, which meant that the number of journals doubled during the period of 10 to 15 years. This would mean that in the period from 1665 to the end of the 20th century initiated and published about 100,000 scientific journals. A large number of these journals have failed to preserve the continuity of publishing. Estimates made by Ole Hook from 1999 (Hook, 1999) indicate that at this point of time there has been between 60,000 and 70,000 scientific journals of which about 15,000 were in the area of biomedical sciences which represented the largest percentage of which belonged to a scientific field. He explains such a large number of scientific journals by the policy of managing the science that requires a larger number of published scientific papers in order to be elected to research and teaching positions, rather than increasing the number of scientists in the world. Maxim which is increasingly heard in scientific circles is "Publish or perish", and the largest number of universities around the world as the most important indicator in the evaluation of scientific work accepted number of publications and the quality of journals in which they were published. The aim of this study is to explore, by the application of the historical method, the first scientific journals in the field of sport and physical education in the world and in our country as well as to present the characteristics of the first scientific articles which are published in them.

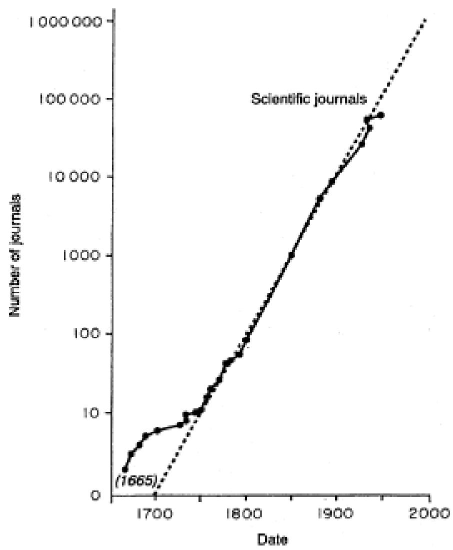


**Chart 1**: Number of published scientific articles from 1665 to 1995 (De Solla Price, 1961)

# METHODS

In studying the historical aspects of scientific publications in sport and physical education are applied historical and descriptive methods. Historical method consists of four phases (collection of knowledge sources - heuristics, analysis and criticism of sources - the criticism of the text; synthesis - generalization and linking the sources; exposure - presenting of results (Илић, 1994)). Sources and literature in the field of sport and physical education were collected at the beginning of the study, and then was performed the analysis of the oldest articles published in scientific journals and their structure and characteristics were presented. The descriptive method involves describing of the phenomenon. It is used to represent the data collected by previously described historical method.

# RESULTS AND DISCUSSION

As this was the case with other similar scientific disciplines, crucial to the development of sport and physical education as a new scientific field was the formation of professional associations and the establishment of scientific journals in which could be published current research in the theory and practice. Today in the world there are dozens of serial scientific publications in the field of science of sport and physical education. Those are the journals that are very respectable compared to other scientific fields, and who for many years recorded an increase in the impact factor on international scientific list (ISI list of journals).

One of the first scientific journals in the field of science of sport and physical education was launched in the USA in 1896 under the name

*American Physical Education Review* (Mechikoff & Estes, 2006; Park 1989). Many physical education teachers in America, especially those who were the leading representatives of this new scientific discipline, possessed the formal education in the field of medicine. For these reasons, the focus of their scientific research was on biomedical research (Lee & Bennett, 1960; Mechicoff & Estes, 2006). However, at seminars and conferences of newly established association could be observed great diversity of articles, each in its own way, treat sport and physical education. There were articles that had quite good methodological quality and had a real scientific approach to the study of physical abilities and responses of the body due to physical exercise, but also very practical work that had great importance for educational practice of physical education teachers, but not for the science of sport and physical education. There were also a lot of works that dealt with the history of sport and physical education (Park, 1981). The first two decades of the profession of physical education teachers in America were marked by growing interest in the psychological and sociological issues (Park, 1989; Sage, Dyreson & Kretchmar, 2005). During the 1930s in the curriculum of physical education teaching leads to significant changes and to the growing dominance of sports, especially sports games (Park, 2005). This has led to changes in the curriculum, faculty staff who are preparing for the call of physical education teachers. The focus of curriculum found the most popular sports then (Massengale & Swanson, 1997; Park, 2005). At the same time there are more and more intensive efforts to promote scientific research in the field of physical education (Lucas, 2006). Then, from the oldest scientific publications for sport and physical education, named *American Physical Education Review*, were formed two new publications. One, is geared towards professional practice in sport and physical education entitled *Journal of Health and Physical Education*, and one which is primarily based on studies published by scientific, quantitative methodology from a wide range of scientific fields that were related to physical education, entitled *Research Quarterly* (Park, 2005; Sage, Dyreson & Kretchmar, 2005). Much of the scientific research base, which has been in continuous expansion, was focused on a scientific approach of various types of measurement and the implementation of research methods from other scientific disciplines (Sage, Dyreson & Krethcmar, 2005). However, this field of study was going through a serious crisis when one of the prominent American scientists and a government representative assess the quality of teacher's education in the United States. James Conant (Conant, 1963) published the report in which stated that physical education doesn't have enough scientific design to justify academic status. Conant's report has resulted in the mobilization of all the prominent scientists in the field of physical education that were try to improve the quality of scientific research process by raising the scientific productivity, and by further establishing a scientific basis in defense of this relatively new scientific discipline. Foremost among them was a physical education teacher Henry Franklin, which was worked very intensive in practice and in scientific research in the field of physical education. He presented his scientific field, which at that time was known as Physical Education, as an interdisciplinary area made up of various scientific disciplines such as physiology, anatomy, motor learning and motor development, sports sociology, history of sport, philosophy of sport, sports psychology (Henry, 1964). This approach is, no doubt, contributed to the improvement of the status of physical education as an academic field of research and prevents the extinguishing of the Department of Physical Education at Universities. However, the introduction of a large number of very different scientific disciplines in the field of physical education had certain drawbacks. The main disadvantage was reflected in a highlighted divisions and relatively isolated areas of study of human movement. Specialization of certain fields within the physical education (physiology of sport, sociology of sport, philosophy of sport, history of sport and physical education, motor control, etc.) has led to the formation of independent professional associations, organizations of specific scientific conferences and reduced communication within the same scientific authorities. All this contributed to the rather vague mission and vision of the development of scientific research in sport and physical education, and a certain loss of integrity and identity (Newell, 1990; Rikli, 2006). Scientists in the field of sport and physical education are increasingly holding plenary lectures around the world asking questions: "Who are we?", "What is the focus of our interest?", "Are we a discipline, profession or field of study?", "What should be the subject of our research - physical exercise, sport, fitness, physical fitness, physical activity, the movement of humans? "(Rikli, 2006).

