



14<sup>th</sup> International  
Scientific Conference  
of Sport Kinetics 2018

# “Movement in Human Life and Health”

## PROCEEDINGS

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Poreč, Croatia, 24<sup>th</sup> - 27<sup>th</sup>, June 2018



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## **“Movement in Human Life and Health”**

Poreč, Croatia  
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## FOREWORD

### **Dear colleagues, Conference participants and Proceedings' readers**

It is our pleasure to greet you on the occasion of the 14th International Scientific Conference of Sport Kinetics 2018 to be held in Poreč, Croatia, June 24 – 27, 2018 with the main topic Movement in Human Life and Health, organized by the Faculty of Kinesiology, University of Zagreb, Croatia, together with the Faculty of Sport and Physical Education, University of Novi Sad, Serbia, under the scientific patronage of IASK (International Association of Sport Kinetics) and in partnership with the Faculty of Education, University J.J. Strossmayer, Osijek, Croatia, FIEP Europe and Croatian Kinesiology Association.

The Conference shall take place in Poreč (Zelena Laguna) in hotel Laguna Parentium. Poreč is a town located in the heart of the western coast of Istria (Adriatic coast). A town of culture, tourism, sport and leisure, where the aromas and colors of past times form a mosaic of unforgettable experiences.

The conference programme includes podium and poster presentations and lectures by the participants from all over the world who will discuss the latest information about the importance of movement in human life and health. Topic of the conference is ever more important, especially today when the modern way of living (inactivity) is threatening with epidemic of various chronic diseases.

Inactivity has recently become one of the biggest issues of contemporary society. That is why the promotion of movement and physical activity is in the last decade the key intervention aiming to prevent many chronic diseases such as overweight, coronary diseases, diabetes, etc. The Conference aim is to provide the latest scientific and professional insights, findings and experiences connected with Movement in Human Life and Health. We sincerely hope that our conference will be one step more towards that aim.

The Croatian Medical Chamber recognized importance of this Conference and rewarded the participants, especially medical doctors, with the highest ever number of points for active and passive participation. We are grateful for the Croatian Medical Chamber recognition in particular. Harmonized interdisciplinary efforts are needed to move the Earth.

Invited lectures and other presentations, all reviewed by the extraordinary diligent referees, will be delivered by internationally and interdisciplinary recognized speakers and researchers. The Proceedings Book contains 117 contributions, which were submitted by the submission deadline, written by 291 authors from 23 countries from five continents. The three best oral and poster presentations of young scientists (under 35 years of age) will be awarded with the special IASK President Cup and N.A. Bernstein Medals.

Many social activities are also planned as an opportunity for participants to establish closer international connections between researchers and other conference participants, and to discuss the ideas connected with the main topic of the conference.

We wish to express our deepest gratitude to all the authors, reviewers, participants, members of the Organizing, Scientific/Program and Honorary Committee, technical, organizing and support staff, and sponsors for their contributions, time and effort inbuilt in quality of the 14th International Scientific Conference of Sport Kinetics 2018 and its Proceedings.

Proceedings is published in digital form and hard copy in order to make the information in it public and accessible to the audience that is professionally connected with the problem of Movement in Human Life and Health.

Convinced that the Conference will give the expected impetus to further cooperation between international scholars and institutions, we are looking forward in advance to meeting you in Poreč.

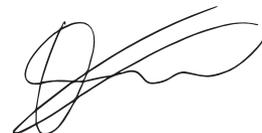
We sincerely apologise for any lapse or fault in the Conference Organization – we tried to do our best, but sometimes it was difficult to establish the highest level of coordination between the Scientific and Program Committee, mostly housed in Warsaw and Poznan (Poland), and the Organising Committee, mostly housed in Zagreb (Croatia) and Novi Sad (Serbia). However, due to such a constellation, this has been an interesting and, in every sense, demanding organisation of an international conference. However, do not hesitate to indicate our mistakes because we wish to perform better next time.

We wish you success in the conference work to all the participants and pleasant stay in Poreč.



**Assoc. Prof. Mario Baić**

Chairperson of the  
Organizing Committee



**Prof. Patrik Drid**

Vice-chairperson of the  
Organizing Committee



“Movement can replace all medicines, but no medicine is able to replace movement.”  
[W. Oczko, XVI. century]

## PREFACE

### Dear Participants of the 14th Sport Kinetics Conference!

On April 28th, 1990 in Rogi near Gorzów (Poland), during the international conference **"Movement Coordination in Sport"** a new scientific organization was created: **International Association of Sport Kinetics (IASK)**. Prof. Dr. hab. **Włodzimierz Starosta** (Poland) became its first President and has been performing this function for the 15<sup>th</sup> term (1990-2018). The following were elected as its vice presidents: Prof. Dr. **Reinhard Dausg** (German Federal Republic) and Prof. Dr. hab. **Peter Hirtz** (GDR). The Association was created because there were few associations in the world dealing with the interdisciplinary concept of human movement science, and **during many previous conferences this issue was treated only marginally** (Starosta, 2007, 50-58). **IASK is the youngest association in the international arena**, but it is an important prestigious scientific association dealing with various issues of human movement science called **kinesiology or anthropokinesiology** (Starosta, 2007, 2010). The science was created, among others, by **Aristotle, Plato, Socrates, Leonardo da Vinci, N. Dally, I. Sieczenow, I. Pawłow, N. Bernstein** (Starosta, 2010, 73-80). This interdisciplinary science created in Europe became extremely popular in the USA, where in the years 1894-2000, 52 handbooks on various aspects of kinesiology were published. There (n = 145) and in Canada most of Physical Education Colleges changed their names into Kinesiology Universities (Starosta, 2010, 93-108). Within this context, Croatia turned out to be a progressive part of Europe, in which the Faculties of Kinesiology were established in the University of Zagreb and University of Split. Earlier, in 1996, the Department of Kinesiology was established at the Sport Institute in Warsaw, and in 2010 a collective work *"Human movement science - anthropokinesiology"* was published, edited by W. Starosta

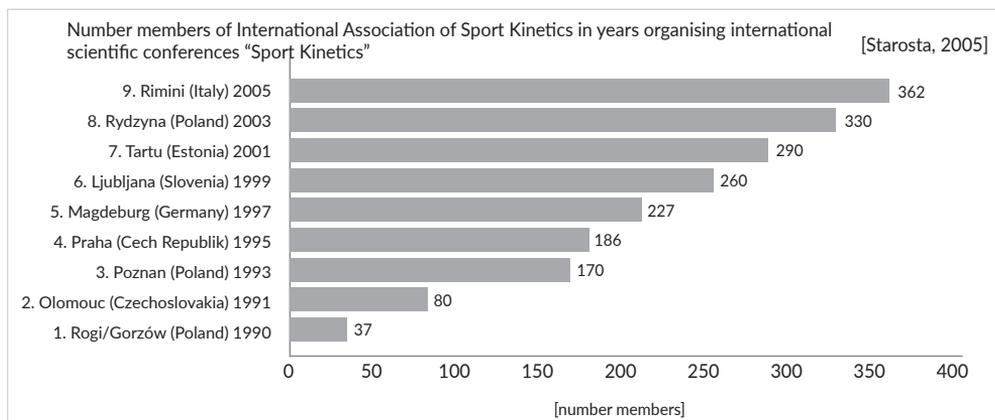
### Aims and functions of IASK

The aim of IASK is to create appropriate conditions for further development of human movement science and sport kinetics as a scientific discipline which constitutes a fundamental element in sciences related to sport. IASK is striving at interdisciplinary cooperation of scientists from numerous related disciplines of science and elementary sciences. The aim of the association is to promote and further develop various branches of scientific research focusing on how to get to know human movement behaviour and physical fitness better. The association concentrates on the problems of movement, physical and health development of children and the youth, as well as of adults and the elderly. IASK is specifically interested in movement and physical fitness of athletes going in for various disciplines. This in particular, requires us to encourage regular discussions on general, theoretical conceptions, specific terminology and methods of diagnosing movement development, as well as to study and disseminate physical activity patterns for people at various age. Working towards these goals, the association aims at co-operation and information exchange, and provides conditions for scientific, interdisciplinary

discussion among researchers of various branches of basic and applied science. IASK is an open association waiting for people who would like to participate in unveiling of secrets in different fields of science.

### Members of IASK in years 1990-2018

During 28 years of IASK's existence, the number of members continued to grow, despite the fact that for many years only professors and then doctor habilitated were accepted. The Association currently has over 500 members from 64 countries of all continents.



Recently, our great family has been joined by scholars from Australia, Pakistan, Nigeria, Kinshasa, and a large group from Ukraine and Poland. We are especially pleased to have the contribution, in the work of the Association and in the conference, of **Dr. Urszula Włodarczyk** – a multiple champion of Poland, Europe and the world in pentathlon and septathlon. In this way, the constellation of scholars is supplemented with a sports star. In over 28 years, our members have organized over 86 international conferences in 10 European countries (Belarus, Estonia, Greece, Germany, Poland, the Czech Republic, Slovakia, Slovenia, Italy). The Association unites experts of various scientific disciplines, among them there is a large group of outstanding honorary members and professors well-known in the world such as: **Robert Malina, James Skinner, Richard Schmidt, Wladimir Zaciorski** from the USA, **Gunter Schnabel, Herman Rieder, Peter Hirtz** from Germany; **Han Kemper** from the Netherlands, **Friedrich Fetz** from Austria, **Paavo Komi** from Finland, **Thomas Reilly** from Great Britain, **Stanislav Celikovsky** from the Czech Republic, **Levan Tschaidze** from Georgia, **Josif Feigenberg** from Russia – Israel; **Napoleon Wolański, Roman Trześniowski** from Poland (Starosta, 2007, 86-102). Not everyone had luck to welcome our conference in Croatia; from this elite group Richard Schmidt and Josif Feigenberg have recently left us forever.

### Publications:

IASK also officially patronizes the publishing in English of two Journals:

1. "Anthropomotorics – Anthropokinesiology" edited by the University School of Physical Education in Krakow (Poland). Chairman of the Editorial Board: Prof. E. Mleczko;
2. "Journal of Combat Sports and Martial Arts" edited by Medsportpress. Chairman of the Editorial Board: Dr. W. Błach (Poland).

### **Library:**

For 28 years, our Association did not use any state subsidies. This means that these 86 international conferences were organized at the expense of the institutions of individual countries, mainly Universities and Academies of Physical Education, as well as thanks to the fees paid by the participants. It was not easy. Moreover, **our Association runs a Library, which consists of 42 monographs published in five languages (English, German, Polish, Russian, Italian)** on various issues related to the movement of human activity (see all titles at the end of this proceedings book). In the international arena, we belong to an exceptional organization, which, on the occasion of **its 15<sup>th</sup> anniversary of existence, issued a bilingual monograph summarizing the various activities of its members** (Starosta, 2007). Some monographs exceeded 600 pages. Where the finances for the publication of the monographs came from, will remain the secret of a few members of the Presidium.

### **IASK Presidium:**

During the General Meeting of IASK on September 24th, 2011 in Cracow (Poland), a new Presidium has been elected for the period 2011-2018: **President:** W. Starosta (Poland). – **Vice-presidents:** A. Cicchella (Italy), L. Georgescu (Romania), B. Jevtić (Serbia), W. Osiński (Poland); **General Secretary** – J.M. Konarski (Poland); **Treasurer:** K. Anioł-Strzyżewska (Poland); C. Gevat (Romania), B. Jošt (Slovenia), C. Peixoto (Portugal), J. Jurimae (Estonia) – members. **Control Commission:** R. Szeklicki (Poland) – Chairman, T. Socha (Poland), V. Psalman (Slovakia) – IASK members. An exceptionally long period of activity of the Presidium was dictated by a small number of members of the Association during the Sport Kinetics conferences in 2013-2015. Usually, the Presidium is elected for two years. Some members showed limited activity because of health reasons. This will have to be taken into account in the elections during the conference in Croatia.

### **The uniqueness of the 14<sup>th</sup> Sport Kinetics Conference**

**It is not the first time that the main subject of the conference is the relationship between movement and health.** This fact results from the care for the human being and the length of human's life. Human organism was genetically programmed for an active life style. **Movement is a biological need of human organism. Experts from the World Health Organization many years ago determined the minimum, i.e. indispensable daily portion of movement of an adult to be 10-15 thousand steps.** Humans, creating the contemporary civilization, seem to have forgotten about this fundamental principle. **Contrary to the needs of the organism, people started to lead a sedentary life style.** Man stopped listening to signals informing him about his own needs, including the necessity to move as a natural need of the body and at the same time the source of health. Man started acting against himself living a life style inappropriate for his organism. **Movement deficit resulted in hypokinesis!** This deficit, together with other negative factors, causes many civilization diseases: hypertension, overweight, vertebral column deformation, flat feet, etc. Their accumulation brings about irreversible changes. Some refer to the process as suicide in installments or, more or less figuratively, as „death spiral”. Its opposite is „life spiral”, i.e. the recommended life style suitable for contemporary man. These are two extreme options connected with life style which in their pure form rarely occur in human life. Each of us construct our own life style and by putting it to practice accordingly affect the health. Thus, as **N. Amosow** says: **„Our health is in our hands”**. With our own actions we can influence the maintenance of health and even its improvement, but we can also cause our own diseases by choosing inappropriate life style. Our activity may also contribute to overcoming a disease faster.

### **Effects of decreased human movement activity**

*How did the societies of many countries treat the appeal of the World Health Organization regarding the necessary minimum daily activity? Answers to this question were provided by*

facts about the US society given by W. Walcott and T. Fahey [2000. 30]: 1. The U.S. National Institute of Health has recently published data showing that **more than 97 million Americans are morbidly obese or are significantly overweight**. 2. The percentage of people suffering from obesity in the United States rose by 32% in the last 15 years (1985-2000). 3. Obesity is major cause of heart diseases, which presently affects one in two Americans. 4. Epidemiological nature of cancerous diseases, obesity, diabetes and many other chronic diseases have reduced the average life expectancy of Americans by 5 years. 5. In the past 18 years [1984-2000] the obesity among children in this country increased by 40% and over 25% of them are morbidly obese or significantly overweight [2000, 30]. These facts gathered, probably more than 10 years ago, are appalling. The more so, that they relate to the country which is set as a model for many. **Losses due to obesity in the US account for about 123 billion dollars per annum (data from 2003 year)**[Szyzborski, 2005, 54]. **The US and Kuwait form the world's leaders, as over 74% of their population is overweight**. Societies of different countries and almost all continents approach them: **the Dominican Republic (71%), Egypt (69.4%), Argentina (69.4%), Greece (68.5%), New Zealand (68.4%), United Arab Emirates (68.3%), Mexico (68.1%), Australia (67.4%), Belarus (66.8%), Chile (65.3%), Canada (61.2%), Poland (47.5%)**. **Obesity is a plague of the XXI, century. According to the World Health Organization in February 2010, there are currently 1.6 billion overweight adults in the world**. People with an index exceeding 25 BMI are considered as such (the ratio of body weight in kilograms divided by their height in square meters). **WHO estimates that over the next 10 years the number of overweight people will increase by 40%**! The cause of obesity and overweight, among others, are incorrect eating habits. From their early age children consume a lot of candy bars, cookies, chips, hamburgers, French fries – instead of fruit and vegetables. This junk food contains a lot of sugar and fat, which the body transforms and accumulates in fat cells. Limiting the number of treats consumed we often forgot that soft drinks and artificially sweetened juices also contain a lot of calories that is **one of the main reasons for such a lifestyle, in which there is less and less movement activity as well as inadequate, for the body needs, amount of food intake**. **According to the results of investigations of M.A. Berg et al. [1994] in the century from 1864 to 1964 physical activity of man decreased by 93%**. The importance of movement for human health was mentioned by Wojciech Oczko – a doctor of Polish kings – in the XV. century: ***"Movement can replace all medicines, but no medicine is able to replace movement."*** A laconic, and at the same time brilliant statement that is currently valid. Taking into account these facts, it is easier to understand the choice of the conference's topic.

**The 14<sup>th</sup> Sport Kinetics Conference 2018 organized in Croatia is exceptional.**

**First** of all, its main subject is physical activity of human beings and its impact on human health, which is briefly summarized as ***"Movement in Human Life and Health"***. It refers to the laconic and brilliant expression of the great philosopher **Aristotle: "Movement is life."** In the light of data from the World Health Organization from 2007 and 2017, **modern civilization is aiming at destroying the human being**, because an increasing number of inhabitants in some countries, including the USA, is hopelessly struggling to reduce the number of overweight and obese people. Other countries from all continents follow the leader.

**Secondly**, taking into account the deteriorating financial situation of higher education establishments of physical education and universities, the organization of our conference was undertaken by: Faculty of Kinesiology, University of Zagreb (Croatia, the leading unit), Department of Sport and Physical Education of the University of Novi Sad (Serbia) and Department of Kinesiology of the University of Split (Croatia).

**Thirdly**, until now the function of the Conference Director (the Chairman of the Organizing Committee) was usually entrusted to an experienced scientist. This time, this function was taken up by a young scientist, **Prof. Mario Baić**, who many years ago was my student, graduate student, doctoral student, and later a co-author of numerous publications.

However, no big risk has been taken here because a year ago he organized an international conference in Novi Sad. It was thanks to his initiative and hard work that we could meet in Poreč over many months. The Polish proverb goes: **"Do not praise the day before sunset."** I know the organizational skills and diligence of Professor Mario Baić and I know that I do not risk anything.

**Fourthly**, I was the chairman of the Scientific Committee of many international conferences, including thirteen previous Sport Kinetics ones, but the organization of this one includes many new solutions. The multinational 30-person Scientific Committee worked exceptionally intensively and according to the principle of full democracy; even the invited lectures were subjected to a slightly more delicate control. All abstracts and entire works were evaluated according to the accepted substantive criteria. In rare cases the authors corrected their work 2-3 times. Members of the Scientific and Programme Committee, including **Prof. J. Skinner evaluated and reviewed the papers. Prof. J Skinner became the record holder in this respect – he rated 11 works.** The afore-mentioned, as well as a large group of other reviewers, sent their assessments relatively quickly. **I wholeheartedly thank all members of the Scientific Committee for their hard and honest work.** It will certainly affect the substantive level of our conference in Croatia.

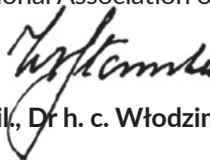
**Fifth**, from the very beginning of the Association's existence, we took care of the high scientific level of young scientists. During the conference from the series of "Sport Kinetics", we organized contests for the best work presented as a part of podium or poster presentation. We rewarded the best not only with diplomas and books, but also with the Cups of the President of the IASK and special medals of **the great scholar, Mikołaj Bernstein.** One of the Cups was won by Dr. M. Baić. During this conference, such a contest will be held for scientists under 35 years of age.

**Sixth**, applying the recommendations of many scholars, including philosophers and doctors, including W. Oczko, during the Conference **President of the Polish Ringo Society, doctor Krystyna Anioł-Strzyżewska will organize a professorial tournament of the Polish ringo game.** The prizes will be diplomas, medals and the President's Cup of the International Ringo Federation. I am convinced that an extremely large group of professors will take part in it.

**Finally**, I would like to express my sincere thanks and words of exceptional recognition to the members of the Scientific and Organizational Committee for invariably support during the preparation of conference materials and the conference itself, ensuring thus a high scientific and organizational level.

Warsaw, May 28th, 2018

President  
of the International Association of Sport Kinetics



Prof. Dr. habil., Dr h. c. Włodzimierz Starosta

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**INVITED LECTURES:  
FULL PAPERS AND ABSTRACTS**

# Comparison of men and women in their responses to exercise and adaptations to training

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## **ABSTRACT**

As long as their level of physical activity is similar, there are few differences in body size, body composition, strength, aerobic abilities or anaerobic abilities of boys and girls before puberty. However, due to the hormonal changes that occur with puberty, there are differences between the two sexes in terms of body size and body composition. As a result, there are quantitative differences in the acute responses to exercise and the chronic adaptations to training, i.e., men and women differ because of differences in body size and/or body composition. However, there are little or no qualitative differences in the way they respond to exercise or adapt to training.

**Key words:** VO<sub>2</sub>max, strength, body composition, environment, anaerobic performance

## **Introduction**

Boys and girls with similar patterns of physical activity do not differ greatly in body size, body composition, strength, aerobic abilities or anaerobic abilities. However, this changes with the hormonal changes associated with puberty.

## **Comparison of men and women**

*Body Size and Body Composition.* Testosterone in the blood of males rises after the second stage of puberty but does not change in women (Kenney & Wilmore, 2015). Higher levels of testosterone are associated with: greater bone formation and larger bones; greater protein synthesis and larger muscles; and greater secretion of erythropoietin (EPO), increasing production of red blood cells.

By contrast, estradiol in the blood of females begins to rise during the first stage of puberty but increases only a small amount in males (Kenney & Wilmore, 2015). Higher levels of estradiol are associated with: greater fat deposition; faster but briefer bone growth; shorter stature and lower total body mass; and higher fat mass and a higher percentage of body fat. *Strength.* While muscle strength differs between men and women after puberty, these differences are mainly quantitative. There are some regional differences in absolute strength in that women tend to be 40-60% weaker in the upper body and 25-30% weaker in the lower body. Part of the reason for this discrepancy is that women tend to have more muscle mass in the lower body and tend to use the upper body less (Wilmore, 2005).

If strength is expressed in relative terms (e.g., per unit of body mass), women are 5-15% weaker. This is due to the difference in total muscle mass and not to a difference in innate muscle mechanisms. While women tend to have smaller muscles (less muscle cross-sectional area), the distribution of muscle fiber types is similar. Therefore, men and

women are similar when strength is expressed per kilogram of fat-free mass (eliminating the effect of extra body fat in women) or per unit of muscle cross-sectional area. In other words, the sex differences are associated more with body size and body composition but not with the characteristics of the muscle itself.

*Cardiovascular System.* Because women tend to be smaller, it is not surprising that their hearts also are smaller. As a result, the amount of blood pumped per beat (stroke volume or SV) is less.

When exercising on a cycle ergometer, the power output (PO) is associated with a given oxygen intake ( $\text{VO}_2$ , L/min) and a given cardiac output (Q, L/min); both are independent of body weight. Thus, at each absolute PO and corresponding Q, women generally have a higher heart rate (HR) and lower SV. Part of this is because women generally have a lower  $\text{VO}_{2\text{max}}$ , so that the same absolute PO is a higher percentage of their maximum. At the same relative PO (e.g., requiring a  $\text{VO}_2$  that is 60%  $\text{VO}_{2\text{max}}$ ), men and women have similar HR but women have lower SV and Q. At maximal exercise, men have higher absolute values of  $\text{VO}_2$ , Q and SV, but a similar HR.

As stated earlier, testosterone enhances the production of red blood cells and hemoglobin in men. Women compensate for the lower oxygen-carrying capacity in the blood by increasing the extraction of oxygen at the cellular level during submaximal exercise. However, there is a limit to how much oxygen can be extracted and this ultimately affects  $\text{VO}_{2\text{max}}$ .

Thus, most of the differences between the sexes is associated with body size (quantitative) but the patterns of response (qualitative) are similar.

*Respiratory System.* As with the heart, the smaller body size of women is reflected by the lower volume of their lungs. At any given absolute PO, women tend to breathe more often because they are working at a higher percentage of their  $\text{VO}_{2\text{max}}$ . At the same relative percentage, however, breathing frequency is similar for men and women, even though the amount of air in each breath is less in women because of their smaller lungs. Again, there are no qualitative differences.

*Blood lactate.* The peak lactate values are lower in women but values at the same relative intensity (%  $\text{VO}_{2\text{max}}$ ) are similar. As well, there appears to be little difference in the percentage of  $\text{VO}_{2\text{max}}$  at which the lactate threshold occurs (Wilmore, 2005).

$\text{VO}_{2\text{max}}$ . The reasons for differences and similarities in  $\text{VO}_{2\text{max}}$  between men and women need to be examined in more detail. It is clear that men have much greater absolute values of  $\text{VO}_{2\text{max}}$  (L/min); this is mainly because of their bigger size. When  $\text{VO}_{2\text{max}}$  is expressed per unit of body mass (ml/kg per minute), the differences are less. However, the fact that women tend to have more body fat needs to be considered. When  $\text{VO}_{2\text{max}}$  is expressed per unit of fat-free mass (ml/kg FFM per minute), then the differences between the sexes essentially disappears. What this means is the metabolic quality of the muscle is similar. In other words, there is no qualitative difference between male and female muscle.

*Anaerobic performance.* Data from studies with the Wingate Anaerobic Test demonstrate that men have much higher values for peak power and mean power; this is not surprising because men tend to be bigger and have larger muscles. However, as shown with other variables, body size and body composition must be considered. Maud and Shultz (1989) studied physically active adults aged 18 to 28 years. The absolute mean power was 48% higher in men. When calculated per kg body mass, the difference was 15%, but only 2% when calculated per kg FFM. For peak power, the differences were 54%, 21%, and 7%, respectively. These results suggest strongly that the gender differences were mainly caused by muscle mass. In other words, there is little difference in the anaerobic performance of muscle from men or women.

## **Adaptations to training**

*Body Composition.* The changes in body composition after training are similar in men and

women. Regardless of the type of training, there is generally a reduction in total body mass, fat mass and percent body fat in both sexes. Men and women increase their lean body mass, with greater effects from strength training than from endurance training. There is one difference, however, in that women tend to have less hypertrophy with strength training; this is expected, however, since men have more testosterone. Even without major increases in hypertrophy, women increase their strength because of enhanced neuromuscular recruitment and better synchronization of motor-unit firing.

**Maximal aerobic power.** Combining data from the HERITAGE Family Study (Skinner et al., 2001) and the study of Kohrt et al. (1991), it is clear that there is no sex difference in the increase in VO<sub>2</sub>max (ml/kg per min) after training 341 men and 407 women ranging in age from 18 to 71 years. Thus, the amount of improvement (quantitative) and the pattern of adaptation (qualitative) were similar in both sexes.

### **Other factors**

**Heat Stress.** Some early studies suggested that women were less tolerant to heat. However, all subjects were tested at the same absolute PO, such that the women were working at a higher percent of their VO<sub>2</sub>max. When subjects were tested at the same relative PO (%VO<sub>2</sub>max), there were no differences. Women tend to produce less sweat per sweat gland, but this seems to have little effect on their tolerance to heat. Studies also show no sex difference in acclimatization to heat (Kenney & Wilmore, 2015).

**Cold Stress.** Women have a slight advantage in moderate cold because they have higher levels of subcutaneous fat for more insulation. In very cold environments, women are at a disadvantage because they have less muscle mass and cannot produce as much heat through shivering.

**Altitude.** There seems to be little difference in how men and women respond to or adapt to altitude.

**Exercise Testing and Prescription.** Given that there are few differences between men and women in how they respond to exercise or adapt to training, few adjustments are needed for exercise testing and for prescribing exercise (Wilmore, 2005). Any differences would more likely be associated with individual preferences for the types of activities they enjoy.

### **Summary**

In summary, there are quantitative differences in the acute responses to exercise and the chronic adaptations to training, i.e., men and women differ because of differences in body size and/or body composition. When adjustments are made for body size and body composition, however, these differences become much smaller and often disappear. There are little or no qualitative differences in the way men and women respond to exercise or adapt to training.

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#### INVITED LECTURE

# Body composition, health and physical fitness: what is optimal level of fatness?

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#### ABSTRACT

**PURPOSE:** Obesity and overweight is now considered to be one of the major health threats in the developed world. The main objective was to present an overview of the problem of relationships between body composition, health and physical fitness. **METHODS:** The study was carried out in a review form based on scientific evidences. **RESULTS:** Problems considered in the review will be as follows: /1/ The current epidemic of obesity, /2/ Conditions associated with obesity, /3/ Relation between the body mass index (BMI) and risk of death, /4/ BMI and cholesterol and diastolic blood pressure, /5/ The various causes of obesity, /6/ Is it possible to be overweight or obese and fit and healthy? /7/ Recommended BMI ranges, /8/ Lower limit of the BMI range, /9/ Making weight: risks connected to severe weight loss! /10/ Body composition and sports performance: linear or non-linear relations? /11/ Body fatness and physical fitness: theoretical scheme. **CONCLUSIONS:** /1/ Most of previous research on the relations between body composition and physical performance have been based on the linear regression equation, when, in fact, the relationship is often strong but non-linear; /2/ The level of body fat close to a slightly lower level than average values observed in population is accompanied by the most advantageous ("optimal") value of physical performance.

**Key words:** body composition, causes of obesity, sport performance, linear relations, non-linear relations.

#### Introduction

Obesity and overweight is now considered to be one of the major health and physical fitness threats in the developed world (Bray, 2000; Hruby & Hu, 2015). We may see a dramatic increase in the prevalence of obesity in the coming decades. Numerous studies have examined the relations between body composition and status of health and mortality (Arroyo-Johnson & Mincey, 2016; Lobstein, 2010). The evidence strongly supports the hypothesis that optimal level of body fat and lean body mass will substantially reduce the

adverse effects of obesity on morbidity and mortality (Barry, Baruth, Beets, Durstine, Lin, & Blair, 2014). However, to our knowledge, relations between body composition and morphological parameters and their influence on motor performance, established by the method of curvilinear regression in the real phenotypical variability of population, were shown only in few studies (Osiński, 1992, 1996).

The main aim of the study was to perform versatile analyses of the real course of relationships between body composition and the selected basic-characteristic parameters of health and components of motor performance in the population. The purpose was also to define critical zones: positive, optimal and negative effects of the size and proportion of the body and fat deposition parameters on health and functional parameters against the background of individual variables.

## Methods

The study was carried out in a review form and its sample comprised scientific papers. The core inclusion criteria were: publication year 1990 or later; design: prospective or retrospective follow-up, case or cohort studies, cross-sectional studies; data on BMI; body composition; outcome data on all-cause mortality; cardiovascular and type 2 diabetes risk factors; sport performance; linear or non-linear relation. Forty-two publications satisfied the inclusion criteria.

## Results

Problems considered in the presentation will be as follows:

*/1/ The current epidemic of obesity.* Obesity is now considered the major health threat in the developed world (Arroyo-Johnson & Mincey, 2016; Hruby & Hu, 2015). The scope of the problem is a result of the prevalence of a combination of health hazards (Bouchard & Katzmarzyk, 2010; Seidell, 1996;). The most common approach to the analysis of body composition has been to estimate percentage body fat and lean body mass (Bray, 2000). In some populations the prevalence of people with the BMI of 25 kg/m<sup>2</sup> and above is more than 70% (Arroyo-Johnson & Mincey, 2016). The prevalence of frank obesity in childhood and adolescence has been more than doubled since early 1960s and continues to increase in many areas of the globe (Lobstein, 2010).

*/2/ Conditions associated with obesity.* The medical profession has been aware of the excess weight effects on morbidity and mortality for more than 2000 years (Bouchard, 2000). Body composition refers to different tissues that compose total body mass; these tissues are usually identified as muscles, fat, bone and residual masses (Bigaard, Frederiksen, Tjønneland, Thomsen, Overvad, & Heitmann, 2004). There appears to be a considerable evidence that links obesity with increased rates of morbidity and mortality (Bigard, Frederiksen, Tjønneland, Thomsen, Overvad, & Heitmann, 2004; Bray, 2000; Lee, Blair, & Jackson, 1999). Overweight and obese people are at risk for developing numerous medical, social and psychological disabilities.

*/3/ Relation of body mass index (BMI) to the risk of death.* The association of BMI with the risk of death was quantified in the Nurses' Health Study. Plots were made for: a) deaths caused by cardiovascular diseases (CVD), b) deaths caused by cancer, c) total deaths, d) noncancer and non-CVD deaths (Bouchard & Katzmarzyk, 2010; Bray, 2000). The multivariate relative risk refers to the relative risk of death compared to the lowest BMI determined by multivariate statistical analysis (Bouchard, 2000). The results indicated that the risk of death was directly dependent upon cardiorespiratory fitness level and not BMI status (Barry, Baruth, Beets, Durstine, Lin, & Blair, 2014).

*/4/ Body mass index (BMI) and cholesterol and diastolic blood pressure and the risk of diabetes.*

All risk factors demonstrate a curvilinear increase as the values of BMI, cholesterol and blood pressure rise (Bray, 2000). Type II, or non-insulin-dependent diabetes mellitus is strongly associated with overweight in both genders in all ethnic groups (Alcazar, Ho, & Goodyear, 2010; Colditz, Willet, Ratnizky, & Manson, 1995). For individuals with the BMI below 24 kg/m<sup>2</sup>, the risk of diabetes was the lowest (Alcazar, Ho, & Goodyear, 2010). The relative risk increases by the BMI increases: at BMI of 35 kg/m<sup>2</sup>, increases in the relative risk are 40-fold, or 4000% (Colditz, 1995).

/5/ *Various causes of obesity.* Behavioural causes (activity level, nutrition, smoking status, socioeconomic status). Metabolic causes (genetic and metabolic-endocrine factors). Biological causes (race, gender, age, pregnancy status). All the listed causes, or influences, predispose the individual to the development of obesity (Bouchard & Katzmarzyk (Eds.), 2010).

/6/ *Is it possible to be overweight or obese and fit and healthy?* All-cause and cardiovascular diseases mortality was calculated in fit versus unfit men stratified by the BMI level → a) 19.0 ≤ 25.0; b) 25.0 – 27.8, and c) ≥ 27.8 kg/m<sup>2</sup>. In all three BMI strata, the relative risk of all-cause and CVD mortality was higher in the unfit versus the fit men. The study provides evidence that fitness may be a more important mortality predictor than BMI (Barry, Baruth, Beets Durstine, Lin, & Blair, 2014; Lee, Blair, & Jackson, 1999).

/7/ *Body composition and mortality rates.* It seems well established that there is a curvilinear relationship between BMI and total or all-cause mortality (Kushner, 1993). U-shaped or J-shaped associations, attempts have been made to established ranges of BMI that are “optimal” for the longevity lowest mortality rates (Seidell, 1996). The highest risk was found among the underweight and obese: BMI <18.5 kg/m<sup>2</sup> and BMI >40 kg/m<sup>2</sup>.

/8/ *Lower limit of the range of BMI.* Subjects who have later developed lung cancer, for instance, may have already involuntarily lost weight some years before the disease has been diagnosed. Low BMI may reflect recurrent or relative energy deficiency, thus implying the impaired immune competence, increased risk of fracture, loss of reproductive function, etc. In the developed countries, thinness (BMI < 18.5 kg/m<sup>2</sup>) is associated with the decreases in work output, productivity, and income-generating ability, which may jeopardize long-term survival (James & Ralph, 1994, Troiano, Frongillo, Sabal, & Levotsky, 1996).

/9/ *Making weight: risks associated with severe weight loss!* Many sports enforce weight standards with the goal of ensuring that the athletes are of optimal body size for participation. Athletes often turn to questionable, ineffective, or even dangerous methods of weight loss to reach their weight goal. Severe weight loss can cause health problems, such as dehydration, chronic fatigue, disordered eating, menstrual dysfunction, and bone mineral components disorders (Bouchard (Ed.), 2000).

/10/ *Body composition and sports performance.* Body size has been traditionally associated with performance quality in certain sports: football, basketball, shot put, sumo, for example. In certain sports, smaller and lighter body size is considered performance favourable: gymnastics, figure skating. The concept of ideal body composition varies across different sports; the less fat mass, the greater the performance. Excessively increased fat-free (muscular) mass is likely to be undesirable for the endurance athlete, who must move his/her total body mass horizontally for extended periods (Wilmore & Costill, 1999; Verhagen, van Sluijs, & van Mechelen, 2007).

/11/ *Contributions of body fat, body height and body mass.* Contributions (coefficients of

determination) of percentage body fat, body height and body mass to the changes in a particular motor performance were obtained by the 3rd degree regression analysis (Osiński, 1996). Body fat defines individual's abilities to perform motor tasks (speed of running, vertical jump height, agility run and endurance fitness) better than body weight and body height. Only static muscular strength can be more accurately predicted by body weight and body height than by fatness (Osiński, 1996).

/12/ *Body composition and sports performance: linear or non-linear relations.* Using statistical methods, a curve was obtained of possibly the lowest degree of relations that still satisfactorily describes the relationship. We also present some determinable values of the extreme values of the non-linear function, which theoretically define (optimal values) the most advantageous level of individual morphological parameters. The relationship between motor performance and body fat is mostly curvilinear. For example: in case of running, the speed and index of endurance "optimum" values are definitely lower than the average values of body fatness of this group (Osiński, 1992, 1996).

## Discussion

Obesity has almost become a synonymous of the high body fat and low fat-free mass values. The prevalence of obesity has increased to epidemic proportions worldwide (Bouchard, 2000; Hruby & Hu, 2015, Arroyo-Johnson, Mincey, 2016). Obesity is a leading risk factor of premature mortality, causes numerous chronic health conditions and reduces physical fitness in populations of both the developed and developing countries. In the light of the previously presented facts, collected from empirical studies, we would like to indicate (in categories of general theoretical schemes) basic variants of connections between the phenotypical fatness level and physical performance level (Figure 1).

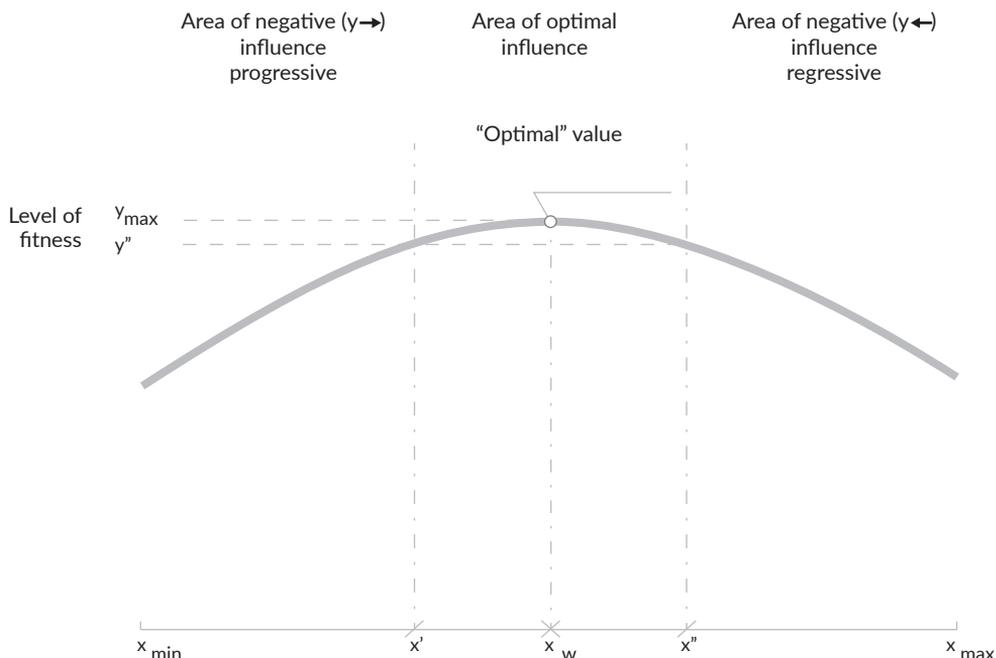


Figure 1. Body fatness and physical fitness: a theoretical scheme.

## Conclusions

1. Overweight and obesity could be treated as the causes of increasing threats for the quality of life that may substantially affect health implications and decrease physical performance. 2. Most of the research done up-to-date on the relation between body composition and physical performance has been based, unfortunately, on the linear regression equation, whereas, in fact, the relationship is often strong but curvilinear. 3. In theoretical schemes, the relations between physical performance level and level of fatness have been reduced to the localization of the body fatness “optimal” value within variability of the population.

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#### INVITED LECTURE

# Movements symmetrization – an effective method of injury prevention, health strengthening and prolonged sport careers of athletes

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#### ABSTRACT

World societies are made up of the right-, left- and both-handed individuals. The latter prevail. The whole locomotion apparatus of a person is adjusted to the dominant side/extremity; that fact plays an important role in what movements or sports discipline would the person select as the favourite one. Disciplines can be divided into the symmetric, asymmetric and mixed ones. The symmetric disciplines reduce asymmetry in person's body

and movements by practice. Quite opposite is the effect of asymmetric disciplines (e.g., athletic jumps and throws), those which are taken up in young age with great training loads and no corrective exercises. The results are overload injuries of the dominant limbs and back (spine), which eliminate players from sports. Right- and left-handed throws are used as preventive measures. Symmetry of movements has been awarded Olympic medals; unfortunately, this idea was not put into sport practice. **AIMS:** To present movements symmetrization as an effective method of preventing injuries to working bodily parts, health strengthening and prolongation of competition sport career. **METHODS:** Literature sources and careers of young and elite athletes who specialize in discus and javelin throwing were analyzed; a comparative statistical assessment of the results achieved by Olympians in either the right- or left-hand throws was performed; 6-9-month pedagogical experiments, connected with the use of tests by those practising long and high jumps, were carried out; interviews. **MATERIAL:** 40 throwing athletes competing in the 1912 Olympic Games; pedagogical experiments/interventions in long, high and triple jump and javelin throwing were conducted in groups of 30-40 athletes; interviews were conducted with 53 elite Polish athletes in long and triple jump; observations were carried out of 30 track-and-field athletes and 411 world long and triple jumpers. **CONCLUSIONS:** 1. Movements symmetrization perfects technique, decreases physical loads on the dominant limbs and prevents injuries. 2. Based on the investigation results classification of symmetric, asymmetric and mixed sports were prepared developed.

**Key words:** movements classification, symmetryzation, laterality, new concept, injury prevention, prolonging athletes' sport careers, stimulating sport achievements.

## Introduction

Symmetrical structure of human body allows performance of both asymmetrical and symmetrical movements. However, most people use mainly right hand, what could be an effect of social tradition and genetic background. Both factors have probably caused the right-hand dominance in human movements. The problem what kind of movement, asymmetrical or symmetrical, is more profitable for a human being has not been solved yet. Since alternative approaches to this problem do not include social, biological, physiological and psychological aspects of human movements, a new concept has been developed to create better movements of the upper extremities. In contrast to other theories, the concept prefers interrelation between both the asymmetrical and symmetrical elements in the human movement system. In practice, the interrelation is individually adjusted to the subject, according to his/her experience in movement. The concept is based, therefore, on a procedure of symmetrization of movements, that is on the process of equalizing efficiency of the left and right hand with individual preferences for the dominance of one. Starosta (1975, 1984, 1990, 2008) and other authors have shown that symmetrization process improves movement coordination and its efficiency, quality and accuracy. It has also been demonstrated that recovery of the exhausted arm/hand can be accelerated if the other arm/hand performs some exercises. Recent cross-sectional study proved that 20% of judoist who underwent symmetrization process during their preparation for the 1980 Olympic Games won over 50% of medals, including 6 gold out of 7 possible. I conclude, therefore, that the process of symmetrization is beneficial for sport performance, work and everyday life movements.

Numerous facts indicate that the dynamic development of competitive sport is coming to an end. If further progress is to be achieved, new reserves should be utilised. The greatest hope lies in the methodology of teaching and technique improvements. One of the reserves that could be used in sport is movements symmetrization, understood as the process of equalising fitness of both body sides while preserving the dominant one. In a wider perspective, this movements symmetrization is concerned with the upper and lower limbs

and the movements of the whole body with turns (ambidexterity, bidirectionality, double-leggedness). This way of human movement development was rarely adopted, especially in competitive sport. However, everyone, irrespective of age, follows this process to a lesser or greater extent both in every day and professional life as well as in the kind of physical activity pursued in sport, recreation and rehabilitation. Movements symmetrization is most often undertaken by left-handed individuals who want to adapt to the majority in the society, namely to the right-handed persons. Thus, we may agree with the following: "A left-handed person has always a certain advantage over the right-handed person who never attempts to gain so much skill in his left hand as the left-handed individual in his right hand." (Boehmig, 1973:137). As a result, the left-handed persons show a higher level of symmetrization and thus a higher level of movement coordination.

Symmetrization becomes a prerequisite for competitive sport athletes who practice sport disciplines (e.g. breast stroke and freestyle swimming or kayak sport) that require equal involvement of both body sides. There are many kinds of movement symmetrization that are determined by different factors (Figure 1).