Scientific research publications in the field of sport and physical education in our country appeared after the Second World War. Certain serial publications in the field of sport and physical education existed before 1940, but in scientific research publications cannot be counted Sokol publications from the period of the early 20th century until the Second World War because they were an exclusively professional character and predominantly contained methodological guidelines for the implementation of the exercise by the Sokol system, ideological essays that are aimed to strengthen patriotism, health and educational texts, reports from Sokol events, etc. The first serial publication in the field of sports in our region was published in 8 january1887. It was the first issue of the journal "Velosipedski list" which is considered the forerunner of the sports press in Serbia. However, the character of this sports journals, as well as those that would later begin to emerge ( "Streljački glasnik" 1889, "Sport i svet" since 1905, "Serbian Knight" from 1909, "Srpski sokolski glasnik"since 1912,"General physical education"since 1948), was not scientific, but exclusively professional and informative.


**Chart 2.** "Velosipedski list" the first journal in the field of sport in Serbia

The first scientific journal in the field of sport and physical education in Serbia appeared in 1947 titled “Fiskultura”. This journal will exist under that name until 1950 when it changed its name in “Physical Culture” under what exists today and is regularly published as a serial edition of the Faculty of Sport and Physical Education in Belgrade. The journal “Physical culture” is the oldest scientific and professional journal in Serbia that continuously comes 67 years. From 1947 to 1949 journal named "Fiskultura, Journal of Theory and Practice", from 1950 to 1960 bears the name of "Physical Culture, Journal of Theory and Practice", and from 1961 to 1996 the name of the "Physical Culture". Until 2005 in the imprint emphasizes that "publishes papers in the field of physical culture (physical education, sports recreation, sports and common biological, humanities, social and natural sciences), the unpublished results of scientific research and new empirical evidence". Since 2010, changes in the imprint, and in which something different defined goal of publishing the journal: "physical culture is a scientific journal that publishes papers in the field of sport science and physical education, as well as the common bio-medical, humanities, social and natural sciences, with unpublished results of scientific research and new empirical evidence. " Change settings "professional and scientific" journal, the "scientific" journal, as well as the definition of professional discipline title of "physical culture" through "in the area of physical education and sport", to the latest "in the field of sport science and physical education" , will significantly affect the structure of the work in the journal (Бокан, 2011).

Another prominent journal in the field of science of sport and physical education will start to come out in 1994 as the issue of the University of Nis. Journal "Facta universitatis - series: Physical Education" is published since 1994 and is a "scientific journal of the University of Nis, which aims to publish works related to school practice in the field of theoretical and experimental knowledge of fundamental physical education, sport and recreation" (Bokan, 2011). Since 2000, with the change of title in the name of the journal "Facta universitatis - series: Physical Education and Sport" was amended his goal too. In the imprint of the journal can now find out that it is "a scientific journal that publishes original research and review papers related to: physical education, recreation, sports, sports games, sports medicine, sports physiology, sports psychology, sports sociology, philosophy of sport, sports history, biomechanics, kinesitherapy, dance, health and exercise. "