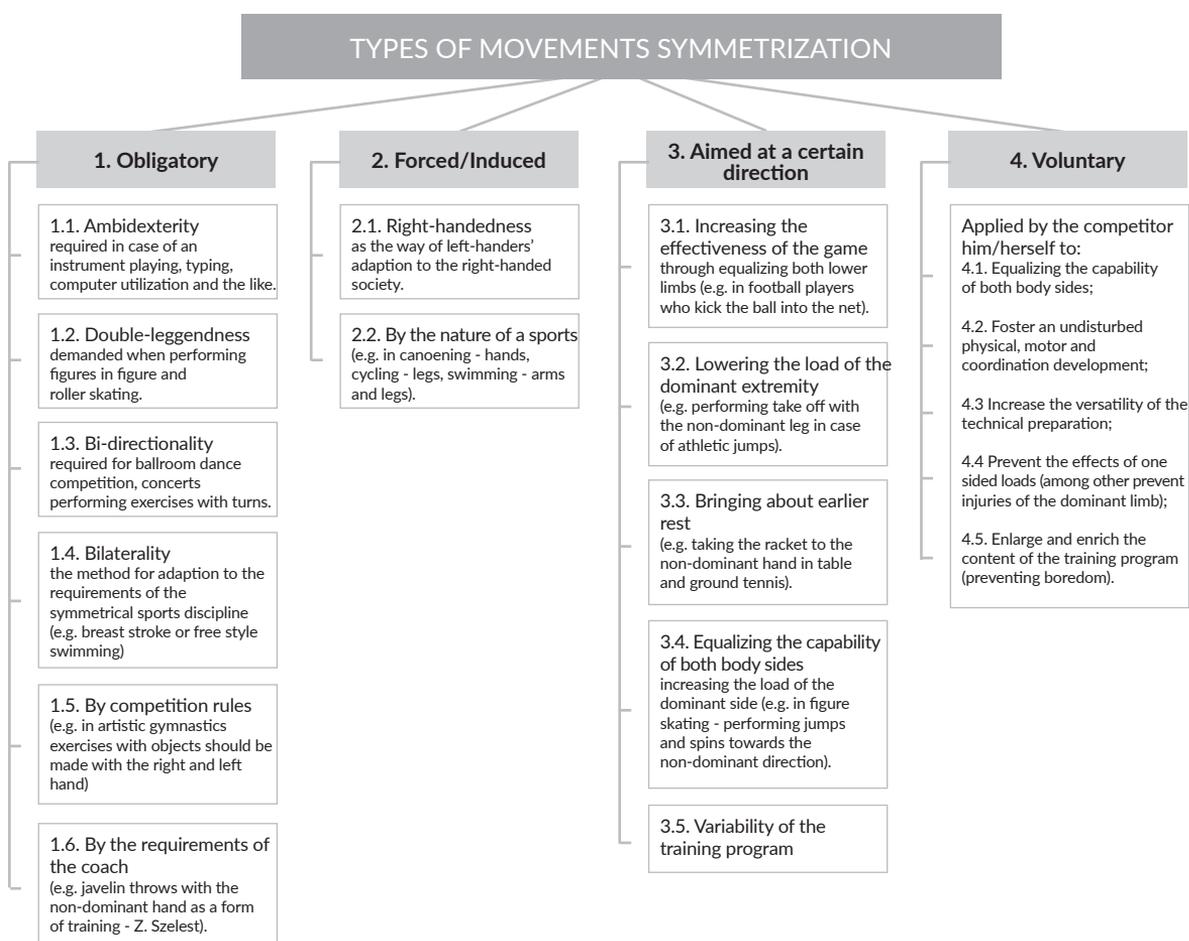


Figure 1. The types of movements symmetrization found in everyday life activities and sport [Starosta, 1995]

The process of symmetrization usually proceeds spontaneously and periodically. Needless to say, it is applied and followed without any knowledge of didactic principles. This is why its effectiveness does not always correspond to the athlete's potential. Moreover, we should ask the following question: Is there any need for the application of symmetrization process if the individuals with a low level of symmetrization also achieve remarkable sports results in the international arena? The question is best answered by the synthesis of the results obtained by different researchers who investigated the issue of symmetrization (Figure 2).

No	Author	Year	N	Sport discipline	Duration of the experiment	Results
1	Puni, A.C.	1959	10	Basketball	4 months	an improvement in accuracy of the throws into basket by 30%
2	Dolja, G.	1973	23	Track and Field high jump	9 months	increase in scores of high jump by 7% and rise in the coordination indicators by 59%
3	Ambarow, E.	1963	24	Track and Field high jump	38 classes	lowering differentiation of results obtained during take-off with use of take-off leg and free leg in boys - 53%, in girls - 50%
4	Drabik, J, et.al	1983	750	Judo - throws during competition	a course of many years observation (1978-1980)	among subjects, 22% performed throws symmetrically: they constituted 57% of medal winners and 71% of those earning the medals during top competitors
5	Drenkow, E.	1960	32	Athletic throws	12 months	advance in scores by 67% for dominant hand by 75% for the non-dominant hand
6	Nagel, S.	1983	20	Shot put	16 hours	the results improvement for the dominant extremity by the 13% (a 3kg ball) and by 15% (a 5kg ball), accuracy better by 53%
7	Fischer, K.	1988	14	Javelin throw	3 months	significant progress in the results of throws made by the right and left hand
8	Młodzikowski G, et.al.	1968	130	Skiing - turns	14 days	60% of subject mastered right ski turns left and right
9	Starosta, W.	1985	56	Figure skating	observations between 1959-1974	56 top world class competitors symmetrically mastered between 1 and 7 of complex exercises
10	Starosta, W.	1975	17	Figure skating	24 months	only slight differentiation in marks given by experts during a competition for symmetrical performance of 10 elements, a high aesthetic value of the movements (culture), higher level of coordination
11	Drenkow, E.	1960	28	Hammer throw	39 hours	improvements of the results for the dominant extremity by 15.2% and for the non-dominant by 19.6%

Figure 2. Synthesis of movements symmetrization results in competitors practicing selected sports disciplines according to studies of different authors [Starosta, 1995]

Although the studies included subjects of different age and sex, involved in various sport disciplines and different methods of recording symmetrization effects, in all cases positive results were obtained (Ambarov, 1963; Dolja, 1973; Drabik, Adam, 1983; Drenkow, 1960; Fischer, 1988; Młodzikowski, Stapiński, 1968; Starosta, 1975, 1990, 1993, 1993a). Based on the conclusions reached in the experiments and studies, I drew up a list of positive and negative effects of movements symmetrization (Figure 3).

## EFFECTS OF SYMMETRIZATION

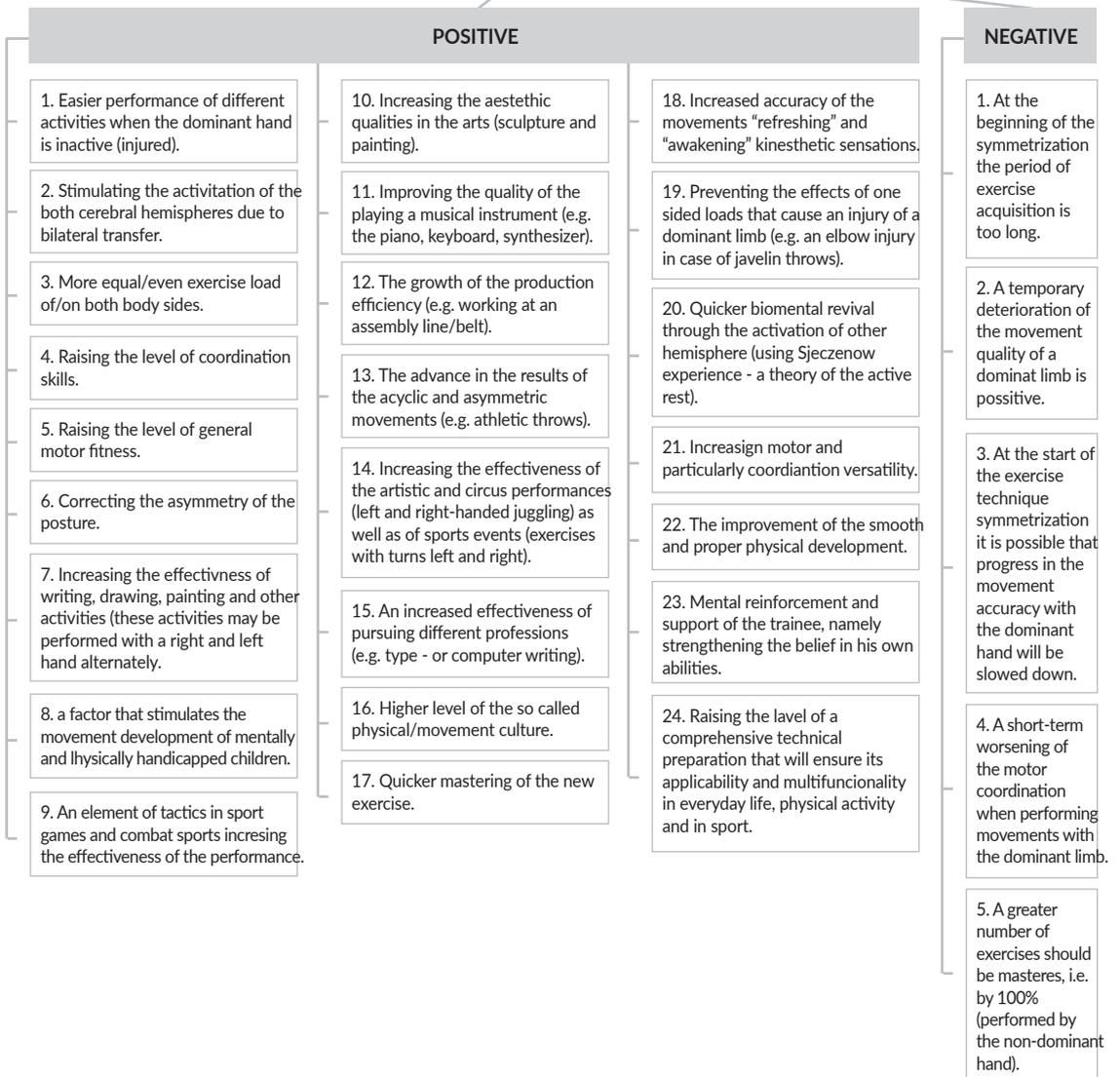


Figure 3. Effects of movements (technique) symmetrization in sport competitors and non-practitioner of sport [Starosta, 1995]

As the positive effects are definitely predominant, we may support the notion that movements symmetrization is an indispensable process on the way to movements development and improvement of any human being. In addition, symmetrization gives an opportunity for improving the technique of exercise performance and for raising the level of movement coordination; it also increases movement accuracy, and the like. If the favourable effect of the symmetrization process is so clear, thus it should be an integral part of the theory of movement teaching regardless of its purpose: everyday and professional activities as well as productive, artistic, rehabilitation, recreational and sports activities.

Considered from the above point of view, movements symmetrization can be recognised as a social problem since it affects every human being and his various forms of activity. Therefore, what we need is the optimisation of the process to achieve the greatest effectiveness possible. Bearing this in mind, the aim of the paper is to present the following: 1. The basic assumptions of a new concept. and 2. The principles and conditions of its application.

### **1. The basic assumption of the new concept**

These assumptions include the following elements:

1.1. Functional asymmetry is favourable in sport if it is based on symmetry.

If asymmetry has no such foundation, the symmetrization of movements leading to an improvement of the less capable body side is recommended. This is one of the important elements of contemporary training of young competitors.

1.2. Early specialisation of an extremity or body side lowers the top-level movement abilities. Whereas, a more comprehensive preparation, and thus the symmetric one, is conducive to the higher level of movement asymmetry, (i.e., higher sports results).

1.3. Sports performance is a result of the symmetric and asymmetric movement preparation). Skillful combination of these two elements (i.e. comprehensive and versatile preparation including symmetric preparation) in many years of training gives better chances of attaining top results in sports activity.

1.4. Many years of training call for different proportions of symmetric and asymmetric preparation should be applied. At the very beginning, the symmetry of performance of all the exercises in general and special preparation is required.

1.5. Movements symmetrization is more effective when all types of preparations are aimed for its development.

### **2. Principles and conditions of new concept application**

2.1. According to sports discipline

Almost every sports discipline requires from an individual practicing it, a different kind-of adjustment (*movements modification*) (Fig. 4). The kind of the sport and the nature of exercises used in the practice of this sport may either strengthen unilaterality or develop bilaterality, i.e., *similar fitness of the left and right side of body*. A lateral differentiation of movements allows us to distinguish the following groups of sports disciplines: asymmetric (they are prevailing), symmetric and mixed.

The asymmetric sports demand the specialisation of one extremity (e.g. *fencing* – Robakowski, 1957) or one body side (e.g. *judo or ice and roller figure skating*), whereas symmetric sports require that a person to use both limbs with almost equal skills (e.g. *kayak sport* -both hands, *ski jumps* - the whole body). So far, the symmetrization has been carried out on the basis of a trial and error method. Although this method proved to be successful in the past, it cannot be considered as effective now. The reason for this is that symmetrization, as the element in process of improving technique of movements, calls for application of concret principles indicating the course of action. It may seem surprising that methods employed so far, not always reasonable and feasible, contributed to attainment of high level of technical mastery by competitors, particularly in symmetric disciplines. This only proves that human adaptation possibilities are great, although we do not know how many people showed unsuccessful symmetrization.

2.2. According to the movement complexity

The effectiveness of symmetrization process is determined by complexity of movement. The local movements of individual parts of the body (*legs, arms*) are easier to be symmetrized. The symmetrization is much more difficult in case of total (global) movements that require the concurrence of the lower and upper limbs movements, which becomes even more difficult when combined with a simultaneous change in position of the whole

body. In terms of coordination, the most complex movements are those that involve the whole body connected with turns (e.g. *rhythmic gymnastic* or *figure ice and roller skating*). Such movements occur very often in everyday life activities and, particularly, in various forms of dancing and sport. When adopting the symmetrization process it would be advisable to consider a draft scale of movement complexity to act in accordance with one of the basic didactic principles that states from "*simple*" to "*complex*". The more complex the exercise is, the longer the time duration of symmetrization is. The effectiveness of symmetrization process depends on the level of movements coordination. The individuals who show higher level of movement coordination are quicker and more accurate at the acquisition of the exercise including their *non-dominant extremity and the turns towards a non-dominant direction*.

### 2.3. According to the level of movement coordination

The range (*the number of exercises*) and level (the level of acquisition) of symmetrization depends on the coordination potential. The higher the level of movement coordination is, the greater the number of exercises can be successfully symmetrized. Moreover, higher movement coordination level allows to obtain greater approximation of the quality of the exercise technique that involves the right and left side of the body. Those with weaker movement abilities may attain symmetrization only through simple exercises. Only the most talented individuals may be the subjects of the very complex symmetrization exercises. The above presented conclusions were reached on the basis of the empirical studies and research (Oberbeck, 1989; Ogurenkov, 1959; Robakowski, 1957; Stadler, Bucher, 1986; Starosta 1975, 1990, 1993, 1993a, 2003).

Depending on the capacity of the technique that is concerned with a concret discipline we decide on a particular number of symmetrization exercises. At the beginning, we employ basic exercises typical of a given discipline. The more complex the exercises are, the smaller there is a number of the exercises that can be mastered symmetrically. There are three stages during which symmetrization takes place:

1. exercise performance during the training;
2. exercise performance during sports competition;
3. exercise performance as an element of the tactics.

The third stage requires the perfect mastering of the movement performance. The movements symmetrization is ruled by the same principles as those found in the teaching and improving sports technique, namely conforming to the process of the stages determined by the levels of coordination by V. Farfel. It means that first a precise movement is demanded (Level I), then the combination of the precise and speed of its performance (Level II) and finally we require a precise and speed movement performed in changing conditions (Level III) (Starosta, 2003, 2006, 2010).

Symmetric exercise performance during competition as the tactic element is available only to the top competitors and it concerns most often the so called "*crucial elements*", namely specific for a technical preparation of concret athletes - competitors. The results of the studies showed a marked effectiveness of symmetric movements in combat sports, among others in wrestling and judo in the master class athletes during European and World Championships and Olympic Games (Starosta, 1990, 2003, 2008).

### 2.4. According to the kind of movement preparation

As competitors begin practising sport having different movement preparation experience (*different scope and level of versatility*) thus various methods and approaches should be adopted by the teacher.

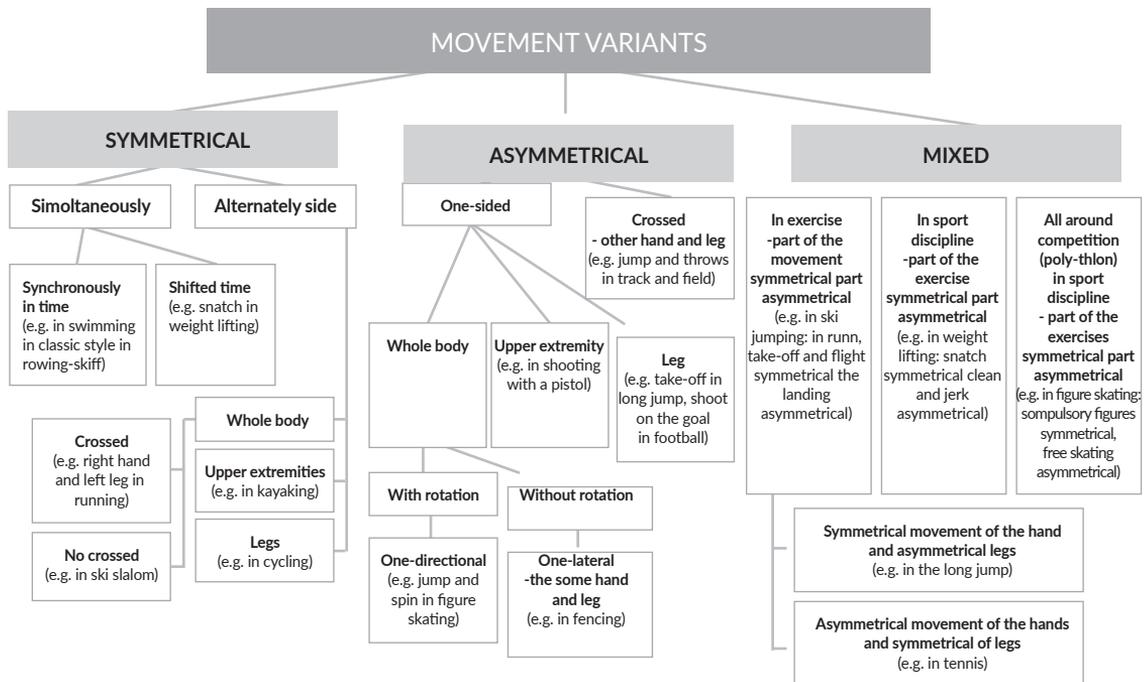


Figure 4. Classification variants of movement symmetry and asymmetry in different sport disciplines [Starosta, 1990]

The crucial idea to be applied is as follows: whatever the skills of the athlete are, the ultimate goal of teaching should aim at developing movements asymmetry through complex exercises (if this is required by the practised discipline) supported by the symmetry in the simple exercises.

Symmetryzation process should be applied regularly from the beginning to an end of the competitor's career. We may distinguish three level of competitor's preparation. They are starting points for a coach-teacher. Thus, we have symmetric (A), asymmetric (B) and asymmetric-symmetric preparation (C).

Out of the *eight variants*, the fifth one seems to be the most feasible and rational. In this variant, competitors, who has already developed symmetric skills, starts performing one part of exercises using his left leg (with *turns left*) and the other using his right leg (with *turns right*). He maintains symmetry in complex exercises while specialising in asymmetric performance of the most difficult exercises. It is an optimal variation, however, it has not been fully tested yet in many sports.

### 3. Final remarks

The concept presented here and the ways of its application were verified by studying first, beginners and then advanced figure skaters. I transmited the obtained results with the competitors of 14 sports disciplines. Although the concept was utilised, it still does not ensure the achievement of high scores in a short period. There is no denying, however, that it increases the effectiveness of the training.

The proposed concept considers movement education as an element of the system that makes it possible to develop all kinds of movement performance with the use of hands, legs, the whole body and the movements combined with the turns of the body. In addition, it

takes into account cyclic and acyclic movements and this is why it may be helpful in improving the technique of all sports disciplines. The above statement makes the concept universal. The concept seems to be original because of the following qualities:

- (1) multivariant aspect - it may be used for the competitors with different level of movement preparation;
- (2) dynamic aspect - it allows for the variability of movement preparation;
- (3) prospective aspect - (the most important feature) it is intended for a many years of training - *from the beginning until the end of the competitor's sports career.*

The implementation of the presented concept will be favourable in all stages of training. This is probably due to the fact that the specialisation of one limb or one direction of body turns, if applied from the beginning of the sports education and without movements symmetrization, lowered the level of the competitors capabilities. Moreover, in asymmetric sports the permanent over load of one body side brought about injuries that for life prevented the competitors from practising sport. Whereas, creating the strong foundation for comprehensive movement preparation, including symmetric preparation, is conducive to the attainment of the movements asymmetry level ensuing better sports results.

Symmetrization, thus understood, is a process of the coordination improvement. It is not only preoccupied with a sport result but first of all with the health status and a proper physical and psychomovement development of a young competitor. No sport result, even the highest one such as the world record can be more important than a human health and well-being (Starosta, 1993, 1993a, 2003, 2006, 2010, 2015).

## Conclusions

1. The symmetrization of movements as a process of equalising fitness of both sides of the human body is undertaken by each individual. It concerns all activities of everyday and professional life, as well as movement activity directed at recreation or rehabilitation. This process progresses usually in a spontaneous way, not systematically and without adhering to any principles of rational learning. Despite that, as a rule, it brings about positive results.
2. The practicing of some sports disciplines (e.g. swimming, kayaking, canoeing) requires from the competitors the symmetrization of their technique. A high level of this technique ensures attaining technical mastery and significant sports results. Also in this case the symmetrization is implemented frequently without any knowledge of principles of rational didactic system.
3. The process of symmetrization is also indispensable in those sports disciplines in which dominating are asymmetrical movements (e.g. track and field throws). Even a partial equalising of fitness of both sides of the body increases the level of movement coordinations and improves the technique of implementation of all exercises, and, what is just as important, prevents injuries resulting from excessive using of the dominating limb (side of the body).
4. Results of studies of numerous authors (including own studies) point at a considerable dominance of positive consequences of movements symmetrization. Therefore, this process may be considered indispensable in the each person's improvement of movement performance. It should constitute an integral component of the theory of movement teaching.
5. On the basis of long term own studies, proposed was a new concept of teaching and improving the technique of movements. Its basic assumption is based on a rational connection of symmetry and asymmetry of movements. This is due to the fact that functional symmetry is only favourable in sports when it is based on symmetry.
6. The symmetrization of movements concerns each individual and all kinds of his activity. That is why the optimisation of that process obtains an importance of a social problem directed at increasing the efficiency of functioning of man.

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#### INVITED LECTURE

## Is physical activity the everlasting fountain of youth and health? (Pilot-project)

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### Introduction

Insufficient physical activity is one of the leading risk factors for death worldwide, as well as the key risk factor for non-communicable diseases (NCDs), such as cardiovascular diseases, cancer and diabetes. According to WHO (World Health Organization), physical inactivity is causing an estimated 3.2 million deaths globally. In addition, WHO statistics show that globally one in 4 adults are insufficiently physically active, as well as that more than 80% of the world's adolescent population is not active enough.

Consequently, one must reach the conclusion that physical activity is an essential prerequisite for maintaining and improving health.

On the other hand, aging is an inevitable reality that cannot be detained, maybe just postponed a little, if one has managed to take timely measures in hoping to achieve the so-called “successful” or “healthy” aging. However, aging is also “a highly individualized and

complex process” (Dionigi, 2015). The mentioned aspect of an individualized aging process presents a sort of starting line in the modern race towards achieving the dream of personalized medicine that strives at attaining “a future in which a simple blood test will determine the best course of treatment based on a patient’s genes” (Technology Review, 2004). Therefore, it is no coincidence that the Massachusetts Institute of Technology (MIT) determined the field of microbial glycobiology as one of the ten emerging technologies that will change our future in revolutionary ways.

Recent studies on biomarkers of aging have shown that glycans are very promising biomarkers in aging research. According to the American Federation for Aging Research, any useful biomarker of aging must, among other criteria, predict the rate of aging and be a better predictor of life span than chronological age alone; also it must be testable repeatedly without harming the person (or animal). Glycans are important structural and functional elements and, as one of the four principal components of each cell (in addition to nucleic acids, lipids and proteins), they participate in virtually all physiological processes. They are now also revealed as the “third revolution in evolution” and a “novel biomarker of chronological and biological ages”.

In 2013, a study by Krištić et al. reported a strong relationship between aging and posttranslational glycosylation of IgG, which suggested that IgG Fc glycosylation modulated inflammation and thus, through this promotion or suppression of inflammation, significantly contributed to the process of biological aging. As opposed to chronological age, for which one could say it is, in fact, just a number, biological age reveals more precise information about a person’s health status and demonstrates the rate at which one is aging.

In 2017, an analysis performed by Sebastiani et al., showed that there were various biomarker signatures that could be significantly associated with physical function, morbidity and mortality. The above-mentioned suggests that these patterns represent differences in biological aging and, furthermore, thus indicating that an individual can physiologically age, for example, 3 years over the course of only one calendar year and, consequently, be much older biologically than chronologically. So, perhaps the next step in aging research is “biological de-aging” research – i.e., studies of possible effects of lifestyle interventions on changes in biological age. One type of lifestyle intervention worth researching would surely be physical activity as a modern “prescription” for any disease or condition, moreover, as an irrefutable preventive method for both avoiding and postponing disease and aging, i.e. for “successful” and “healthy” aging.

As previously mentioned, aging is a process followed by an increase in systemic inflammatory activity, referred to as inflammageing. There are also some other age-associated alterations that are observed with the number, phenotype and function of innate immune cells. Certain contemporary studies suggest that aerobic exercise training is anti-inflammatory and might counter the age-associated decline in immune function, referred to as immunosenescence. Besides the idea that aerobic exercise training could prevent, limit or delay immunosenescence, this also suggest that the exercise-induced anti-immunosenescence effect might even rejuvenate aged immune profiles and thus be linked to lower morbidity and mortality from diseases with infectious, immunological and inflammatory aetiologies.

## Methods

A unique study of the effects of physical activity is currently implemented by the Faculty of Kinesiology University of Zagreb, in which the GlycanAge test is used to thoroughly and scientifically investigate the many times proven benefits of physical activity. The study is aiming at generating a scientifically accurate “dose” of physical activity for any individual who decides to “turn back the clock” and biologically “de-age” his/her body. The so-called GlycanAge index, which is composed of only three glycans, provides a way of measuring human biological aging by molecular profiling.

## Results

When compared to other markers of biological age (e.g. telomere lengths), the combination of these three glycans can explain up to 58% of variation in chronological age (Krištić et al, 2014). Up to 50% of plasma glycome variability is estimated to be heritable, whereas the remaining variability is apparently caused by environmental factors, including health status and lifestyle. The mentioned study by Krištić et al. (2013) also showed that a large part of nongenetic variability of the plasma glycome could be explained by age and physiological variables related to age.

The target sample of examinees in this comprehensive study are sedentary middle-aged and older people (aged 35 to 70 years) who are involved in physical activity programmes of two (2) training sessions per week over the course of 14 weeks. Prior to the PA programme, as well as after its successful completion, each examinee is thoroughly tested by a series of morphological and functional tests, to determine the effects of the programme and, in addition, by the GlycanAge test that requires only a small sample of blood from each examinee.

The participants of this study are distributed into three different types of PA programme: Nordic walking programme, strength training programme, or cardio training programme. The estimated duration of this research is three (3) years and the anticipated final number of examinees will be around one thousand (1,000). Certain examinees will be subjected to the 14-week PA programme over two or more cycles in an attempt to determine the outcome of extended participation in PA programmes; however, the primary aim of the study is to scientifically “measure” the effects of 14 weeks of health-oriented PA on biological age of sedentary individuals who are likely to be of the increased biological age than their chronological age.

T-test for Dependent Samples (KIF_GA_201802) Marked differences are significant at $p < 0,5000$			
	Variables		
	Biological age - initial	Biological age - final	Average chronological age
Mean	41,52	40,41	44,56
Std.Dv.	14,95	14,44	8,59
N	91	91	91
Diff.		1,11	
Std.Dv.		3,23	
t		3,28	
df		90	
p		0,001	
Confidence		0,44	
Confidence		1,78	

Table 1. Statistical data on the difference between the initial and final biological age of examinees and average chronological age of examinees

T-test for Dependent Samples (Glycan statistics_MODIFICATION)						
Marked differences are significant at $p < 0,5000$						
	Variables					
	Lunges - initial	Lunges - final	Squats - initial	Squats - final	Push-ups - initial	Push-ups - final
Mean	13,70	17,03	36,84	44,95	26,26	32,68
Std.Dv.	3,22	2,97	8,26	8,61	8,84	8,30
N	89	89	89	89	89	89
Diff.		-3,34		-8,11		-6,43
Std.Dv.		2,73		6,28		5,48
t		-11,51		-12,18		-11,13
df		88		88		88
p		0,000		0,000		0,000
Confidence		-3,91		-9,43		-7,57
Confidence		-2,76		-6,79		-5,28

Table 2. Statistical data on the difference between the initial and final test results (lunges, squats and push-ups) of examinees

T-test for Dependent Samples (Glycan statistics_MODIFICATION)		
Marked differences are significant at $p < 0,5000$		
	Variables	
	Beep test - initial	Beep test - final
Mean	5,77	6,87
Std.Dv.	2,15	2,55
N	80	80
Diff.		-1,10
Std.Dv.		1,51
t		-6,51
df		79
p		0,000
Confidence		-1,44
Confidence		-0,76

Table 3. Statistical data on the difference between the initial and final 15-metre beep test of examinees

## Conclusions

As demonstrated in the above tables, after the completion of the first cycle, the preliminary study results indicate that all the final tests and measurements demonstrate an improvement when compared to the initial evaluation. Therefore, it is expected that after completing the entire study and upon thorough analysis of all results, this research will provide an innovative, scientifically based evidence of the physical activity benefits, thus bringing us one step closer to the afore-mentioned dream of “a future in which a simple blood test will determine the best course of treatment based on the patient’s genes”. At the same time, the results of this study will constitute the Faculty of Kinesiology University of Zagreb a front-runner in the realisation of what Dr. Robert N. Butler stated when he said: *If exercise could be packed in a pill, it would be the single most widely prescribed and beneficial medicine in the nation.*

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# Can mechanical load from daily physical activity, sport and physical education induce the health of bones in youth?

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## **ABSTRACT**

**PURPOSE:** This presentation will reveal what physical activities, that can be used in daily life (walking, cycling, climbing stairs up and down), sport and physical education of children and adolescents, are optimal to increase their bone mass qualitatively and quantitatively. **METHODS:** For the last 25 years we can investigate the health of human bones by non-invasive techniques such as Dual X-ray absorptiometry and ultrasound. These methods have shown that bone is not a passive tissue, but a tissue that continuously renews its cells by osteoblast and osteoclast activities. In the case of overload by muscle traction or gravitational forces, bones are in a very specific way stimulated by both electric and fluid responses to change their bone matrix to optimize the strain on the bone. **RESULTS:** Effects of overload is demonstrated in excellent animal models (in roosters, rats) by researchers as Turner et al (USA) and Rubin and Lanyon (UK) as well as in human bones in Canada (Bailey and Baxter-Jones). This knowledge is important because a high-impact physical activity of the young in their daily life has proven to increase the peak bone mass after puberty; furthermore, this healthier bone mass remains unchanged during adult age and can also prevent osteoporosis at older age in both females and males. **CONCLUSIONS:** In many longitudinal intervention studies the positive effects of physical activity have been evidenced in boys and girls; furthermore, a high-impact activity of a relative short duration and frequency can result in stronger bones. This can help preventing sports injuries during competition and in older age prevent osteoporotic fractures in arms, the hip and the lumbar vertebrae.

**Key words:** children, adolescents, bone mass, physical activity, sport injuries, prevention of osteoporotic fractures

# Comparison of children and adults in their responses to exercise and adaptations to training

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## **ABSTRACT**

**PURPOSE:** This presentation is a summary of the literature overview on how children differ from adults in their responses to exercise and their adaptations to training. Some people think of children as miniature adults. However, many functions in their bodies are not fully developed and they cannot perform as well in some kinds of exercise. In general, the basic physiological responses to exercise and adaptations to training are similar at all ages. There are quantitative differences which are mostly related to body size. With maturation and the associated hormonal changes, qualitative differences also occur. Associated with a smaller body size, children: are less efficient and require more energy to perform the same exercise; have smaller hearts (therefore, smaller cardiac outputs and stroke volumes, but higher heart rates at the same power output or PO); and have smaller lungs (therefore, less volume per breath and more breaths at the same PO). Qualitatively, anaerobic glycolysis is enhanced after puberty, such that the maximal levels of lactate are higher and adults can better perform the types of exercise that depend on that energy source. As well, there is a major improvement in the ability to regulate body temperature and to acclimatize to heat.

**CONCLUSIONS:** The effect of these quantitative and qualitative changes with puberty can be summarized as follows:

- 1) Children have no problem with brief, very high-intensity exercise because their ATP-CP system is adequate,
- 2) Children do have a problem with high-intensity exercise lasting 30-120 seconds because their system of anaerobic glycolysis is inadequate.
- 3) Children have no problem with moderate-intensity, moderate-duration exercise because their aerobic system is adequate.
- 4) Children do have a problem with prolonged endurance exercise because their ability to regulate body temperature is inadequate.

**Key words:** aerobic performance, anaerobic performance, body composition, environment

# Effects of physical exercise and intake of hydroxytyrosol on redox status of exercised wistar rats

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## ABSTRACT

**PURPOSE:** Polyphenols function as antioxidants due to their chemical structure composed of several hydroxyl groups on aromatic rings. Hydroxytyrosol (HT) is the main phenolic compound of olive oil, responsible for its beneficial effects on health and one of the component most biologically active and metabolized by humans. Accordingly, among other biological properties, HT has powerful *in vivo* antioxidant effects (HU et al. 2014; Manach et al. 2004). The aim of our study is to describe the effects of different doses of HT on REDOX capacity in sedentary and exercised rats. **METHODS:** 40 male Wistar rats were distributed in 6 groups: Sedentary (Sed), SED with intake of 20mg/kg/day of HT (SED20), SED with intake of 300 mg/Kg/day of HT (SED300), Exercised (EXE), EXE with 20 mg/Kg/day of HT, EXE with 300 mg/Kg/day of HT. During 20 weeks of experimental project; the maximum running speed (3 tests during the study) and the daily work was evaluated. Hemoglobin (HGB), and hematocrit (HCT) were measured in blood. Finally, the concentration of mitochondrial plasma hydroperoxides as a marker of lipid peroxidation (oxidative stress) was evaluated. **RESULTS:** In Sedentary rats HT induced an antioxidant effect without implying improvements in spor m.krts performance. However, in combination with the exercise, the dose of 300 mg/kg/day produced a pro-oxidant effect. **CONCLUSION:** In summary, HT dosages, ranging from 20 mg/kg/d to 300 mg/kg/d for 10 weeks, induced an antioxidant response in a dose-dependent manner in sedentary animals. However, 20 mg/kg/d HT decreased the running capacity when this dose was supplemented during exercise, whereas 300 mg/kg/d HT was able to maintain and even increase the running capacity. This effect might be due to a systemic pro-oxidant effect induced when a high HT dose is supplemented during exercise training (Boots et al. 2007).

**Key words:** polyphenols, ROS, exercise, oxidative stress, antioxidants

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INVITED LECTURE

# Exercise prescription and chronic diseases

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**Purpose**

The global epidemic of non-communicable diseases like diabetes mellitus, hypertension, obesity and metabolic syndrome is growing. As for those patients, the adherence to physical exercise is of the greatest importance, and a very essential part of their therapy. However, special health considerations should be taken into account when prescribing an exercise program (Pedersen, B.K. & Saltin, B., 2015)

**General outline**

Exercise is considered to have an effect of panacea or polypill on most common chronic diseases, such as hypertension and diabetes mellitus (Pareja-Galeano, H., Garatachea, N. & Lucia, A., 2015), but the problem might be to choose the activity type and the appropriate intensity. Exercise intensity determination is in elite athletes usually more exact than in recreational athletes because, in recreation, we are often forced to roughly estimate maximal intensities as the health condition of the patient does not permit the maximum load testing, like all-out treadmill test or similar. Therefore, the first part of the lecture will present some simple methods of determining the intensity of exercise that could be applied either by the instructors, therapists or the patients themselves (Miller W.C., Miller, W.C., Wallace, J.P. & Eggert, K.E.,1993). The second part of the lecture will contain some practical

information about prescribing an exercise program in hypertension and diabetes mellitus.

## Content

Traditionally, aerobic activity is recommended in the prevention / treatment of most chronic illnesses. In physiological terms, aerobic activities are those in which the dominant sources of energy for work derive from oxygen in mitochondria of muscle cells from sources of energy (mainly fats and carbohydrates). The role of aerobic physical activity is twofold – besides helping to maintain body weight and body composition, it regulates blood glucose levels by improving direct transport and entry of glucose into cells unrelated to GLUT-4 (glucose transporter-4) carriers and improving the sensitivity of targeted tissue on insulin. Although this mechanism of energy generation is already significantly included after a minute of activity, however, in the informal sense, it could be said that aerobic activities involve a rhythmic repetition of muscle contractions that belong to large muscle groups for more than 3 or even 5 minutes. Aerobic physical activity includes walking (the most common and most appropriate activity for most people with chronic diseases), cycling, swimming, exercises in the water, which can be performed even by people with peripheral neuropathy, then running and “jogging” that represent aerobic activity of higher intensity, and are only suitable for people without locomotor complications or the disease.

At the cellular level, the benefits of aerobic physical activity and aerobic exercises include increasing the density of mitochondria and oxidative enzymes; at the level of blood vessels, their density and adaptability are increased, and on the level of organs and organic systems, the physical activity has an effect on the function of the lung, the immune and cardiovascular system. In persons suffering from diabetes or hypertension who are involved in regular aerobic exercise of moderate and high intensity, the lower mortality from cardiovascular disease is being observed. In patients with type 2 diabetes, regular aerobic physical activity reduces HbA1c, triglycerides, insulin resistance, and blood pressure. In people with type 1 diabetes, with aerobic physical activity, the readiness of the cardiovascular system has increased, the sensitivity of the tissue to insulin is improved, and the effect on the lipidogram is favorable. Similar effects are seen in metabolic syndrome (Stefani, L. & Galanti, G., 2017).

When a person is instructed and advised to join an exercise program, he/she is often unable to choose from a vast number of program that various fitness centers or health clubs offer. Not rarely, some of these programs might not be good for them or even might be contra productive or dangerous. For example, a high intensity, might elicit a raise in blood glucose concentration in diabetes, which was not the goal. Regarding the different intensities of exercise, it should be noted that activities carried out with high intensity, ie, intensities above the level of the anaerobic threshold do not cause a beneficial effect on blood glucose levels in diabetic patients. The stress of response that is activated at high intensities results in raise of stress hormones concentration (catecholamines, cortisol, IGF-1) and the activation of the sympathetic part of the nervous system accompanied with an increase in arterial blood pressure and glycaemia. For most patients, this occurs above 80-85% of the maximum heart rate. The important concern in diabetes is also a possibility of a sudden drop in blood sugar, hypoglycemia. Hypoglycemia is more common in people with type 1 diabetes, but it is also possible for people with type 2 diabetes if treated with insulin or insulin secretagogues. In programmed exercise, the hypoglycemia episodes could be prevented if higher intensity or strength and resistance training precede the aerobic part of moderate intensity training or if moderate intensive aerobic exercises are interrupted by shorter high-intensity bouts. In people with type 1 diabetes, the particular problem is the occurrence of postponed hypoglycemia (after 6-15 hours of exercise), especially nighttime hypoglycemia. This can be prevented by planning training and reducing insulin dosages. Strength training as an additional activity is primarily aimed at increasing or maintaining muscle mass, and the decrease of rate of muscle loss. Numerous health benefits of strength

training are evident in chronic diseases such as diabetes, arthritis, osteoporosis, obesity, metabolic syndrome. In older population the strength training can affect the prevention of falls and better maintenance of the balance and improving the everyday quality of life. It may be particularly important to highlight the significant impact of muscle strength precisely on the prevention of falls in the elderly, which may have a lethal outcome. Nevertheless, the risks always exist and for example a strength-training program which contains a lot of static contractions could lead to increase in diastolic pressure.

### Conclusions

For a medicine to be efficient in a particular disease, we need to prescribe the right type of a drug, its action, its dose and frequency. Similarly, if we consider exercise to be a medicine, in order to achieve its maximal efficiency, the physical exercise must be thoroughly programmed, better say personalized. Even though many general practitioners, as well as internal medicine and other specialist would say that anything is better than nothing, and more is better than less, this might not be completely true when it comes to people with chronic illnesses.

**Key words:** exercise prescription, hypertension, diabetes mellitus, chronic disease, health

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## FULL PAPERS

# Rhythm in serves and its influence on play effectiveness of volleyball world elite athletes

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## **ABSTRACT**

**AIMS:** 1. To determine the place from which serves are executed and directions of the ball flight in relation to the types of eurhythmics of the move on the example of world top-level volleyball players. 2. To establish effectiveness of serves executed in different rhythms by leading volleyball players of the world. **MATERIALS AND METHODS:** Players of the four leading volleyball teams of the final round of the World League – Brazil, Bulgaria, France and Poland, were analysed. The observation of rhythmic and arrhythmic executions serves was done on thirty-three players. The level of effectiveness was assessed according to the scale. The method of indirect observation (the video and DVD recordings) was used in the research. It allowed for repeated analyses of individual technical-tactical actions. **RESULTS.** Most often the players have commenced the tennis serve on the right. They have most often pointed the ball into the centre field of the defence (n = 139). They decided 58.4 % of all tennis serves from the jump. whereas 75 passes were carried out into the right field of the defence. The ball has most rarely been inserted into the game on the left fields of the serve – only 9.3 %. Serve without rotation, so-called “brazilian” 109 cases were executed. Players while performing it have most often stood from right or of left hand of service field. Numerical values turned out to be similar with a quantitative narrow lead of the serve without rotation directed after the straight into right and left field of the defence. Numerical marked differences concerning the flight of the ball toward the given field of the defence weren't stated. In contrast with the tennis serve from the jump, volleyball players have most often played service field on the left – as many as 47.7 % out of everyone. The ball has most often been pointed into the centre field of the attack. A tennis serve turned out to be most effective from the jump. However least competitors made a mistake performing the serve without rotation. The least effective was so-called „shortcut” behind the net. **CONCLUSIONS:** 1. Analysis of findings showed, that most often applied by leading volleyball players of the World League, was the most difficult in terms of the technique and the rhythm of the performance, tennis serve in the jump (62.3 % of all registered serves). It was found exceptionally frequent to be done from the field on the right, diagonally. Examined players regardless of the type of the serve, usually pointed the ball into centre zones of the field of the game of the opponent. 2. The observed right-handedness of the majority of volleyball players was probably influencing the performance of the tennis serve most often on the right of service field. Characteristically for the serve without rotation was its most frequent doing, on a straight line into right and left field of the defence of the opponent. „Shortcut” behind the net appeared mainly after the serve from the middle and

the right side of service field. It was the rarest (merely 12.5 % of all considered serves). 3. Gathered material indicated for diversity of considered serves in terms of their effectiveness. With least effective offensive action of the best volleyball players of world, was „shortcut” behind the net. Most stable in terms of the effectiveness proved itself to be a serve without rotation, because unsuccessful serves only constituted 6.4 %. The greatest effect, as well as the risk of error were characteristic of the tennis serve from the jump.

**Key words:** volleyball, rhythm, serve, effectiveness, world elite.

## Introduction

In search of ways and means of further development of team sports, special attention is paid to the effectiveness of competitors in an increasingly complex sport rivalry. The factor that appears frequently in specialist literature as the main determinant of the optimal technical-tactical interaction of players is movement coordination (Blume, 1979, 1981; Hirtz, 1985; Starosta, 1993, 1995, 2003; Starosta, Lamcha, 2009; Starosta, Stronczyński, 1994, 1998, 2010). A discipline in which coordination abilities play the key role is volleyball (Starosta, 2003, Starosta, Lamcha, 2009). A high level of performance of technical elements in both defense and attack is designated to one of the leading coordination skills – rhythmization of movements. Technical complexity of volleyball, in comparison to other team games, results from a very short contact time of player with the ball. It is characterized by exceptional accuracy of passing the ball to the leading player, who decides on the pace of offensive actions. This requires aiming the ball at the optimal speed into the precise place of the team’s own field or the opponent’s field, depending on the piece of sporting activities. The basis of technical and tactical mastery in volleyball, among others, is a high level of rhythmization abilities and of the arrhythmia of movements. It refers to a high-rate synchronization of steps with the rhythm of attack, block and serve. Adaptability of rhythm of players’ steps to the serve/play, greatly facilitates rapid responses and time-space orientation. Alternating rhythm of optimum rate and frequency of steps enables effective implementation of most technical elements. The game is characterized by enormous rhythm variability of typical volleyball motor behavior. Most serve receptions and underarm or overhand ball passes require a synchronous rhythm of both arms/hands. However, in attack, in addition to the proper rhythm of steps, arrhythmia of jumps and ball strikes can also be recognized. The culmination of attack is the synchronized, rhythmic motor behavior. It involves running up/ at the appropriate pace and a strong, directed ball strike. However, arrhythmia is manifested in "dodging" and "placing". The match of volleyball begins with a serve – the only technical element in which the athlete is fully responsible for its execution. The limiting time factor is prescribed by the game regulations – the player has eight seconds for serve execution. Offensive action quality depends on the serve quality. The main task of the server is to impede the opponents’ intentions to regain ball possession. The serve in contemporary volleyball is characterized by a pronounced arrhythmia in its performance, as well as by high speed of the served ball flight and its direction. The greater the diversity of the mentioned serve characteristics, the greater the chances of “surprising” the opponent. Serve is a major contributor to the final match outcome. Its effectiveness depends on a high level of athletes’ power, and on the stabilized structure of the move technique (trajectory of the striking limb), all associated with action rhythm. Hence, serve effectiveness is largely determined by the optimal rhythm of steps and proper timing. A significant link between the ability of movement rhythmization and serve effectiveness, executed by qualified men and women volleyball players, was demonstrated by W. Starosta, Ł. Lamcha (2009), W. Stronczyński (1998), W. Stronczyński and J. Lojewski (2000). These studies’ findings contradicted the statements of Ljach W. and K. Zimmermann (1995, 1982) about the insignificant importance of the ability of movement rhythmization in the performance of particular sport actions. Only a few authors (Hirtz, 1985) pointed out a

significant impact of properly applied techniques of rhythm and arrhythmia on volleyball playing effectiveness. Most commonly used serves are: the (tennis) jump serve, “Brazilian” and a serve “shortcutting” the ball’s trajectory. Rhythmic pattern of the jump (tennis) serve consists of: throw of the ball upwards, accompanied usually by approaching two rhythmic steps and the third arrhythmic one (short) followed by a rapid jump upward. A few players use the rhythm of up to five steps, the last of which is arrhythmic. The “Brazilian serve” substantially differs from the previous one. It is performed smoothly, in a uniform rhythm of 3-5 steps, with a throw of the ball upwards at a height of about one meter. In a serve with a short ball flight (“a shortcut over the net”), the rhythm of the steps and the jump is same as in other serves. Arrhythmia is manifested in the release of hand motion just before hitting the ball. Precisely executed serve is the basis for further effective individual, group and team actions. Coaches and researchers try to determine how effective are each of the above-mentioned serves. For tactical reasons, it is extremely important in which area of the opponent’s court the ball will be “sent”. Observations of volleyball events show that these factors are significantly conditioned by the manifestations of rhythm characteristics in each serve type. Hence,

the evaluation of effectiveness and direction of the serves in contemporary volleyball is very important for theoretical and practical reasons. In the available literature, this problem has not been treated. Analysis of the game of world-class players should enable the determination of effectiveness of each type of serves, while at the same time, it should present trends in their tactical execution (place of serve execution and direction of the served ball). The acquired knowledge may be useful in training volleyball players of various ages and of various sport standard.

**Aims:** 1. To determine the place from which the serve is executed and directions of the ball, depending on its types of the eurhythmics of the move, on the example of world top volleyball players. 2. To establish effectiveness of serves executed in different rhythm patterns by leading volleyball players of the world.

### **Materials and methods**

Players of the four leading volleyball teams of the final round of the World League – Brazil, Bulgaria, France and Poland, were analysed. The observation of rhythm and arrhythmia of serves was done on thirty-three players. There were thirty right-handed (90.9%) and three left-handed players. The level of effectiveness was assessed according to the scale drawn up by W. Starosta and Ł. Lamcha (2009): very good serve results in the direct point scoring (the so-called ace); good serve creates a major difficulty in offensive action performance; easy serve allows the opposing team to apply various offensive combinations; and failed serve is the one in which the server made a direct mistake, due to which the team lost a point. The method of indirect observation of video and DVD recordings was used in the research. It allowed multiple analyses of individual technical-tactical actions. For a more accurate analysis, freeware programs for image processing were used.

### **Results**

As a result of the observations carried out during the World League, three different places were determined from where most of jump tennis serves were executed. Depending on the place of the serve strike, the flight of the ball and the place of its landing on the opponent’s court were defined (Fig. 1). Three places were established to which the ball was directed: left, mid and right court of defense. Twenty-five volleyball players executed a total of 269 tennis serves from different places of the court to the mentioned court segments of the opponent.

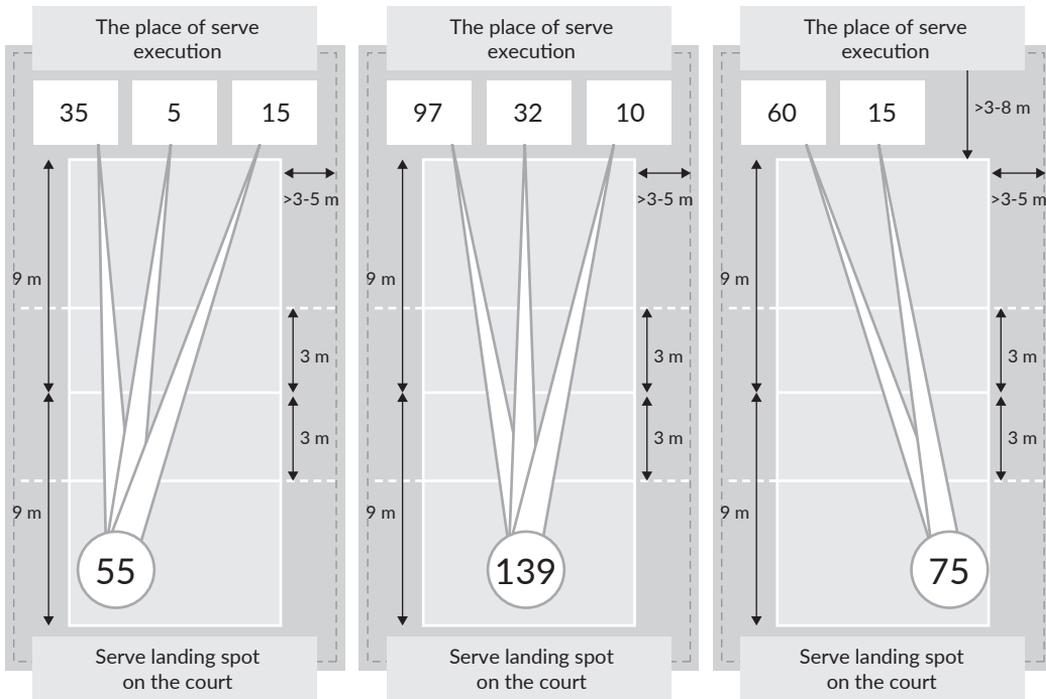


Figure 1. The place of jump tennis serve execution and direction of flight of the ball (n = 25).

Volleyball players usually began a match with a serve from the right side (Fig. 1), as indicated by the figures: 35, 97, 60. The ball was most frequently directed towards the mid defense court (n = 139), which accounted for 58.4% of all jump tennis serves. As many as 75 serves were performed to the right court of defense. Least often the ball was introduced into the game from the left side of the court (respectively: n = 15, 10, 0), which accounted for only 9.3% of the total number of serves. The examined type of serve is characterized by a particularly high dynamics. Because of usually the longest flight of the ball passed along the diagonal, a lower probability of error was expected (i.e., the ball falling off the court). Thus, it appears that players often guided the ball towards the middle or right court of defense, rather than along a straight line. The basis for the full execution of jump serves was a high level of technique, which depended on the player's ability to harmonize rhythm of steps and ball strikes. Not a single serve was performed along a straight line, which began on the left side of the serve field. Maybe this proves that the manifestation of the rhythm of serves for the right-handed volleyball players is more complex from the right rather than from the left side of the service court.

Serve without ball rotation, the so called Brazilian, was executed 109 times. Volleyball players during its execution mostly lined up along the right or left side of the court (Fig. 2).

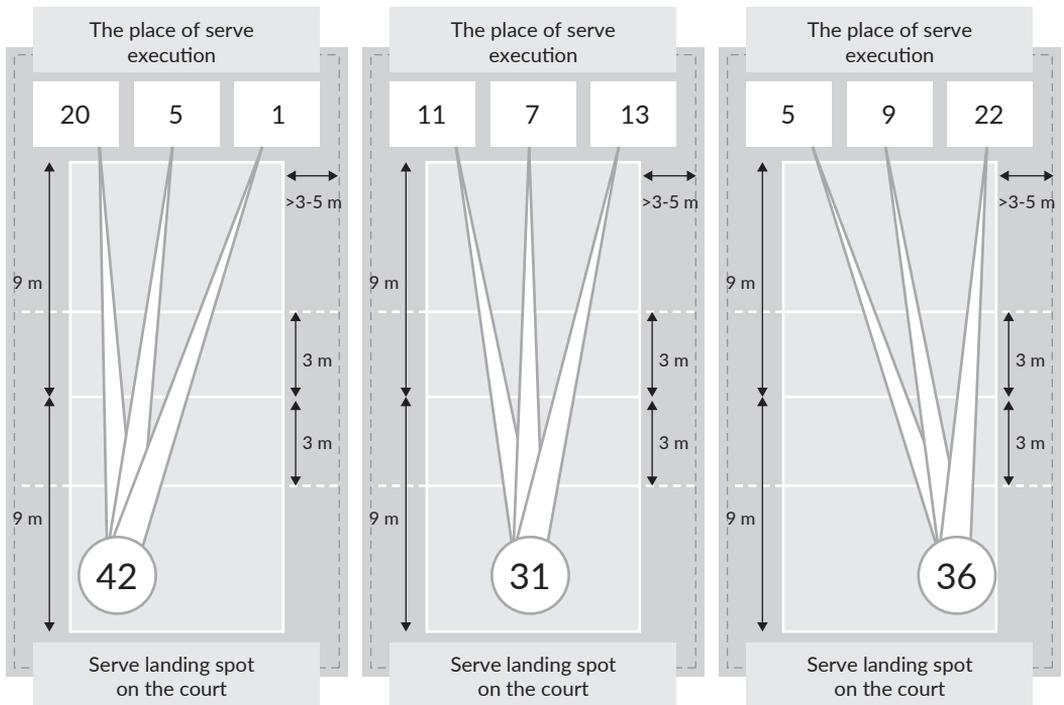


Figure 2. The place of serve without rotation execution and direction of flight of the ball (n = 18).

Numerical values were similar, with a slight predominance of serves without ball rotation, guided straight to the right and left court of defense (n = 20, 22). There were no significant numerical differences regarding the flight of the ball in the direction of the court of defense (n = 42, 31, 36). In contrast to the jump tennis serve, volleyball players often executed the serve without ball rotation from the left side of the court (n = 17, 13, 22), which accounted for 47.7% of all serves executed. Quite rarely the serve was executed from the central zone of the court (n = 5, 7, 9). In total, they amounted to 19.3%. The third type of serves called "shortcut behind the net" was performed only 54 times (Fig. 3), which accounted for only 14.3% of the total serves executed.

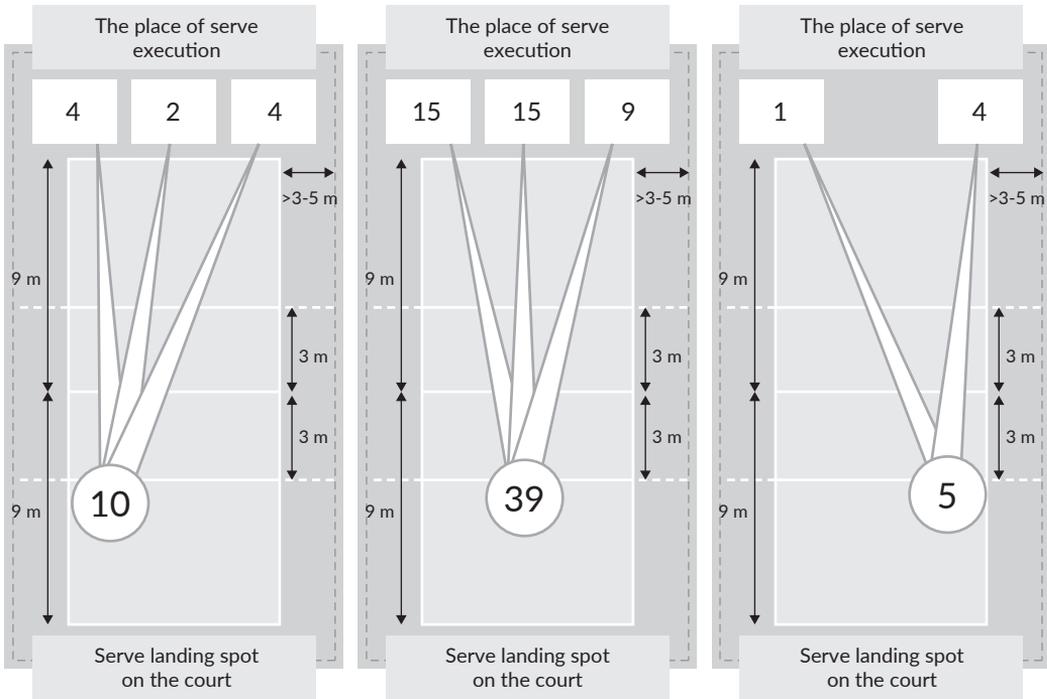


Figure 3. The place of serve execution and direction of a short flight of the ball (n = 10).

This serve performance is different from the previous by the final phase of strike. The arrhythmia manifested in it consisted of slowing down of the motion of the striking limb. As a result, the ball falls around the line of the opponent's attack. The ball was mostly directed towards the middle of attack – the shortest ball flight (n = 39). The lowest figures for the serves towards the right court resulted probably from the right handedness of most volleyball players. Presumably, the final phase of the rhythm, and arrhythmia, affected the effective execution of the “shortcut”. It seems that directing the ball towards the mid or left of the opponent's attack court was much easier for the right-handed players. In effectiveness assessing of three types of serves (Tab. 1) a four-degree division was used (Starosta, Lamcha, 2009).

The effectiveness of serves	Jump tennis serve	"Brazilian"	"Shortcut behind the net"
Very good (ace)	7	5	0
Good	64	31	12
Easy to receive	125	66	36
Failed (points for the opponent)	73	7	6
Total	269	109	54

Table 1. Effectiveness evaluation of various types of serves (n = 33)

Highly proficient volleyball players from four top-level national teams executed in the final round of the World League a total of 432 serves, out of which 269 were jump tennis serves, 109 “Brazilians” and 54 “shortcuts behind the net”. Only by two types of serves direct points were scored: by jump tennis serve – 7 points, and by the “Brazilian” – 5 points. Most errors (n=73) were made while performing the jump tennis serves. This confirms its high technical and rhythmic complexity. The largest number of all types of serves were considered the “easy” ones, meaning they did not cause any difficulties in serve reception by the opposing team (Fig. 4).

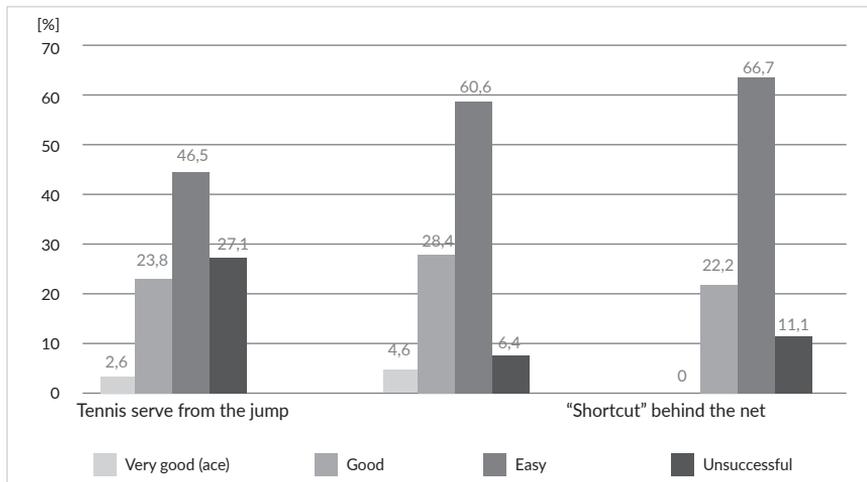


Figure 4. Effectiveness of different types of serves (n = 33).

In jump tennis serve they accounted for 46.5%, in the “Brazilian” for 60.6%, and most easy serves accounted for the serve with the shortest flight of the ball, as much as 66.7%. The smallest percentage of serves were those followed by the points scored. In jump tennis serve only 2.6% of aces were recorded, and in the serve without ball rotation 4.6%. By the serve “shortcut behind the net”, not a single point was gained.

## Discussion

The game of volleyball is one of the most popular team sports. Its appeal results from, among others, its technical-tactical abundance being dependent on the interaction of the group and the rational regulatory changes which enhance the dynamics of the game. Coordination abilities have a special role in the game. Most technical elements, to a large extent, depend on high levels of the manifestation of: a rapid response, time- spatial orientation, kinesthetic differentiation of movements and their rhythmization. Especially the latter ones form the basis of accurate execution of complex, dynamic movement acts. Such is the serve, whose types are used depending on the skills of the players, as well as depending on the tactical situation occurring during the sport contest. Previous studies have shown that its level depends on the movement rhythmization ability (Starosta, Stronczyński, 2010; Starosta, Lamcha, 2009). Top volleyball players of the world took part in the research. On their basis, one can cautiously define the contemporary trends in the realization of the basic technical-tactical element of the volleyball match - which is the serve. The obtained results showed the particular importance of serves in tennis and of the serves without rotation, for the effectiveness of offensive actions. Numerical analysis allows a generalization of the effectiveness of different serves, as far as the place of their execution, direction of flight and of the "targeting" of the ball. However, a rather scarce number of tested volleyball players is not conducive to the recognition of the results as

model ones. Even more so that the majority were right-handed players. The novelty in the presented results of research refers to the attempt to determine the types of serves, including the contained in them variety of rhythms. This seems to be the reason of taking up further research exploration in volleyball, and particularly in exploring the effectiveness of other technical and tactical elements, which are determined, to the highest degree, by the ability of movement rhythmization.

## Conclusions

1. Analysis of findings showed that the leading volleyball players of the World League most frequently applied jump tennis serve, the most difficult one in terms of performance technique and rhythm (62.3 % of all the registered serves). Jump serve was exceptionally frequently executed from the right court, diagonally. The examined players, regardless of the type of the serve, usually pointed the ball into central zones of the opponent's court.

2. The observed right-handedness of majority of volleyball players was probably the reason why they performed jump tennis serve mostly from the right of service court. Characteristically for the serve without ball rotation was its most frequent execution in a straight line into the right and left defence court of the opponent. „Shortcut” behind the net appeared mainly after the serve from the middle and the right side of service court. It was the rarest serve (merely 12.5 % of all considered serves).

3. Findings indicated diversity of the considered serves in terms of their effectiveness. The least effective was „shortcut” behind the net. Most stable in terms of effectiveness was the serve without ball rotation (unsuccessful serves accounted for only 6.4 %). The greatest effect, as well as error risk, had the jump tennis serve.

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# Effects of recreational volleyball on health markers in middle-aged men

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## **ABSTRACT**

**PURPOSE:** Recreational volleyball is a popular alternative to the classical continuous exercise mode among all age groups. The aim of this paper was to determine the effects of recreational volleyball on health markers in untrained healthy individuals. **METHODS:** Twenty-four participants (age  $33.5 \pm 6.3$  years) were randomized in a recreational volleyball group (RV = 12) and control group (CG = 12). RV performed recreational volleyball training twice a week (six-a-side volleyball match) on indoor field, 60 min per session over 8 weeks. **RESULTS:** No significant interaction (time vs. group) was observed for the majority of variables analysed ( $p \geq 0.05$ ), although significant main effects of time were evident regarding resting HR ( $F = 5.48, p = 0.027$ ), and systolic BP ( $F = 52.9, p = 0.04$ ). No effect of time and group was shown on  $VO_{2max}$  ( $P > 0.05$ ). However, there was an interaction effect ( $P < 0.05$ ), with the recreational volleyball group improving performance by 4.3 % between the pre- and post-tests, while a 3.2 % decrease was observed in the control group. **CONCLUSION:** Recreational volleyball can be an effective training modality to stimulate some health benefits. However, two recreational volleyball sessions per week were not beneficial in improving cardiovascular fitness in healthy middle-aged men.

**Key words:** volleyball, recreational, impact, adults.

## **Introduction**

The benefits of regular physical activity in adults are wide-ranging. As stated earlier (Haskell et al, 2007), regular physical activity can reduce risk of cardiovascular disease, hypertension, type 2 diabetes mellitus, osteoporosis, obesity, anxiety, and depression. ACSM suggests that 150 min a week of moderate physical activity can have substantial health benefits for healthy adults (Garber et al., 2011). Moreover, a group of researchers stated that 15 min a day or 90 min a week of moderate-intensity exercise might be of benefit, even for individuals at risk of cardiovascular disease (Wen et al., 2011). However, numerous barriers exist that prevent the adults to fulfil this physical activity recommendations (Wen et al., 2011). Nevertheless, one of the most important properties in life for middle-aged adults is staying physically and mentally fit (Moschny, Platen, Klaaßen-Mielke, Trampisch, & Hinrichs, 2011). Volleyball represents one of the most popular sports in the world. Moreover, volleyball has beneficial health effects (Gouttebauge, Zwerver, & Verhagen, 2017). The physical effort involved in volleyball was first characterized as a mixed effort without a clear identification of the most important energy pathways (Smith, Roberts, & Watson, 1992). However, now we know that it is an intermittent sport that requires players to compete in frequent short bouts of high-intensity exercise, followed by periods of low-intensity activity (Gabbett, Georgieff, Anderson, & Cotton, 2006). Therefore, it could be logically assumed

that playing volleyball can develop speed, muscular power and the ability to perform these repeated maximal efforts with limited recovery in adult healthy participants (Sheppard, Gabbett, & Reeberg Stanganelli, 2009). However, only limited data exist concerning the benefits of recreational volleyball in adult population. One recent study showed evidence that the volleyball course can improve the health-related fitness variables of the students (Hamdan & Hashem, 2018). Additionally, Stojanović, Nikolić, & Milenkoski (2006) found significant increase in maximal anaerobic ability and relative and absolute maximal oxygen uptake in students which trained recreational volleyball. We know that recreational football is an effective physical activity with many cardiovascular benefits (Krustrup & Bangsbo, 2015). Moreover, it was stated that recreational football lowers blood pressure, as well as heart rate at rest, fat percentage, and increases lean body mass as well as maximal aerobic power (VO<sub>2</sub>max) (Milanović et al. 2015; Oja et al. 2015). However, research regarding the benefits of recreational volleyball in middle-aged adults are insufficient. Moreover, according to author's knowledge, there are no research concerning the effects of recreational volleyball on physical fitness in middle aged participants. Therefore, the aim of this study was to determine the effects of recreational volleyball on health markers in middle-aged healthy people. It was hypothesized that 8 weeks of recreational volleyball will give meaningful positive changes on health markers in healthy individuals.

## Methods

### Subjects

Twenty-four healthy untrained men aged 22–53 years took part in the study. The participants did not take medication and had not been involved in any type of organized physical training for at least 2 years. The study was approved by the ethical committee at the faculty of sport and physical education, University of Novi Sad. The subjects were matched and randomly assigned to a volleyball recreational group (RV; n = 13; age: 34.7±6.34 years; Height:183.10±5.59 cm), or a control group performing no physical training (CG; n = 12; age: 32.9±8.72 years; Height:186.60±6.74 cm). One subject dropped out due to injury during volleyball training (ankle sprain). For the participants who completed the study no group differences were present in preintervention values for age, body mass, fat percentage or VO<sub>2</sub>max. The participants in RV carried out a 12 weeks volleyball training programme, whereas the participants in CG continued their daily life activities during the period.

### Procedures

Subjects were familiarised to all test procedures. Resting heart rate and blood pressure were determined from 8 to 10 a.m. under standardised conditions after an overnight fast. Blood pressure was measured at least six times by an automatic upper arm blood pressure monitor (HEM-709; OMRON, Illinois, US), and an average value was calculated. Body height and body weight were measured according to the instructions of the International Biological Program–IBP. 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= weight (kg) ÷ height<sup>2</sup> (m<sup>2</sup>). 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. Internal and external cross-validation of the prediction formulas showed that they gave valid estimates of body fat in males and females at all ages (Deurenberg et al., 1991).

The 20 m shuttle run test (SRT) was conducted as described by Leger, Mercier, Gadoury, & Lambert, (1988). The subjects ran back and forth between 2 lines 20 m apart, while running speed was dictated by CD audio bleeps. Initial speed was 8.5 km/h and increased by 0.5 km/h at every new level (every minute). As most of the subjects had no earlier experience with running the 20 m SRT, the test was thoroughly explained and demonstrated. In addition, experienced coach always ran the first 2 levels together with the subjects to

ensure that initial pace was set correctly. The test ended when the subject was unable to reach the line on 3 consecutive occasions. Heart rate was monitored in all subjects during the test (S 610; Polar Electro OY, Kempele, Finland).

#### Training intervention

Indoor training was performed two times per week for 12 weeks. Each training session lasted 60 minutes. The volleyball sessions consisted of ordinary six-a-side matches on a volleyball court pitch. Each training session was initiated by a 5 min low-intensity warm-up period.

#### Statistical analysis

Descriptive data were calculated for all variables. Group differences at baseline were evaluated using independent sample t-tests. Shapiro-Wilk tests assessed the normality of distributions. A two-way repeated measure ANOVA (2 × 2) was used to test for interactions and main effects for time (initial vs. final) and group (training vs. control) on the dependent physical fitness variables. Statistical analyses were conducted in SPSS (SPSS, Version 18.0, Chicago; IL, U.S.A.). Statistical significance was established a priori at  $p < 0.05$ .

## Results

	RV		CG	
	pre	post	Pre	post
Body mass	97.30±11.50	95.40±10.70	91.10±13.23	92.15±13.43
BMI	29.01±3.08	28.15±3.12	27.16±3.42	27.45±3.51
Body fat %	26.59±4.53	25.63±4.26	23.76±4.31	24.05±4.67
Resting HR	71.14±6.23	66.20±5.34*	72.24±4.65	71.34±4.47
Systolic BP	132.9±6.2	128.3±5.5*	132.3±6.6	131.7±5.8
Diastolic BP	83.8±5.4	81.6±5.2	82.4±6.3	83.1±5.7
VO 2max	39.5±5.4	41.2±4.8	40.2±6.2	38.9±5.8

All data are presented in mean ± SDs. \*  $P < 0.05$  significantly different from pre. BMI: body mass index; VO2max; maximal aerobic power; SBP: systolic blood pressure; DBP: diastolic blood pressure;

Table 1. Summary of physiological and anthropometrical data before and after 8 weeks of recreational volleyball (RV,  $n = 12$  and CG,  $n = 12$ ).

No significant interaction (time vs. group) was observed for the majority of variables analysed ( $p \geq 0.05$ ), although significant main effects in time (Table 1) were evident regarding resting HR ( $F = 5.48$ ,  $p = 0.027$ ), and systolic BP ( $F = 52.9$ ,  $p = 0.04$ ). No effect of time and group was shown on VO2max ( $P > 0.05$ ). However, there was an interaction effect ( $P < 0.05$ ), with the recreational volleyball group improving performance by 4.3 % between pre- and post-tests, while a 3.2 % decrease was observed in the control group.

## Discussion

To our knowledge, this is the first study examining the effect of an 2-hour recreational volleyball sessions per week on health markers in middle-aged men. As hypothesized, we found that 8 weeks of recreational volleyball decreased some risk factors, specifically decreased resting HR and systolic BP. However, there were no significant changes in

cardiovascular fitness and body composition (Table 1). In order to find greater improvements, it may be necessary to include more intensive recreational activities with more than two training sessions per week. Moreover, exercise without dietary intervention has a small capacity to reduce weight and fat percentage, (Beato, Giuseppe Coratella, Federico Schena & Franco M. Impellizzeri (2017). Systolic BP decreased after the training period which confirms the positive effects of RV can have on blood pressure. Regarding the recreational activities, Krstrup et al. (2013) stated that football can be used as a nonpharmacological treatment of hypertension in middle-aged men. This study reported an improvement of 4 mmHg in systolic BP. Krstrup et al. (2013) reported an improvement of 13 mmHg in systolic BP, which is somewhat higher than our findings. Nevertheless, the improvements found in our study are comparable to the 3mmHg reported in normotensive male population after 12 weeks of endurance training (Fagard 2001). As a study limitation may be the lack of nutritional and physical activity control in both RV and CG. Participants were asked to continue their usual diet and to avoid any other physical activity programs. This might have affected the training effect on some health markers.

## Conclusion

Recreational volleyball can be an effective training modality to stimulate some health benefits. However, it was not beneficial in improving cardiovascular fitness in healthy middle-aged men. Nevertheless, this study shows that two recreational volleyball sessions per week can give meaningful benefits compared to ACSM recommendations. Accordingly, people with limited leisure time can practice recreational volleyball 2 h per week and still have some health benefits. However, the observed changes are less pronounced than those in previous studies that included a higher training intensity and volume.

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# The kinesthetically creative behaviour: exploring the domain-specificity of creativity in the medium of movement

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## **ABSTRACT**

PURPOSE of this study was to explore the construct space and the psychometric properties of a new scale measuring creativity in movement. The study aims to add to the currently lacking knowledge on the operationalization and measurement of the kinesthetic behavioural manifestations of creativity in future educators, and its theoretical and practical implications. METHODS: The participants (N = 127) were students of university teacher studies, women aged 22 to 33 years. They completed a questionnaire in which they rated their own general creativity, as well as creativity across 17 activities. The originally developed instrument used in this study included a questionnaire containing in the previous author's studies collected behaviourally operationalized kinesthetically creative behaviour items focusing on the productivity in the medium of movement. The participants also rated their general intelligence and their psychomotor, spatial, auditory, verbal, and quantitative-numeric abilities. RESULTS: The newly constructed Creativity in Movement Scale (CIMS-14), had the mean of inter-item correlations of .47, and high internal consistency ( $\alpha = .92$ ). As a linear item combination, displaying a moderate positive skew, the scale measured the overall kinesthetic creative productivity in the body movement, as it is evident in the convenience sample of young women studying to become teachers (i.e., predominantly dance). In support of both convergent and discriminant scale validity, the CIMS-14 scale correlated with the self-concept constructs as follows: the self-assessed psychomotor abilities,  $r_s(127) = .42, p < .001$ , auditory abilities,  $r_s(127) = .31, p < .001$ , and spatial abilities,  $r_s(127) = .23, p = .01$ . Factor and regression analyses pointed further to the domain-specific nature of creativity in movement and its embeddedness in the general self-concept structure. In CONCLUSION, this study adds to the currently lacking knowledge about how the behaviourally operationalized creativity in movement relates to other domain-specific creativity and ability constructs within the self-concept structure. It calls for further studies in kinesiology, the psychology of creativity, as well as studies on the implicit theories of teachers on creativity and their practices in teaching (for) creativity in physical education.

**Key words:** physical education, teacher's self-concept, creative-productive giftedness, art-bias

## **Introduction**

Creativity is a complex, multidimensional psychological construct. It requires both originality and effectiveness (Runco & Jaeger, 2012). Based on the self-report data, creativity displays hierarchical structure with an over-arching general factor and more

specific thematic areas of creative performance (e.g., Hong & Milgram, 2010; Kaufman, Cole, & Baer, 2009). Creativity, to most people, suggests the arts and the sciences, but it actually occurs in many other fields as well, such as sports (Abra & Abra, 1999, p. 577), and dance (Alter, 1999). Embedded within the structure of general self-concept (e.g., Byrne & Shavelson, 1996; Vispoel, 1995) is the artistic self-concept. It includes dramatic art, visual art, music skills, and dance (e.g., Van Rossum, 2001). The construct studied here and termed—creativity in the medium of movement—dance and sports included, may also be educational in nature and partially domain-specific for it follows the psychology of creativity research findings, the developmental, and the educational approach to the human movement science (e.g., Starosta, 2015). In order to lessen the terminological inconsistencies in the description of motor activity (e.g., Starosta & Petryński, 2007), this study, therefore, asks two questions: 1) how to operationalize the construct of general creativity in movement in the behavioural terms, and 2) what are the relationships of such creativity construct with the self-concept in the future physical education teachers in the primary schools.

## Method

### Participants

Students of university teacher studies (N = 127) volunteered to participate in the study anonymously. These middle-class, educated Caucasian women, aged 22 to 33 ( $M = 22.09$ ;  $SD = 1.74$ ), represented education generalists—future class teachers who will teach all school subjects, including physical education (PE) in grades 1–4.

### Materials and procedures

The participants gave their written consent and participated in the study for one hour. They were debriefed immediately following the study, in line with the research ethics.

The participants completed a questionnaire in which they assessed their own general and specific intelligence, and general and specific creativities, as listed in Table 1, on a 1–5 scale (*low to high*). The 14 kinesthetically creative behaviours described here are a part of the author's ongoing study on creativity manifestations. These behaviours were collected and defined within the author's previous research in view of the act-frequency approach to measuring creativity as a trait (i.e., the act frequency approach to personality measurement by Buss & Craik, 1983). The participants assessed how much each item correctly described them now or in the past six months, on a 0, 1, and 2 scale (*meaning completely incorrect, sometimes or partially correct, and often or completely correct*). These items are listed according to the sample item mean size and presented here in English, and in the Croatian language: 1) *I dance in an expressive way and in my own manner (e.g., I have my own way of dancing/dance style)/ Izražajno i na svoj način plešem (npr. imam svoj način, stil plesanja)* ( $M = 0.92$ ); 2) *I adjust the way I dance to given circumstances (e.g., space and occasion)/ Prilagođavam način kako plešem prostoru i prigodi* (0.79); 3) *I invent new body movements and positions / Izmišljam nove položaje i pokrete svoga tijela* (0.62); 4) *I invent new physical exercises/ Smišljam nove tjelesne vježbe* (0.57); 5) *I show/teach new dance moves/steps to others/ Drugima pokazujem nove plesne korake* (0.57); 6) *I learn new dances (e.g., via Internet, DVDs, etc.)/ Samostalno učim nove plesove (npr. putem interneta, dvd-a i slično)* (0.56); 7) *I invent new dance moves/steps/ Smišljam nove plesne korake* (0.38); 8) *I combine dance and physical exercise in new ways /Spajam ples i vježbanje na novi način* (0.34); 9) *When I dance I imitate the movement of waves, wind, sound or animals/ Kad plešem oponašam kretanje valova, vjetra, zvuka, životinja* (0.34); 10) *I dance with a dance troupe/group/ Plešem u plesnoj skupini* (0.27); 11) *I invent dance routines/ Smišljam plesne točke* (0.24); 12) *I invent complete new dances – choreographies/ Smišljam cijele nove plesove – koreografije* (0.23); 13) *I invent dance acrobatics (i.e., acro)/ Smišljam plesne akrobacije* (0.18); and 14) *I invent steps, body movements, and their sequence for the rhythmic gymnastics/ Smišljam korake, pokrete i njihov redoslijed za ritmičku gimnastiku* (0.12).

## Results

The results include the sections on the participants' structure of creativity and ability self-assessments, the behavioral operationalization of creativity in movement in line with the partial domain specificity of creativity, and the prediction of creativity in movement from the self-concept structures evident in the self-assessment factor scores. The statistics used in these sections include descriptives for scale properties, confirmatory factor analysis for testing the hypothesis of scale unidimensionality, factor analysis of self-concept structure, and the multiple regression analysis for exploring the domain-specificity of CIMS-14 by testing for differences in the predictive importance of extracted self-concept structures. The results are presented in Figure 1, Table 1, and Table 2.

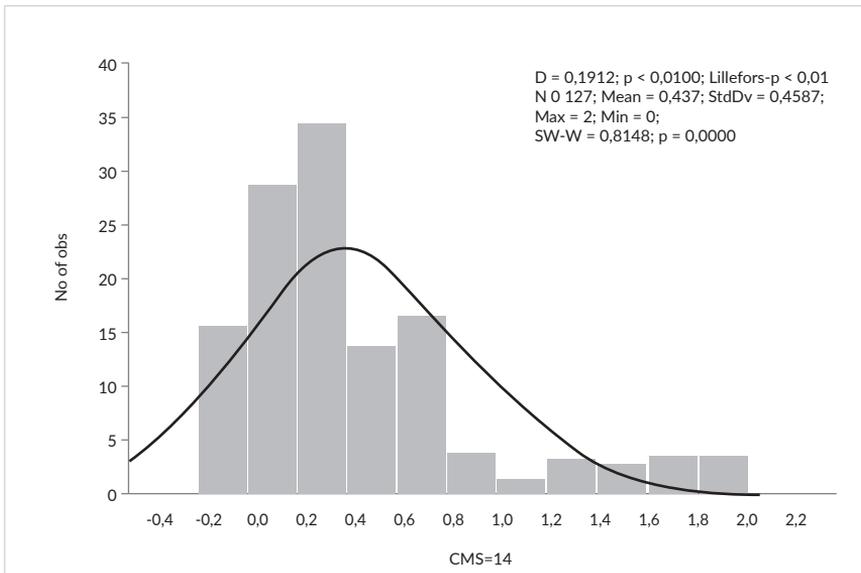


Figure 1. Distribution of the results on the CIMS-14 scale in the study sample.

### The behavioral operationalization of the Creativity in Movement Scale (CIMS-14)

With the Kaiser-Meyer-Olkin Measure of Sampling Adequacy at .91, and the Bartlett's Test of Sphericity at  $\chi^2(91) = 1157.80$ ,  $p < .001$ , the principal component analysis (PCA) was performed. Based on the scree plot and interpretability, the one-component solution for the scale results was retained. It accounted for 51.94% of the common variance, with item saturations in the range of .50-.90. The scale had high internal consistency (Cronbach  $\alpha = .92$ ), and the mean of inter-item correlations at 0.47 (0.18-0.86). The CFA conducted in LISREL 9.30, however, did not support the hypothesis of scale unidimensionality,  $\chi^2(77) = 447.82$ ,  $p < .001$ , RMSEA = .195 [CI 90% 0.177-0.212], SRMR = 0.055, GFI = .78.

Participants' self-assessed creativity and intelligence in:	Components				
	I	II	III	IV	<i>h</i>
1. Drawing/Painting	<b>.81</b>	.17	.09	-.18	.67
2. Modeling/Sculpting	<b>.78</b>	.03	.24	-.06	.73
3. Design/Fashion	<b>.71</b>	.14	.16	.13	.56
4. Photography	<b>.61</b>	.21	.02	.18	.45
5. Drama/Acting/Puppetry	<b>.51</b>	.26	-.03	<b>.49</b>	.58
<b>6. General creativity</b>	<b>.51</b>	.32	.17	<b>.46</b>	.60
7. Cooking/Culinary Arts	<b>.49</b>	.18	.17	.13	.32
8. Psychomotor intelligence	.03	<b>.84</b>	.16	.06	.73
9. Auditory intelligence	.22	<b>.70</b>	-.00	-.05	.54
10. Dance	.19	<b>.61</b>	-.02	.29	.49
11. Physical Education (PE)/Sports	.05	<b>.60</b>	.10	.28	.45
12. Spatial intelligence	.27	<b>.54</b>	.32	-.16	.50
13. Music	.20	<b>.50</b>	.01	.16	.31
<b>14. General intelligence</b>	.09	<b>.46</b>	.28	.20	.34
15. Mathematics	.08	.20	<b>.78</b>	-.15	.67
16. Quantitative/Numeric intelligence	-.00	.28	<b>.77</b>	-.22	.72
17. Inventions/Technical modeling	.33	-.07	<b>.66</b>	.36	.67
18. Computer Science	.08	.16	<b>.62</b>	.14	.43
19. Research	.34	-.00	<b>.57</b>	.34	.55
20. Robotics	.26	-.10	<b>.49</b>	.28	.39
21. Creative Writing	.27	.00	-.01	<b>.76</b>	.64
22. Verbal intelligence	-.13	.16	.03	<b>.74</b>	.60
23. Humor	-.09	.31	.15	<b>.58</b>	.47
24. Play/Play-like activities/Games	.34	.19	.33	<b>.52</b>	.53

Table 1. Patterns of creativity and intelligence self-assessments in exploratory factor analysis with the orthogonal rotation of four-factor solution.

Note. Factor loadings  $\geq .40$  are in boldface. Intelligence self-assessments are in boxes. General creativity loaded more strongly on visual and linguistic modality (i.e., the Art bias in creativity implicit theories).

### The structure of creativity and intelligence self-assessments

The PCA with orthogonal rotation on 24 creativity and intelligence self-assessments in Table 1 resulted in an interpretable four-factor solution explaining 53.91% of the common variance. The four components, in the same order, describe how creativity and intelligence self-assessments load on the latent structure of the visual, kinesthetic, numeric, and linguistic modality of the self-concept, therefore delineating different media of creative productivity and ability structures.

### Predicting creativity in movement with the self-concept structures

A moderate positive skew of creative behaviour measured with the CIMS-14 scale, as seen in Figure 1, was expected due to creativity inherently representing statistically infrequent behaviour ( $M = 0.44$ ,  $SD = 0.46$ ). With the diagnostics pointing to no collinearity issues and standardized residuals within the expected limits, the multiple regression model presented in Table 2 proved robust,  $F(4, 122) = 10.16$ ,  $p < .001$ , with  $R^2$  at .25 and 95% confidence limits from .11 to .37.

Creativity in Movement Scale (CIMS-14)	B	SE B	$\beta$	95% CI of B
Constant	0.56	0.03		[0.51, 0.62]
Component I	0.04	0.03	.11	[-0.02, 0.09]
Component II	0.15	0.03	.43**	[0.10, 0.21]
Component III	0.05	0.03	.16*	[0.00, 0.11]
Component IV	0.06	0.03	.16*	[0.00, 0.11]

$R = .50$ ;  $R^2 = .25$ ;  $AdjR^2 = .22$ ; [95% CI .11-.37]

Table 2. Results of the multiple regression analysis with the self-assessments of creativity and intelligence as predictors of the self-assessed kinesthetic creative productivity on the CIMS-14 scale

Note.  $N = 127$ . The 95% CI for  $R^2$  was calculated in Steiger & Fouladi's  $R^2$ .  
\* $p < .05$ . \*\* $p < .001$ .

### Discussion

With the multiple regression analysis used in Statistica 13.1, the highest percentage of the explained variance (25%) of the square-root transformed, and therefore normalized CIMS-14, a scale of high reliability ( $\alpha = .92$ ) and face validity, resulted from the combined use of three predictors: the components II, III, and IV of the self-concept structure, in that order. Given a value of  $R^2$  at .25, the effect size for this multiple regression model (i.e., Cohen's  $f^2$ ) is .33, indicative of a large effect size. Although CIMS-14 had high internal consistency, the poor fit indices imply more research is required in order to fully map and delineate the contents of the kinesthetic creativity micro-domain. There are limitations inherent in this study that caution to over-generalize the results: a relatively small sample of women, and the reliance on self-assessments in the measurement of kinesthetically creative behavior.

### Conclusion

In conclusion, the behaviourally operationalized construct of general creativity in movement (CIMS-14) had high internal consistency and face validity. In line with the

componential models of creativity, one-fourth of the variance of the participants' results on this scale was predicted by the theoretically related similar domain-specific intelligences (i.e., psychomotor, auditory, and spatial) and similar domain-specific creativity self-assessments (i.e., dance, PE/sports, and music), supportive of the partially differentiated self-concept in the future primary school teachers—and physical education (PE) teachers in grades one through four—presenting informative bases for further studies on creativity in the medium of movement.