Since they appeared, in 1665, scientific papers have undergone a series of changes in its structure and content. It can be said that until the mid 19th century, they did not have standardized form and style. During these first 200 years of scientific papers generally had a form letter or report on experiments that were conducted (Sollaci & Pereira, 2004; Kronick, 1976). The first scientific letters were usually written by a single author, written in polite style and simultaneously focused on several different issues. Experimental reports had exclusively descriptive form, and the events that have been written were presented in chronological order. Over time, scientific papers have evolved to get stricter form in which they are couched in more detail the methods and results with more adequate interpretation. Method descriptions rapidly developed during the second half of the 19th century, and the structure of work began to be based on the triad made up of theory - experiment - discussion (Day, 1998; Atkinson, 1992). In the early 20th century scientific papers in the field of medical science reached some standard form. To the mid-20th century medical journals established as general rule accepted structure of scientific research papers presented by acronym IMRAD - Introduction, Methods, Results, and Discussion (Huth , 1987). Prior to this articles were mainly organized in a way that is more like a chapter in a book with a variety of titles and subtitles that matched case studies. The International Committee of Medical Journal Editors published late seventies guide that is also recommended IMRAD structure (International Committee of Medical Journal Editors, 1992). The advantage of these structured scientific papers is in their easier review and receptivity easier for readers. Taking in account the dizzying advances in science and the huge number of new research papers that are published daily in the world, IMRAD structure offers the possibility of so-called modular reading scientific papers, where readers are not forced to linearly follow the text of the paper, but to focus only on its individual segments which are the subject of their interest. This standard form is made up of parts that are known in advance what in itself should contain (Meadows, 1985).

Analyzing the structure of papers published in national scientific journals in the field of sport and physical education, we can see that they get the same development path. This is most obvious in the case of the journal “Physical Culture” that starts to come out in 1947, just one year after the establishment of the State Institute of Physical Culture in Belgrade. The first articles published in this journal were mainly theoretical and descriptive character. The largest number of theoretical papers that represented the most professional, methodical instructions for conducting training practice in the sport or the organization of lessons in physical education was published in the first decade of the existence of the journal “Physical Culture”. This journal eventually reduces the proportion of theoretical papers, on account of original scientific studies that have started to implement the State Institute of Physical Culture, later the Faculty of Physical Education, in schools and sports clubs.

After the oldest journals in the field of sport and physical education, which is called “Physical Culture” (issue of the Belgrade Faculty of Sport and Physical Education) and the journal "Facta universitatis - series: Physical Education and Sport" (published by the University of Nis) in the territory of Serbia will appear for a few scientific journals that we can classify in the field of sports science that is now called. These are "Serbian journal of sports sciences" published as an issue of Sports Academy in Belgrade since 2008 and the journal of the Faculty of Sport and Physical Education in Novi Sad "Exercise and Quality of Life."

These four journals today make scientific research corpus in science of sport and physical education in Serbia, because these are leading Serbian journals, based on the categorization of journals in the fields of humanities given by the Ministry of Education, Science and Technological Development in 2013. Journal "Facta universitatis - series: Physical Education and Sport", according to the categorization of the journal by the Ministry of Education, Science and Technological Development, has a category M24, or belongs to a group of journals of international significance verified by special decisions of the Scientific Committee of the Ministry. "Serbian journal of sports sciences" falls into the category M51, respectively, in the category of leading journal of national importance. A leading journal of national concern is the scientific journal of domestic publisher who is the most influential in their scientific discipline, and which, on the basis of the sum of citations in the ISI citation indexes and a national citation index, achieve the highest impact factor, calculated for a period of five years and is not eligible for the admission into the category of M20. In this category of journals can be put on the recommendation of the relevant scientific committee who accepts the Ministry of Education, Science and Technological Development. The basis for the admission can be satisfactorily bibliometric analysis and preliminary categorization by the ministry. The minimum requirement is regularity of publication.

The journal “Physical Culture” belongs to the category M52, journal category of national significance. Journal of national importance is the scientific journal of domestic publisher of influence after his event is among the top 50% of domestic journals and at the same time meets the requirements of bibliometric analysis and preliminary categorization by the ministry.

Novi Sad journal "Exercise and Quality of Life" falls into the category M53. In this category are classified those journals that in addition to the general prerequisites to be considered scientific bibliometric meet the requirements for indexing in the national citation index, and by their impact in their discipline does not belong to the international nor in the first 50% of the local journals. The minimum requirement is regularity of publication.

## CONCLUSION

On the basis of these results we can conclude that the first scientific journal in the field of sports and physical education published in America in 1896 under the title *American Physical Education Review*. The first publications in the field of sport and physical education were heavily influenced by medical publications primarily because of the great similarity in the study of man and his anthropological characteristics. The first scientific journal in the field of sport and physical education in Serbia was published in 1947 titled "Fiskultura". Then the other colleges run their journals that are mainstays of scientific thought and the latest scientific discoveries. The study historical aspects of scientific publications in sport and physical education provided the possibility to explain what was the path of development of methodology of scientific research in this field, as well as to what were the trends in research theory and practice.

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