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# Motivation and psychological states in elite wrestlers

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## **ABSTRACT**

**PURPOSE:** The study of motivation and psychological states in elite wrestlers. **METHODS:** Twenty-six athletes, members of the national team of Ukraine of Greco-Roman wrestling were studied. For the study of motivation, the questionnaire (by Mehrabian A.) was used. The athletes were divided into three groups by the level of corresponding motivation. The psychological states were studied using several methods: sensory-movement reaction, color test of Lusher and stress-test (stress resistance). **RESULTS:** The results show a significant decrease in the latent time of sensory-movement reaction and stability in wrestlers with average level of achievement motivation. In wrestlers with a high level of achievement motivation a significant increase in stability of sensory-movement reaction was observed. This fact indicates absence of rigid organization of the nervous system in athletes with a high level of achievement motivation. The psychological states of athletes with achievement motivation were linked with a high level of capability, eccentricity and heteronomy. The increased levels of eccentricity and heteronomy reflects on the activity and search for ways to compensate for the problem with the ability to compromise in the wrestlers with a high level of achievement motivation. Lower values of stress resistance and throughput of visual analyzer were found in the wrestlers with avoidance motivation. Higher values of throughput of visual analyzer were found in the athletes with an average level of achievement motivation. **CONCLUSION:** The states of relative comfort, desire to act, advance and find support were found in wrestlers with a high level of achievement motivation. A low level of achievement motivation was found to relate with decline in capability and occurrence of discomfort.

**Key words:** athletes, sensory-movement reaction, capability, psychological comfort

## Introduction

Among different factors which influence effectiveness of sports activities, the most characteristic are neurodynamics and psychological functioning of athletes. These functions may be used in selection and orientation in sport activity (Lopatenko, et al., 2015; Iermakov, et al., 2016).

In addition, among these characteristics are properties of higher neural activity: strength, mobility and balance of neural processes. The combination of different abilities characterizes higher neural activity and differentially determines types of persons in different activity (Makarenko, et al., 2001; Allen, et al., 2011).

The properties of the nervous system are manifested not so much in productive as in the neurodynamic and cognitive characteristics of activity. These characteristics of the activity are largely determined by the individual and typological properties of the individual (Korobeynikov, et al., 2013).

In sport activity the individual style of activity performance is formed depending on various factors: the ratio of basic and specific abilities; typological properties; anthropometric data; morphological features. But, the formation of individual strategies of sport activity performance corresponds to motivational process (Duda, 2005; Podrigalo, et al., 2013).

According to the theory of motivation there are two types of motivation: achievement motivation and avoidance motivation. Both types of motivation are related to personal-typological characteristics of the nervous system (Salamone, 2010; Korobeynikov, et al., 2011).

Achievement motivation, oriented to success, is one of the most important factors of sport activity and relates with athletes' capabilities to adapt to environmental condition and internal psychological states (Kerr, 2013; Domuschieva-Rogleva, 2015).

In modern wrestling, achievement motivation is crucial for psychological and tactical preparation during training process. But under the stressful psycho-emotional conditions of competition, efficacy of technical, tactical and psychological components of sport activity links with the capability to perceive and process external information (Korobeynikov, et al., 2017).

Purpose of the paper is to study motivation and psychological states in elite wrestlers.

## Methods

Twenty-six athletes, members of the national Greco-Roman wrestling team of Ukraine were studied. The study complied with Ethical Principles for Medical Research according to the Declaration of Helsinki. All athletes agreed to participate in the study by signing consent form upon detailed information about the study has been delivered and its scientific purpose has been explained.

To study achievement motivation, a questionnaire (Mehrabian, 1968) was used. The aim of the test was diagnostics of both personality motives: motivation to achieve success and motivation to avoid failures. The structure of test is based on the J. Atkinson's theory. The participants were divided into three groups according level of corresponding motivation: first group – wrestlers with a high level of achievement motivation (9 athletes), second group – wrestlers with an average level of achievement motivation (10 athletes), and third group – wrestlers with a low level of achievement motivation and a high level of avoidance (7 athletes).

The psychological states of wrestlers were studied using several methods: sensory-movement reaction, color test of Luscher (1990) and stress test (stress resistance). All the methods are included in the psychological study software package "Multypsychometer-05".

The statistical analysis was executed using program "Statistica 6.0". Non-parametric statistics was used by Wilcoxon criterion to process medians and low (25%) and upper (75%) quartiles.

## Results

In Fig.1 average sensory-movement reactions of wrestlers with different types of motivation are presented.

The results show a decreased average latent time of sensory-movement reaction and stability in wrestlers with an average level of achievement motivation in comparison to other wrestlers. The finding indicates a high speed of information processing and stability of reaction in this group of athletes. Increased stability of sensory-movement reaction in wrestlers with a high level of achievement motivation testifies about the absence of rigid organization of the nervous system.

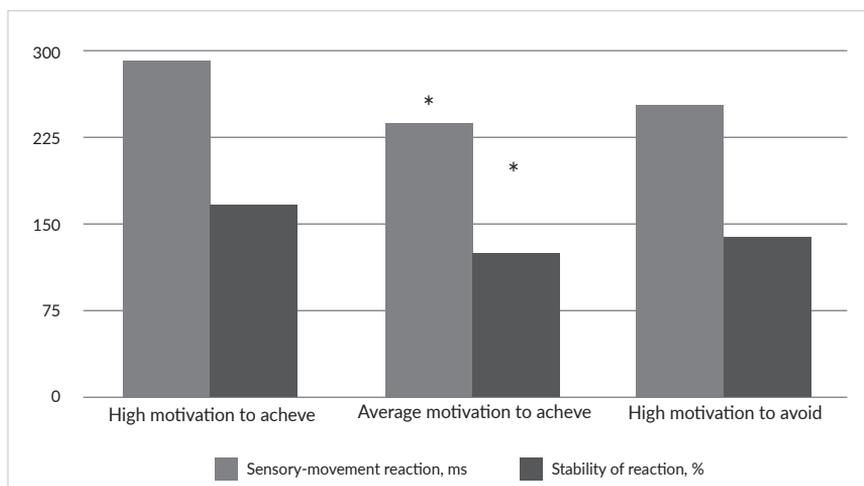


Figure 1. Group average values of sensory-movement reactions of wrestlers with different types of motivation, \* $p < 0.05$ .

This creates favourable conditions for a more flexible and variable organization of neural activity and points to many possibilities of the mechanisms for compensating the nervous system.

In Tab. 1 the medians of group average values are presented of psychological states assessed by Color Test of Lusher in wrestlers with different types of motivation.

Values	High motivation to achieve success (Median, Lower Quarter, Upper Quarter)	Average motivation to achieve success (Median, Lower Quarter, Upper Quarter)	High motivation to avoid failures (Median, Lower Quarter, Upper Quarter)
Capability, secret unit	14,00; 12,00;14,00	10,00*; 9,00;11,00	9,00*; 9,00;10,00
Fatigue, secret unit	2,00; 1,00;3,00	2,00; 1,00;3,00	2,00; 2,00;3,00
Anxiety, secret unit	0,50; 0,00;1,50	1,00; 0,00;3,00	2,00; 1,00;3,00
Concentricity-Eccentricity, secret unit	11,00; 9,00;12,00	8,00*; 8,00;10,00	7,00*** 5,00; 10,00
Autonomy-Heteronomy, secret unit	9,00; 7,00;10,00	6,00; 6,00;7,00	6,00***; 5,00;7,00

Table 1. Results of Color Test of Lusher in wrestlers with different types of motivation

Notes: \* $p < 0.05$  significantly different from the high-level motivation group; \*\* $p < 0.05$  significantly different from the average-level motivation group.

The results show that the wrestlers with a high level of achievement motivation have increased average values of capability, eccentricity and heteronomy.

A low level of these parameters has been revealed in the wrestlers with a high level of avoidance motivation. The obtained results indicate better psychological states of the wrestlers with a high level of achievement motivation in comparison with other athletes with different types of motivation. The increased level of eccentricity and heteronomy reflects on the activity and search for ways to compensate for the problem with the ability to compromise in the wrestlers with a high level of achievement motivation.

Values	High motivation to achieve success (Median, Lower Quarter, Upper Quarter)	Average motivation to achieve success (Median, Lower Quarter, Upper Quarter)	High motivation to avoid failures (Median, Lower Quarter, Upper Quarter)
Stress resistance, secret unit	101,18; 87,84;114,90	93,09; 65,29;103,50	88,79*; 88,11;128,20
Throughput of visual analyzer, secret unit	1,10; 1,00;1,14	1,47*; 1,00;1,55	0,92***; 0,86;1,13
Impulsiveness, secret unit	(-0,01); (-0,04);0,02	(-0,06); (-0,24);(-0,01)	(-0,03); (-0,06);0,02

Table 2. Results of Stress Test in wrestlers with different types of motivation

Notes: \*p<0.05 significantly different from the high-level motivation group; \*\*p<0.05 significantly different from the average-level motivation group.

The results of Stress Test in wrestlers with different types of motivation are presented in Tab. 2. The data in Table 2 indicate significant differences in stress resistance between the wrestlers with different levels of achievement motivation. Much lower values of stress resistance and throughput of visual analyzer in the wrestlers with avoidance motivation are results of the reduced stress tolerance. Much higher average values of throughput of visual analyzer were registered in the athletes with an average level of achievement motivation.

## Discussion

Our previous studies manifested that a high level of achievement motivation links with the activation of neurodynamic and cognitive functions in elite athletes (Korobeynikov, 2011; 2013). The data obtained here indicated the decreased time of sensory-movement reaction and increased reaction stability in the wrestlers with achievement motivation, probably due to the optimal organizing strategy of information processing in this group of wrestlers.

The psychological states of wrestlers of different types of motivation demonstrated peculiarities in relation with Greco-Roman wrestling. The parameter of capability is significantly higher in the wrestlers with a high level of achievement motivation than in the wrestlers with other types of motivation. Also, the condition of relative comfort, desire to act, advance and seek support was also observed in the wrestlers with a high level of achievement motivation, which is in line with the findings of some previous studies that found relations between psychological comfort and achievement motivation being favourable to the efficacy of sport activity performance (Filaire, 2001; Dalwinder & Saini, 2013). A low level of achievement motivation provokes a decline in capability and occurrence of discomfort like demonstrated by the reduced averages capability and increased averages of discomfort condition in the athletes with avoidance motivation.

Stress resistance is higher in the wrestlers with a high level of achievement motivation. This corresponds to a higher throughput of visual analyzer found in the athletes with an average

level of achievement motivation. The findings link with our previous study where the obtained level of stress resistance in achievement motivated elite athletes related with tension of the regulatory systems (Korobeynikov et al., 2016). However, in the wrestlers with avoidance motivation a low level of stress resistance was observed.

### Conclusion

1. Decreased averages of latent time of sensory-movement reactions and stability in the wrestlers with an average level of achievement motivation were observed. In athletes with other types of motivation the time of sensory-movement reaction and stability of reaction were increased.
2. Increased averages of capability, eccentricity and heteronomy (by Test Lusher) were observed in the athletes with a high level of achievement motivation.
3. A high level of stress resistance in the athletes with achievement motivation was observed. Reduced stress tolerance was observed in the athletes with avoidance motivation.

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# Construction and validation of measurement instruments for balance evaluation in judo

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## **ABSTRACT**

**PURPOSE:** The research's main goal is to construct new measure instruments (tests) for balance assessing. **METHODS:** Twenty-three judokas were tested with three balance tests (one standard and two new tests). According to the results of subjects in these tests, sensitivity, reliability and validity of new tests were determined. **RESULTS:** The both new tests have high values of all important kinesiometric values. **CONCLUSIONS:** The both new tests could be useful tools for balance assessing in judo, especially, in younger judokas.

**Key words:** judo, dynamic balance, motor abilities, performance evaluation

## **Introduction**

Balance is a motor ability responsible for equilibrium maintaining when stationary or moving, through the co-ordinated actions of our sensory functions (vision, hearing and proprioception) (Mackenzie, 2005). Two types of balance can be recognised: static and dynamic. A recent research study (Maslinski, Witkowski, Cieslinski & Sliz, 2016) showed that, when comparing the lower junior category with the senior category, the statistically significant difference was established in dynamic balance, but no such difference was observed in static balance. Dynamic balance is one of the most important abilities of judokas; athlete's body is always under influence of forces of different directions and should always adapt to the changing conditions of body movement. The research of Hrysomallis (2011) has shown that dynamic balance does not differ among judokas of different quality level. That could be a proof that this ability is the key for all other motor manifestations in judo.

There is not enough measuring instruments (tests) that assess balance, and especially tests that are sensitive enough for younger population. Construction and validation of new balance tests for younger population is the main goal of this research.

## **Methods**

Sample of subjects consisted of 23 young judokas, aged 11-13 years. All of them have been involved in judo training for at least two years and trained three times a week.

Sample of variables consisted of one standard balance test (Mackenzie, 2005) and two new balance tests, both being the modification of the mentioned standard test:

1. Standard balance test: Standing Stork Test (SST) was done on both the right (SST (D)) and left leg (SST (L)).
2. New balance tests:
  - a) Modified Standing Stork Test (MSST) is performed same as the SST test, with

the difference of supporting area. In the MSST test, the subject is trying to keep balance while standing on flat foot without raising the heel and standing on the toes, as in SST test. The MSST test was also performed on both the right (MSST (D)) and left leg (MSST (L)).

b) Dynamic Standing Stork Test (DSST) is performed same as the MSST test with the addition of one step and jump into the final position. During the step and jump performance, the subject turns by 180° compared to the starting position. This step, jump and turn is very similar to the tsukuri phase of judo throwing techniques Uchi mata and harai goshi – phase of positioning all body parts into the throwing techniques. By adding the step, turn and jump into the final position of the test, one has brought the test performance closer to the-judo specific situations where dynamic balance is more important than static balance.



Statistical package STATISTICA/W 13.1 was used. Central parameters, dispersion parameters, and indicators of distorted parameters were analysed from descriptive statistics to establish tests' sensitivity. Normality of data distribution was tested by the Kolmogorov-Smirnov test; reliability was tested using the method of internal consistency – Cronbach's alpha, and validity by factor analysis.

## Results and discussion

VAR	N	Mean	Min	Max	Std.dev.	Skew	Kurt	K-s d
SST(D)	23	6,76623	1,47667	19,36333	5,10581	1,409405	1,35600	0,21176
SST(L)	23	6,51072	1,60333	15,17000	3,79721	0,784340	-0,1030	0,15142
MSST(D)	23	41,02522	15,52667	75,32000	19,41793	0,158144	-1,4889	0,18325
MSST(L)	23	45,47174	16,80667	84,03333	19,55703	0,099556	-1,1903	0,16688
DSST(D)	23	31,11188	1,26000	72,62333	23,58128	0,540493	-1,0094	0,14755
DSST(L)	23	28,42870	1,85333	72,42000	24,22041	0,600085	-1,0354	0,18284

Table 1. Descriptive statistics

Kolmogorov-Smirnov normality test (Table 1) indicated that the noticed divisions did not differ from the normal ones and that all measure instruments met standards of sensitivity. Values of skewness show that SST test was a bit too difficult for this sample of subjects and that the both new measuring instruments are somewhat easier and more appropriate for this population.

VARIABLES	Cronbach alpha	Standardized alpha	Average inter-item corr
MSST(D)	0,871428	0,872312	0,699140
MSST(L)	0,855880	0,859623	0,678112
DSST(D)	0,802835	0,813841	0,599091
DSST(L)	0,821184	0,821161	0,611160

Table 2. Coefficient of reliability

In the reliability analysis (Table 2.) of the new measuring instruments (tests), using the method of internal consistency (Cronbach's alpha), the coefficients of reliability pointed to a high reliability of the MSST and DSST tests.

Factor analysis of the tests SST, MSST and DSST, according to the G-K (Guttman Keiser extract criteria), produced one common factor with very high correlations of variables with the factor (Tables 3 and 4). Based on these results, it can be concluded that all measuring instruments (tests) measure the same dimension and that they are factually valid tests for balance evaluation.

VARIABLES	Factor1
SST(D)	-0,852925*
SST(L)	-0,826302*
MSST(D)	-0,892274*
MSST(L)	-0,894809*
DSST(D)	-0,756445*
DSST(L)	-0,892942*
Expl. Var.	4,376648
Prp.Totl	0,729441

Table 3. Factor loadings

Value	Eigenvalue	% Total variance	Cumulative Eigenvalue	Cumulative %
1	4,376648	72,94413	4,376648	72,94413

Table 4. Eigenvalues

## Conclusion

This study, along with metric characteristics, pointed that the new measuring instruments (tests) – MSST and DSST, can be used as good instruments for balance assessment. MSST test appears to be more suitable for the younger population of subjects, where the SST test was found to be less sensitive. Also, DSST test is a very good tool that can be applied to judo sport, where dynamic balance is one of the most important abilities. Authors believe that constant search for new, better and more suitable measuring instruments is one of the most important areas of research in sport.

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# Incidence of metabolic syndrome among former athletes

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## ABSTRACT

**PURPOSE:** The purpose of this review study was to determine incidence of metabolic syndrome (MS) among former athletes, non-athletes and physically active subjects in their later life. **METHODS:** The inclusion criteria were: former athletes had to have a minimum of 3 years competition experience in a given sport and had to be at least 34 years old or older. The criteria for the metabolic syndrome were based on the International Diabetes Federation (IDF) and National Cholesterol Education Program (NCEP). Participants who had three markers out of five impaired values, were considered as the ones with presence of MS. **RESULTS:** Batista and Soares (2013) have reported that former elite athletes were least presented in the subject pool with MS (13%), followed by the former non-elite athletes (37%) and non-athletes (55%). Kelly *et al.* (2014) reported that even half of the investigated former athletes (50%) appeared to have MS. Laine *et al.* (2016) investigation results showed that the prevalence of MS was lower among former athletes vs. the controls (51% vs 64.7%, respectively). Panayiotoglou *et al.* (2017) reported a slightly lower occurrence of MS (33.3%)

among former athletes compared to their controls (50%) according to their pilot study. Miller et al. (2008) investigated the prevalence of MS among retired NFL linemen compared to non-linemen; MS was present in 59.8% of retired linemen and in 30.1% of retired non-linemen. Owiredu *et al.* (2011) compared the presence of MS among active sportsmen/sportswomen and sedentary workers. The prevalence was generally higher among sedentary group (26.7%) as compared to the physically active population (3.9%). **CONCLUSION:** Former athletes represent a distinct group of individuals who have exercised for several years and regularly participated in competitions, which activities make them different from the general population during their lifetime. Some studies suggest that former athletes have lower prevalence of CVD (cardiovascular disease), hypertension and diabetes due to their sport careers, while the others claim that it is only a consequence of a later-life higher physical activity compared to non-athletes.

**Key words:** former athletes, physical activity, metabolic syndrome, central obesity

### **Introduction**

Physical activity is an important aspect of health behavior and lifestyle when considering the possibilities to prevent premature deaths and sustain functional capacity. Moderate leisure-time physical activity has been shown to have many health benefits compared to sedentary lifestyle. Moderate-intensity physical activity is generally defined as the activity completed at an intensity of 3.0-5.9 metabolic equivalents (METs), such as brisk walking, i.e., walking at 3.0 mph or 80.4 m/min or faster. According to the 2008 Physical Activity Guidelines for Americans, adults in the general population should accumulate at least 150 min of moderate-intensity physical activity per week to gain substantial health benefits.

Participation in sports offers potential benefits for individuals of all ages, such as combating obesity and enhancing cardiovascular fitness. However, the epidemiological studies on which these conclusions have been based have not been able to demonstrate conclusively whether extended periods of vigorous exercise increase these benefits. The limits of human performance are continually being pushed in keeping with the Olympic motto "stronger, higher, faster". World-best sport performances appear to plateau for only short periods of time before being taken to new levels. This has been achieved by several factors including more sophisticated coaching, the year-round training of high performance athletes in "amateur" sports, better equipment, incentives that motivate athletes to push the boundaries of intensity and volume of training, and an advanced knowledge of training methodology. Elite performances require around 10 years of practice to acquire the necessary skills and experience to perform at an international level. Long-term training spans a period between 10-15 years of an athlete's competitive life. Once an athlete has reached the fringe level of international performance, a further period of 6-8 years of competitive experience may be needed to achieve consistent world-class stature. Top class athletes and their coaches constantly protract both the volume and intensity of training to find an edge in competition (Smith, 2003). Thus, studies of the long-term effects on health of participating in competitive sports can elucidate the effects of long-lasting participation in vigorous sports on health (Sarna et al., 1997).

It is probable that physical activity in childhood and youth has a positive impact on participation at a later age. Physical exercise for the elderly seems to play a particularly important role, especially in the prevention of slowly progressing functional deficiencies. According to Backmand et al. (2006), increasing physical exercise is associated with improved physical daily ability. Engaging in a physically active lifestyle early in life, as exemplified by elite athletes, can also maintain psychological wellbeing later in life. Physical exercise influences not only physical fitness, but also psychological and social ability (Backmand et al., 2006).

According to the Compendium of Physical Activities (Ainsworth et al., 2011), based on the

intensity of exercise performed between each sport, with their respective metabolic equivalent (MET) intensity levels, athletes could be classified by the sports they had participated in. Sports are categorized (Pate et al., 1995) as light (<3.0 METs or <4 kcal/min; walking, golf, bowling), moderate (3–6 METs or 4–7 kcal/min; volleyball, gymnastics, archery, field athletic events – throwing and jumping), and vigorous (>6 METs or >7 kcal/min; judo, canoeing/rowing, sprinting, middle- and long-distance running, triathlon, decathlon, swimming, basketball, handball, and soccer).

According to the adult recommendations from the American College of Sports Medicine and the American Heart Association (Haskell et al., 2007), subjects are considered to have lower physical activity than recommended (Lower PAR) if after career termination they engage in less than 30 min/day on 5 days/week of moderate-intensity aerobic, or less than 20 min/day on 3 days a week of vigorous-intensity aerobic activity. If engagement is at least 30 min/d on 5 d/wk of moderate-intensity aerobic, or 20 min/d on 3 d/wk of vigorous-intensity aerobic activity, we consider subjects as meeting physical activity recommendations (Meet PAR).

The purpose of this mini review study was to determine the incidence of metabolic syndrome (MS) among former athletes, non-athletes and physically active subjects in their later life. Typically, individuals with the metabolic syndrome are overweight/obese, and have elevated plasma triglycerides, hypertension and elevated plasma glucose. Idea of this study was to provide more information by observing the results obtained in various studies. The study observes the results of multiple research regarding health state and presence of MS among retired athletes and general population.

## Methods

In the collected material, presence of MS among individuals is shown as percentages. The inclusion criteria were: participants former athletes had to have a minimum of 3 years competition experience in a given sport and had to be at least 34 years old or older. Metabolic syndrome was investigated in the following way: for the waist circumference (WC) measurements were carried out without clothes; that is, directly over the skin, halfway between the lowest rib and the top of the hipbone. Blood pressure (BP) was measured by the physicians. Blood samples were taken from the participants and used in a laboratory analysis to determine FG, TG and HDL levels (Fasting Glucose, Triglycerides and High-Density Lipoprotein, respectively). The criteria for the metabolic syndrome were based on the International Diabetes Federation (IDF) and/or National Cholesterol Education Program (NCEP). Values of WC ( $\geq 94$ cm;  $\geq 102$ cm(M);  $> 88$ cm(F)); FG ( $\geq 100$ mg/dL); TG ( $\geq 150$ mg/dL); BP ( $> 130/85$ mmHg) and HDL ( $< 40$ mg/dL) presented the cut-off values. Participants who had three out of five of these values impaired, were considered as ones with presence of MS.

## Results

The observed studies have reported generally similar results. Batista and Soares (2013) have reported that former elite athletes were the ones with fewer subjects within the syndrome (13%), followed by former non-elite athletes (37%) and non-athletes (55%). Kelly et al. (2014) reported that even half of the investigated former athletes (50%) appeared to have MS. Laine et al. (2016) investigation results showed that the prevalence of MS was lower among former athletes versus the controls (51% vs 64.7%, respectively). Panayiotoglou et al. (2017) reported a slightly lower occurrence of MS (33.3%) among former athletes compared to their controls (50%) according to their pilot study. Miller et al. (2008) investigated the prevalence of MS among retired NFL linemen compared to non-linemen, and MS was present in 59.8% of the retired linemen and in 30.1% of the retired non-linemen. Owiredu et al. (2011) compared the presence of MS among active sportpersons (F and M) and sedentary workers. The prevalence was generally higher among

sedentary group (26.7%) as compared to the physically active population (3.9%). Table 1. presents the incidence of metabolic syndrome among former athletes, physically active subjects and control groups.

Study	Participants		Age		Gender	Metabolic Syndrome (%)		
	Former athletes	Non-athletes				Former athletes	Non-athletes	
Batista and Soares (2013)	n=393	n=98	50.13 ±15.63		Men (n=267) Women (n=224)	Elite 13 <sup>a</sup>	Non-elite 37 <sup>a</sup>	55 <sup>a</sup>
Kelly <i>et al.</i> (2014)	n =68	NR	47.3 ±10.2		Men (n =68)	50 <sup>b</sup>		NR
Laine <i>et al.</i> (2016)	n=392	n=207	72.7 ± 6.1		Men (n=599)	51.0 <sup>b</sup>		64.7 <sup>b</sup>
Panayioutoglou <i>et al.</i> (2017)	n=12	n=12	47 ± 4.9		Men (n=24)	33.3 <sup>b</sup>		50.0 <sup>b</sup>
Miller <i>et al.</i> (2008)	Retired Lineman n = 164	Non lineman n = 346	53.75 ± 18.25		Men (n=510)	Retired lineman 59.8 <sup>b</sup>	Non lineman 30.1 <sup>b</sup>	NR
Owiredu <i>et al.</i> (2011)	Sportsmen sportswomen  n = 85	Sedentary workers  n =101	Sportsmen Sp. Women 42.51±0.90	Sedentary subjects 45.10±1.45	Men and women (n=186)	Sportsmen Sp.women 3.9 <sup>b</sup>	Sedentary workers 26.7 <sup>b</sup>	NR

Data are expressed as percentages (%); a=results based on National Cholesterol Education Program (NCEP); b=results based on International Diabetes Federation (IDF)

Table 1. Incidence of metabolic syndrome among former athletes. physically active subjects and control group

## Discussion and conclusion

Metabolic syndrome is defined by a constellation of interconnected physiological, biochemical, clinical, and metabolic factors that directly increases the risk of atherosclerotic cardiovascular disease, type 2 diabetes mellitus, and all cause mortality (Kaur, 2014). Although the primary cause is debatable, the root causes of the metabolic syndrome are overweight/obesity, physical inactivity, insulin resistance, and genetic factors. Former athletes represent a distinct group of individuals who have exercised for several years and regularly participated in competitions; this experience made them different from the general population during their lifetime. Some studies suggest that former athletes have a lower prevalence of CVD (cardiovascular disease), hypertension and diabetes due to their sport careers, while others claim that is only the consequence of being more physically active in later life compared to non-athletes. It is believed that leisure-time physical activity (LTPA) and healthy lifestyle contribute the most to low risks for MS. However, there is still a lack of research in this field and this syndrome should be investigated further, in order to prevent health issues among entire population.

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### **Conflict of interests**

There are no potential conflicts to declare.

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# Side movement differentiation in highly advanced competitors in the selected track-and-field of exercises presented on competitions

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### **ABSTRACT**

**AIM:** The determination of the side differentiation of technique in the execution of selected kinds track-and-field events in highly-advanced competitors. **METHODS:** The research involved 447 athletes of both genders. The methods used were: interviews, questionnaires, observations (mainly during competitions), attempts and tests of basic and specific physical fitness, many months of pedagogical experiments, as well as laboratory measurements of: strength, jumping ability, range of movement in the joints, muscular and joint kinesthetics sensations. **RESULTS:** For the athletes specializing in long jump, the take-off limb was stronger, more dynamic and manifested a higher level of jumping ability. The leg dominant in

hurdle attack in women and men was the left leg; however the range of this dominance was very diverse. In many track-and-field events of both women and men, there was a definite crossed functional asymmetry. With the skill improvement of jumps execution with both legs, the progression of results for the dominant limb was observed. CONCLUSIONS: 1. The findings of studies conducted on the track-and-field athletes competing in pentathlon and decathlon indicated the dominance of the left leg in jumps and right hand in the throws. There was a distinct – typical for men and women – variation of crossed asymmetry (right hand – left leg). 2. During the experiments, the following trend was observed: the symmetrization of the technique first induced a decrease in the results of jumps (in which the athletes were specialized), followed by their increase and stabilization at a higher level.

**Key words:** side differentiation, track-and-field, men, women, right and left, world elite.

## Introduction

The research conducted on highly-advanced track-and-field athletes is of exceptional importance, as in its most events competitors are focused on achieving maximum results, expressed in measurable units, by performance of asymmetrical movements. In this sport discipline the competitor exerts to his/her maximum by maximally exploiting one side of the body. So far, this issue has been the subject of many scientific investigations in numerous works (Ambarov, 1963; Baley et al., 1952; Dolja, 1973, 1979; Drabik, 1983; Grab, 1978; Kotowski, 1978; Łomejko, 1961; Manno, 1984; Mekota, 1984; Niedzwiedz, 1980; Puni, Starosta, 1979; Starosta, 1963, 1965, 1965a, 1970, 1971, 1971a, 1972, 1973, 1983, 1984, 1985, 1986, 1990, 2008). Although different research methods were used, the dominance of the left leg was established in them. Moreover, it was found that the more complex the jump was, the more often the take-off was done with the left leg. This also refers to the world records in high jump, which were most often performed with the left leg take-off (Table 1).

Year	Record [cm]	Name of athletes (country)	Take-off leg	
			Right	Left
1887	193	Peage B. (USA)		
1885	197	Sweeney M. (USA)		
1912	200	Horine G. (USA)		+
1914	201,4	Beeson E. (USA)		+
1917	203	Larson C. (USA)		
1924	203,8	Osborn H. (USA)		+
1933	204,6	Marty W. (USA)	+	
1934	206	Marty W. (USA)	+	
1936	207	Albritton D. (USA)		+
1936	207,6	Johnson C. (USA)	+	
1937	208	Walker M. (USA)		
1939	209	Walker M. (USA)		
1941	209	Stewart W. (USA)		
1941	211	Steers L. (USA)		+
1953	212	Davis W. (USA)		+
1956	215	Dumas Ch. (USA)		+
1957	216	Stiepanow J.(USSR)	+	
1960	217	Thomas J. (USA)		+
1960	218	Thomas J. (USA)		+
1960	222	Thomas J. (USA)		+

Year	Record [cm]	Name of athletes (country)	Take-off leg	
			Right	Left
1961	223	Brumel W. (USSR)		+
1961	224	Brumel W. (USSR)		+
1961	225	Brumel W. (USSR)		+
1962	226	Brumel W. (USSR)		+
1962	227	Brumel W. (USSR)		+
1963	228	Brumel W. (USSR)		+
1970	229	Chin-Chin N. (CHINESE REP.)	+	
1971	229	Matzdorff P. ( W.GERMANY)		+
1973	230	Stones D. (USA)		+
1976	231	Stones D. (USA)		+
1976	232	Stones D. (USA)		+
1977	233	Jaszczenko W. (USSR)		+
1978	234	Jaszczenko W. (USSR)		+
1980	235	Wszota J. (POLAND)	+	
1980	235	Moegenburg D. ( W.GERMANY)		+
1980	236	Wessig G. (EGERMANY)		+
1983	237	Jianhua Zhu (CHINESE REP)		+
1983	238	Jianhua Zhu (CHINESE REP)		+
1984	239	Jianhua Zhu (CHINESE REP)		+
1985	240	Powarnicyn R. (USSR)		+
1985	241	Paklin J. (USSR)	+	
1987	242	Sjoeberg P. (SWEDEN)		+
1988	243	Sotomayor J. (CUBA)		+
1989	244	Sotomayor J. (CUBA)		+
1993	245	Sotomayor J. (CUBA)		+
		<b>total n 21</b>	<b>6</b>	<b>15</b>
		<b>% 100</b>	<b>28.6</b>	<b>71.4</b>

Table 1. The take-off leg in high jumpers, the world record bearers, in the period 1887 – 1993 (n = 21)

## **Aims**

1. Determination of the possibility of controlling the choice of the dominant (take-off) leg. 2. An attempt to determine the influence of the symmetrization of movements on the sports achievements in jumps. 3. Determination of the reasons for the choice of the attacking leg in 400 m hurdles depending on the gender and the impact of this choice on the sports results. 4. Kind of load on both limbs in the track-and-field events of pentathlon and decathlon and the influence of the coach on its differentiation.

## **Methods**

The material was collected during the investigations of highly-advanced athletes specializing in: high jump, long jump and triple jump, hurdles and track-and-field events of pentathlon and decathlon. In total, 447 athletes were investigated, out of which 69 (15.4%) belonged to the Polish junior and senior national teams, and 181 to the world elite (40.5%). The standard level of the athletes was variable – from the beginners to the Olympic champions and world record holders. The largest group of athletes were specialists in 110 m hurdles (26.5%), and the smallest (6.6%) competitors in the track-and-field events of pentathlon and decathlon (14 women and 10 men). Most of the investigated persons were men (85.1%).

## **Results and Discussion**

Symmetry and asymmetry of movements in the selected track-and-field events  
In the studies on symmetry and functional asymmetry in track-and-field events of pentathlon and decathlon (Niedźwiedź, 1980; Starosta, 1990, 2008), the following was attempted to determine: 1. Is there a rational, i.e. symmetrical, load on both limbs? 2. Is the uniform load controlled by the coach in cooperation with the competitor? The results of questionnaire investigations included 24 person, aged 21.5 years (14 women – pentathletes and 10 men – decathletes), 19 of whom were members of the Polish national team (the majority had the 1st and the master class). The findings regarding the limbs (Table 2) showed some uniformity of the load on the right and left side of the body (72 and 74 cases, respectively). Detailed analysis, however, showed the dominance of the right hand in throws and of the left leg in the activities performed with the lower limb (take-off in high jumps, pole vault). This can be called a specific variation of crossed asymmetry.

no	gender	competitor	Kind of multi-field event	Kind of exercises- dominant leg (R - Right, L - left)											Number of exercises with the use of upper and lower limbs					
				Low start to a 100 m run/front leg/	Long jump	Shot put	High jumps	Low start to 400 m run	hurdles /take off/	discus throw	Pole vault	javelin	Number of exercises with the use of limbs		Number of exercises with the use of upper and lower limbs					
													R	L	Upper limb		Lower limb			
															R	L	R	L	R	L
1.	men	R. Skowronek	Decathlon	R	R	R	R	R	R	R	L	R	8	1	3	-	5	1		
2.		R. Katus	Decathlon	L	L	R	L	L	L	R	L	R	3	6	3	-	-	6		
3.		F. Jóźwicki	Decathlon	L	R	R	L	L	L	R	L	R	4	5	3	-	1	5		
4.		K. Kuligowski	Decathlon	R	L	R	L	R	R	R	L	R	6	3	3	-	3	3		
5.		W. Podsiadło	Decathlon	L	L	R	L	L	L	R	L	R	3	6	3	-	-	6		
6.		A. Sieradzki	Decathlon	L	L	R	L	L	L	R	L	R	3	6	3	-	-	6		
7.		A. Bagiński	Decathlon	L	L	L	L	L	R	L	R	L	2	7	-	-	2	4		
8.		W. Jurkowski	Decathlon	L	R	R	L	L	L	R	R	R	5	4	3	-	2	4		
9.		B. Frączek	Decathlon	R	R	R	R	R	R	R	L	R	8	1	3	-	1	5		
10.		A. Krężlik	Decathlon	L	R	R	L	L	R	R	L	R	5	4	3	-	2	4		
11.	women	A. Cały	Pentathlon	-	L	R	L	-	R	-	-	-	2	2	1	-	1	2		
12.		G. Niestój	Pentathlon	-	R	R	R	-	R	-	-	-	4	-	1	-	3	1		
13.		E. Karolczyk	Pentathlon	-	L	R	L	-	R	-	-	-	2	2	1	-	1	2		
14.		M. Lisowska	Pentathlon	-	L	R	L	-	L	R	R	R	1	3	1	-	-	3		
15.		B. Wiącek	Pentathlon	-	L	R	L	-	L	-	-	-	1	3	1	-	-	3		
16.		J. Szuba	Pentathlon	-	L	R	L	-	L	-	-	-	1	3	1	-	-	3		
17.		A. Botolej	Pentathlon	-	L	R	L	-	R	-	-	-	2	2	1	-	1	2		
18.		A. Bubala	Pentathlon	-	L	R	L	-	L	-	-	-	1	3	1	-	-	3		
19.		C. Piasek	Pentathlon	-	L	L	L	-	L	-	-	-	-	4	-	1	1	3		
20.		M. Roszkowska	Pentathlon	-	L	R	L	-	R	-	-	-	2	2	1	-	1	2		
21.		R. Wróbel	Pentathlon	-	L	R	L	-	R	-	-	-	2	2	1	-	1	2		
22.		B. Sadowska	Pentathlon	-	R	L	R	-	R	-	-	-	3	1	-	1	3	1		
23.		J. Walencka	Pentathlon	-	L	R	L	-	R	-	-	-	2	2	1	-	1	2		
24.		W. Tomaszewska	Pentathlon	-	L	R	L	-	R	-	-	-	2	2	1	-	1	2		
TOTAL	n	R	3	7	21	4	3	14	9	2	9	72	74	39	5	29	73			
		L	7	17	3	20	7	10	1	8	1									
	%	R	30,0	29,2	87,5	16,7	30,0	58,3	90,0	20,0	90,0	49,3	26,7							
		L	70,0	70,8	12,5	83,3	70,0	41,7	10,0	80,0	10,0	50,7						3,4	19,9	

Tab. 2. Side differentiation of limbs in the execution of exercises by female in pentathlon and male in decathlon (n = 24)

This asymmetry was manifested in the partial side differentiation of activities performed partially by the right upper limb and the left lower limb. Some athletes manifested a specific load distribution for the right and left side of the body. It was not very clear and did not provide symmetry of movements and even equal load on both sides of the body. Observations confirmed this trend. The results of investigation carried out with various methods (questionnaires, interviews, observations) were convergent. They indicated a decided advantage of the left leg in the events that make up the track-and-field pentathlon and decathlon field events. The size of this dominance depended on the method used: 70% on the basis of questionnaires (women 69%, men 70%), 77% interviews (women 66.7%, men 77.1%) and as much as 91% on the basis of competition observations (women 91.6%, men 85.6%). A more pronounced dominance was characterized by the activities performed with the right hand (throws). In the pentathlon and decathlon athletes, both female and male, there was a definite functional crossed asymmetry (right hand – left leg). The findings also showed a tendency to evenly load both sides of the body, by execution-dividing the exercises, some of which are done with the right hand, and some with the left leg. However, this was not the optimal solution.

Effects of symmetrization of track-and-field event technique

The efficiency of the process of symmetrization of the high jump technique (Susoł, 1977) was determined in a 6-month pedagogical experiment conducted with 20 students of the Agricultural Technical School. Progress was controlled by a set of tasks assessing the level of basic and specific physical fitness carried out 5 times in different training periods (at 6-week intervals). In the experimental group, during the 117 training hours, the symmetry of the lower limbs was developed. The alternate performance of the exercises, i.e. the right and left leg, significantly reduced the asymmetry previously exhibited in the applied fitness tasks, the more diagnostic of which was the high jump execution using the right- and left-leg take-off alternately. Along with the improvement of the ability to perform the take-off with both legs, the progression of results for the dominant limb was observed.

## Conclusions

1. Investigations conducted on athletes specializing in track-and-field jumps indicated the dominance of the take-off limb, which was characterized by a higher level of strength and jumping ability as a result of its more frequent use during training and competition in a long-term specialist training. The limb was usually the left leg (53-57% of cases). The take-off limb change occurred only in emergency situations, i.e. due to injury. The choice of the take-off limb is often done in a random manner, conditioned mainly by the tradition of a given discipline. Narrow specialization and pursuit of high sport results prevent competitors and coaches from seeing the benefits of symmetrization in other categories than sports utility. 2. The results of investigations conducted on the athletes of the track-and-field events of pentathlon and decathlon indicated the dominance of the left leg in jumps and of the right hand in throws. There was a visible variation of crossed asymmetry in women and men (right hand – left leg). 3. Pedagogical experiments carried out in different groups of competitors have shown that it is possible to control the choice of the dominant take-off leg.

Symmetrization of sports technique improves the results accomplished by the left- and right-leg take-offs. Along with the improvement of the results achieved by the “weaker” limb, the dominant limb’s results also increased. 4. During the experiments carried out, the following trend was observed: the symmetrization of the technique first induced a decrease in the results of jump (in which the athletes were specializing), and then their increase and stabilization at a higher level. 5. In the presented experiments, the same load of both legs was applied. It is not known: what effects would be caused by the symmetrization with a

greater load applied on the "weaker" limb? One can only assume that it would be a more effective method.

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# A longitudinal study of some anthropological characteristics of young water polo players.

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## **ABSTRACT**

**PURPOSE:** The purpose of this article is to determine and explain the growth and development of some anthropological characteristics of young water polo players using longitudinal data. **METHODS:** The sample of participants consisted of young water polo players, members of the national team (n = 18). They were measured and tested at three time points. At the first time point they were 12 years of age, at the second time point they were 13 years of age, and in the final measuring point they were 14 years of age. The sample of variables consisted of data on five morphological characteristics and three motor abilities. **RESULTS:** Using the analysis of variance for dependent samples (ANOVA) and multiple comparisons of mean ranks at the significance level of  $\alpha=0.05$ , the hypothesis that there exists a statistically significant differences in six out of eight anthropological characteristics for young water polo players was confirmed. **CONSLUSIONS:** The statistically significant differences in four morphological characteristics and two motor abilities are probably the result of a systematic two-year training and natural process of growth and development of young water polo players. Determined modal values of young water polo national team members can help coaches of young water polo players in the planning, programming and control of training process.

**Key words:** anthropometric characteristics, motor skills, selected young water polo players

## **Introduction**

A longitudinal study is an optimal way to determine and explain the impact of motor development, since participants are followed during long periods, either months or years. In most ball games, coaches assess motor and physical capabilities and technical skills on a regular basis in early stages of talent identification in order to further athletes' development (De Siati et al., 2016). Measuring and testing of anthropological characteristics of young water polo players is very important for several reasons: the determination of water polo potential, training process control and monitoring as well as the control of growth and development. Anthropological dimensions are good predictors of specific motor skills of

young water polo players (Aleksandrovic, Jorgić, Georgiev, Ozsari, & Arslan, 2015). Following the history of water polo is evident that the water polo developed especially through the development trends of speed, power and speed endurance (Hraste, Bebić, & Rudić, 2013). Progress in performance of water polo players is achieved due to the acquisition of new motor skills and development of certain motor abilities (Hraste, 2001; Hraste, 2003; Hraste, Karninčić, & Drpić, 2016;). The process of water polo training is designed to develop all energy systems. According Hraste, Jelaska and Lozovina (2014), a multi-annual work in water polo training and preparation can be represented as a pyramid, which is segmented into three parts. These segments are related to the type and modes of training and age. From the years nine to fourteen, when the primary selection of water polo players is carried out, the emphasis in training is on learning and development of swimming and water polo motor skills and general physical preparation (Hraste et al., 2014). A few authors (Toskić, Lilić, & Toskić, 2013) have indicated a very high correlation between morphological characteristics and motor abilities of young water polo players. According Hraste et al. (2014) in the majority of Croatian water polo clubs at the age of 12-13 years, players move into the league of younger cadets and train, on average, five times a week for 60 minutes and play one game a week, while 13-14-year players, cadets, train on average five times a week for 75 minutes and play one game per week.

Average 12 years old boy starts with puberty and ends with critical period of physical and movement development. According O' Brien (2013), adolescents aged between 12 and 13 years, entering their first year of post-primary physical education, do not display proficiency in nine basic movement patterns. This finding indicates that adolescents may have a difficult time in making successful transition towards more advanced skills within the sport-specific stage. Boys who mature early are generally stronger, heavier and have more muscle mass than boys of the same chronological age that mature later (Malina & Bouchard, 1991). Changes in body shape for boys who mature earlier create certain advantages in achievements. High sports result achieved by boys is often a result of genetically conditioned earlier maturation. The development of muscle strength is particularly expressed in adolescence, and individual differences are mostly pronounced in the period between 12 and 15 years of age (Armstrong & McManus, 2011).

The purpose of this article is to determine and to explain growth and development of some anthropological characteristics of young water polo players using longitudinal data.

The following hypothesis was set in accordance with the research scope: i) there are statistically significant differences in some anthropological characteristics between the age of 12 and 14 years in young water polo players.

## Methods

The sample of participants consisted of young water polo players ( $n = 18$ ). The participants were members of the Croatian cadet national team. They were measured and tested at three time points. At the first time point they were 12 years of age, at the second time point they were 13 years of age, and at the final measuring point they were 14 years of age.

The sample of variables consisted of data on 5 morphological characteristics and 3 motor abilities and skills. The set of 5 morphological variables were: BH (body height), BM (body mass), BMI (body mass index according to Keys et al., 1972), VC (volume of chest) and AV (abdominal volume). Variables 400MC (400 m crawl), 25MCB (25 m crawl with the ball) and 50MC (50 m crawl) made up the observed space of motor abilities and skills.

The basic statistical parameters (mean, standard deviation, maximal and minimal result) were calculated. These parameters were calculated separately for each time point. Differences between three time points in the space of 8 indicators of anthropological characteristics were calculated using analysis of variance for dependent samples (ANOVA). Level of statistical significance was set at 5% ( $\alpha = 0.05$ ). When statistically significant differences were found, the multiple comparisons of mean ranks were used to determine

pairs responsible for the differences. Data were processed by the Statsoft Statistica ver. 11.0, at the Faculty of Kinesiology, University of Split.

## Results

Table 1 contains data of the basic statistical parameters (mean, standard deviation, maximal and minimal result).

Variable	Water polo players 12 years old			Water polo players 13 years old			Water polo players 14 years old		
	AS±SD	min	max	AS±SD	min	max	AS±SD	min	max
BH	160.94±8.38	146	177	165.17±7.76	152	180	177.8±8.67	156	193
BM	56.44±11.58	35	73	59.61±9.7	43	76	70.17±11.33	49	95
BMI	21.76±4.25	15.6	32.4	21.82±3.12	17.7	28.3	22.12±2.62	17.4	26.9
VC	82.06±6.64	70	93	84.28±6.76	72	95	91.06±6.38	76	101
AV	79.08±9.16	61.5	96	79.89±9.18	63	99	83.94±6.84	72	100
400MC	354.94±23.81	310	392	347.5±23.87	301	383	315.44±18.07	288	364
25MCB	17.77±2.88	14.6	28.2	17.36±2.11	14.7	24.6	16.08±3.92	13.3	31.3
50MC	34.9±1.79	32.3	38.9	33.71±1.96	30.6	37.2	31.13±2.51	28	36.4

Table 1. Mean and standard deviation (M±SD), minimal and maximal results (min, max) at all three time points (12 years of age, 13 years of age, and 14 years of age) for five morphological characteristics and three motor abilities of young water polo players

Legend: BH – body height, BM – body mass, BMI – body mass index, VC – volume of chest, AV – abdominal volume, 400MC – swimming 400 m crawl, 25MCB – swimming 25 m crawl with the ball, 50MC – swimming 50 m crawl

Table 2 below shows the results of dependent samples ANOVA and multiple comparisons of mean ranks at the significance level of  $\alpha=0.05$ .

Variables	F	p	$\eta^2$	I-II	I-III	II-III
ATV	180.115	0.00	0.914	0.00	0.00	0.00
ATM	35.625	0.00	0.677	0.00	0.00	0.00
BMI	0.253	0.779	0.015	-	-	-
AOPP	90.842	0.00	0.842	0.00	0.00	0.00
AOPTR	16.051	0.00	0.486	0.00	0.00	0.00
M400m	73.517	0.00	0.812	-	0.00	0.00
M25mL	1.676	0.202	0.09	-	-	-
M50m	71.466	0.00	0.808	0.00	0.00	0.00

Table 2. Analysis of variance for dependent samples (ANOVA) and multiple comparisons of mean ranks (F-test value, p – empirical significance level,  $\eta^2$  – size effect) for five morphological characteristics and three motor abilities for water polo players 12 years old (I), water polo players 13 years old (II) and water polo players 14 years old (III)

Legend: BH – body height, BM – body mass, BMI – body mass index, VC – volume of chest, AV – abdominal volume, 400MC – swimming 400 m crawl, 25MCB – swimming 25 m crawl with the ball, 50MC – swimming 50 m crawl.

As it can be seen from Table 2, multiple comparisons of mean ranks for six variables showed significant differences ( $p < 0.05$ ) among three seventeen pairs of the observed groups.

## Discussion

It is quite logical that young water polo players have a statistically significantly improved results of swimming over 400 m between the thirteenth and fourteenth years of age. Namely, in this period, swimming training for the development and maintenance of water polo aerobic endurance is emphasized (Hraste et al., 2014; Arsoniadis, Botonis, Nikitakis, Kalokiris, & Toubekis, 2017). It is well known that the development of endurance can be significantly affected by training. Additionally, it is logical that young water polo players did not statistically significantly improve the results of swimming over 25 m with the ball because it was a speed and skill test. The speed is genetically highly conditioned and can be hardly significantly developed under the influence of training (Hraste, 2003). At the same time, adolescents, aged between 12 and 13 years, may have a difficult time in making the successful transition towards more advanced skills within the sport-specific stage (O'Brien, 2013). The rapid-strength characteristics, expressed in the 50-meter swimming test, were statistically significantly improved by young water polo players as a result of growth and development as well as systematic training between twelve to fourteen years of their age (Hraste, 2003).

The reasons for the significant differences found in the four measures of morphological characteristics of young water polo players between 12 and 14 years of their age are most likely expected since growth and development are particularly pronounced in adolescence, when is the period of the greatest adolescent growth in boys (Mišigoj-Duraković, 2008). Changes in morphological characteristics were probably additionally conditioned by a 2-year systematic water polo training (Hraste, Lozovina, & Radmilo, 2009).

## Conclusions

The set hypothesis was confirmed. The results of this research confirmed that, under the influence of systematic training during adolescence, endurance, speed-power abilities and a part of morphological characteristics of young water polo players can be significantly developed. The established modal values of young water polo national team members can help water polo coaches in planning, programming and control of training process. Future research should monitor young water polo players throughout the whole period of growth and development, distinguish young players according to their biological age, and increase the number of investigated anthropological variables in order to gain a wider insight into the development of young water polo players.

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# Do more behavioral risk factors increase the odds of having chronic diseases in young adults? A population-based study.

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## **ABSTRACT**

**PURPOSE:** The purpose of this study was to explore the cluster association of behavioral risk factors with the presence of chronic diseases. Little is known of how these behaviors, presented as a cluster, are associated with chronic disease/s in young adults. Therefore, the purpose of this study was to explore the behavioral risk factors (BRFs) clusters associations with the presence of chronic diseases. **METHODS:** In this cross-sectional study, 2100 university students (50.4% of women) were recruited from 8 randomly selected faculties in the City of Zagreb. The measurement protocol was conducted from September to November 2017. To assess the number of BRFs and chronic diseases, we used structured questionnaires. Logistic regression analyses were used to explore the associations between BRFs and chronic diseases. **RESULTS:** From the total sample, 9.3% of participants reported to have some kind of chronic diseases. In univariate model, logistic regression showed that having 2 (OR=2.63; 95% CI 1.59-4.34), 3 (OR=3.79; 95% CI 2.14-6.71) and  $\geq 4$  (OR=7.69; 95% CI 3.05-19.39) BRFs was associated with chronic diseases. After the adjustments for gender, self-rated health, sleep quality, socio-economic status, psychological distress and location of birth, having 2 (OR=2.34; 95% CI 1.41-3.87), 3 (OR=2.88; 95% CI 1.60-5.18) and  $\geq 4$  (OR=4.91; 95% CI 1.85-13.05) BRFs remained associated with chronic diseases. **CONCLUSION:** Our study shows that more BRFs are associated with a greater likelihood of having chronic diseases. Thus, special policies aiming to prevent 'risky' behaviors are warranted.

**Key words:** youth, alcohol drinking, obesity, risk factors, sedentary lifestyle, tobacco smoking

## **Introduction**

Chronic diseases have become the 'number one' cause of death worldwide (Pate RR, et al. 1995.). Among numerous factors, there is a relatively small number of the so called 'behavioral risk factors' (BRFs) (Mokdad AH, Marks JS, Stroup DF & Gerberding JL., 2004.). Previous studies have shown that a higher number of health risk behaviors increases the odds for having a chronic disease/s (Meng L, Maskarinec G, Lee J & Kolonel LN.1999.). Specifically, having 2 or more BRFs was associated with a higher incidence of mortality (Khaw KT, Wareham N, Bingham S, Welch A, Luben R & Day N.,2008), while the opposite engagement leads to decrease in both mortality and chronic diseases (Knoops KT, et al.). Thus, understanding the combinations and co-occurrences of BRFs might possibly lead to

more effective strategies for chronic disease control (Alamian A, & Paradis G. 2009., Fine LJ, Philogene GS, Gramling R, Coups EJ & Sinha S. 2004. and Li Y, Zhang M, Jiang Y & Wu F. 2012.).

A high prevalence of negative BRFs has been an emerging problem, especially in young adults, the age when exposure to such behaviors usually starts (Chen K & Kandel DB 1995.). More importantly, the transition from adolescence to young adulthood is a critical period for establishing health behaviors (Harris KM, Gordon-Larsen P, Chantala K. & Udry JR. 2006.), with the emphasis on the fact that behaviors established in this time frame become more habitual later in life. Therefore, special interventions and policies aiming to increase the prevalence of healthy behaviors in order to prevent the incidence of chronic diseases are warranted. As mentioned before, the associations between BRFs and chronic diseases have been well established so far (Alamian A, & Paradis G. 2009., Fine LJ, et al. 2004. and Li Y, Zhang M, Jiang Y & Wu F. 2012.). However, there has been a lack of studies exploring whether are multiple BRFs associated with higher odds of having chronic diseases in young adults. This age group, going through big lifestyle changes (Pelletier JE, Graham DJ & Laska MN. 2014. and Keating XFD, Guan JM, Pinero JC, Bridges DM. 2005.), represents a risk group for BRFs and, thus, for a higher incidence of (the development of) chronic diseases.

## Methods

The study was conducted among university students in Zagreb. Eight faculties were randomly selected out of 33 University of Zagreb faculties. All 8 faculties agreed to take part in the study, representing 2320 students enrolled in the 2017 academic year. Of these, 2100 students (1041 men and 1059 women, aged 18-24 years) provided full data (90.5%) and were considered for further analysis. Students were pursuing a variety of social, technical and health-related sciences. Before the main analysis, we examined the differences between the participants and non-participants. No significant differences were observed, so no potential bias was expected ( $p=0.21-0.74$ ).

### Outcome variable

The presence or absence of a chronic disease was assessed by the one-item question with 'Yes' and 'No' answers.

### BRFs

Participants self-reported their height in meters (m) and weight in kilograms (kg), from which BMI ( $\text{kg}/\text{m}^2$ ) was calculated. Before the study, we had chosen 35 men and 40 women to validate self-reported height and weight with the objective measures taken by the trained examination staff. Pearson's coefficient of correlation showed an excellent relationship between two measures in men ( $r=0.96$ ) and women ( $r=0.97$ ). For the purpose of this study, the BMI score was divided into two categories. Binge alcohol consumption was assessed by one question. To assess current cigarette smoking status of the study participants, we asked one question. To assess physical activity in the last 7 days, we used the International Physical Activity questionnaire, a reliable and valid instrument designed to measure physical activity in respondents between 18-65 years of age (Craig CL, et al. 2003.). Screen-time was assessed by the two-item questions.

### Covariates

Self-rated health was assessed using the one-item question: "How would you rate your health?". Answers were arranged along a Likert-type scale. This measure has previously been shown as reliable and valid (Craig CL, et al. 2003.). To assess sleep quality, we used the Pittsburgh Sleep Quality Questionnaire (World Health Organization, 2010). Socio-economic status was assessed by one question. Psychological distress was assessed by the Kessler's 6-item questionnaire (Tremblay et al., 2011).

### Statistical analysis

Basic descriptive statistics are presented as frequencies (N) and percentages (%). Differences between the participants with diagnosed chronic diseases and those without them were calculated using Chi-square or Kruskal-Wallis test. BRFs were the following: being overweight/obese ( $>25 \text{ kg/m}^2$ ), tobacco smoking (current smokers), participating in binge drinking ( $\geq 5$  glasses for men and  $\geq 4$  glasses for women during one night), being 'insufficiently' active (not meeting the recommendations of  $\geq 150$ -minute participation in moderate physical activity or  $\geq 75$ -minute participation in vigorous physical activity weekly or the equivalent combination of these two), and being in 'high' screen-time group ( $\geq 120$  minutes of television watching and/or computer playing). We coded the participants without BRFs and those with BRFs with 0 and 1, respectively. Then, all BRFs were summed up and gave the number of BRFs as follows: (1) 0, (2) 1, (3) 2, (4) 3, (5)  $\geq 4$ . Logistic regression analyses were used to explore the associations between the BRFs clusters and chronic diseases. First, under the univariate model (model 1), odds ratios (ORs) were calculated with 95% confidence intervals (95% CI) for each category of BRFs clusters with the presence of chronic diseases. Second, we entered gender, self-rated health, sleep quality, socio-economic status, psychological distress and location of birth in the multivariate model (model 2) and re-calculated the associations between BRFs clusters and the presence of chronic diseases. Significance was set up at  $\alpha \leq 0.05$  and it was two sided (2-sided).

### Results

Basic descriptive statistics of the study participants are presented in Table 1.

Study variables	Total sample (N=2100)	Absence of chronic diseases (N=1905)	Presence of chronic diseases (N=195)	p-value*
	N (%)	N (%)	N (%)	
<b>Number of BRFs</b>				
0	445 (21.2)	424 (22.3)	21 (10.8)	
1	777 (37.0)	718 (37.7)	59 (30.3)	
2	634 (30.2)	561 (29.4)	73 (37.4)	
3	215 (10.2)	181 (9.5)	34 (17.4)	
≥4	29 (1.4)	21 (1.1)	8 (4.1)	<b>&lt;0.001</b>
<b>Gender</b>				
Men	1041 (49.6)	953 (50.0)	88 (45.1)	
Women	1059 (50.4)	952 (50.0)	107 (54.9)	0.20
<b>Self-rated health</b>				
Good	1935 (92.1)	1779 (93.4)	156 (80.0)	
Poor	165 (7.9)	126 (6.6)	39 (20.0)	<b>&lt;0.001</b>
<b>Sleep quality</b>				
Good	1310 (62.4)	1213 (63.7)	97 (49.7)	
Poor	790 (37.6)	692 (36.3)	98 (50.3)	<b>&lt;0.001</b>
<b>Material status</b>				
Middle/high	2048 (97.5)	1861 (97.7)	187 (95.9)	
Low	52 (5.2)	44 (2.3)	8 (4.1)	0.14
<b>Psychological distress</b>				
Low	1878 (89.4)	1723 (90.4)	155 (79.5)	
High	222 (10.6)	182 (9.6)	40 (20.5)	<b>&lt;0.001</b>
<b>Location of birth</b>				
Urban	1480 (70.5)	1355 (71.1)	125 (64.1)	
Rural	620 (29.5)	550 (28.9)	70 (35.9)	<b>0.05</b>

\*Chi-square or Kruskal-Wallis test

Table 1. Basic descriptive statistics of the study participants, Croatia (2017)

Roughly, 9.2% of all participants reported having some kind of chronic disease. From 2100 participants in this study, 335 (16%) were overweight/obese, 506 (24.1%) used tobacco, 570 (27.1%) were binge drinkers, 474 (22.6%) were 'insufficiently' active and 921 (43.9%) participated in  $\geq 120$  minutes of screen-time. When BRFs were summed, a higher percentage of participants with 2, 3 and  $\geq 4$  BRFs was found to have chronic diseases ( $p < 0.001$ ). Table 2. shows the associations between the BRFs clusters and the presence of chronic diseases in the study participants.

BRFs clusters	OR (95% CI)	p-value
<b>Number of BRFs*</b>		
0	1.00	
1	1.66 (0.99-2.77)	0.053
2	2.63 (1.59-4.34)	<0.001
3	3.79 (2.14-6.71)	<0.001
$\geq 4$	7.69 (3.05-19.39)	<0.001
<b>Number of BRFs**</b>		
0	1.00	
1	1.57 (0.94-2.64)	0.08
2	2.34 (1.41-3.87)	<0.001
3	2.88 (1.60-5.18)	<0.001
$\geq 4$	4.91 (1.85-13.05)	<0.001

\*univariate model;

\*\*model adjusted for gender, self-rated health, sleep quality, material status, psychological distress and location of birth.

$p < 0.05$

Table 2. The associations between the clusters of BRFs and the presence of chronic diseases in the study participants, Croatia (2017)

Under the univariate model, logistic regression showed that having 2 (OR=2.63; 95% CI 1.59-4.34), 3 (OR=3.79; 95% CI 2.14-6.71) and  $\geq 4$  (OR=7.69; 95% CI 3.05-19.39) BRFs was associated with chronic diseases. After adjusting for gender, self-rated health, sleep quality, socio-economic status, psychological distress and location of birth, having 2 (OR=2.34; 95% CI 1.41-3.87), 3 (OR=2.88; 95% CI 1.60-5.18) and  $\geq 4$  (OR=4.91; 95% CI 1.85-13.05) BRFs remained associated with chronic diseases.

## Discussion and conclusion

The purpose of this study was to explore the cluster associations of behavioral risk factors with the presence of chronic diseases. Our results showed that, after adjusting for gender, self-rated health, sleep quality, socio-economic status, psychological distress and location of birth, a higher number of BRFs increased the odds for having chronic diseases in young adults. The prevalence of BRFs in our study was similar to some previous studies (Li Y. et. al. 2012). We found the significant associations between more BRFs and the presence of chronic diseases. Future studies should aim to explore the associations between BRFs and

the presence of chronic diseases over a longer period of time using more objective methods (actigraphy, anthropometer and valid digital scale) in order to track and establish the direction of association, especially in youth, where health behaviors are established (Harris KM. et. al. 2016). Despite these limitations, our study shows, that after adjusting for several covariates, having 2, 3 or  $\geq 4$  BRFs is associated with higher odds of having chronic diseases in a large sample of young adults. Evidence shows that BRFs are modifiable and can change over time. Therefore, special policies and strategies, especially in education system (more physical education classes, extra-curricular activities, leisure-time physical activity, university cafeterias with fruits and vegetables), as well as information-dissemination workshops should be implemented to increase the levels of physical activity and fruits and vegetables consumption and to decrease sitting-time, tobacco and alcohol use.

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## The stability of factors underlying sports talent

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### **ABSTRACT**

**PURPOSE:** This study deals with the time stability of factors underlying sports talent on the basis of changes in individual physical fitness test scores. **METHODS:** Data were collected from 12 elementary school boys aged 6 and 7 years. To determine children's individual physical fitness levels, 10 physical fitness tests were administered. The main factors underlying talent included motor coordination, strength, agility, speed, endurance, flexibility, and decision-making. **RESULTS:** The mean values for particular physical fitness tests showed performance increase over a one-year period in all tests except the sit-and-reach test. An interesting finding is that decision-making performance in the pull-the-flag game decreased, which shows little talent for team games and sports. **CONCLUSIONS:** The results show that factors underlying sports talent among elementary

school children need to include the assessment of speed, strength, motor coordination, and endurance rather than flexibility and decision-making.

**Key words:** sports, talent identification, time stability

## **Introduction**

A youth's talent potential is not a stable trait (Abbott & Collins, 2002), but is constantly evolving throughout the developmental phases (Unnithan et al., 2012). The athletes must be selected from the crowd, and this selection is achieved through talent identification programs based on certain criteria (Breitbach, Tug, & Simon, 2014). We can conceptualize broad types of identification strategies from relatively generic strategies and activity-specific measures to ability-specific strategies (Bailey & Morlay, 2006). The problems with talent detection and identification programs that are based only on anthropometrical and physiological measurements of individuals is that the physically mature will tend to be identified for strength sports and the less mature for coordination sports; moreover, children born in the early part of the selection year are likely to be identified for strength sports (Wolstencroft, 2002). Therefore, a new talent identification model is needed to be conceptualized as early as elementary school age using generic factors of performance rather than sport-specific factors.

## **Methods**

Data were collected from 12 boys aged 6 and 7 years. The boys who participated in the study were 1st and 2nd graders, respectively. To determine children's physical fitness parameters, 10 physical fitness tests were administered: repeated routine with a stick (motor coordination), flexed arm hang (upper-body strength), standing long jump (lower-body explosive strength), 4 x 10 m shuttle run (agility), 50-meter sprint (speed), endurance shuttle run (aerobic endurance), sit-ups (abdominal strength and endurance), sit-and-reach test (flexibility), and rolling-of-three-balls test (spatial coordination) (Měkota & Blahuš, 1983; Šimonek, 2015). To assess the quality of decision-making processes, children played a flag chasing game. This study is in accordance with recognized ethical standards and was approved by the Ethics Committee of the University of Presov. Also, written informed parental consent was obtained from all participants. Test scores provided data about children's physical fitness levels. Using the test scores, individual factors underlying sports talent were assessed. We assume that children at this age are highly affected by the maturation processes, which may have significant effects on their physical fitness levels without being exposed to specific exercise stimuli. Therefore, the tests in which a performance increase was recorded were considered to indicate stable factors of talent corresponding to the internal predispositions of the participant to engage in physical activity. The descriptive statistical characteristics used included the mean as a measure of central tendency and the standard deviation and standard error of mean as measures of variability. To detect the incidence of outlier values in the data collected, we applied the Grubbs test. Stability of particular factors was assessed by determining significant differences in children's paired test scores recorded in 2016 and 2017 using the t test for dependent samples. The changes in physical fitness over time were assessed at the probability levels of  $p < 0.01$  and  $p < 0.05$ . The effect size was determined using Cohen's  $d$  coefficient which was calculated as the difference of the means of the individual groups of data divided by the pooled standard deviation (Thomas & Nelson, 2001). Effect size was estimated according to Cohen (1992) who presented that  $d < 0.3$  indicated small,  $d < 0.8$  medium, and  $d > 0.8$  large effect size.

## Results

		M	SD	SEM	Grubbs test		Difference s	SD of differences	t	d
					statistic	p				
SAR (cm)	t <sub>1</sub>	1.09	6.96	2.10	1.88	0.444	-1.91	5.07	-1.248	0.24 small
	t <sub>2</sub>	-0.82	9.09	2.74	2.00	0.288				
SU (no)	t <sub>1</sub>	19.91	8.61	2.60	2.22	0.109	7.27	5.87	4.11†	0.76 medium
	t <sub>2</sub>	27.18	10.34	3.12	2.40	0.037				
FAH (s)	t <sub>1</sub>	6.87	7.87	2.37	1.88	0.442	1.66	3.03	1.815	0.21 small
	t <sub>2</sub>	8.53	7.67	2.31	2.09	0.197				
SRA (s)	t <sub>1</sub>	13.69	1.01	0.30	1.76	0.662	-0.41	1.03	-1.334	0.40 medium
	t <sub>2</sub>	13.28	1.03	0.31	2.22	0.110				
50m(s)	t <sub>1</sub>	10.60	0.79	0.24	2.27	0.084	-0.47	0.31	-5.11†	0.63 medium
	t <sub>2</sub>	10.13	0.70	0.21	2.12	0.176				
SLJ (cm)	t <sub>1</sub>	122.27	13.38	4.03	2.19	0.126	15.18	11.88	4.238	0.89 large
	t <sub>2</sub>	137.45	20.07	6.05	1.87	0.458				
RTB (s)	t <sub>1</sub>	117.46	19.63	5.92	1.44	1.000	-27.16	12.80	-7.038	1.64 large
	t <sub>2</sub>	90.30	12.73	3.84	1.59	1.000				
RRS (s)	t <sub>1</sub>	46.29	22.14	6.68	2.68	0.003	-14.81	11.58	-4.043	1.31 large
	t <sub>2</sub>	25.55	3.64	1.15	1.72	0.641				
ESR (s)	t <sub>1</sub>	179.36	60.18	18.14	1.68	0.814	52.36	56.51	3.073*	0.76 medium
	t <sub>2</sub>	231.73	76.20	22.98	1.91	0.397				
PTF (no)	t <sub>1</sub>	7.82	3.19	0.96	1.94	0.361	-0.55	2.81	-0.645	0.21 small
	t <sub>2</sub>	7.27	1.79	0.54	1.82	0.534				

Table 1. Descriptive statistics and significant changes in physical fitness test scores

Note. BH – body height; BM – body mass; RRS – repeated routine with a stick; FAH – flexed arm hang; SLJ – standing long jump; SRA – shuttle run agility test; SU – sit ups in 60 s; RTB – rolling three balls; SAR – sit-and-reach; ESR – endurance shuttle run; PTF – pull the flag; \* p < 0.05; † p < 0.01; t<sub>1</sub> – testing conducted in 2016; t<sub>2</sub> – testing conducted in 2017

Descriptive statistics and significant differences in physical fitness test scores are presented in Table 1. The mean values for particular physical fitness tests show increase in performance over a one-year period in all tests except for the sit-and-reach test. An interesting finding is that decision-making performance in the pull-the-flag game decreased.

The differences in test scores achieved after one year, which indicates the stability of

factors underlying sports talent, were statistically nonsignificant for flexibility, upper-body strength and endurance, agility, and decision-making. The tests that assess motor coordination, speed, and aerobic endurance showed a high degree of time stability, ranging from a medium effect size for SU, 50-meter sprint, and ESR to a large effect size for SLJ, RTB, and RRS. The results of the pull-the-flag game, which are based on the decision-making processes demonstrated during the game itself, are also indicative of children's spatial orientation and their talent for team games and sports.

### Discussion

Sports profiling has been addressed in a variety of studies (Geithner, Malina, Stager, Eisenmann, & Sands, 2002; Pion et al., 2014). The results of this study show that the administered tests provide valid and reliable data necessary for the establishment of the factors underlying sports talent among elementary school boys. The battery applied consists of generic tests from which relevant talent characteristics may be identified for particular sports. As reported by Pion et al. (2014), the primary effort of sports profiling programs should be to orient children towards sports that best match children's somatic and fitness profiles and to apply these findings to talent identification as early as late childhood.

### Conclusions

This study deals with the time stability of factors underlying sports talent on the basis of changes in individual physical fitness test scores. Mean values for particular physical fitness tests showed performance increase over a one-year period in all tests except for the sit-and-reach test. An interesting finding is that decision-making performance in the pull-the-flag game decreased, which shows little talent for team games and sports. The results show that factors underlying sports talent among elementary school children need to include the assessment of speed, strength, motor coordination, and endurance rather than flexibility and decision-making.

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## Sports recreation as a public need in sport of the City of Zagreb

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### **ABSTRACT**

**PURPOSE:** The aim of this article was to demonstrate the financing of sports recreational programmes by funds provided from the budget of the City of Zagreb and to show the City's position, including that of the Republic of Croatia, in the field of sports recreation and physical activity with regard to global indicators. **METHODS:** This paper gathered financial

data on the the total revenue of sport in the City of Zagreb for the period from 2009-2018, the total annual expenditure amount and expenditure share of the Zagreb Sports Association Recreation in the total expenditure of sports programmes in the budget, and the overall budget of the City of Zagreb. The variable-frequency method was used for data processing, with the calculated percentages. RESULTS: The share of funds allocated to sports recreation in the total funds for sports development of the City of Zagreb amounted from 0.81% to 1.31% or 0.98% on average in the period of ten years. As a result, 57% of Zagreb's citizens actively participate in recreational sport programmes, which is at the top of the European average between 13% and 72% of active participation relative to the population. CONCLUSION: Although it has been scientifically proven that recreation has a positive impact on health, hence on the quality of life and work efficiency of citizens, and that regular exercise prevents long-term sick leave, mental symptoms and poor general health among working population, physical activity is largely connected to the private, individual sphere. Therefore, the City of Zagreb, as the capital of the Republic of Croatia, has recognized importance of sports recreation and benefits of exercising for its citizens, so through the public needs in sport it provides funds from the city budget to stimulate sports recreation every year, especially for the needed groups of citizens.

**Key words:** physical activity, life quality, efficient population, financing

## Introduction

The term recreation derives from the Latin verb *recreare*, meaning to recreate, renew, refresh, divert, amuse oneself. Recreation represents a spontaneous reflection of a human desire to meet the needs and tendencies in activities of their own choice, all for the purpose of a more meaningful use of leisure time (Relac, 1975). Recreation refers to the overall human activity taking place outside the domain of professional work that has positive effects on humans and is chosen according to their own wishes (Andrijašević, 1996). People who participate in sport-recreation programmes are more likely to acquire the so-called healthy habits such as healthier eating habits, non-smoking habits, low alcohol consumption, etc. (National Institute of Health, 2003). Recreation has a positive impact on human health through the advancement of anthropological status by acting preventively against typical illnesses of modern man, increasing the level of satisfaction of people, hence quality of life (Vuori, 2004).

Every society should incorporate sporting recreation into life of its citizens as an important factor determining the quality of life, health and work efficiency, which results in having a strong effect on the country as a whole. The awareness of importance of health and work efficiency of citizens should encourage the investment into development and quality of acting in the field of sporting recreation (Andrijašević & Širić, 2015). Regular exercise prevents long-term sick leave, mental symptoms and poor general health among working population and acts as a remedy for major public health problems (Bernaards et al., 2006, Houtman et al. 2002, Vuori, 2004).

The Programme of Public Needs in Sports of the City of Zagreb is the basic annual document which defines priorities in co-financing sports programmes by means of public money. This document also defines goals to be achieved through such investment, one of them being the inclusion of as many citizens of the City of Zagreb as possible, especially children and young people, in exercise programmes and sports. The City of Zagreb is the capital city of the Republic of Croatia with approximately 780 thousand people living in the downtown area, which accounts for almost one fifth of the population of the Republic of Croatia. Public needs in sports, the funds for which are provided from local-level budgets, include programmes, i.e. activities, jobs and tasks important for the community in question, among others sporting recreation activities of citizens (Sports Act, Article 76, Official Gazette no. 85/15). Sporting recreation is an essential need of modern humans, especially

in urban areas. The “Sport for All” movement is the primary social initiator of creative style of living promotion, thus preserving population overall health via the realization of human need for movement, physical activity and play. The cultural and civilizational attainment of a society or a community is nowadays measured according to the degree of organization, the range of activities and the number of citizens involved in active life style. “Sport for All” Zagreb Association of Sports Recreation deals with the organized sports recreation and is committed to connecting the health system, Sport for All and physical exercise in the strict sense in the city life (Programme of Public Needs in Sports of the City of Zagreb for 2018).

## Methods

This paper presents financial data on the total revenue of sport of the City of Zagreb for the period from 2009-2018, its total annual expenditure and expenditure share of the Zagreb Association of Sports Recreation in the total expenditure of sports programmes in the sport-related budget and the overall budget of the City of Zagreb. For the purpose of data processing the variable-frequency method was used, with the calculated percentages. The research results are presented by tables and graphs.

## Results

Year	Sporting recreation programmes	Sporting recreation facilities	Overall sporting recreation	Overall sports programmes	Budget of the City of Zagreb	Index 2/5*100	Index 4/5*100	Index 4/6*100
1	2	3	4	5	6	7	8	9
2009	1,936,559	2,113,840	4,050,399	309,901,921	7,493,208,000	0.6	1.31	0,05
2010	1,867,451	1,218,305	3,085,756	300,552,195	6,202,889,000	0.6	1.03	0,05
2011	1,657,637	1,471,124	3,128,761	332,819,796	6,284,912,000	0.5	0.94	0,05
2012	1,615,036	1,443,090	3,058,126	303,896,931	6,281,720,000	0.5	1.01	0,05
2013	1,755,166	1,513,650	3,268,816	316,290,363	6,638,437,000	0.6	1.03	0,05
2014	1,727,900	1,495,500	3,223,400	336,051,242	6,649,133,000	0.5	0.96	0,05
2015	1,587,400	1,206,500	2,793,900	290,630,437	6,204,867,000	0.5	0.96	0,05
2016	1,503,400	1,452,300	2,955,700	363,837,000	8,169,749,000	0.4	0.81	0,04
2017	1,503,400	1,720,300	3,223,700	367,637,000	7,248,500,000	0.4	0.88	0,04
2018	1,550,000	1,720,300	3,270,300	365,527,000	7,095,200,000	0.4	0.89	0,05
<b>TOTAL</b>	<b>16,703,949</b>	<b>15,354,909</b>	<b>32,058,858</b>	<b>3,287,143,885</b>	<b>68,268,615,000</b>	<b>0.5</b>	<b>0.98</b>	<b>0,05</b>

Table 1. Financing of sports recreation via the sports programme and the Zagreb City's Budget

Source: www.zagreb.hr; Zagreb Sports Association – facilities analytics  
Exchange rate: 1€ = 7.432 HRK; 1\$ = 6.029 HRK (the midpoint exchange rate)

Table 1 shows the finance allocations for sports recreation programmes in sport of the City of Zagreb in the period 2009-2018, the share of overall sport recreation funds in the total sport funds of the City of Zagreb and in the total expenditure of the City's budget.

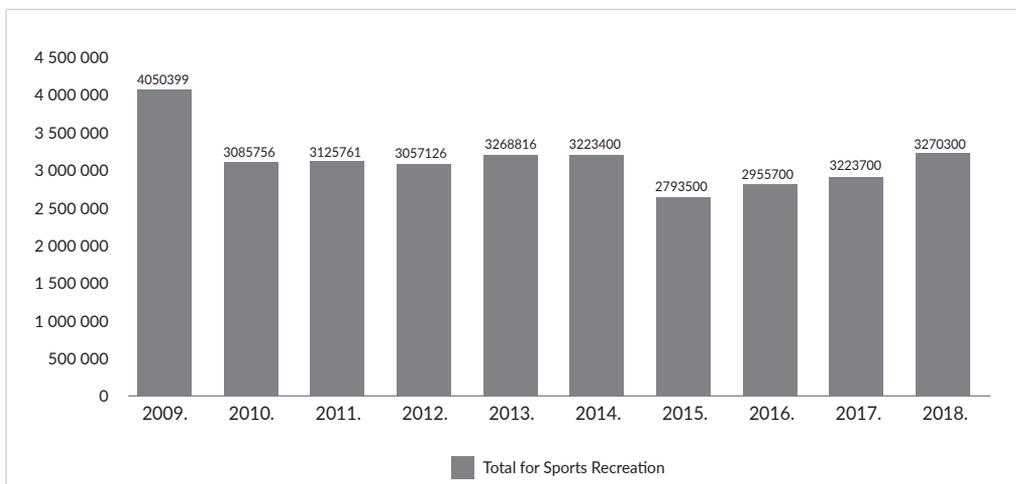


Figure 1. An overview of sports recreational resources through the period 2009-2018.

The Programme of Promoting Organized Sports Recreation is carried out by “Sport for All” Zagreb Association of Sports Recreation. The Association brings together 15 sports recreation sociates (non-profit organizations) from the City of Zagreb, carries out around 200 “Sport for All” programmes in 50 locations throughout the city for 10 to 12 thousand users. “Sport for All” programmes include the Regular Physical Exercise Programme in City districts in approximately 30 locations of local self-government units, with more than 70 groups of people exercising, including the young, the elderly and people with special needs, the Recreational Swimming Programme in City Swimming Pools offering aquaerobics, improvement of swimming techniques and competitions in the Recreational Swimming League, as well as the Nordic Walking Programme – Moving towards Health. Sports recreation competitions (Games for All) are carried out on a territorial basis, in city districts and through the activity of sports recreation associations. The events and happenings are programme-oriented to those of importance for the city, such as City Summer Programmes or City District Days, Jarun Seniors’ Meetings or Maksimir Autumn, but also national and international events such as World Walking Day, World Sport Day or International Movement Week, as well as the organization of trips, meetings or sports recreation festivals (Programme of Public Needs in Sports of the City of Zagreb for 2018).

According to membership information of “Sport for All” Zagreb Association of Sports Recreation, there are 30,000 registered citizens actively participating in recreation. However, a much larger number of citizens takes part in sports recreational activities, but they pay for their sports recreation themselves. The Association membership provides certain benefits and cheaper programmes for the user, some of which are available completely free of charge (physical exercise in local districts).

Out of 300 sports recreation associations registered in the Register of Sport Activities of the City of Zagreb, only 15 are members of the “Sport for All” Zagreb Association of Sports Recreation.

## Discussion

The share of funds allocated for sports recreation in the total funds for sport development in the City of Zagreb amounted from 0.81% to 1.31% or 0.98% on average in the period of ten years. The level of funds allocated for Sports Recreation Programme in the Programme of Sports of the City of Zagreb in the indicated period ranged from 0.4% to 0.6%, i.e. 0.5% on average. The share of funds allocated for sports recreation in total funds for City Budget of the City of Zagreb amounted on average 0.05% in the period of ten years. Nominally,

there has been a constant decrease in funds allocated for sports recreation programmes in the last ten years, with minor deviations.

While average investment in sports recreation from public needs in sport has amounted to 0.34% at the state level in the period of ten years, the City of Zagreb has committed funds from public needs in sport amounting to 1.09% of public funds on average in the period of ten years, i.e. 0.98% of total sports funds for the overall sports recreation programmes.

According to the annual Activity Report of the Croatian Health Insurance Fund for the year 2016, the largest part of total benefits paid in 2016 accounted for sickness and disability benefits amounting to HRK 1,091,915,847.00, which is an increase of 9.79% or HRK 97,389,712.00 compared to benefits paid for temporary incapacity for work in the previous year (HRK 994,526,135.00) and they account for 4.74% of total expenditures, i.e. 46.09% of total benefits. Due to temporary incapacity for work, 45,832 employees on average are absent from work on a daily basis, which accounts for 3.06% of the total number of active insured persons, i.e. 1,442 persons more than in 2015 (44 390 workers) (Activity Report of the Croatian Health Insurance Fund, 2016).

Although the data on benefits refer to the Republic of Croatia in its entirety, and not only to the City of Zagreb, the alarming fact is that the amount of HRK 1,091,915,847.00 was allocated for sickness and disability benefits in 2016, out of which the amount of HRK 685,108,887.00 or 62% accounted for sick leave benefits. According to the Statistical Yearbook of the City of Zagreb for 2017, the number of days of absence from work in the City of Zagreb in 2016 amounted to 6,054,000 (sick leave accounting for 66%) or 13.7 per active participant. On the other hand, in 2016 and 2017 the City of Zagreb alone allocated HRK 1,503,400.00 annually for sports recreation programmes, i.e. the total of HRK 2,955,700.00 – 3,223,700.00 annually, including sports facilities.

According to the report of the World Health Organization for 2012 and statistical data per countries, mortality rate according to illness types in Croatia is very serious, but is declining. For example, 23.5% of causes of death accounts for heart diseases and 14.1% for stroke. The largest share of all diseases causing death accounts for cardiovascular diseases and diabetes, as well as for cancer (the data on Zagreb in the same year show that the number of deaths caused by similar illness types amounts to 6528 out of the total of 8329 deaths). Other indicators of the World Health Organization demonstrate the prevalence of overweight adults (aged 18 and over) for the year 2016, accounting for 59.6% of the total population of Croatia. Physical inactivity has been identified as the fourth leading risk factor for global mortality (6% of deaths). The WHO Report shows that globally, 23% of adult citizens aged 18 and over is insufficiently physically active, and the common conclusion of the WHO member states is that by 2025 the number should be reduced by 10% (2010). At the same time, the data on the Republic of Croatia showed that 80.2% of adult Croatian population (aged 18 and over) is physically active, meaning that there are less than 20% physically inactive citizens, which is the global average. When it comes to adolescents (aged 11-15), the situation is alarming since there are 25.6% active adolescents, and the situation is no better at a global level either.

According to the research carried out by Ipsos Agency in June 2017 for the Central State Office for Sports, 38% of Croatian citizens take part in sports recreation (cycling, dancing, etc.) or other types of physical activity. The youngest age group (aged 15-20) takes part in physical activity much more frequently, with 72% of them being physically active at least once a week. Population aged 60 and over is least physically active and 80% of them never engages in physical activity. Croatian people prefer doing the abovementioned physical activities in open spaces, parks and nature (46%), 30% of citizens opt for a sport/fitness club or centre, while 27% of Croatians exercise at home. Health is the main motive of 61% of citizens participating in sports, recreation or other types of physical activity. Apart from health reasons, Croatian people mostly do physical activity in order to improve their fitness (38%), relax (37%), spend time with friends (29%), have fun (27%), improve their physical

appearance (25%), control their weight (18%) and improve their athletic performance (13%). For the majority of the population (61%) the type of sports and physical activities they do does not require any expenses since they prefer outdoor activities. 57% of population of the City of Zagreb and its surroundings participate in some type of physical activity.

## Conclusion

Although it has been scientifically proven that recreation has a positive impact on health, hence on the quality of life and work efficiency of citizens, and that regular exercise prevents long-term sick leave, mental symptoms and poor general health condition among working population and that it acts as a cure for major public health problems, physical activity is largely connected to the private, individual sphere. The City of Zagreb commits significant funds from its budget for the promotion of sports recreation through sports recreation associations given the small number of associations to which these funds are allocated. The comprehensive representation of overall citizen participation in sports recreation is difficult since it is carried out on several levels and through several subjects, mostly through payment itself. The latest research from 2017 show that 57% of citizens of the City of Zagreb takes part in some type of physical activity, (European average of between 13 and 72 per cent of active participation), but no systematic research on the actual number of citizens engaged in sports recreation activities. Zagreb position is better than in the Republic of Croatia, and on average at global level. However, a growing trend of citizens' self-engagement in activities such as recreational walking, marathons and various sports recreation events can be noticed. Every country, as well as local community, should pay close attention to sports recreation as a proven instrument of providing general health benefits to its citizens, and numerical indicators presented provide a strong basis. Greater involvement of sport and health systems in a joint research on this topic is needed for the purpose of common interests of improving public health and better use of public money.

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# Physiological profile of cheerleading adolescent girls in flying and basing positions

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## ABSTRACT

**PURPOSE.** This study evaluates main physical features inherent in flying and basing positions in cheerleading girls. **METHODS.** Eighteen female members of a cheerleading squad, aged 15-18 years, underwent anthropometric measurements and tests of static balance (Romberg test, «Target» test), muscle power (squat jump, countermovement jump), and isokinetic strength of knee flexors and extensors. **RESULTS.** Results showed that cheerleading girls performing basing positions, in comparison with those of flying positions, had a significantly higher body fat (16.9 kg vs. 11.1 kg,  $p < .01$ ), a higher content of musco-skeletal components of body weight (23 kg vs. 19.1 kg,  $p < .001$ ), were taller (166 cm vs. 158 cm,  $p < .05$ ), have higher body mass index (22.5 kg/m<sup>2</sup> vs. 19.3 kg/m<sup>2</sup>,  $p < .01$ ) and higher body mass (63 kg vs. 48 kg,  $p < .05$ ). In addition, mean value of peak knee extension torque was significantly higher for cheerleading girls of basing than flying positions for the right leg (97.7 Nm and 74 Nm, respectively,  $p < .05$ ) as well as for the left leg (99.2 Nm and 76.3 Nm, respectively,  $p < .05$ ). Mean value of peak knee flexion torque was significantly higher for cheerleading girls of basing than the flying positions for the right leg (73.9 Nm and 57 Nm, respectively,  $p < .05$ ). However, there were no significant between-group differences in the variables of static balance and vertical jumps. **CONCLUSION.** Cheerleading girls performing basing positions are taller, heavier, and have a higher BMI than those of flying positions. They also achieve higher isokinetic strength of knee

extensors and flexors. Such measurements of body composition and physical fitness can provide useful information on their development during training.

**Key words:** adolescents, basing, flying, body composition, isokinetic strength, static balance, vertical jump

## Introduction

Cheerleading is a type of competitive sports that includes components of acrobatics, dance, jumps, cheers, and stunting. It originates from the motivational teams for American football's intercollegiate game, whose purpose was to support players and entertain the audience (Universal Cheerleading Association, 2002). Nowadays it is a separate kind of sport implying complicated athletic performances. Organized cheerleading started as an all-male activity. Initially, participants of the squad yelled cheers, then tumble and acrobatics were added to their routines. Women were actively joining teams in the times of World War II since a lot of college-aged men went off to war (Universal Cheerleading Association, 2002). A contemporary discipline cheer is considered as a female kind of sport. It includes three main positions: flying, basing and spotting. Every position requires a special degree of flexibility and such physical features as athlete's strength and weight. An irregular trend could be observed in athlete's physical fitness status between the positions (Thomas, Seegmiller, Cook, & Young, 2004). Although it is considered to expect special anthropometric parameters for every position, very little is known about their physiological profile. Moreover, there a lot of cases of injuries that could be connected with physical requires for every position. Catastrophic injuries have increased over the years, presumably because of an increase in the gymnastic-like stunts currently common in cheerleading and inapplicable fitness level (Thomas, et al., 2004). In addition, a lifetime of adolescence or young adulthood may predispose to eating disorders such as anorexia nervosa and bulimia nervosa (Deering, 2001). Important to note, between high-school cheerleaders there is an above-average number of eating disorders (Macleod, 1998). Although athletes may not suffer life-threatening medical complications, it can lead to significant weight loss or weight gain vastly changing body composition (Thompson & Digsby, 2004). Therefore, the purpose of current study was to evaluate the main physical features inherent to flying and basing positions and compare the obtained data between different age groups of youth.

## Methods

**Subjects.** Eighteen female members of cheerleading squad were investigated. Subjects ranged in age from 15 to 18 years. Experimental procedures were conducted by highly qualified athletes in the preseason cycle of training. Subjects did not have any injuries to musculoskeletal system or any contraindications to the testing. Participants read and signed an informed agreement of MCAST.

**Measurements.** Anthropometric assessment, which included the determination of height and body weight, body composition (bioimpedance analyses, "ABC-01 Medass"). Stabilometry was performed using equipment "Stabilan-01" (the "European" way of feet position). Romberg test was performed with open and closed eyes, 1 min for each test. Test "Target" was conducted with biofeedback in a stance 20 s long. Vertical jump tests consisted of two types of jumps: squat jump (SJ) and countermovement jump (CMJ). Jump test procedure was performed on the AMTI force plate. The height of the jump was calculated from the ground reaction forces sampled at a rate of 1000 Hz. The evaluation of the speed-power capabilities of flexors and extensors of the knee joint of both legs was performed on an isokinetic dynamometer "Humac Norm" (USA, CSMI) in the isokinetic mode at the angular velocity of 180 degrees/s. Three to five maximum attempts were executed with rest intervals of at least 20 seconds.

Statistical analyses included checking the data for normal distribution by the Shapiro-Wilk's

test, the Box-Cox transformation for the failed test, and the one-way ANOVA analysis. The statistical analysis was made with the help of libraries and Python: scipy 0.19, statsmodels 0.8.

## Results

According to the results (Table 1) of bioimpedansometry, the representatives of the basing position had a significantly higher content of fat (% , kg) and, correspondingly, a higher content of skeletal muscle (kg) components of body weight. At the same time, the basing position was higher in comparison with the flying position and had a higher weight-growth index.

	Parameters	BASING (n=11)	FLYING (n=7)	p-values
Antropometry	Age, years	16.2 (1.1)	15.7 (0.7)	NS
	Body heigh, cm	166.0 (4.9)	158.0 (5.5)	p<.05
	Body mass, kg	63 (9)	48 (2.8)	p<.05
	BMI, kg/m <sup>2</sup>	22.5 (2.2)	19.3 (2.3)	p<0,1
	Body fat, %	26.5 (3.6)	23.0 (2.5)	p<0,05
	Body fat, kg	16.9 (4.1)	11.1 (1.6)	p<.01
	Muscle mass, %	36.8 (2.6)	39.7 (1.9)	p<.1
	Muscle mass, kg	23.0 (2.5)	19.1 (0.8)	p<.001
Static balance measures	CoPsquare*, mm2 (open eyes)	152.5 (105.0)	131.8 (77.0)	NS
	CoPsquare, mm2 (close eyes)	220.3 (93.9)	187.7 (67.4)	NS
	CoPvelocity, mm/s (open eyes)	7.41 (1.71)	6.9 (1.3)	NS
	CoPvelocity, mm/s (close eyes)	10.3 (2.5)	9.7 (1.9)	NS
	Quality of balance, %	69.6 (11.0)	73.6 (11,1)	NS
Isokinetic testing	MT extensor of knee, Nm(right)	97.7 (25.8)	74.0 (10.6)	p<.05
	MT extensor of knee, Nm (left)	99.2 (24.3)	76.3 (16.4)	p<.05
	MT flexor of knee, Nm(right)	73.9 (18.0)	57.0 (10.0)	p<.05
	MT flexor of knee, Nm (left)	67.0 (15.5)	52.7 (10.9)	NS
Vertical jump	CMJ <sub>h</sub> , cm	21.1 (3.2)	23.4 (2.1)	NS
	SJ <sub>h</sub> , cm	23.1 (4.0)	26.5 (2.2)	NS
	CMJ/SJ	1.11 (0.11)	1.13 (0.07)	NS

Table 1. Influence of main cheerleading positions on physical fitness status and body composition of female young athletes (n=18); data are means ( $\pm$ SD)

\* CoP – center of pressure, CMJ<sub>h</sub> – countermovement jump height, SJ<sub>h</sub> – squat jump height, MT– maximal torque, NS – non-significant.

The unexpected absence was noticed of significant differences in flying position in terms of static equilibrium. From our point of view, the specificity of the competition and training activities of the “flyers” presented increased requirements for postural control, especially for complex supports performance at altitude. Probably, examining female athletes of higher qualifications and using more specific equilibrium tests, it would be possible to see these differences. According to the results of stabilography in our study, the “flyers” insignificantly demonstrated smaller values of the area and velocity of the center of pressure movements both in the rack with open eyes and with closed eyes and the higher quality of the equilibrium function.

The results of our study indicate that cheerleading basing position demonstrated significantly higher values of knee extension/flexion peak torque compared to flying position (Fig.1).

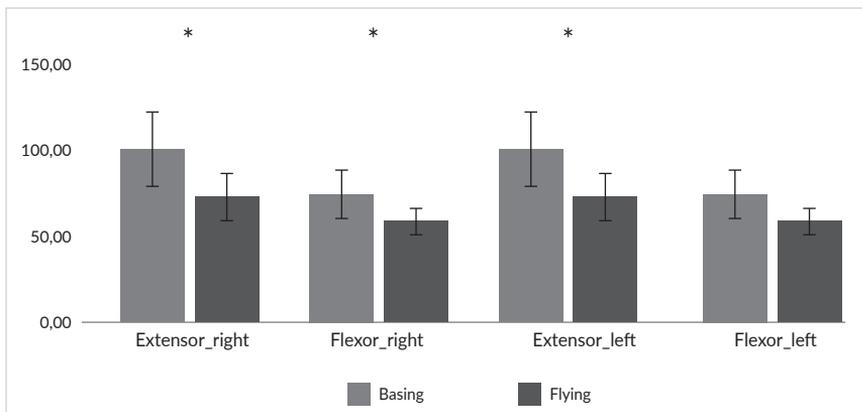


Figure 1. Knee extension/flexion peak torque of cheerleaders, Nm.

The absence of significant position differences in the results of the vertical jump test among cheerleading athletes makes it possible to assume an equally topical high ability for athletes' leg power, determined by this test. Competitive compositions in this discipline of cheerleading are saturated with hopping elements, which are performed by all team members (Thomas, 2004; Universal Cheerleading Association, 2002). The ratio of the heights of CMJ / SJ jumps, characterizing the effectiveness of the use of elastic properties of muscles and tendons by athletes, in both positions was > 1, which indicates a high level of this ability (McGuigan, Doyle, Newton, Edwards, et al., 2006).

## Discussion

Training specificities of sports as gymnastics, rock-and-roll-dancing, figure skating, resemble cheerleading activity. For instance, the mean BMI of female cheerleaders flying position in our research (Fig.2) were similar to those reported for elite female athletes in figure skating: 16 (2.5) years BMI 19.8 (2.1), respectively (Ziegler, Nelson, & Jonnalagadda, 2003), as well as rhythmic and artistic gymnastics athletes (16 years, BMI 18.6) (Georgopolous, Markou, Theodoropoulou., et al.,2004; Malina, Baxter-Jones, Armstrong, Beunen, Caine, Daly, Lewis, et al., 2013). In our investigation low level of postural stability of athletes is noticeable. Relying upon Zemkova (2014) in research regarding disciplines with difficult acrobatic skills, mentioned that decrease in postural stability may be produced by intensive bouncing exercises.

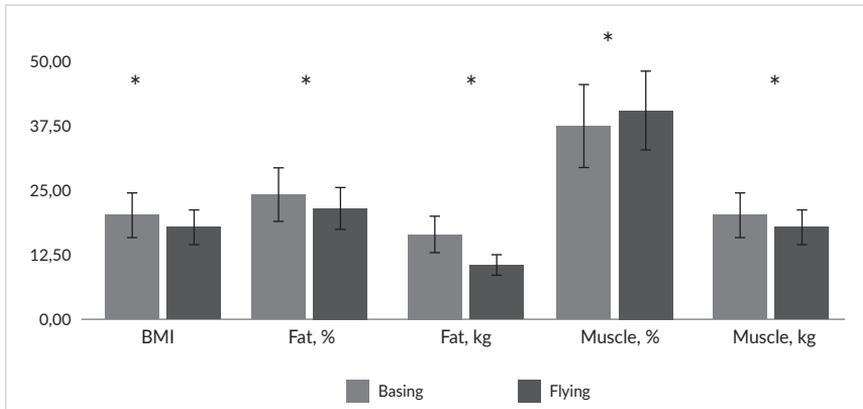


Figure 2. Body composition of adolescent cheerleaders

The main physical abilities of gymnasts are strength, speed, flexibility, skill and muscular endurance (Arkaev & Suchilin, 2004; Marina, Jemni, Rodríguez & Jimenes, 2012; Monem, Sands, Salmela, Holvoet & Gateva, 2011). Only developing these skills from the earliest ages of specialization with regular practice can lead to success in gymnastics and high-level achievements.

The development of leg power is an important component for success in a variety of sports. Vertical jump test is considered to be the most effective tool for assessing leg power and, therefore, a valid predictor of athletic performance (De Salles, Vasconcellos, De Salles, et al., 2012; Hoffman, Epstein, Einbinder, & Weinstein, 2000; Wisløff, Castagna, Helgerud, et al., 2004).

During cheerleading performance, both flying and basing positions are involved in jumping and hopping activities. Thus, it can be assumed, that jump height could be an important variable in physiological profile of a successful cheerleader (for both positions).

CMJ/SJ height ratio, which is also known as eccentric utilization ratio (EUR) (Hawkins, Doyle & McGuigan, 2009; Impellizzeri, Rampinini, Castagna, Martino, Fiorini & Wisloff, 2008; McGuigan, et al., 2006), indicates the ability of an athlete to use elastic energy of the muscle-tendon complex to enhance countermovement jump height. We believe that EUR, as well as SJ and CMJ height, must be included in a profile as an indicator of cheerleader's plyometric performance.

## Conclusions

To sum up, the results of this study revealed the significant differences in physical and physiological characteristics between flying and basing positions of cheerleaders. That is why an individual approach to every athlete is so substantial during training process. In addition, the data obtained on stabilometry and leg power assessment are necessary for planning optimal accurate programs of the core-strength and speed-strength training for every position in cheerleading.

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# Objective assessment of gymnasts' dynamic posture using the functional movement screen

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## **ABSTRACT**

**PURPOSE:** To find out if gymnasts are prone to injury based on their dynamic stability assessment results. The aim is to verify the observations made with the Functional Movement Screen (FMS) test via the objective method – Kinovea, video-analysis software. To the best of the authors' knowledge, there exists no previous research using the FMS to assess young gymnasts. Furthermore, no scientific report has been published showing a precise analysis of the FMS via Kinovea. The seven movement tests, used in the FMS, have different positions and movements that reveal gymnast's weaknesses and asymmetries; therefore, they can help identify a level of athlete's injury risk as well as provide the basis of testing for potential injuries. This information may be of benefit to trainers and physiotherapists in the injury prevention protocol. **METHODS:** The sample consisted of 10 adolescent competitive gymnasts (6 male and 4 female), mean age 11.57 years, body height 138.87 cm, body weight 34.04 kg. The FMS test included seven subtests: deep squat, hurdle step, in-line lunge, shoulder mobility, active straight leg raise, trunk stability push-up and rotary stability. It is used as a diagnostic procedure for assessing postural stability and mobility, and for the broader purpose of preventing professional injury. The movements were recorded by two digital video cameras. Objective assessment was conducted using Kinovea video-analysis software, with the FMS scores based on the criteria established by Cook et al. (2010) and on kinematic equivalents adapted from Whiteside et al. (2016). The results were analysed by descriptive statistics and presented in tables. **RESULTS:** The total mean score of the FMS test for the overall sample is 14.12. The average score for males (14.5) is higher than the average score for females (13.75). We can conclude that our participants are not at risk of injury. The lowest average scores were measured in shoulder mobility (1.12), deep squat (1.15) and rotary stability (1.87), while the highest scores were measured in active straight leg raise (2.87), hurdle step (2.41) and in-line lunge (2.41).

**CONCLUSION:** Competitive young gymnasts do not have increased risk of injury, since they have achieved a score higher than 13, which represents the cut-off score for high-school athletes.

**Key words:** gymnastics, stability, mobility, FMS, Kinovea movement video-analysis software

## **Introduction**

The International Gymnastics Federation (Fédération Internationale de Gymnastique-FIG) defines Artistic Gymnastics as an Olympic sport divided into Men's and Women's Artistic Gymnastics, which differ in the number and type of gymnastic events. Gymnastics, as one of the basic kinesiological activities, is listed into the group of conventional aesthetic sports according to the criterion of structural complexity of movement patterns (Milanović, 2013), and into aerobic sports according to the criterion of dominant energy processes. The most important motor skills are: coordination, explosive strength, flexibility, balance and speed. As many as 1327 technical elements appear in the Manuals of both Women's and Men's Gymnastics. The prescribed techniques of 527 elements can be found in the Manual of Women's Gymnastics (Vault 80; Uneven Bars 155; Beam 189, Floor 103), and we can find as many as 800 prescribed techniques of gymnastic elements in the Manual of Men's Gymnastics (Floor 137; Pommel Horse 118; Still Rings 144; Vault 104; Parallel Bars 155; Horizontal Bar 142) (Živčić Marković & Krističević, 2016).

Experience of coaching at the Novi Zagreb Gymnastics Club enables us to observe distinctive features in gymnasts' dynamic posture and stability-mobility relationship. Stability and mobility (dynamic stability) can be evaluated by various tests, and nowadays the assessment tool often used is Functional Movement Screen (FMS). The FMS consists of seven tests, with the maximal composite score of 21 (3 in each subtest). In order to achieve the best score (3), a participant must perform on the test efficiently without any mistakes. Performing the movement pattern with minimal deviations and compensations is evaluated with a score of two, and movement with greater deviations or loss of balance is scored one (Stobierski et al., 2015). It is also evaluated whether the body shows dorsoventral and bilateral asymmetry (Cook et al., 2010; 2014a; 2014b). FMS performance, especially when conducted on populations of athletes, is analysed by various researchers via different methods. In their systematic review, Moran et al. (2016) distinguished two ways of evaluating FMS performance: live ratings and video ratings. Since video ratings are also based on observational assessment principles, there is a need for truly objective assessment. The aim of the research is to objectify results of the observational screening FMS test, using the method of Kinovea software video-analysis. According to the authors' reference to the existing literature, FMS study has not yet been attempted on gymnasts neither has a scientific report, showing a precise FMS analysis using Kinovea video-analysis software, been published.

## **Methods**

The sample comprised 10 adolescent competitive gymnasts (6 males, aged  $11.3 \pm 0.39$  years, BH  $136 \pm 1.38$  cm, BW  $32.3 \pm 0.36$  kg, and 4 females, aged  $11.84 \pm 0.66$  years, BH  $141.75 \pm 5.81$  cm, BW  $35.78 \pm 2.47$  kg). The Functional Movement Screen (FMS) system was used for injury risk assessment. There are numerous studies that has proven its reliability (Bonazza et al., 2017; Minick et al., 2010; Moran et al., 2016; Schneiders et al., 2011; Teyhen et al., 2012;). Movement models tested in the FMS put the athlete in a position in which the limits of functional movement can be identified, e.g. asymmetry, which is a potential predictor of injury. The FMS consists of seven tests: deep squat, hurdle step, in-line lunge, shoulder mobility, active straight leg raise, trunk stability push-up, and rotary stability tests (Cook et al., 2010). Five out of 7 tests are bilateral. The protocol of the tests and evaluation of FMS scores is described in detail in literature (Cook et al., 2010;

2014a; 2014b; Teyhen et al., 2012). The movement performance was recorded by two digital video cameras (Canon EOS 550D model) located in the sagittal and frontal planes. FMS scores were measured using Kinovea software. Kinovea is a simple but popular tool used for basic kinematic analysis (Kinovea, 2013). It is easy to measure joint angles using Kinovea; by using any single known length, Kinovea is able to calculate distance and its derivatives, speed and acceleration. Table 1 lists FMS scoring criteria and its kinematic equivalents.

<b>FMS 1: Deep Squat</b>	
Upper torso is parallel toward vertical	Trunk lateral shift < 10°
Upper torso is parallel with tibia	Trunk sagittal shift < 20°
Knees are aligned over feet	Calf lateral shift < 15°
Dowel aligned over feet	AP shift from line passing through ankle joint < 15 cm
<b>FMS 2: Hurdle Step</b>	
Hips, knees, and ankles remain aligned in the sagittal plane	LL shift of calf < 15°
Dowel and hurdle remain parallel	Shift from hurdle parallel < 7,5°
<b>FMS 3: In-line lunge</b>	
Dowel remains vertical + No torso movement	AP or LL shift < 7,5°
Knee touches board behind heel of front foot	Vertical or AP knee displacement < 5 cm
<b>FMS 5: Active Straight Leg Raise</b>	
Beyond the middle of the thigh (score 3)	Distance from line through lat. malleol is > half of thigh length
Between the middle of the thigh and knee (score 2)	Distance from line through lat. malleol is < half of thigh length
Not beyond the knee (score 1)	Distance from line through lat. malleol is < thigh length
<b>FMS 6: Trunk Stability Push-up</b>	
Body lifts as a unit with no lag in the spine	No deviations from line connecting sacrum, thoracic kyphosis and occipitum
<b>FMS 7: Rotary Stability</b>	
Performs a correct unilateral repetition	Hyperextension in hip joint
	Distance from elbow to knee joint < 10 cm

Table 1. FMS scoring criteria using Kinovea

For the purpose of FMS scoring, we used the exact original criteria as set by Cook et al., 2010. However, in order to utilise benefits provided by Kinovea software, we adapted and slightly modified the set of kinematic criteria developed by Whiteside et al., 2016. The modifications are as follows: Whiteside kinematic criteria equivalents were simplified, L5S1 movement was not measured because of different measuring techniques and in FMS 5 tested thigh length was used rather than the length of the adjacent side. The FMS 4: Shoulder Mobility is the only FMS subtest that was not scored using Kinovea software, since that test employs very objective measurements for scoring and there is no need for

kinematic equivalents. The FMS has been applied and rated exactly how Whiteside et al. (2016) have suggested. All participants performed each task three times, and the best attempt was extracted for further analysis. The results have been analysed by descriptive methods.

### Results

Ten young gymnasts were measured, six males and four females. The basic anthropometric characteristics of the participants are presented in Table 2.

	Age		Height (cm)		Weight (kg)		BMI	
	$\mu$	$\sigma$	$\mu$	$\sigma$	$\mu$	$\sigma$	$\mu$	$\sigma$
Males	11.3	0.39	136	1.38	32.3	0.36	17.47	0.45
Females	11.84	0.66	141.75	5.81	35.78	2.47	17.81	0.77

Table 2. Basic parameters

The lowest average scores were measured in shoulder mobility (1.12), deep squat (1.15) and rotary stability (1.87), while the highest scores were reported for active straight leg raise (2.87), hurdle step (2.41) and in-line lunge (2.41). Distributions by gender are presented in Table 3.

	FMS 1	FMS 2	FMS 3	FMS 4	FMS 5	FMS 6	FMS 7
Males	1.3	2.33	2.33	1	3	2.5	2
Females	1	2.5	2.5	1.25	2.75	2	1.75

Table 3. Average FMS values per test measured with the help of Kinovea software

Combined FMS scores are shown in Table 4, with the total mean score for the overall sample being higher than 14 (14.12).

	$\mu$	$\sigma$	Min	Max
Males	14.5	1.05	13	16
Females	13.75	0.5	13	14

Table 4: FMS scores

### Discussion

The mean score of the FMS test for the overall sample is 14.12. The score for the group of boys is 14.5 and 13.75 for girls. According to the measured scores, we can conclude that our participants are not at risk of injury. The average normative values for the FMS in preteen and teen populations (10 to 17 years) are shown in a study by Abraham et al. (2015). The study presented 14.59 as a normative value, which is slightly lower than the one applied by Schneiders et al. (2011) for active young people. Schneiders' score ranged from 14.4 to 15.7. Another study reported an average score of 16.9 for professional football players (Kiesel, Butler, & Plisky 2014). Bardenett et al. (2015) also proposed normative values for high-school athletes (age 13-18) of 13.0 for both males and females. Krumrei et al. (2014) investigated accuracy of the FMS to identify individuals with an elevated risk of musculoskeletal injury, questioning the universality of the limit value of  $\leq 14$ , concluding that the responsiveness and predictive accuracy of the FMS may be enhanced by using an alternative cut-off score. The aforementioned authors suggest that further studies of the

FMS are needed with other physically active populations, which is one of the goals of our research. Only one scientific report (the recent paper by Saki, 2017) has been published using the Kinovea video-analysis software for the FMS assessment, but it was used only for observational video analysis, whereas our research used a more precise evaluation methodology. Saki used Kinovea video-analysis software for the Functional Movement Screen in elite basketball players. The research procedure was to have subjects perform each task two times; along with that the raters could observe the video records of the participants' FMS test without any restrictions. The author claims video analysis is limited and may affect the raters' scoring. In our research, all participants performed each task three times, and the best attempt was further analysed. Many authors (Beach, Frost, & Callaghan, 2014; Minick et al., 2010; Stobierski et al., 2015) suggest performing post-assessment via video observation, emphasizing that composite FMS scores are reliable when graded by experienced observers on the basis of video recordings. Since the Kinovea method is objective in its nature, an examiner's experience should not be a significant factor. Moran et al. (2016) examined the reliability of FMS scores, concluding that ratings made from live observation were superior to those made from viewing of video recordings. In order to utilize the benefits of video analysis for FMS scoring, we suggest that Kinovea generated scoring should be preferred over that made from an observational analysis of a recorded video.

## Conclusion

Through the examination of gymnasts' posture, we noticed a specific postural adaptation developed by day-to-day exercise with optimal mobility of lower limbs, which is significantly reduced in upper extremities. Sport-specifically, participants attained very good scores in the FMS hurdle step and in-line lunge tests, which are biomechanically similar to gymnastics tasks. Gymnasts do not belong to a group with increased risk of injury, since they have achieved a score higher than 13, which represents the cut-off score for high-school athletes. When using video analysis for FMS scoring, we recommend the Kinovea software approach instead of the insufficient objective observation of video recordings.

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# Evaluating injury risk in female karate athletes: bilateral and unilateral asymmetries of isokinetic strength

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## **ABSTRACT**

**BACKGROUND:** Karate, currently one of the most practised individual martial arts and non-Olympic sport, will be included in the Olympic Games for the first time in 2020. As sport, karate comes in two forms, kumite (combat sport) and kata (martial art) (Vujkov et al., 2015; Kotrljanovic et al., 2016; Koropanovski et al., 2017). Development of modern karate is associated with the increased involvement of science, which significantly influences the process of athlete preparation. Development of motor skills is the core of karate training, as they constitute the basis upon which combat techniques are formed (Truszczyńska et al., 2015). Although injuries in martial arts are frequent, it is incumbent on the scientific community to propose ways to decrease their incidence (Arriaza et al., 2016). Therefore, in order to evaluate injury risk, as well as to develop a knee injury rehabilitation program, an isokinetic dynamometer for evaluating knee strength has been used (Crosier, 2002; Impellizzeri et al., 2008). The so-called bilateral deficit occurs during bilateral movements where the withstood load is less than that observed in the summed-up unilateral motions (sum of both sides) (Daneshjoo et al., 2013). Asymmetry between the dominant and non-dominant limbs is in direct correlation with increased risk of injury (Knapik et al., 1991). The type and rates of martial arts injuries are often dependent on the techniques, rules, and protective equipment. However, the hypothetical effects of different requirements on muscle imbalances and the risk of injuries are unknown. Using various isokinetic tests, several authors have observed lower limb bilateral and unilateral asymmetries in athletes practicing different martial arts (Drid et al., 2009a; Drid et al., 2011; Rađo et al., 2011; Golik-Perić et al., 2011). Data obtained by isokinetic testing could be of great importance for every athlete and coach, because they enable precise training plans. Furthermore, isokinetic testing is of great importance for female karate athletes since they are typically endomorph somatotypes, with the total percentage of fat along with subcutaneous adipose tissue negatively affecting strength (Kapo et al., 2015). The imbalance of strength between hamstrings and quadriceps is an important predictor of the

risk of injuring the hamstrings (Crosier et al., 2002) and anterior cruciate ligaments (More et al., 1993). Unilateral, and bilateral, imbalance in muscle strength of lower limbs may cause specific types of injury, including hamstring sprain or tear (Carvalho et al., 2016). Muscle asymmetry (Scattone-Silva et al., 2012) of lower limbs (due to the specific techniques), and the possibilities of injuring the ankle joint, hip joint, or knee, have been specifically investigated (Probst et al., 2007). Scattone-Silva et al (2012) have concluded, based on the estimation of muscular efficiency of the dominant and non-dominant limbs, that imbalance between agonist and antagonist muscles (the knee and elbow joints) was less than 10%. Therefore, they concluded that daily practice of karate does not lead to bilateral asymmetry of either the lower or upper limbs, which is associated with the risk of injury. **OBJECTIVE:** This study aims to investigate and compare muscle imbalances in female karate athletes of different age groups. **METHODS:** The study sample consisted of three groups: 10 cadet, 10 junior, and 10 senior female karate athletes. The following isokinetic parameters were gathered: ratio of right/left leg extensor force, ratio of right/left leg flexor force, ratio of right leg quadriceps/hamstrings, ratio of left leg quadriceps/hamstrings, ratio of right/left shoulder internal rotation, ratio of right/left shoulder external rotation, ratio of internal/external rotation in the right shoulder, and ratio of internal/external rotation in the left shoulder. **RESULTS:** The ratio of extensor and flexor muscles of the left and right leg in female karate athletes of different ages did not show statistically significant differences between the groups. The hamstring/quadriceps ratio of the left leg in female karate athletes of different ages showed statistically significant differences and high effect size (22%). The ratio of internal and external rotation of the right/left shoulder in female karate athletes of different ages did not show statistically significant differences between the groups ( $p > 0.05$ ). Finally, the quadriceps/hamstring ratio of the left leg was significantly higher in senior than in junior athletes. **CONCLUSIONS:** One possible cause of asymmetry is that the junior athletes favoured use of one foot unilaterally for kicking. The results indicate that this group of karate athletes may have demonstrated sport-specific adaptations in certain strength measurements, but they showed no increased risk for knee injury.

**Key words:** martial arts, knee, shoulder, muscle imbalances

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# Changes in physical fitness in pre-school children involved in different forms of physical activity

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## **ABSTRACT**

**AIM:** The aim of the study was to assess changes in physical and motor development of children aged 4-5 years from various kindergartens in the city of Szczecin, NW Poland. We compared 3 groups: children taking swimming classes, those training karate, aikido and dancing, and those not taking part in any additional sports activities. **METHODS:** Measurements of somatic and motor development (the Wrocław Physical Fitness Test by B. Sekita) were performed twice – before and after a year-long series of additional sports classes. **RESULTS:** The largest increases in weight and body height were recorded in the group of children taking part in swimming classes. The highest progress in the explosive leg power test scores was recorded in girls taking part in swimming classes. This groups, however, showed a regress in the speed test scores. Compared to girls, boys showed smaller differences in the levels of the tested traits between those taking part in swimming classes and the group training other sport disciplines. **CONCLUSIONS:** 1) Swimming was more effective in stimulating the development of physical fitness in the tested pre-school girls than in boys. 2) In the tested pre-school girls, swimming classes had the strongest influence on changes in physical fitness, which was not observed in pre-school boys. 3) The tested pre-school girls showed a higher level of motor development than pre-school boys.

**Key words:** children aged 4-5 years, swimming, martial arts, dancing

## **Introduction**

At the age of 4-5, an average child experiences an increase in its height by 5-7 cm and body weight by 2-3 kg. There is a gradual improvement in locomotor movements and other activities associated with the manipulation of objects. It is the period when children achieve a high level in movements associated with plays and sports. They are able to throw and grab the ball, kick the ball at the end of a run, and some of them manage to perform a long jump. This is also a period of a high increase in coordination of movements and sense of rhythm (Umiastowska, Makris 2000). Children exhibit a biological need for movement, which leads to their enormous mobility, stimulating the development of the body and facilitating the acquisition of motor skills and motor experience. The motor development in pre-school children reveals sexual dimorphism, consisting in the diversification of fitness and preferred activities between boys and girls (Przewęda 1980). The presented work attempts to find a relationship between physical and motor development of pre-school children and targeted physical activity. The research involved 606 Szczecin preschoolers aged 4 and 5 years, participating in additional classes of either swimming (96 girls and 101

boys), or karate, aikido and dancing classes (109 girls and 105 boys), as well as those who did not take part in any additional sports classes (98 girls and 97 boys). On the basis of many years of experience in conducting swimming lessons, literature on the subject and research scores, we adopted a research hypothesis that children taking part in swimming classes would exhibit greater increases in physical fitness than those active in other fields or those not taking any additional classes.

## Methods

The tests included the Wrocław Physical Fitness Test for children aged 3-7 (Sekita Test) consisting of four fitness tests: arm strength – a medicine ball (1 kg) overhead throw, explosive leg power – standing long jump, speed – run over the distance of 20 m from a standing start, and agility – a “swing” run 4 x 5 m carrying a block. The results were converted into point scores based on tables (from 1 to 100 points), which made it possible to compare the tests (Sekita, 1988). We also calculated the general fitness score – an arithmetic mean of all 4 scores. The changes in children’s somatic development were assessed on the basis of two basic parameters of weight and body height. All measurements were performed twice in the same group of respondents – before and after their annual participation in additional sports classes. The Student’s t-test was used for statistical analysis (t was calculated, while  $t_{\alpha}$  was taken from the distribution table at  $\alpha=0.05$ ), using calculation procedures of the Excel spreadsheet.

## Results

After the one-year study period, the largest increases in height and weight were recorded in the group of children who took part in swimming classes. In girls, an increase in body height was 6.76 cm and in boys it was 6.45 cm. The smallest body height increments were recorded in the group of girls training aikido, karate or dancing (5.50 cm) and non-training boys (5.92 cm) (Figs. 1 and 2).

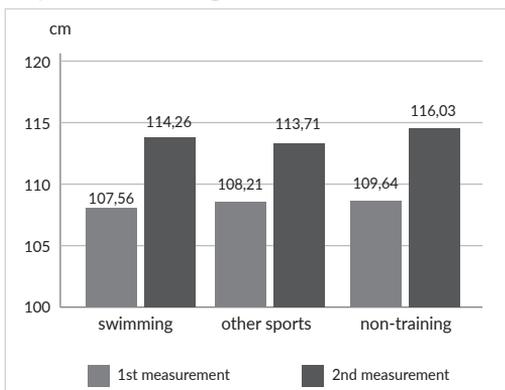


Figure 1. Body height of the studied girls (source: own research).

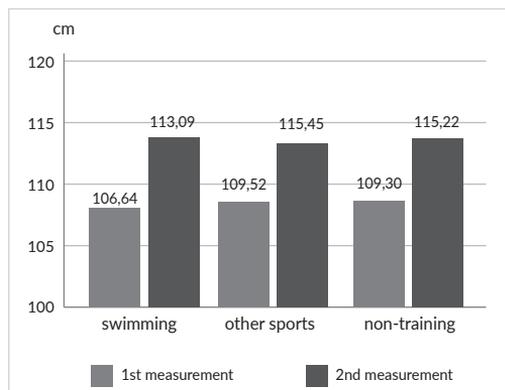


Figure 2. Body height of the studied boys (source: own research).

After the one-year study period, the largest increases in body weight were recorded in the group of children who took swimming classes – in girls it was 2.04 kg, and in boys 2 kg. The smallest mass increase was recorded in the group of girls training other sports (1.4 kg) and boys (1.68 kg) (Figs. 3 and 4).

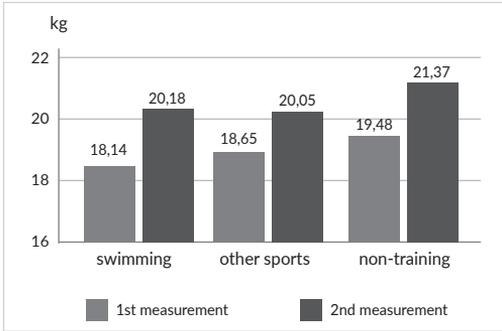


Figure 3. Body weight of the studied girls (source: own research).

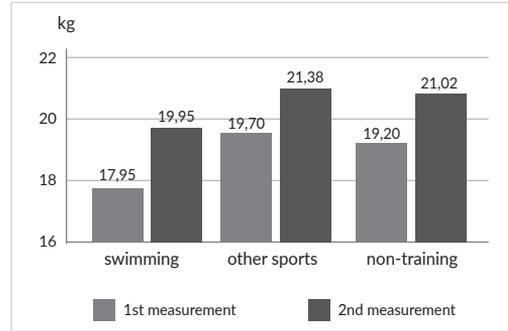


Figure 4. Body weight of the studied boys (source: own research).

After a year-long involvement in additional sports classes, we found a regress in pre-school girls' speed. Girls who took swimming classes had lower running test scores by 0.42 points, and training girls by 6.27 points. However, in the non-training group, the speed improved by 0.58 points. In boys, an increase in speed test scores was recorded in all the groups studied. The biggest improvement was found in boys training aikido, karate or dancing – by 4.12 points, and the smallest in swimmers – by 1.49 points (Figs. 5 and 6). Differences in the speed tests level between the first and the second measurements were statistically insignificant in girls, at  $\alpha=0.05$  (swimming classes  $t=0.161 < t_{\alpha}=2.037$ , other sports classes  $t=0.442 < t_{\alpha}=1.992$ , non-training  $t=1.578 < t_{\alpha}=1.985$ ) and in swimming boys ( $t=0.623 < t_{\alpha}=2.048$ ). On the other hand, statistically significant differences between the measurements were recorded in the group of boys training sports other than swimming ( $t=4.257 > t_{\alpha}=1.992$ ) and in non-training boys ( $t=5.247 > t_{\alpha}=1.985$ ).

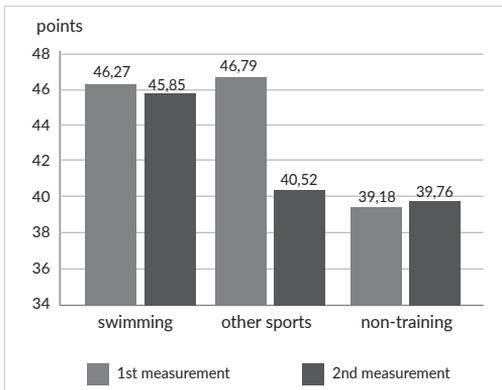


Figure 5. Speed test scores in the studied girls (source: own research).

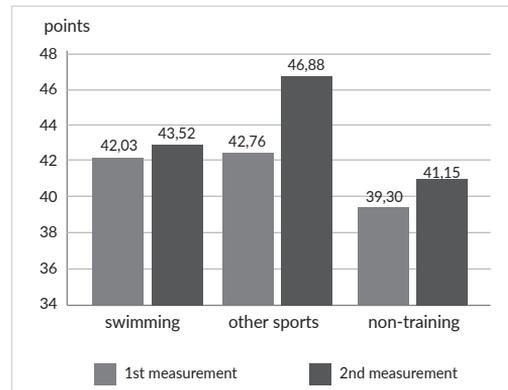


Figure 6. Speed test scores in the studied boys (source: own research).

The highest increase in explosive leg power was observed in girls taking part in swimming classes (by 6.08 points), while in non-training girls no change was noted ( $d=0.03$  points). In all groups of boys there was an increase in explosive leg power, the highest in the swimming group (by 5.28 points), then in the training group (4.09 points), and the non-training group (2.67 points) (Figs. 7 and 8). Differences in explosive leg power increases between the first and the second measurements in the studied groups of children were statistically significant at  $\alpha=0.05$  (swimming girls  $t=3.660 > t_{\alpha}=2.037$ , girls training sports other than swimming

$t=6.201 > t_{\alpha}=1.992$ , non-training girls  $t=4.772 > t_{\alpha}=1.985$ ; and swimming boys  $t=3.352 > t_{\alpha}=2.048$ , boys training sports other than swimming  $t=6.692 > t_{\alpha}=1.992$ , non-training boys  $t=7.958 > t_{\alpha}=1.985$ .

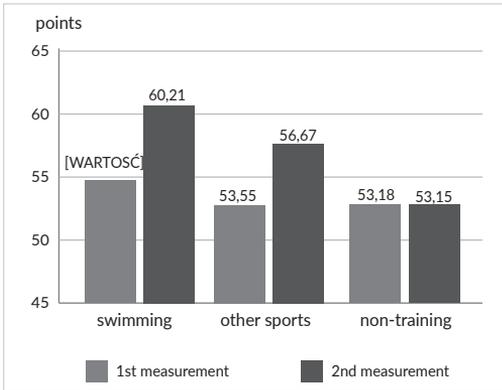


Figure 7. Explosive leg power test scores in the studied girls (source: own research).

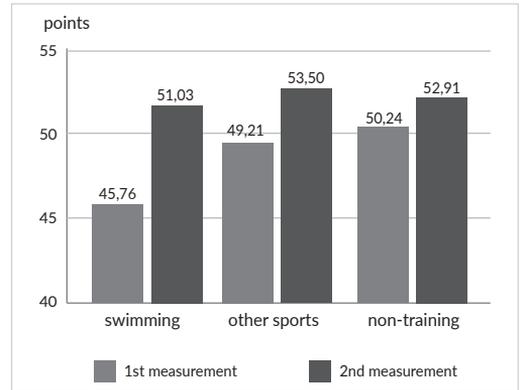


Figure 8. Explosive leg power test scores in the studied boys (source: own research).

The analysis of arm strength test scores after one year showed an increase in girls who took part in swimming classes by 2.36 points, and regression in the non-training group (5.27 points) and in girls training karate, aikido, or dancing (3.12 points). An increase was recorded in the group of swimming boys (2.55 points), and regress in the group training other sports (by 1.21 points). In boys from the non-training group, the increase between the first and second measurement was 0.18 points (Figs. 10 and 11). The difference in the arm strength test scores between the first and second measurement in the group of swimming girls was statistically significant at  $\alpha=0.05$  ( $t=2.410 > t_{\alpha}=2.037$ ). In the girls training sports other than swimming and non-training girls, they were statistically insignificant (training girls  $t=1.324 > t_{\alpha}=1.992$ , non-training girls  $t=0.979 < t_{\alpha}=1.985$ ). In contrast, in swimming boys, the difference between the measurements was statistically insignificant at  $\alpha=0.05$  ( $t=1.962 < t_{\alpha}=2.048$ ), and in the statistically significant in the remaining groups (boys training sports other swimming  $t=2.198 > t_{\alpha}=1.992$ ; non-training  $t=2.357 > t_{\alpha}=1.985$ ).

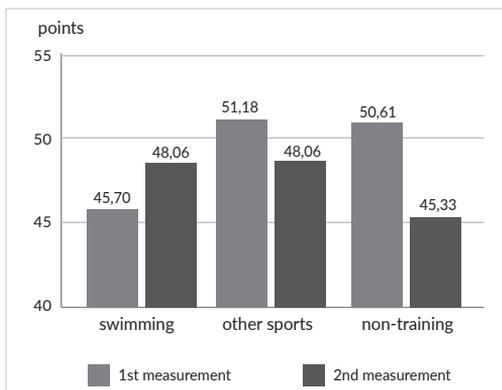


Figure 9. Arm strength test scores in the studied girls (source: own research).

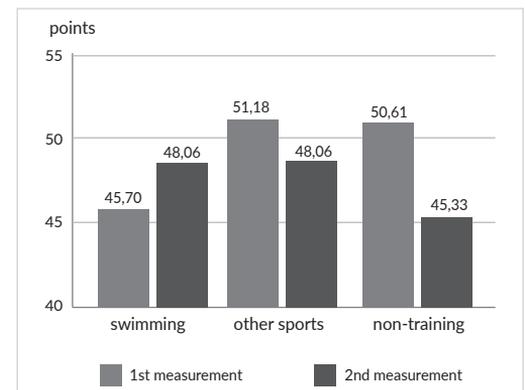


Figure 10. Arm strength test scores in the studied boys (source: own research).

Agility test scores showed the highest increase in the group of training girls 4.55 points, and the smallest in the group of swimming girls – by 2.65 points. In the boys, the highest increase in agility was recorded in the training group (3.06 points), and the smallest in the

swimming group – by 0.15 points (Figs. 11 and 12). The differences between the first and the second measurement were statistically significant at  $\alpha=0.05$  in all groups of children (girls training sports other than swimming  $t=3.643 > t_{\alpha}=1.992$ , non-training girls  $t=2.888 > t_{\alpha}=1.985$ ; and swimming boys  $t=3.022 > t_{\alpha}=2.048$ , boys training other sports  $t=5.966 > t_{\alpha}=1.992$ , non-training boys  $t=6.040 > t_{\alpha}=1.985$ ). The only exception were swimming girls ( $t=0.140 < t_{\alpha}=2.037$ ).

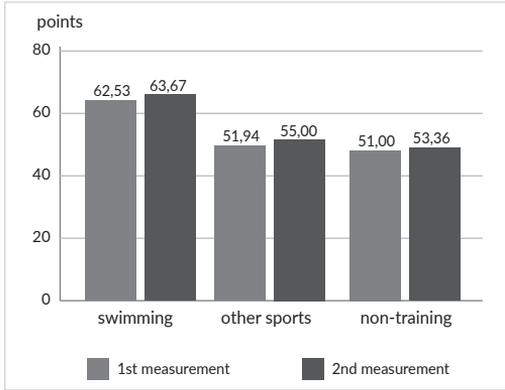


Figure 11. Agility test scores in the studied girls (source: own research).

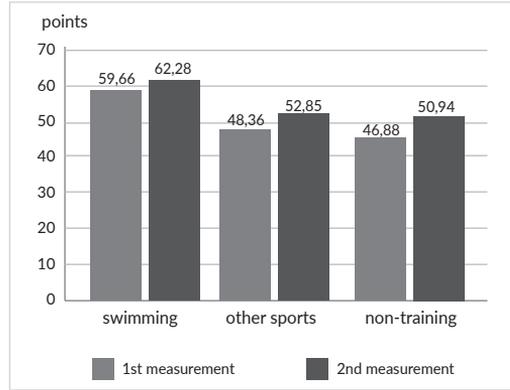


Figure 12. Agility test scores in the studied boys (source: own research).

In the second measurement, the analysis showed the highest increase in general fitness (the total of the four aforementioned tests) in swimming girls (by 2.03 points). A regress was recorded in girls training other sports (by 1.05 points) and in the non-training group (by 0.59 points). The differences in general efficiency between the first and the second measurement in all the analyzed groups were statistically significant at  $\alpha=0.05$  (swimming girls  $t=2.084 > t_{\alpha}=2.037$ , training  $t=3.501 > t_{\alpha}=1.992$ , non-training  $t=4.180 > t_{\alpha}=1.985$  and boys swimming  $t=2.941 > t_{\alpha}=2.048$ , training  $t=7.784 > t_{\alpha}=1.992$ , non-training  $t=9.047 > t_{\alpha}=1.985$ ).

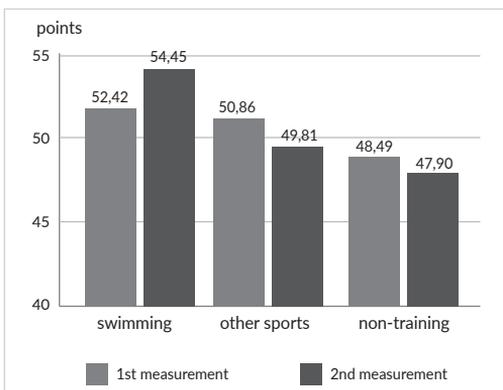


Figure 13. General fitness scores in the studied girls (source: own research).

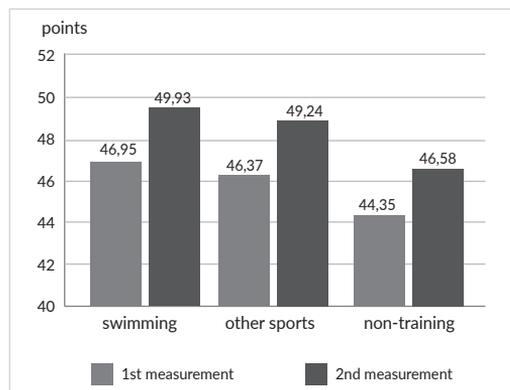


Figure 14. General fitness scores in the studied boys (source: own research).

## Discussion

According to B. Łaciak, childhood in the 21st century has a slightly different character than it used to be because, in addition to functioning in real life (family and peer environment) children also live “in a virtual world created by television, video, computer games or the

Internet” (Łaciak 2005, p.56). Interest in physical activities is definitely weakening among children, which is manifested by the declining share of physical activities among the forms of spending free time. Research conducted among American children showed that motor skills were associated with an increased amount of distance covered by the subjects during the day, but did not affect manipulation of objects (Robinson, Wadsworth, Peoples 2012). Another study, on Finnish 4-year-olds, showed a positive relation between mobility and development skills, with increased physical activity of children (Iivonen, Saakslähti, Mehtala 2013). PD Loprinzi, RE Davis and YC Fu showed the influence of participation in sports competitions on motor development in later years (Loprinzi, Davis, Fu 2015).

### Conclusions

- 1) Swimming strongly stimulated the development of physical fitness in pre-school girls.
- 2) In the studied pre-school girls, swimming classes had the strongest influence on the changes in physical fitness as opposed to pre-school boys, in whom the type of additional activities did not influence changes in physical fitness.
- 3) Pre-school girls showed a higher level of motor development than pre-school boys.

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# Physical movement and healing in alternative medicine: in perspective of sociology of leisure and mass culture

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## **ABSTRACT**

**PURPOSE:** Health is such a precious value that people often look for non-standard, natural methods of caring for health or therapy. To what extent does movement (physical exercise) combine with alternative methods of treatment and self-treatment? The analysis takes into account selected traditions and methods, according to their presence in mass culture. The terms “health” and “man” are understood holistically. **METHODS:** The analysis of the content of mass media and popularizing literature as well as the analysis of the literature on the subject were used. Sociological research of social reception allows us to analyze it indirectly through the presence in opinion-forming magazines and other periodicals. The sources were 14 selected periodicals from 1982 to 2014. Other qualitative methods were also used: the long-term participant observation and analysis of the content of the literature. **RESULTS:** A set of healing or self-healing methods has been depicted and a general picture of alternative medicine in mass culture is presented, based on the contents published in various journals. Particularly in some far-eastern methods physical exercise is often used in special non-pharmacological therapies. **CONCLUSIONS:** Differentiated images of alternative medicine (natural, holistic) in mass culture are shaped by media. It rarely associated traditional forms of movement with natural medicine.

**Key words:** perpetual movement, natural medicine, social reception, bujutsu ido

## **Introduction**

Health is such a precious value that people often look for non-standard, natural methods of caring for health or therapy. To what extent does movement (physical exercise) combine with alternative methods of treatment and self-treatment? The analysis takes into account the selected traditions and methods, according to their presence in mass culture.

The exchange of knowledge between the countries of eastern Asia and the West regarding knowledge about health is just a manifestation of cultural dialogue and cultural exchanges in the era of globalization. A kind of medium of this knowledge are martial arts as educational systems. Martial arts are associated with many areas of life (physical culture, safety), as instructors of different varieties indicate (Redzisz, 2004), but very rarely with medicine. Meanwhile, in the educational systems of some schools and organizations there is, e.g. in tradition of Idokan organisation we find a concept of *Ido* – the perpetual movement. It is connected with martial arts, other disciplines of sport, and strictly health. This aspect has its own name – the “martial arts medicine” (*ido* or *bujutsu ido*) (Cynarski, 2017a). The terms “health” and “man” are understood holistically. Systemic theory of health according to Fritjof Capra (Cynarski, 2000b) and the concept of self-healing by Andrew Weil

(1997) are the inspiration here. On the other hand, man is treated personally as a psycho-physical being, with the needs of a higher order, including spiritual ones. This issue is analyzed in the perspective of sociology of leisure, sociology of health, sociology of (mass) culture, and a concept of cultural dialogue (Tokarski, 1989; Cynarski, 2000a; 2017b). Particularly interesting is the social reception of this and related forms of natural medicine (mainly of Chinese origin), which is the main topic of reflection, and the use of movement exercises. The description considers the following issues: 1) Selected oriental traditions and forms of therapy; 2) Alternative medical and paramedical methods associated with movement exercises; 3) Image of alternative medicine in mass culture (in magazines).

## Methods

For this study a set of three complementary qualitative methods was used. Social reception is analyzed here indirectly by presence in opinion-forming weekly and other periodicals (analysis of contents of mass media). Selected are 14 Polish magazines from the years 1982-2014. There are two more methods – a long-term participant observation (40 years of practicing and high master degree 10 dan in *bujutsu-ido*) and analysis of the contents of literature (analytical method).

## Results

### 1. Selected oriental traditions and forms of therapy

Perhaps the cradle of medical knowledge combined with the practice of martial arts is India. There are still studied vital places and vital points, to this day. They are used in healing massage and are the target of attack in combat. They are factors of life and death (Kogel, 2006, 2008; Sieler, 2015). Probably this knowledge came from India to neighboring countries, carried by Buddhist missionaries, merchants and warriors. In Chinese tradition medicine is mixed with martial arts in the theory of vital points and energy circuits (acupuncture, acupressure, moxa), energy exercises (*qigong*) and in the pursuit to the balance. This is accompanied by the herbal medicine and other forms of natural medicine, in which the Shaolin monastery is very famous (Cynarski & Swider, 2017). Chinese tradition cultivates health care. Dr Chen Yong Fa, Principal of Choy Lee Fut style, conducts lectures on Chinese medicine and exercises "*Luchan qigong*" (Kieta, 1999). In turn, one of the leaders of the *kung-fu* organizations in Poland mentions: "When I was a student, I first learned anatomy, studied acupuncture and qi circulation in a human body. The first lesson I learned was that medicine and good health are the real basis of all *kung-fu*." (Szymankiewicz, 1998). Traditional medicine exists in many schools of old Japanese martial arts, co called *bujutsu* or *kobudo*. In the *Tenshinshoden Katorishinto-ryu* (continuity of tradition from the 15th century) the medical skills called *te-ate*, at Hakko-ryu school - *koho shiatsu*, by Takeda-ryu - *bujutsu ido*. E.g. the famous martial arts' actor Steven Seagal practiced it. Moreover, in the *jujutsu schools*, *kappo* / *kuatsu* resuscitation methods were taught, which in the reduced form exists in *judo* today (Craig, 1995; Punzet, 2001; Kuboyama, 2015). *Te-ate* in *Tenshinshoden Katorishinto-ryu* included psychological-magical healing methods, and herbal medicine. *Shihan Yoshio Sugino* (1904-1998) was leading the counseling and herbal pharmacy until the end of his activity. Similarly, in Korean traditions, such as *in-sul* in *hwarangdo*, medical issues are part of the teaching system (Lind, 1996; Wasik & Wojcik, 2017). This ancient medical knowledge came from China to Japan, where it is often taught in parallel with the methods and techniques of martial arts. Also, it is always with physical movement in psycho-physical practice.

*Bujutsu ido* of Takeda-ryu is cultivated by Bernard Lalandre in France, 9 dan. *Koho shiatsu* Hakko-ryu, Okuyama-ryu version, created by Terry Rissier (France), is cultivated and propagated today by Zenon Liszkiewicz from Poland. This is essentially a kind of gymnastics and massage, which is supposed to improve the circulation of energy in the body. *Bujutsu*

*ido* in the Idokan system (Idokan Poland Association, IPA) is practiced as a form of natural medicine, among others by Lothar Sieber (10 dan, Germany) and Romuald Włodyka (7 dan, Poland). Sieber focuses on developing the power to self-healing of the patient. He also teaches sports medicine within the Deutscher Dan-Traeger und Budo-Lehrer Verband e.V., DDBV. Włodyka is a specialist in Chinese medicine, iridology and *qigong*. Both specialists are trying to treat the sick. And in turn Wojciech J. Cynarski promotes the method of developing positive health potential, as is the case for healthy people practicing martial arts (Cynarski & Sieber, 2015). This positive potential describes: the level of body function, physical fitness, tempering state (changes in temperature, pressure, humidity, etc.) and mental immunity (emotional self-control and effectiveness in difficult situations). In further analyzes we will focus on the IPA system of martial arts and healing.

## 2. Alternative medical and paramedical methods associated with movement exercise

Wojciech Pasterniak cultivates the healing and therapeutic “quantum training” method, similar to the bio-energetic therapy of Loyd and Johnson (2012), but uses the influence of images and music. It is like the frontiers of sports medicine, psychology, pedagogy and the theory of training, where spiritual training is a form of therapy (Pasterniak & Cynarski, 2014). On the other hand, Sieber draws on both the know-how of the Far East and the knowledge of the European representatives of natural medicine. He teaches parallel the natural medicine and martial arts. *Chi kung* or *ki-keiko* are sets of exercises that are applied to improve or maintain good health. They promote proper functions of the digestive system, the nervous system, the improvement of motor coordination ability, etc. (Kalisz, 1995; Włodyka & Cynarski, 2000). *Tai chi* (taiji quan) especially the Yang style, practiced for health purposes gives similar results. Forms of the battle style of Chen *tai chi* are not recommended here. Only soft, smooth movements produce a health effect similar to *chi kung*. There is even the name *tai chi kung* (*taiji qong*) used for the distinction of therapeutic *tai chi*.

Cynarski's method of *Training for Health* was established in 1993-1997 under the name *Aiki-Jindo* that be translated: "harmonization of energy in the way of humanity". In 1997 Hans Schöllauf (10 dan), President of the Idokan Europe International, awarded Cynarski 5 dan in *ido*. It is a method of total self-regulation and harmonization of widely understood health in connection with the practice of martial arts. It includes *ki-keiko* energy exercises, shiatsu and aikitaiso massage and gymnastics, relaxation and meditation exercises, dietary, hygienic and ethical-ascetic recommendations. This is a form of *bujutsu ido* and a component of the *Idokan Yoshin-ryu Budo* system. The theory is based on the concept of systemic theory of health, the mechanism of psychoneuroimmunology and the self-healing hypothesis (Weil, 1997; Cynarski, 2000b). Its review was conducted in a confrontation with the knowledge and experience of sports doctors such as Dr Marvin Solit, Didier Rausseau (6 dan in judo), Lothar Sieber (10 dan *jujutsu, karate and ido*), Wong Kiew Kit (2001), and own experience over 40 years. There are four stages in the method: 1) Introduction (learning relaxation, concentration, *ki-keiko*); 2) self-regulation I (receptor interaction, toning of the nervous system); 3) self-regulation II (balancing of the energy system); 4) striving for a state of harmony (pursuit of inner peace and in various relations with the outside world). Moped training on the mat is automatic foot massage, and many exercises on the back - back massage. In addition, practicing are, *shiatsu, aikitaiso, kiatsu* (according to Koichi Tohei), sporty auto-massage and others are practiced (Mucha, 1997). Most of all, you should practice regularly and do everything in both directions - symmetrically. *Ki-keiko* are breathing exercises that improve lung capacity, strengthen the diaphragm and tone the emotional states (Kondratowicz, 1996; Swami Rama, Ballentine, & Hynes, 2000). Like mental training, it is a form of complementary exercise. This includes running, swimming, stretching, wellness and hardening. The *Aiki-Jindo* method has been described in detail (Cynarski & Sieber, 2015).

Many methods of natural medicine are based on the ability of a living organism to self-heal

itself, as described by Weil (1997). Sometimes it is enough to not interfere in this process. Sometimes, however, it is worthwhile to help, using relaxation exercises with positive autosuggestion (Kondratowicz, 1982). Science has not explained how acupuncture, acupressure and related methods work. The theory of energy meridians and energy circuits is more poetic than rational. That does not mean it does not work. In China it has been used for two or four thousand years, and in Europe this is supported by medical authorities (Garnuszewski, 1988).

### 3. Image of alternative medicine in mass culture

Fashion for the East and its religions have influenced the emergence of new, fashionable ideas that contribute to the eclectic New Age. There is, among other things, “vegetarian utopia”. This is to be “tolerant of all, regardless of race, religion, intelligence or number of paws” (Appleton, 2007). So we do not eat animals or products from them, we do not wear fur, leather belts or shoes. The author knows several martial arts practitioners who have consistently used the vegetarian diet for a long time. However, more people use a variety of balanced diet. Dietary views on whether to be low fat or other is changeable (Kossobudzka, 2006). In general, East Asian martial arts lovers prefer kitchens of that part of the world (Cynarski, 2000a). Also, the producers intentionally refer to the traditions of East Asia, e.g. on the bottle “Kombacha” (a drink from fermented tea according to the ancient Chinese procedure) there is an image of a Chinese or kyudo archer.

Yoga is being especially fashionable as an alternative sport. Scientists regret that 88% of American adults accept alternative medicine (Shermer, 2002). In turn enthusiasts pay attention to the excellent effects of acupuncture and homeopathy, balneotherapy and hippotherapy, phototherapy and reflexotherapy, bubbling and use of leeches (Załoga, 2003). The same *chi* (qi, ki) energy can be used for treatment (bioenergetotherapy) and to fight (the legendary “blow of a vibrating hand”) (Maziarczyk, 2003). It hits not so much with “energy” (*vis vitalis*). It blocks a flow of the energy in a given organ. In turn, massage, such as *shiatsu*, helps regulate this flow (Mucha, 1997). The term “vital energy” includes the circulation of blood, lymph, hormones and nerve impulses.

Systemic health theory and holistic medicine gain supporters in the Western world and global scale. It is associated with martial arts in the form of Feldenkreis’ method, *taiji*, *qigong*, acupuncture etc. (*nota bene*, psychophysical martial arts systems have always treated humans holistically). But it lives with its own life. As “clinical” medicine examines and heals the human body, holistic medicine seeks to go deeper. “Holistic” doctors work with spiritual leaders (psychological health) and psychologists (mental health) (Szczeklik, 2003). Probably a condition for good health is a fair life, in accordance with normative ethics and the principles of faith (cf. Feynman, 1999; Grayling, 1999; Freeman, 2006; Szmyd, 2013).

### Discussion

The beneficial effects on health (both physical and mental) of martial arts are quite unmistakable (Cynarski & Sieber, 2015; Smoleń & Bernat, 2017). Regular training creates a strong and active personality, lowers the level of aggression, leads to increased health and better self-control. On the other hand, contact sports of fighting (combat sports), especially those that are professionally trained, can lead to loss of health. The distinction here is very important. Martial arts and combat sports are completely different in fighting arts theory; their goals and training methods are different. Martial arts and East Asian healing methods are the subject of adaptation in the process of cultural dialogue. As such, they go parallel to the areas of mass culture, physical, and health culture (Cynarski, 2000a). The methods of treatment or self-treatment in martial arts are, however, a separate issue. They are present in the history of martial arts for centuries. It is an area of interest in the theory of training and sports medicine, but ontologically co-founded by various traditions of natural medicine – massage, herbalism and psychotherapy. In some schools, martial arts medicine is still alive

today, e.g. under the name *bujutsu ido* (Cynarski & Sieber, 2015; Sieler, 2015; Cynarski, 2017c).

Various forms of exercise practiced for health are known (Puza, 2007; Ubbes, 2008). Generally, systematic effort is more important than the type of diet. But it is important to take care of – generally – active and hygienic lifestyle. And always be modest. Some paramedical methods are strongly opposed by the representation of academic medicine, which is probably correct. Especially in case of necessary surgery, natural or alternative medicine will probably not work. Are not the main sources of conflict the interests of the pharmacy industry, as proponents of natural/alternative medicine say? Doctors themselves, often drug abusers (faith in pills), do not know and do not understand alternative methods. And there is a problem of scammers, without the proper education and knowledge, who offer their services in return. Among bioenergy therapists it is quite difficult for their ability and competence to verify (Konarska, 2002).

Proponents of the electrodynamic theory of life point to its discovery in the mid-twentieth century by Harold Saxton Burr and F.S.C. Northrop from the University of Yale (Bodnar, 2001). This method also applies to self-regulation of the body, but is said to be a bioenergetic field. There is no scientific explanation for the bioenergetic implications. Actions against the healers are being carried out, but there are also voices in their defence: "A new media strike has begun for alternative medicine and healers. (...) This is a one-sided operation, because the advocates of the other side have no place to defend themselves." (Kuncewicz, 2002).

## Conclusions

The image of alternative medicine (natural, holistic) in the mass culture has been shaped by the media. This is not a homogeneous image and the reception is multiform here. Traditional forms of movement are rarely associated with natural medicine.

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# Efficiency of verbal and visual teaching method in adopting the elements of basketball

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## **ABSTRACT**

**INTRODUCTION:** Basketball is one of complex sports and it is one of the most dynamic sports games. Motor learning is a process which implies practice of certain motor movements in order to improve particular motor skills. Motor learning affiliated with performance or experience leads to relatively permanent changes in motor performance. **AIM:** The objective of the research is to evaluate some of the metric characteristics (objectivity, sensitivity and homogeneity) of a newly constructed basketball polygon and to establish probable existence of differences between the verbal and visual teaching methods for the adoption of the elements of basketball game. **METHODS:** Children from two sixth-grade classes from one primary school in Dugo Selo participated in the research. The total number of respondents who participated in the study was 50 (N = 50), of which 21 were girls and 29 were boys aged between 12 and 13 years. Students attended the regular program of physical and health education. The research was conducted in May 2017. The survey contained the initial and final evaluation of children's performances. On a targeted set up of basketball polygon, the evaluation was carried out via 3 basketball elements: ball control, passing and shooting, which were rated from 0 to 2. **RESULTS:** The visual and verbal group showed a statistically significant improvement over the pre-instruction period and there was an insignificant trend in the direction that the visual group achieved better results than their peers. The distribution of normality was checked by Kolmogorov-Smirnov test (KS). Alpha coefficient of internal consistency was high (0.91) and the correlations of court judgments with the first principal component were high and uniform and the first principal component was explained by a large percentage of total variance (85.39%). The main effect of the group (visual-verbal) was not statistically significant ( $F_{1 / 48} = 3.41$ ,  $p = 0.07$ ). On average, regardless of the polygon time, the visual group achieved somewhat better results based on the judgments (Visual group:  $M = 3.81$ ,  $SD = 1.06$ , Verbal group:  $M = 3.3$ ,  $SD = 1.01$ ), but this difference did not reach statistical significance. **CONCLUSION:** The visual method of adopting elements of basketball game is more effective than the verbal one.

**Key words:** basketball, motor learning, motor skills

## **Introduction**

From the point of kinesiological view, motor skills learning is a permanent change in the abilities of a person to perform a motor task as a consequence of training or experience

(Neljak, 2013). Motor skills learning with activity or experience leads to relatively permanent changes in motor performance (Schmidt & Lee, 2005). Motor skills learning and performance can be affected by anxiety, fatigue, motivation, physical fitness and so on. It is therefore essential to differentiate temporary changes in motor performance from the one that reflects real effects of motor skills learning (Miletić, 2010).

Basketball belongs to complex sports and is one of the most dynamic sports games. It is attractive for the audience, can be played throughout the year in bigger or smaller groups, at various ability and standard levels (Wissel, 2012). In order to acquire certain specific basketball skills' structures, it is necessary players actively participate in a longterm process of learning and practising, i.e. basketball training (Matković, 2010) Andrieux and Proteau (2016) suggest that providing verbal instructions on performance and its quality can help participants discover their performance errors, thus improving their performance based on the verbal instructions. The method of demonstration secures the best results in learning how to perform most basketball elements and the overall success in the game. The verbal method has proven itself to be best applicable in acquiring more complex elements of the basic basketball technique, whereas positive effects of the situational method have been less significant (Knjaz, Matković & Janković, 2013).

Purposes of this research was to determine which teaching method was the best and most beneficial to the acquisition of specific elements of basketball, but also which method was more suitable for the acquisition of either complex or simple basketball elements. The purpose was also to ascertain existence of any differences between the verbal and visual teaching method in teaching/learning skills required to master basketball.

In line with the research objectives, the following hypotheses have been established:

In line with the first objective and its specific objectives, operational hypotheses have also been established.

H1.1. The objectivity coefficients provided by a group of independent assessors (referees) will provide satisfactory results.

H1.2. Based on the contributions of each individual referee to the common benchmark outcome, we will achieve a satisfactory homogeneity of referees, which will allow us to set up a benchmark test to assess skill level for the basketball polygon.

H2 – There is a difference between the verbal and visual teaching method in rate of mastering basketball polygon.

## **Methods**

This research was based on the results achieved by the children of two sixth-grade classes from the Ivan Benković Primary School in Dugo Selo. Using random selection, classes 6d and 6b were chosen for this research. The total number of subjects was 50 (N=50), 21 of which were girls and 29 boys, all aged between 12 and 13. The students were all attending their regular PE (Physical Education) curriculum lessons. The research was conducted in May 2017.

To make sure that the assessment of skill level is as accurate as possible in all measured aspects, the subjects' performance was recorded using a video-camera for all three skills (dribbling, chest pass and jump shot). To avoid subjectivity, skill performance was assessed by three independent referees, with at least 10 years of experience in refereeing the Premier Basketball League and a membership in the Croatian Association of Basketball Referees. Every element performance was assessed with a mark of either 0, 1 or 2, and the final mark was achieved by adding all element marks into one summation mark. The final summation result was graded on a scale of 0 to 6 for each subject. The basic inclusion requirement was that the children did not and had never trained basketball before, and that they were not familiar with the elements of basketball game. This was the main prerequisite so that the children could be taught specific motor skills from zero. The subjects were divided into two test groups of 25 students. The research consisted of preliminary testing

(grading) and final assessment (grading). The preliminary testing was followed by four school lessons of teaching the children the elements of basketball game, after which they were tested, i.e. subjected to the final assessment. This research was conducted in the school gym during PE lessons. The experiment was conducted by dividing the sample subjects into two groups: a) the first test group was taught basketball skills only by the verbal teaching method, and b) the second test group was taught basketball skills only by the visual teaching method. The research consisted of the initial testing and the final assessment.

The variable used in this research was a basketball polygon consisting of four elements: right-handed dribble, left-handed dribble, chest pass and jump shot. The experiment was conducted through three stages: preliminary testing, a two-week intervention of motor skills practice, and the final assessment.

**Initial position:** The subjects were initially positioned on the three-point line, i.e. on the 6.75 m line with the basketball in their hands.

**Performance:** The subject is at the start, near the first pin, with the basketball in his or her hands. When ready, the subject starts dribbling with his/her right hand to the first cone, where he/she switches hands, then continues to dribble with his/her left hand to the next cone, where he/she stops, passes the ball from the chest to the referee, and, after receiving the ball passed back to him/her by the referee, does a small lunge, with both feet on the free-throw line, performs a jump shot.

**Data processing methods:** In order to analyze metric characteristics of grading basketball elements performance: to analyze sensitivity, we used the descriptive statistics parameters: arithmetic mean (M), standard deviation (SD), minimal results (Min), maximum results (Max), and the distribution normality was verified with the Kolmogorov-Smirnov test (KS). To analyze referee objectivity we used the Cronbach Alpha coefficient. . For the differences between the two test groups (the verbal and visual method groups) and between the two measuring points (before and after the demonstration), we used the mixed samples' Analysis of variance. The listed analysis was implemented within the SPSS software package (v 21), whereas the graphic diagram is provided within the JMP software package.

## Results and discussion

Both the visual and verbal group have shown statistically significant progress when compared to the period before intervention, and there was a non-significant indication that the visual group made a better progress than the verbal group.

### 1) Pre-intervention analysis

The distribution of average grades given by the referees on the basketball court did not differ statistically significantly from the normal.

	M	Min	Max	SD	KS-test
<b>Sum Grade</b>					
<b>R1</b>	3.06	1	6	1.45	1.47*
<b>R2</b>	2.98	1	6	1.44	1.31
<b>R3</b>	2.94	1	5	1.25	1.65**
<b>Average Grade</b>	2.99	1	5.67	1.27	0.84
<b>R1-R3</b>					

Table 1. Pre-intervention measurement: descriptive statistics and KS test (total sample N=50)

\*p<0.05, \*\*p<0.01, The KS test is significant at the level of 0.05, when is:  $d > 0.19$  (N = 50)

Legend: M – arithmetic mean, SD – standard deviation, Min – minimal result, Max – maximum result; the distribution normality was verified by the Kolmogorov-Smirnov test (KS).

	R1	R2	R3	ALPHA	IIR
<b>Sum Grade</b>					
<b>R1</b>	1.00			0.91	0.78
<b>R2</b>	0.71***	1.00			
<b>R3</b>	0.93***	0.70***	1.00		

Table 2. Pre-intervention measurement: correlations between referees, the Cronbach alpha coefficient (ALPHA) and the inter item correlation (IIR)

\*\*\*p<0.001 (R1 – the first referee, R2 – the second referee and R3 – the third referee)

This table shows that the correlations between referees are high and statistically significant. The Cronbach alpha coefficient of internal consistency was high (0.91) and the correlations between the referees' assessments with the first principal component were high and almost equal, whereas the first principal component accounted for a high percentage of the total variance (85.39%). All the three referees showed significant, positive and high-to-very-high correlation coefficients, which points to the congruity of their assessment.

	Sum Grade
<b>R1</b>	0.95
<b>R2</b>	0.86
<b>R3</b>	0.95
<b>Total variance explained</b>	2.56
<b>% of the explained variance within total</b>	85.39

Table 3. Structures of latent dimensions in the area of assessor particles to be graded before intervention

The correlations between referee assessments with the first principal component were very high and similar in size (number) for all the three referees, and the first principal component explained 85.39% of the total variance.

## 2) Analysis of intervention effects

The correlations of assessments by R1 and R3 with the first principal component were high and similar in size, whereas the correlation with S2 was slightly lower. The percentage of the explained variance with the first principal component was 72.55%, which is slightly lower than in the pre-intervention assessment.

	Summation mark
<b>R1</b>	0,95
<b>R2</b>	0,65
<b>R3</b>	0,92
<b>Total variance explained</b>	2,18
<b>% of the explained variance</b>	72,55

Table 4. Structure of latent dimensions in the area of the assessors' particles after instruction/intervention

	M	Min	Max	SD
<b>Visual group</b>				
Before	3.28	1.00	5.67	1.39
After	4.35	2.33	6	1.12
Total	3.81	2.17	5.33	1.06
<b>Verbal group</b>				
Before	2.71	1.00	5	1.09
After	3.89	1.33	5.33	1.09
Total	3.30	1.17	5.0	1.01
<b>TOTAL</b>				
Before	2.99	1.00	5.67	1.27
After	4.19	1.33	6.00	1.12

Table 5. Instruction/intervention effects: comparison of the visual and verbal group (average scores for all the three referees)

The analysis of instruction effects ( $F_{1/48}=37.35$ ,  $p<0.001$ ). On average, there was a significant improvement in basketball polygon time for both groups, before instructions:  $M=2.99$ ,  $SD=1.27$ ; after instructions:  $M=4.12$ ,  $SD=1.12$  (Andrieux & Proteau, 2016). The main effect of the group (visual-verbal) was not statistically significant ( $F_{1/48}=3.41$ ,  $p=0.07$ ). On average, regardless of polygon performance time, the visual group performed slightly better, based on the referees' assessment (visual group:  $M=3.81$ ,  $SD=1.06$ ; verbal group:  $M=3.3$ ,  $SD=1.01$ ), but this difference did not reach statistical significance (Knjaz, et al., 2013).

The principal limitation of the study lies in absence of retention phase between the preliminary and final assessment, which would provide additional insight into the efficiency of motor skill learning manifested in basketball polygon performance (Matković, 2010).

## Conclusion

Both groups have shown a statistically significant improvement in correlation to the period before the intervention, whereas the visual group achieved better results than the verbal one. Even though the visual group had more success on average, the level of learning between the two groups was almost equal. A better contribution to the research itself and the general progress in teaching a basketball polygon would be achieved by the inclusion of learning retention phase, because comparing the skills in retention time with the preliminary tests would show actual significant progress in motor skill learning.

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## Properties of some kinematic parameters in handstand technique in artistic gymnastics

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### ABSTRACT

**PURPOSE:** The aim of this study was to determine the difference between key kinematic parameters of handstand phases. **METHODS:** Sample of this investigation consisted of five second-year students of the Faculty of Kinesiology, University of Zagreb. Variables consisted of kinematical parameters. The kinematic parameters were extracted from the key positions of certain handstand phases: 1st phase–lunge step, 2nd phase–hand support, 3rd phase–back kick, 4th phase–take off, 5th phase–handstand support. Kinematic parameters were extracted with the program package MVN Studio BIOMECH Software (Xsens North America Inc.), and their processing was done using the one-way ANOVA analysis and Bonferroni post-hoc test with statistical significance at  $p < 0.05$ . **RESULTS:** Results showed statistically significant differences ( $p = 0.00$ ) in the hip angle of the kick leg, the hip angle of the take-off leg, head angle and the duration of all phases of handstand. The Bonferroni post-hoc test showed the differences between the phases of handstand. **CONCLUSION:** Information were obtained about the significance of the hip angles, shoulders, and head in different stages of handstand execution. By precisely defining all kinematic parameters of handstand performance, it would be possible to early detect causes of mistakes and find the best way to eliminate them. This will help coaches to find the most important exercise and pay attention to key points of handstand.

**Key words:** artistic gymnastics, biomechanics, performance, technique, acrobatic element

## Introduction

In artistic gymnastics, handstand is an acrobatic element that is an integral part of every gymnastic exercise and is present on all apparatus (Uzunov, 2008; Živčić Marković, Krističević, & Aleksić-Veljković, 2015; Živčić Marković & Krističević, 2016). It is performed as a separate element in connection with other acrobatic elements and as a transitional position within another element's technique. The technical execution of handstand technique is governed by the evaluation rules (FIG, 2017). For the correct performance of the handstand the following is important: strength of the entire body, coordination, orientation and flexibility of joints, especially shoulders (Uzunov, 2008; Yedon & Trewartha, 2003; Živčić Marković et al., 2015; Živčić Marković & Krističević, 2016).

Performance of handstand can be divided into several phases: lunge step, hand support, back kick, take-off, and handstand support (Živčić Marković & Krističević, 2016). In each phase there are certain key points that influence execution of the final phase of handstand – hold of the stretched body in the vertical position. They are related to the following: length of lunge step (1st phase), placement of the hands in relation to the take-off leg (2nd phase), timing of taking the kick with the kick leg which begins with forward bending of the trunk in the lunge step (3rd phase), timing of take-off that begins with the hands fully supported on the floor (4th phase), vertical position of the body in relation to the floor (5th phase) and holding the extended arms along the head through all the phases.

Investigations in the field of the ideal performance model in gymnastics are rare. Prassas (1988) conducted a study of biomechanical modeling on the handstand to estimate and predict rotational forces in the shoulder of the wrist and move the center of gravity from the initial to the final position of the body standing on the arms. The variables that are important for biomechanical research on the handstand are: the phase of the center of mass, the horizontal and vertical positions, velocity, distance between the hands and the feet, differences between the angles and the angular velocities of the hip and shoulder joint (Kim, So, & Yeo, 2006). The aim of this study was to determine the differences between the key kinematic parameters of handstand phases.

## Methods

The sample of participants consisted of five second-year students of the Faculty of Kinesiology, University of Zagreb. Participants passed the exam Artistic Gymnastic 1 and they were selected randomly and evaluated by three gymnastic experts. The sample of variables consisted of kinematical parameters. The hip and shoulder angles were defined by the take-off and kick leg. Variable HIPTAKEOFF means the angle of the hip at the side of the take-off leg, HIPKICK=angle of the hip at the side of the kick leg. SHOTAKEOFF=angle in the shoulder on the take-off leg, SHOKICK=angle in the shoulder at the kick leg side. Variable HEAD=head angle. TIME=duration of all phases of handstand. The kinematic parameters were extracted from the key positions of certain handstand phases: 1st phase–lunge step, 2nd phase–hand support, 3rd phase–back kick, 4th phase–take off, 5th phase–handstand support. Kinematic parameters were extracted using the program package MVN Studio BIOMECH Software (Xsens North America Inc.), and their processing was done using the one-way ANOVA analysis and Bonferroni post-hoc test with statistical significance set at  $p < 0.05$ .

## Results

Table 1 shows the results of one-way ANOVA analysis of handstand angles in all phases. Results showed statistically significant differences ( $p = 0.00$ ) in the hip angle of the kick leg, the hip angle of the take-off leg, head angle and the duration of all phases of handstand.

Dependent Variable	Multiple R	Multiple R2	Adjusted R2	SS Model	df Model	MS Model	SS Residual	df Residual	MS Residual	F	P
HIPTAKEOFF	0,94	0,88	0,86	70176	4	17544	9679	25	387	45	0,00*
HIPKICK	0,97	0,94	0,93	95033	4	23758	5887	25	235	101	0,00*
SHOTAKEOFF	0,51	0,26	0,14	6698	4	1675	19429	25	777	2	0,10
SHOKICK	0,35	0,12	-0,02	1545	4	386	11378	25	455	1	0,51
HEAD	0,95	0,91	0,89	17926	4	4481	1862	25	74	60	0,00*
TIME	0,74	0,55	0,48	12	4	3	10	25	0	8	0,00*

Table 1. One-way ANOVA analyses of handstand angles in all phases

\*statistically significant difference

The Bonferroni post-hoc test showed the differences between the phases of handstand. For the variable HIPKICK, the Bonferroni test (Table 2) indicated the differences between the phase lunge step and hand support (1 and 2), lunge step and back kick (1 and 3), and lunge step and handstand support (1 and 5), between the phases hand support and take off (2 and 4), and hand support and handstand support (2 and 5). The differences were also established between the phases back kick and take-off (3 and 4), and back kick and handstand support (3 and 5).

Cell No.	FAZE	{1} 165,83	{2} 67,667	{3} 67,667	{4} 184,00	{5} 193,50
1	1		0,00*	0,00*	0,51	0,04*
2	2	0,00*		1,00	0,00*	0,00*
3	3	0,00*	1,00		0,00*	0,00*
4	4	0,51	0,00*	0,00*		1,00
5	5	0,04*	0,00*	0,00*	1,00	

Table 2. Bonferroni post-hoc test for the variable HIPKICK

\*statistically significant difference

For the variable HIPTAKEOFF, Bonferroni test (Table 3) showed the difference between the phase step lunge and hand support (1 and 2), step lunge and take off (1 and 4), and step lunge and handstand support (1 and 5). The difference was established between the phases hand support and back kick (2 and 3) and hand support and take off (2 and 4), as well as between back kick and handstand support (3 and 5) and take off and handstand support (4 and 5).

Cell. No.	FAZE	{1} 113,50	{2} 177,33	{3} 93,167	{4} 70,167	{5} 195,17
1	1		0,00*	0,86	0,01*	0,00*
2	2	0,00*		0,00*	0,00*	1,00
3	3	0,86	0,00*		0,54	0,00*
4	4	0,01*	0,00*	0,54		0,00*
5	5	0,00*	1,00	0,00*	0,00*	

Table 3. Bonferroni post-hoc for the variable HIPTAKEOFF

\*statistically significant difference

In the variable head (Table 4) Bonferroni test showed the difference between all phases.

Cell. No.	FAZE	{1} 187,50	{2} 200,00	{3} 194,83	{4} 202,17	{5} 136,33
1	1		0,19	1,00	0,07	0,00*
2	2	0,19		1,00	1,00	0,00*
3	3	1,00	1,00		1,00	0,00*
4	4	0,07	1,00	1,00		0,00*
5	5	0,00*	0,00*	0,00*	0,00*	

Table 4. Bonferroni post-hoc for the variable HEAD

\*statistically significant difference

For the duration of the individual phases, the Bonferroni test (Table 5) showed the differences between the phases hand support and handstand support (2 and 5), back kick and take off (3 and 4), and, finally, between take off and handstand support (4 and 5).

Cell. No.	FAZE	{1} 1,1100	{2} ,62667	{3} 1,3767	{4} ,07500	{5} 1,9550
1	1		1,00	1,00	0,09	0,30
2	2	1,00		0,52	1,00	0,01*
3	3	1,00	0,52		0,02*	1,00
4	4	0,09	1,00	0,02*		0,00*
5	5	0,30	0,01*	1,00	0,00*	

Table 5. Bonferroni post-hoc for the variable TIME

\*statistically significant difference

## Discussion

The results obtained by ANOVA indicated that there was the statistically significant difference in four kinematic variables: hip joint angle at the side of the kick leg and at the take-off leg, head and the duration of all phases of handstand. The obtained significant difference of the hip angle at the side of the kick leg in the individual phases of the handstand indicates its importance in all stages of handstand performance. Apart from the trunk, the kick leg is the only part of the body which moves throughout the entire performance of handstand. When kick leg leaves the floor, the trunk moves (arms are extended) from the beginning of the lunge step to the last phase of handstand. It should be mentioned that the kick leg defines the position of the body in handstand by it stopping movement exactly in the vertical position, 90° in relation to the floor. Theoretical models of performance techniques suggest that, if the angle of the hip joint of the kick leg is smaller with regard to the trunk, the quality of the kick will be poor (Gautier, Marin, & Thouvareq, 2009; Scotton, Grosso, Ferraris, Caire, & Pizzigalli, 2009; Živčić Marković, et al., 2015). The initiation of the kick leg motion depends on the lunge length and the weight transfer from the body onto the take-off leg. Technical mistakes in performance of the first phase of handstand (lunge step) will be presented in the next phases. That indicates that the lunge step should be longer. If the lunge step is short, the kick leg will be stopped on the floor, a distance between the feet of the take-off leg and the hands on the floor will be short. Also, both the kick and take-off will be incorrect and, in the last phase of handstand, the position of the body and holding a handstand will be unregular. In any further stage errors will accumulate and systematically increase (Kim, et al., 2006). The take-off power determines the establishment of balanced position in the handstand and indirectly depends on the length of lunge step, placement of the hands on the floor and control over the move of the kick leg (Kochanowicz, Kochanowicz, K., Niespodzinski, Mieszkowski, & Biskup, 2015; Yedon & Trewartha, 2003; Uzunov, 2008). As the time length of the lunge step and placement of the hands on the floor is short, the kick leg will have delayed movement in the first and second phases and will need to compensate for it by a stronger take-off from the floor. Interpreting the size of the hip angle at the side of the kick leg, which is a higher angle value, the overall technical execution and handstand support position will be more correct

(Živčić Marković, Milčić, Krističević, Aleksić-Veljković, & Lagančić, 2018). Variable head all phases shows the difference in all phases of handstand. The placement of the straight body in the vertical support and maintenance of the balanced position directly depends on the head position (Gautier, Thouvarecq, & Chollet, 2007; Gautier, et al., 2009; Kim, et al., 2006; Scotton, et al., 2009; Živčić Marković, et al., 2015). If the angle between the head and the body is smaller (the head is backward), the position of the body in the handstand support will be curved. That head position will cause muscular relaxation of the front of the body and lowering in the shoulders. However, the head may be bend (also a small angle value), which will cause the bending (backward or forward) of the body position. Only if the head is straight in line with the trunk extension, then the athlete will be able to establish and maintain the body in the vertical position.

The mentioned mistakes in the separate phases of the handstand will cause disturbances in their duration. In a proper technique performance, the first phase is defined by the lunge step length. The longer it is, the longer the time of holding handstand. The same is valid for the phase of placing the hands on the floor and other phases. Maintenance of the balance position, along with other factors, related to the physical fitness level of the gymnast, will directly depend on the length of the individual phases, particularly the phase of lunge step and kick (Živčić, et al., 2018).

## Conclusion

With this research information were obtained about the significance of the hip and shoulders angles as well as of head angles in different stages of handstand execution. By precisely defining all kinematic parameters of handstand performance, it would be possible to early detect causes of mistakes and find the best way to eliminate them. This will help coaches to find the most important exercises and pay attention to key points of handstand. Also, it would be necessary to analyze the kinematic parameters in exercises that serve to the learning a handstand technique.

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## Age differences among the Croatian female young pivots in the indicators of basic and handball-specific physical fitness

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### ABSTRACT

**PURPOSE:** The aim of the research was to determine and analyse differences among the Croatian female pivots of a younger-cadet, cadet and junior age (U14, U16, U18) in several basic and handball-specific physical fitness indicators. **METHODS:** The sample of 23 participants, female circle runners or pivots was drawn out of the population of members of the Croatian handball clubs recognized as promising players within their respective age group. Eighteen tests, defining four latent dimensions: agility, power, dynamic strength and flexibility, were chosen to assess basic and handball-specific motor abilities of the young pivots. Univariate analysis of variance (ANOVA) was used to establish global and individual differences among the age groups. **RESULTS:** The significant global age differences were established in three variables: at the level of  $p < 0.01$ , in two variables assessing power of throwing and dynamic relative strength of arms, and at the level of  $p < 0.05$  in the variable assessing dynamic relative strength of the legs. Significant differences were established only between junior and younger cadet pivots since no significant difference was observed between cadets and younger cadets.

Only one variable differed junior pivots from their cadet colleagues ( $p = 0.01$ ): bench press with 50% BW (MRSBP5). **CONCLUSIONS:** The significant global age differences were obtained only in the three indicators of arm and leg strength (explosive and dynamic),

primarily due to the differences between juniors and younger cadets. The differences originated from different growth and maturation stages.

**Key words:** female young pivots, Croatian, physical fitness, age differences

## Introduction

Handball pertains to a group of complex team activities with the ball due to its structural characteristics and physical fitness requirements. A high level of motor and functional abilities of handballers is needed for top-level performance. All the mentioned causes a rather high complexity of training procedures and programmes (Vuleta, Milanović, et al., 2004). For a long time, handball experts, both researchers and practitioners, have been in a search for performance criteria (Vuleta et al., 2003), that is, they have been trying to determine performance relevance of individual abilities and skills for particular playing positions. Information on their performance relevance facilitates the design of training plans and programmes helping coaches with the creation of a stimulating training environment the main target of which is sport achievement. The information also represents a guideline in the processes of talent identification in general and for specific playing position. Čavala et al. (2002), Ohnjec and Gruić (2008), and Bojić-Ćaćić et al. (2015) determined positional differences in the basic and handball-specific motor abilities of women players. Bojić-Ćaćić et al. (2016) established, with the sample of 56 women juniors, and in 2017 with the sample of 48 women younger cadets, significant positional differences in the basic and specific motor abilities between wingers and backs as well as between wingers and pivots. Available literature search indicates few research studies have been published on age and positional differences among women handballers, especially of a younger age.

The aim of the research was to determine and analyse differences among the Croatian female pivots of younger-cadet, cadet and junior age (U14, U16, U18) in several basic and handball-specific physical fitness indicators.

We hypothesised that there were statistically significant global and individual age differences among young female pivots (younger cadets, cadets, juniors) in the indicators of basic and handball-specific physical fitness.

## Methods

### Sample of participants

Twenty-three female circle runners or pivots participated in the investigation, out of which three subsamples were formed: juniors (U18,  $n=6$ ; age  $18.43\pm 0.80$  years, body height  $171.28\pm 6.51$  cm, body weight  $71.78\pm 4.19$  kg, average BMI about  $25$  kg/m<sup>2</sup>), cadets (U16,  $n=7$ ; age  $15.94\pm 1.16$  years, body height  $174.97\pm 2.88$  cm, body weight  $70.93\pm 5.14$  kg, average BMI about  $23$  kg/m<sup>2</sup>), and younger cadets (U14,  $n=10$ ; age  $13.88\pm 0.46$  years, body height  $170.06\pm 5.83$  cm, body weight  $62.02\pm 6.02$  kg, average BMI closer to  $22$  kg/m<sup>2</sup>). The sample of participants was drawn out of the population of the Croatian handball clubs' players who had beforehand been evaluated by their coaches and the Croatian Handball Federation selectors as promising players within their respective age group according to their handball skills and experience.

### Sample of variables

Eighteen tests, defining four latent dimensions: agility, power, dynamic strength, flexibility, were chosen to assess basic and handball-specific motor abilities of the young pivots (Vuleta et al., 2006).

	Variables	Acronyms	Intentional object of measurement
1.	Two triangles/star agility – seconds	MAG2TR	Agility
2.	Agility 96369 OK – seconds	MAG9OK	Agility
3.	Side steps – seconds	MAGKUS	Agility
4.	Maximal movement speed over 5 m – seconds	MES5m	Power – explosive strength of sprinting
5.	Maximal movement speed over 10 m – seconds	MES10m	Power – explosive strength of sprinting
6.	Maximal movement speed over 20 m – seconds	MES20m	Power – explosive strength of sprinting
7.	One-handed handball throwing while sitting – dm	MESB4S	Power – explosive strength of throwing
8.	Basic ground throw from 9 m with approach – dm	MESB9T	Power – explosive strength of throwing
9.	Basic jump throw from 9 m with approach – dm	MESB9S	Power – explosive strength of throwing
10.	CMJ with arm swing – cm	MESCMJ	Power – explosive strength of jumping
11.	Standing vertical jump – dominant, take-off leg – cm	MESMAX	Power – explosive strength of jumping
12.	Standing broad jump – cm	MESSDM	Power – explosive strength of jumping
13.	Sit-ups in 30 seconds – repetitions	MRSPTL	Dynamic repetitive-relative strength
14.	Squatting in 30 seconds – repetitions	MRSČUČ	Dynamic repetitive-relative strength
15.	Bench press 50% body weight – repetitions	MRSBP5	Dynamic repetitive-relative strength
16.	Shoulder rotation test with a stick – cm	MFLISP	Flexibility
17.	Straddle (V) sit forward bent – cm	MFLPRR	Flexibility
18.	Leg raise from supine position – cm	MFLPRL	Flexibility

Table 1. Variables obtained by the measurements and assessments of the participants' motor abilities using basic and handball-specific motor tests

### Statistical analysis

Basic descriptive statistical procedures were applied to determine central and dispersive parameters of the variables. Univariate analysis of variance (ANOVA) was used to establish global and individual differences among the age groups. The number of participants ensured the enough number of degrees of freedom, thus enabling the power of statistical inference at the reliability level of 95%.

### Results

In Table 2 results of ANOVA are presented. The significant global age differences were established in three variables: at the level of  $p < 0.01$  in two variables assessing power of throwing dynamic relative strength of arms, and at the level of  $p < 0.05$  in the variable assessing dynamic relative strength of legs. Analytically speaking, the significant differences were established only between junior and younger cadet pivots since no significant difference was observed between cadets and younger cadets.

Only one variable differed junior pivots from their cadet colleagues ( $p = 0.01$ ): bench press with 50% BW (MRSBP5). The variable assessed players' dynamic strength of arms and shoulder grid: junior pivots completed 20.00 repetitions, whereas cadets completed only 8.57 repetitions. Juniors are two years on average older than cadets and have a longer training experience (eight years vs. six years). In the future, the cadets will, hopefully, catch up with the juniors' performance if they will involve in a more intensive resistance training and if they will improve their ball technique. Although the other differences between juniors and cadets were statistically insignificant, they must not be completely neglected in further

analyses and comparisons in women handball since they can highlight certain aspects of sport fitness.

Three significant differences between junior and younger-cadet pivots were obtained in the following variables: one-handed handball throwing while sitting on the 4-metre line (MESBR4S), bench press 50% BW (MRSBP5), at the level of  $p < 0.01$ , and squats in 30 s ( $p < 0.05$ ; MRSCUC).

PIVOTS/ CIRCLE RUNNERS	Means			Standard deviations			Total		JU- CAD	JU-YC	CAD-YC
	JU=6	CAD=7	YC=10	JU=6	CAD=7	YC=10	F	p	p	p	p
MAG2TR	7.23	7.64	7.52	0.35	0.82	0.54	0.78	0.47	0.49	0.64	0.93
MAG9OK	8.29	8.66	8.84	0.44	0.32	0.51	2.97	0.07	0.34	0.07	0.71
MAGKUS	8.29	8.41	8.29	0.56	0.66	0.50	0.11	0.89	0.93	1.00	0.91
MEKS5m	1.68	1.65	1.71	0.05	0.09	0.10	0.83	0.45	0.91	0.77	0.46
MEKS10m	2.62	2.53	2.64	0.18	0.12	0.33	0.47	0.63	0.79	0.99	0.64
MEKS20m	3.98	4.05	4.13	0.14	0.27	0.19	1.00	0.39	0.83	0.40	0.74
MESBR4S	52.63	47.70	43.03	2.24	6.13	3.32	10.04	0.00	0.13	0.00	0.10
MESBR9T	75.24	73.39	67.70	3.89	12.29	6.17	1.91	0.17	0.92	0.22	0.38
MESBR9S	73.19	71.98	65.70	5.52	12.31	4.99	2.10	0.15	0.96	0.22	0.30
MESCMJ	34.59	35.71	35.22	3.18	5.72	2.00	0.14	0.87	0.87	0.95	0.97
MESMAX	36.78	37.52	35.40	4.01	9.63	3.86	0.26	0.78	0.98	0.91	0.79
MESSDM	197.56	193.43	182.23	14.21	23.01	12.55	1.83	0.19	0.91	0.23	0.41
MFLISP	71.61	73.33	67.23	10.12	8.25	15.62	0.54	0.59	0.97	0.80	0.62
MFLPRL	105.83	103.93	106.50	12.52	8.64	10.29	0.13	0.88	0.95	0.99	0.88
MFLPRR	77.72	81.86	75.00	12.71	6.60	8.11	1.17	0.33	0.72	0.85	0.33
MRSBP5	20.00	8.57	4.90	3.03	7.14	5.65	13.69	0.00	0.01	0.00	0.43
MRSCUC	28.50	26.29	23.40	0.84	3.45	3.98	4.70	0.02	0.49	0.02	0.23
MRSPTR	50.00	49.00	45.00	8.53	6.35	6.48	1.18	0.33	0.97	0.40	0.52

Table 2. Basic descriptive parameters of the variables and analysis of the age differences among female pivots in their basic and handball-specific motor abilities

Legend: MAG2TR – two triangles/star agility, MAG9OK – agility 96369 with turns, MAGKUS – side steps, MEKS5m – maximal movement speed (sprinting) over 5 m, MEKS10m – maximal movement speed over 10 m, MEKS20m – maximal movement speed over 20 m, MESBR4S – one-handed handball throwing while sitting, MESBR9T – basic ground throw from 9 m with approach, MESBR9S – basic jump throw from 9 m with approach, MESCMJ – countermovement jump, MESMAX – standing vertical jump, MESSDM – standing broad jump, MFLISP – shoulder rotation test with a stick, MFLPRL – leg raise from supine position, MFLPRR – straddle (V) sit forward bent, MRSBP5 – bench press 50% body weight, MRSCUC – squatting in 30 seconds, MRSPTR – sit-ups in 30 s.

## Discussion

Juniors demonstrated better power of throwing type – an average speed of ball juniors achieved was 52.63 km/h, whereas younger cadets achieved throwing speed of 43.03 km/h. This difference may be explained by a better quality of throwing/shooting skills in juniors and, if the performance in bench press 50% BW and squats in 30 seconds, by far more developed dynamic strength of arms, shoulders and legs. Junior pivots were able to complete 20.00 repetitions of bench press, whereas younger cadets performed only 4.90

repetitions.

Chronological age of younger cadets is four years less than the age of junior pivots. Therefore, the younger cadets will, hopefully, catch up with the juniors' performance in the future if they will commit themselves to a more intensive resistance training and if their ball technique will be improved. Certain strength exercises can be applied early in training, but load/resistance must not be too heavy since overloading in weight training may cause chronic damages or injuries of the musculoskeletal system of prepubertal children, especially of the epiphysis (round ends of long bones), or of the joints' soft tissues or cartilage (Mišigoj-Duraković, 2008).

The last difference in dynamic strength of legs between juniors and younger cadets was expected – juniors managed to complete 28.50 squats, whereas younger cadets executed only 23.40 repetitions. Namely, an ascending curve of strength development has been noticed in girls until the age of 15 years, when it starts to show stagnation (L. Milanović et al., 2003). Therefore, resistance training and strength development programmes, aimed at developing static and dynamic strength of legs, may be introduced in the process of sport preparation only after 15 years of age. Before that age, dynamic strength can be addressed/developed by the application of low-load dynamic exercises and methods (L. Milanović et al., 2003): method of low resistance load-many repetitions (30 repetitions), method of circular training using moderate resistance loads (10 drills, 20 repetitions) and moderate to high resistance load (8-10 drills, 10 repetitions).

Juniors from our study had been involved in various specific resistance training programmes aimed at strengthening their leg muscles, whereas younger cadets, due to the phase of intensive growth, could develop their dynamic leg strength only by low (minimal) load-high repetition method.

Playing position of a pivot is highly demanding as regards leg and the whole-body strength – it is characterised by a myriad of physical body contacts in struggle for the front position, both in attack and defence.

Therefore, in the process of sports preparation, much time and attention is dedicated to resistance training under simulated game conditions – junior pivots execute many technical-tactical exercises wearing weight vests and/or weight bracelets around ankles, for example, to increase dynamic leg strength and improve their performance.

In the training of younger cadets such loads are not allowed due to injury risks and because their technical-tactical skills have not been perfected yet.

The findings confirmed the hypothesis about the significant age differences among female pivots of different ages in some indicators of basic and handball-specific motor abilities or physical fitness.

## Conclusion

The aim was to determine age differences among 23 young pivots (U14, U16, U18) in certain indicators of basic and handball-specific motor abilities. ANOVA revealed significant global age differences in power/explosive strength of throwing while sitting and dynamic repetitive-relative strength of arms ( $p < .01$ ), and in dynamic repetitive-relative strength of legs ( $p < .05$ ).

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# Polish Physicians' Reflections on Health

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## **ABSTRACT**

**AIM:** The main purpose of the paper is to give an overview of Polish physicians who have written works considering health and physical activity and who knew that human organism is genetically programmed to live an active life. Its main functions and the basic life-sustaining activities take the form of incessant movement. Therefore, exercise is good for one's health. Modern science has confirmed what physicians have long known and sought to communicate to others – sometimes in a naive way, but always to the point. The fundamental truth that, no matter what kind of activity one pursues, exercise is always necessary as it allows one to stay fit (and the lack of exercise breeds disease) has been repeatedly pointed out by physicians in Poland since the 16th century. **METHODS:** This paper is based on a critical examination of written works by Polish physicians. They described various forms of movement, giving many examples of the anatomical structure of man and its connection with physical exercise. Their popular belief and in-depth reflection alike associated health with motor activity, although, it needs to be stressed, the strength and postulated mechanisms of this association varied. Generally, physicians intended to promote health and build up in their patients an immunity to physical and mental ailments, so that people would become masters of their bodies without the need to think of their health at all times. Initially, it was believed that the desired forms of behaviour could be instilled in people through health education conducted by means of the printed word. Basically, the authors advocated an individualised regimen to ensure good health, improve one's physical and mental abilities and increase life expectancy. **CONCLUSIONS:** It follows that – contrary to popular belief – the interest in matters of health and the tremendous activity of health-promoters observed in Poland today are hardly a new development. In fact, they stem from the work of the luminaries of Polish medicine throughout the ages. Polish physicians' reflections on health and movement are unknown. Such review seems to be an interesting exercise.

**Key words:** Polish medicine, physical activity, education, history, Renaissance

## **Introduction**

God said to Adam: "In the sweat of thy face shalt thou eat bread". He thus indicated that motor activity (physical labour) would form an inseparable component of human existence. However, as the development of civilisation progressed, the distribution of the God-ordained physical labour became increasingly unequal, in accordance with the principle linking in inverse proportion the prosperity of a household and the amount of work performed by its members. Forgetting the Divine prescription of active life, people have gradually switched to a passive lifestyle in which they put an insufficient load on the motor system, while overstraining the central nervous system. That was hardly a beneficial change as it upset the phylogenetically established physiology of the entire organism and,

in particular, its cardiovascular system. These mechanisms became the subject of reflection in the 16th-century Poland. With the advent of Renaissance thinking, positive prescriptions for a healthy living made their appearance in which motor activity played a prominent role. Physicians began to take an interest in – or at least advocate for – prevention, hygiene and physical education, and to promote exercise among adults as an essential condition of health.

### **Motor activity and health: theoretical considerations**

The formulation of a definition of health was the most essential aspect of the study of this subject. The content ascribed to the notion of health had a bearing on the diagnostic methods and objectives, the choice of therapies applied, and, most importantly, on the ways of nurturing good health. Until the 19th century, the contribution of physicians to the issues of health consisted in the integration and systematisation of the relevant knowledge. It was formulated in terms of humour theory. From that point of view, health was equivalent to the balance and harmony of the humours, various parts of the organism, organs and forces governing the body. A similar formulation was used in the definitions of health put forward by Hippocrates, Galen, Avicenna, Paracelsus (Adams 1891, Galen 1597, Goodman 2006, Hartmann 1918, Montani 1556). Proportions, balance and harmony were the most frequently invoked concepts in the multitude of views on the nature of health, although these concepts were often based on varying criteria. To make health comprehensible to ordinary people, it was not enough to state its medical definition: one also had to couch it in appropriate terms. Its contents had to be meaningful to the layman. The discussion of health and disease was usually founded on the same premises, the two concepts being juxtaposed as opposites. Physicians would often resign from formulating an explicit definition of health, contenting themselves with a discussion of factors affecting health.

In this way they forced their readers to make an intellectual effort, while also shifting to them the responsibility for the absorption of the knowledge being imparted. Sometimes they simply described the appearance of a healthy man, which was intended to subsume the medical and the popular accounts of health. It was no easy task to write about health, particularly when the latter was to be associated with motor activity. To prescribe exercise to the sick was far easier than to the healthy.

Poland's first physician-writer to philosophise about health was Wojciech Oczko.<sup>1</sup> This eminent 16th-century physician was a capable author who knew how to share with the reader, in a way that was both accessible and professional, the knowledge gained in the course of his studies in Italy and France, supplemented by a trip to Spain. On returning home, Oczko successfully combined his practice as a physician with the work of a writer. His books included *Przymiot* [Venereal diseases], *Cieplice* [Baths] (all dating from 1581). These works contained a methodical presentation of the tasks of medicine, which, as he wrote, was divided into three components, comprising, in the order of decreasing importance: the promotion of health ("home" medicine), therapy and surgery. Close reading of Oczko's output indicates that the use of the word "home" was intended to emphasise every person's responsibility for his or her health, which depended mainly on individual conduct and only marginally on the entire repertoire of medical remedies (Oczko 1581,34). His idea found followers. Two hundred years later, Leopold Lafontaine gave it a more modern formulation, observing that everyone should monitor their health and be their own doctor. Both these thinkers espoused a view which is widely held today – your health is in your own hands. They used the printed word to promote and disseminate this truth. However, the attainment of this task – persuading people to adopt a healthy lifestyle – was

<sup>1</sup> Wojciech Oczko (1537-1599) – one of the founders of Polish medicine, the court physician to Kings Sigismund Augustus, Stephen Bathory and Sigismund III. He was the author of the first medical texts in Polish about balneology and syphilis. Polish medicine owes to him much of its terminology.

by no means easy. The main problem was that most people turned a deaf ear to the postulates of healthy living. This can be illustrated by popular attitudes towards exercise and food, of which Wojciech Oczko and Leopold Lafontaine took note, respectively, in the 16th century and at the turn of the 18th century.

Doctor Oczko viewed health in a broad context. He wanted to make people aware that it depended on a variety of circumstances, such as: environmental factors, diet, type of work, ability to rest, or positive thinking. Motor activity was one of the more important health boosters. Oczko warned against the harmful consequences of idleness, sedentary life, excessive eating and overindulgence in alcohol, which bred disease or led to obesity, likewise making one vulnerable to illness. He painted a vivid – not to say graphic – image of the repulsive external appearance, spiritual misery and ailments afflicting people who led an unhealthy life; this model was contrasted with that of an active man, whose physical attractiveness, intellectual capacity and health allowed him to enjoy life to the full. In his philosophical discourse on health, Oczko relied on various devices to stimulate the readers' interest. It should be borne in mind that their writings were addressed to a readership whose acquaintance with matters of health was scant. Suitable illustration is provided by an epigram, well-known to every Pole, written by the Renaissance poet Jan Kochanowski: "O precious Health / No-one will come / To know your taste / Ere you decline..." These words reflected the attitudes prevailing in those times, based on a negative definition of health. Such a way of thinking admitted of treatment and prevention, but lacked the power to stir up an interest in exercise that would foster a better, healthier life. Presumably, health was viewed as an abstract thing which an individual might possess or lose; as such, it was less readily comprehended than its visible, external attributes. Therefore, Oczko invoked a "halo effect". He intended to portray convincingly a healthy and fit man, to whom he invariably ascribed good looks and favourable traits of character. His readers were thus expected to build up a chain of associations, linking health (physical attractiveness, desirable personality traits) with motor activity. The broadly construed attractiveness of the active man was intended to make the reader emulate the proposed model. *Przymiot* contains the first identifiable postulates ever formulated in Polish concerning the maintenance and improvement of good health. His intention was to reduce therapeutic medicine to the role of a last resort. Physicians in later epochs struck nearly identical tones, associating health with external beauty. Lafontaine,<sup>2</sup> for instance, described the model of a healthy man (invoking the notion of "constitution") relevant to the Enlightenment period. Thus a healthy man was characterised by: a broad chest, flat belly, round and muscular arms and thighs, and smooth and silky skin. "Constitution" was a gift of nature. It determined an individual's hereditary propensity to illness; however, a faulty "constitution" could be rectified by appropriate exercise (Lafontaine, 1801).

Motor activity in a broad sense of the term was believed by physicians to regulate blood circulation and strengthen the joints and ligaments. Emphasis was laid not only on the preventive, but also the remedial and stimulating function of exercise. Physical exercises were discussed with recourse to various examples which often made reference to ancient Greece. Some doctors formulated mnemonic slogans. Oczko, for instance, contributed an observation of universal validity: "Exercise can replace any medicine, but no medicine can replace exercise." His teaching was addressed to adults and his critique of the neglect of exercise was a consequence of the fact that most of the forms of behaviour relevant to health were imprinted upon individuals in their childhood and youth. This issue was also taken up by Sebastian Petrycy,<sup>3</sup> who viewed the questions of health from the double

<sup>2</sup> Leopold Lafontaine (1756-1812) – a Polish-German who practised medicine at the spa of Krzeszowice. He was the editor of the *Dziennik zdrowia dla wszystkich stanów* [A health journal for people of every station].

<sup>3</sup> Sebastian Petrycy (Petricius) (1554-1626) – a physician and philosopher, Professor of the Cracow Academy and an exponent of Renaissance Aristotelianism in Poland. As a doctor, he represented the Padua school. Petrycy was one of the founders of the Polish philosophical terminology. His medical works include the treatise *De natura, causis, symptomatibus morbi gallici*...

perspective of a physician and a patriotic philosopher. The latter point of view appears to predominate in his writings.

Health represented for him mainly a utilitarian value, a sine qua non of military aptitude, to which one should aspire from childhood. Such an understanding of health determined the ways of argumentation and the selection of exercises, mainly of paramilitary character. As was appropriate for a Renaissance scholar, Petrycy presented his arguments in the form of an elaborate philosophical discourse in which he made some very interesting observations concerning the attitudes of the Poles towards motor activity. Petrycy's writings bore a visible imprint of the views of the nobility, who extended their dislike of manual labour onto physical exercise. Apparently, the latter was equated by many with the craftsman's work. There also existed a widespread notion, reinforced by Petrycy, that certain types of exercise (ball games, jumps) did not befit adults and could only be excused as a preventive measure against plague (Petrycy 1613).

Physicians (Oczko, Petrycy) viewed motor activity as a health-enhancing factor. They often mentioned physical exercise, swimming, horse riding, walking, dancing and games. Generally, they wrote about the need for any type of physical activity. Conventional wisdom of the time advocated moderation in exercise: the effort should not be too intensive or strenuous, but should be undertaken frequently. While praising exercise and recommending it as a therapeutic and preventive measure, physicians warned that it might also lead to insomnia and a variety of ailments, including anasark (subcutaneous oedema), if practised too vigorously. They invoked the physiological theory prevailing in those times (based on antiquated premises and rather difficult for the modern reader to follow) to account for the beneficial effects of exercise, which included improved functioning of the heart and the respiratory system, as well as the elimination of fatty tissue.

The physicians writing about health were convinced about the didactic importance of the printed word. Therefore, they were keen to share with the Poles their reflections on health, concentrating on the link between health and motor activity, although, admittedly, they differed both in the postulated explanation of this link and in the degree of emphasis they placed on it. Their writings encouraged the readers to adjust their individual habits so as to maintain good health, stay fit, improve their physical and mental prowess and extend their life span. One ought to nurse one's health not only for egotistical reasons, but also with a view to common good – in the form of an individual's utility to society (Oczko 1581, Petrycy 1956, Lafontaine 1801).

The reflection of Polish physicians on health and motor activity and their efforts to promote a healthy lifestyle deserves praise. Importantly, all the physicians in questions tried to overcome, in various ways, the lure of the passive lifestyle of the rich. What they especially emphasised was not that the physiological dysfunctions typical of the privileged classes (overeating, sedentary life, alcohol abuse) lead to death – which is inevitable anyway; the main point they made was that by choosing an unhealthy way of life, their compatriots traded joy and satisfaction for discomfort and suffering.

Their philosophical endeavours were intended to enhance the potential for a healthy living and, depending on the situation, served the purposes of either improving, or maintaining the current state of affairs. Their writings pertained to all the phases of the life cycle and, regardless of the readers' medical knowledge, stressed the beneficial effects of exercise for the organism. Assuming a high value of health in the eyes of society, they expected that their praise of exercise would encourage the readers to lead more active lives – which was not always the case. When advocating for such lifestyles, they knew that success was possible only if they presented their audience with easy choices to make. When faced with a choice, most people will pick an easy way out, that is, one which does not place exceeding demands on one's financial resources and time. Therefore, they advocated simple, popular forms of exercise, accessible to all.

## Conclusion

Physicians' reflections on health and motor activity was extremely important, as it increased the awareness of the relationship between lifestyles and health. It prepared the ground for future endeavours that the 20th century was to bring. It follows that – contrary to popular belief – the interest in matters of health and the tremendous activity of health-promoters observed in Poland today are hardly a new development.

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# Changes in the physical development of school students aged 8–18 years from Szczecin, Poland

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## ABSTRACT

AIM: The study analyzed changes in the physical development of children and adolescents from Szczecin, Poland, over the period of 25 years. METHODS: Subjects' body mass, body

height, and BMI were measured. RESULTS: The analysis indicates that present-day children display a greater variability in their physical development than their peers earlier. This is evidenced by the ranges of minimum and maximum anthropometric measurements. Even two-fold differences in results were noted over the studied period of 25 years. CONCLUSIONS: 1) Girls studied in 1999 and 2008 had a greater body mass than their peers from 1992 and 2016. 2) Boys aged 9, 10 and 12 years studied in 2016 had a greater body mass than their peers in earlier years. 3) Boys aged 10-15 years studied 2016 are shorter than their peers studied earlier. 4) Girls aged 9-16 years (with the exception of 14-year-olds) studied in 2016 are shorter than their peers studied earlier.

**Key words:** children, adolescents, body mass, body height, BMI

## Introduction

There is an increasing number of research reports regarding a negative impact of the progress of civilization on health and physical development of young generations. Results of studies on physical fitness of young Poles made Ryszard Przewęda assert that subsequent generations of the Polish youth became physically taller and reached pubescence faster (2003). This can also be associated with the growing disproportions between the somatic and motor development of adolescents, which Przewęda refers to as the “opening scissors syndrome” (Przewęda 2003, p. 40).

The data from the present study and their analysis can be used to assess changes in the somatic development of children and adolescents. Results of anthropometric measurements taken over 25 years constitute the basis for conclusions regarding the population of Szczecin, Poland.

## Material and methods

Anthropometric measurements were carried out in the following periods: 1992–1999 (longitudinal study, 920 subjects, Umiastowska, 2002); 1998–1999 (6959 subjects, Umiastowska et al., 2001); and 2008–2011 (1345 subjects, Umiastowska, 2009) and in 2016 (729 subjects). The subjects were primary, middle, and secondary school students, and the anthropometric measurements included body mass, body height, and BMI. In the years 1992–1999 the measurements were taken with the use of weighting scales with a height gauge, and with the Tanita WB380H digital scales during the later measurement periods. Microsoft Excel spreadsheets were used for all descriptive statistics and for the determination of significance of differences.

## Results

The anthropometric measurements of students' body height over a period of 25 years revealed the least differences in 12-13-year-old girls and 11-year-old boys. Girls aged 11, 15 and 16 years, and boys aged 15 and 16 years were shown to be shorter than their peers studied earlier. Only in 14-year-old girls a systematic increase in body mass was found. However, in all other age categories this trend was not noted (Tab. 1–2, Fig. 1–2). The analysis of body mass of boys aged 8–13 years revealed an increasing trend in 2016 in comparison with results of the earlier measurements. Boys over 14 years of age had a lower body mass than their peers 25 years ago. The girls aged 10, 15, and 16 years had lower body mass than their peers studied earlier. The largest percentage of high body mass and body height values were found in girls studied in 2008 (Tab. 3–4, Fig. 3–4). According to Ryszard Stupnicki, while body height is mainly determined by genetic factors, and only to some extent by environmental factors, the environmental determinants are decisive for body mass (2015, 43). The analysis of BMI variability in Tables 5–6 and Figures 5–6 confirms the aforementioned increasing trend in younger children.

Age	1992*	1999**	2008***	2016
8 years	26.5±4.74	27.0±4.71	31.1±3.98	26.1±4.21`
9 years	29.5±5.16	30.5±6.32	23.6±5.47	30.3±5.29
10 years	33.1±5.81	34.6±5.98	30.7±5.33	30.8±5.27
11 years	37.5±7.43	39.3±6.33	39.0±4.33	38.5±4.86
12 years	41.7±8.37	42.3±5.45	45.6±5.21	44.3±5.72
13 years	47.8±8.97	51.0±9.24	51.2±8.33	47.9±9.33
14 years	52.8±9.14	54.0±9.11	54.4±5.54	52.7±8.65
15 years	56.4±9.17	53.9±6.94	55.0±8.99	51.9±7.88
16 years	-	54.4±6.31	57.8±5.87	51.7±6.01
17 years	-	56.0±6.17	57.6±6.37	-
18 years	-	56.5±6.20	57.9±6.62	-

Table 1. Girls' body height over 25 years.

\*1992 Umiastowska, 2002, \*\* Umiastowska et al., 2001, \*\*\*Umiastowska, 2009

Age	1992	1999	2008	2016
8 years	27.1±4.96	29.0±4.92	33.6±5.01	30.8±4.96
9 years	30.5±5.42	31.4±5.71	24.5±5.23	34.3±5.99
10 years	34.0±6.08	38.6±6.12	37.8±6.39	39.9±7.01
11 years	37.5±7.38	40.5±7.04	47.7±8.01	41.1±7.65
12 years	41.3±8.48	45.5±6.20	47.6±7.22	48.9±7.12
13 years	47.4±9.78	53.6±10.32	55.6±9.45	50.2±8.85
14 years	53.5±11.24	57.5±11.23	62.1±12.01	52.4±11.42
15 years	50.4±11.24	64.8±9.62	62.7±9.17	46.0±8.63
16 years	-	67.9±9.21	65.4±9.08	-
17 years	-	71.5±7,64	70.2±7.37	-
18 years	-	71.7±8.30	70.8±8.15	-

Table 2. Boys' body height over 25 years.

(source: own research)

Age	1992	1999	2008	2016
8 years	128.1±6.07	127.0±6.51	129.5±6.38	130.4±6.29
9 years	133.3±6.05	133.0±10.33	137.6±7.67	134.4±9.34
10 years	139.1±6.54	142.5±7.20	145.5±6.99	140.2±7.93
11 years	151.8±7.37	149.3±8.61	152.8±6.23	143.4±6.92
12 years	151.0±7.93	156.1±7.24	154.5±7.22	151.2±7.54
13 years	157.6±7.35	160.9±7.91	158.6±7.88	156.3±7.65
14 years	162.0±6.58	163.7±6.50	164.1±6.10	164.5±6.26
15 years	166.4±6.15	165.0±6.02	164.9±7.00	163.7±6.76
16 years	-	165.8±5,73	165.9±5.12	164.0±5.55
17 years	-	166.6±5.70	167.9±5.22	-
18 years	-	165.7±6.11	168.4±6.73	-

Table 3. Girls' body mass over 25 years [kg].

(source: own research)

Age	1992	1999	2008	2016
8 years	129.1±6.18	129.4±7.62	131.3±6.44	132.6±7.03
9 years	134.2±5.79	133.2±10.01	122.3±6.44	135.3±7.21
10 years	139.8±6.06	145.0±6.52	143.1±5.98	141.2±5.76
11 years	145.7±6.98	149.7±7.83	155.6±7.55	145.7±7.75
12 years	150.1±7.10	156.4±6.64	153.9±6.78	154.9±6.97
13 years	157.7±8.16	164.0±8.70	159.8±7.98	158.3±8.32
14 years	164.4±8.49	169.3±8.53	171.0±9.00	165.3±8.86
15 years	176.6±7.83	174.7±6.51	171.7±6.13	165.0±6.78
16 years	-	176.4±6.90	175.8±7.02	-
17 years	-	178.8±5.82	179.9±6.09	-
18 years	-	178,2±6.23	180,1±6.98	-

Table 4. Boys' body mass over 25 years [kg].

(source: own research)

Age	1992	1999	2008	2016
8 years	16.11±2.345	16.74±2.398	16.58±2.765	16.11±2.349
9 years	16.60±3.297	17.24±3.541	16.37±3.715	16.60±6,653
10 years	17.11±5.231	17.04±3.341	14.50±2.121	17.11±3.989
11 years	16.27±5.387	17.63±5.375	16.70±5.443	16.27±5.901
12 years	18.29±4.765	17.36±4.773	16.87±4.176	18.29±4.268
13 years	19.32±4.231	19.70±3.995	19.09±4.005	19.32±4.376
14 years	20.12±5.254	20.15±4.975	20.15±4.736	20.12±4.086
15 years	20.37±3.427	19.80±4.002	20.19±4.309	20.37±3.984
16 years	-	19.79±4.987	21.00±5.101	-
17 years	-	20.18±4.355	20.41±5.182	-
18 years	-	20.07±5.221	20.47±4.387	-

Table 5. Girls' BMI over 25 years.

(source: own research)

Age	1992	1999	2008	2016
8 years	16.44±3.001	17.32±3.138	16.83±2.985	17.71±2.974
9 years	16.94±3.009	17.70±3.726	16.68±3.554	18.76±4.062
10 years	17.40±3.112	18.36±3.483	18.45±3.987	20.07±4.262
11 years	17.66±2.887	18.07±3.098	18.57±3.991	19.33±4.963
12 years	18.33±3.222	18.60±4.287	19.84±3.498	20.30±4.002
13 years	19.06±4.230	19.93±4.651	21.77±5.005	20.04±5.265
14 years	19.79±6.002	20.06±4.962	20.95±5.001	18.98±4.387
15 years	16.16±7.398	21.23±5.234	20.97±5.281	16.90±4.880
16 years	-	21.82±4.996	21.16±4.476	-
17 years	-	22.37±4.376	21.63±4.801	-
18 years	-	22.58±5.007	21.76±5.964	-

Table 6. Boys' BMI over 25 years.

(source: own research)

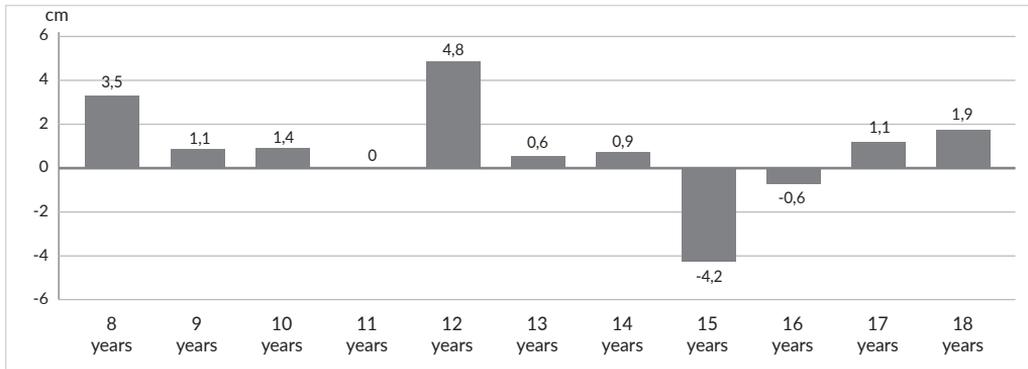


Figure 1. The differences in body height, girls 1992 and 2016

(source: own research)

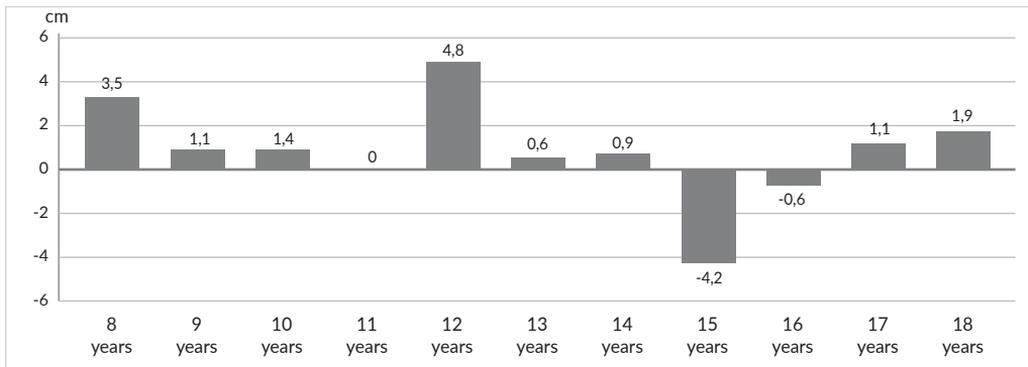


Figure 2. The differences in body height, boys 1992 and 2016

(source: own research)

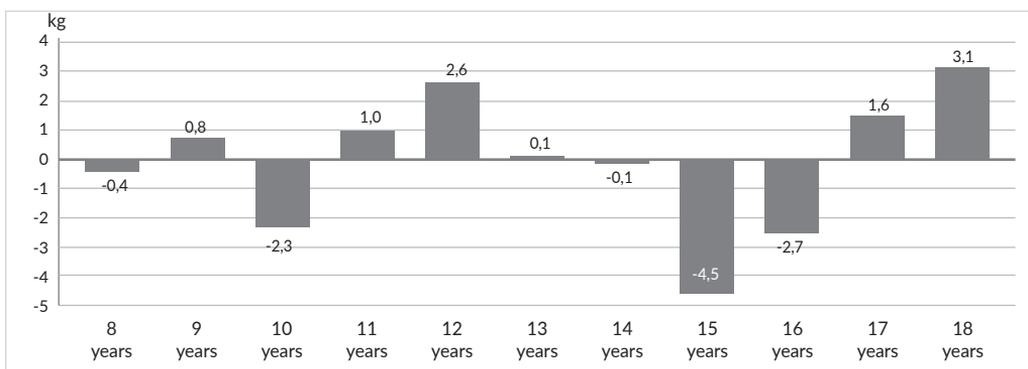


Figure 3. The differences in body mass, girls 1992 and 2016

(source: own research)

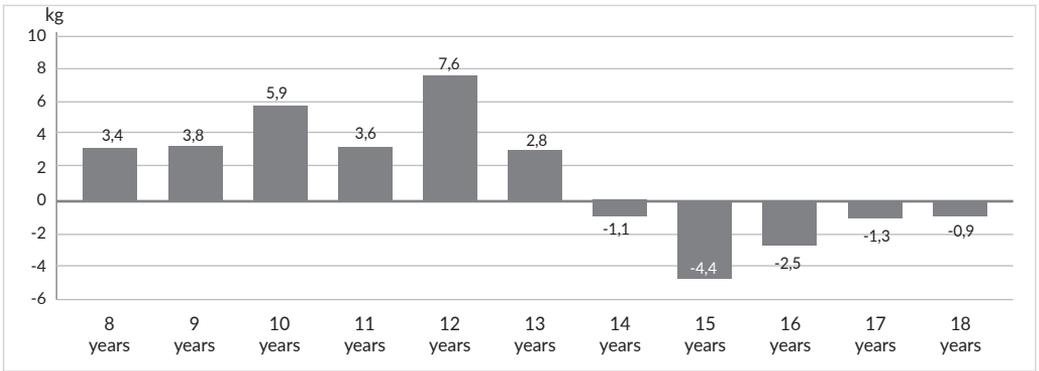


Figure 4. The differences in body mass, boys 1992 and 2016

(source: own research)

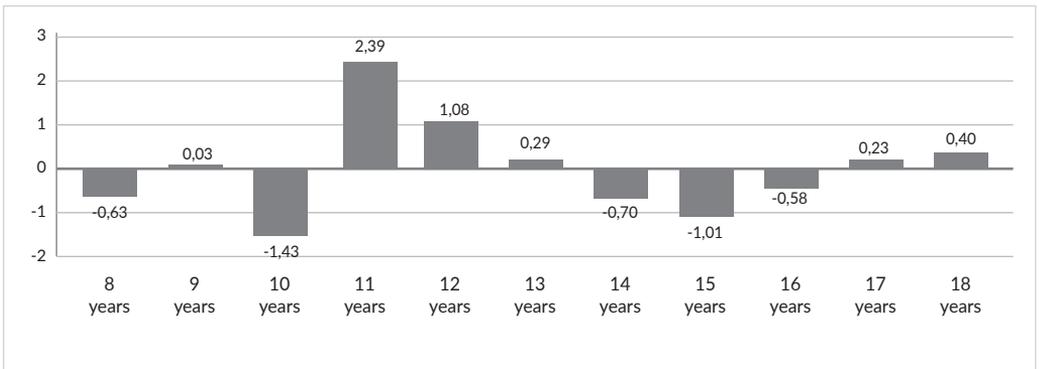


Figure 5. The differences in BMI, girls 1992 and 2016

(source: own research)

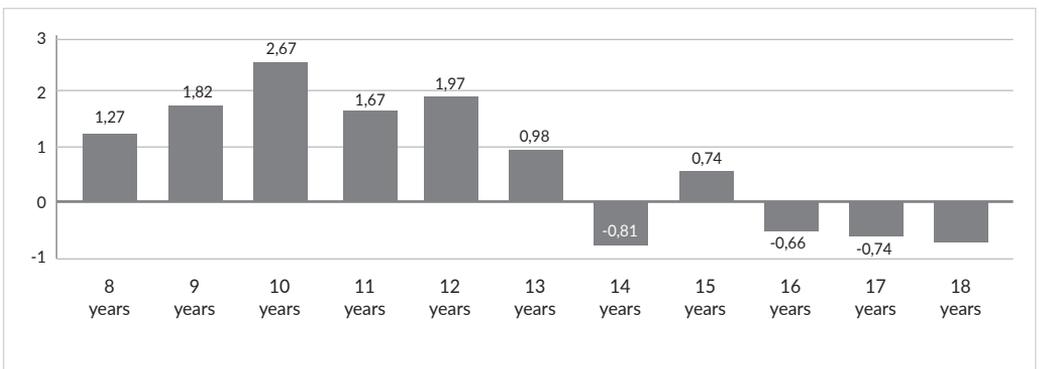


Figure 6. The differences in BMI, boys 1992 and 2016

(source: own research)

## Conclusions

1. Girls studied in 1999 and 2008 had a greater body mass than their peers from 1992 and 2016.
2. Boys aged 9, 10 and 12 years studied in 2016 had a greater body mass than their peers in earlier years.
3. Boys aged 10–15 years studied 2016 are shorter than their peers studied earlier.
4. Girls aged 9–16 years (with the exception of 14-year-olds) studied in 2016 are shorter than their peers studied earlier.

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# Effect of 4 weeks of resveratrol intake on hematological parameters in recreational trained cyclists

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## **ABSTRACT**

**PURPOSE:** Effects of resveratrol (RE) on lowering blood fats have been claimed in several studies. A population who could benefit from the intake of resveratrol are the recreational cyclists. One study existing at present time about the effect of resveratrol in recreational cyclists (Braakhuis et al., 2015). Our aim was to investigate the effect of a prolonged (28 days, 1g/day) supplementation of RE in recreational well-trained amateur cyclists on their body weight, plasma lipids and basic hematological parameters, blood pressure, lactate and exercise fatigue perception. **METHODS:** Twenty recreational cyclists (mean age 38.7±9 years for resveratrol group, RE = 9, and 31.3±8.6 years for placebo groups, PL = 11) were evaluated for basic hematological parameters, lactate, blood pressure, and fatigue perception, before and after acute (1g, 30 min before a maximal trial) and long-term consumption (4 weeks) of 1g/day of resveratrol (before and after a 1-hour exhaustion trial). **RESULTS:** No long-term changes in blood pressure were observed (RE group 111±13/81±13 and 116±8/82±10; PL group 116±18/84±13 and 114±30/78±20, respectively at day-0 and day-28). No changes in body weight were observed (74.46±7.14 kg on day 0 and 75.9± 6.8 on day 28 in RE group; 73.96± 6.55 kg on day 0 and 73.78± 5.87 on day 28 in PL group). Scores on the Borg visual analog scale was: 19±1 on day 0 and 18±2 on day 28, for PL group, while RE group scored 19±1 and 18±2 without any significant pre-post differences and between the groups. Total cholesterol showed a larger decrease in the long term in the RE group: 181.44±23.77 vs 141.75±52.67 (p= 0.10) in the RE compared to 185.80±23.59 vs 81.67±20.31 (p=0.48), day 0 and day 28, while LDL significantly decreased only in the RE group: 86.11±18.26 vs 75.67±17.85 (p=0.19) for RE, and 93.08±15.68 vs 90.14±15.76 (p=0.68) in the PL group. **CONCLUSION:** Main effect of resveratrol was manifested in controlling fat markers in blood in long term (4 weeks) with 1g/day ingestion.

## **Introduction**

Resveratrol is believed to be responsible for some of the benefits of the Mediterranean diet (Murase et al., 2009). Effect of resveratrol (RE) on fatigue and performance is controversial. Most studies, done on mice, produced conflicting results, some showing improvements in physical performance (Dolinsky et al., 2012, Wu et al., 2013) and some showing detrimental effects (Mayers et al., 2009, Hart et al., 2013). It was observed that resveratrol could be useful in highly active rats, bred for high running performance, but detrimental in rats bred for low running performance (Hart et al., 2014). Few studies exist on resveratrol in humans in general and athletes in particular, without any clear evidences. A large review

study observed that there was a need of research in the sport field (Braakhuis et al., 2015). Gliemann (Gliemann et al., 2013) performed, in sedentary men, a study, using as a test the time to 5 km walk, with 250 mg/day of resveratrol intake. He observed a detrimental effect of 4% on the performance. Studies in rodents demonstrated that administration of resveratrol significantly reduced blood glucose, body weight and plasma triglyceride levels (Yan et al., 2018, Singh & Shashibara, 2017), while recent review studies do not support these conclusions (Hunter et al., 2017). Also, resveratrol in association with aerobic exercise has claimed to reduce plasma lactate post exercise (Kan et al., 2016) and to maintain muscle performance with aging (Rodríguez-Bies et al., 2014). Voduc et al. (2014) in man did not observe any changes in exercise duration during two 4-week periods of resveratrol treatment, and observed small reductions in fasting glucose, small increases in liver enzymes, total cholesterol, and triglycerides. They also did not observe any change in complete blood count, inflammatory markers, renal function, or other measures of liver function (Voduc et al., 2014). In mice, an effect on reducing cholesterol synthesis was observed (Do et al., 2008). Effect on low-density lipoprotein has also been claimed (Vivancos-Moreno 2008). Contrary, in a large review study (Sahebkar, 2013), RE supplementation had no significant effect, independently from dosage, on total cholesterol, low-density lipoprotein, cholesterol, and high-density lipoprotein. These findings were further confirmed recently in a study (Haghighatdoost & Hariri, 2018), which did not find any effect of RE on lipid profile independently of sex, age, dosage and take-time span. An influence of RE on the immune response (WBC increase) was demonstrated in mice, independently of diet (Fogacci et al., 2018). Effect of resveratrol on lowering systolic BP in diabetes men with dosage > 300 mg/day was found in a meta-analysis (Banfi et al., 2012), but no studies on the effect of resveratrol on BP have been done with athletes. Our aim was to investigate the effect of a prolonged (28 days, 1g/day) supplementation of RE in recreational well-trained amateur cyclists on their body weight, plasma lipids and basic hematological parameters, blood pressure, lactate and exercise fatigue perception.

## Methods

Twenty male amateur cyclists were randomly assigned to 2 groups: resveratrol (RE = 9) and placebo (PL = 11). Mean age was  $38.7 \pm 9$  years for RE group and  $31.3 \pm 8.6$  years for PL; body height  $175.2 \pm 6.1$  and  $180 \pm 1.8$  cm, BMI  $26.8 \pm 4.2$  and  $25.8 \pm 4.8$  for RE group and PL group, respectively. Mean km of training per week were  $322 \pm 135$  (max 550 vs. min 60) in RE group and  $308 \pm 146$  (500 vs. 96) in PL group. No significant differences in the weekly mileage was found between the groups. The cyclists continued with the same mileage during the study period of 4 weeks. RE group took 1 g/day resveratrol for 28 days, while PL group took a pill of 1g of sugar. A double-blind procedure was followed. Blood were sampled 4 times: before and after the exhaustion trial on day 0 and on day 28.  $VO_{2max}$  (ml/kg/min) was assessed with an incremental ramp test on a cycloergometer (Lode Corival, Nederland), with ramp of 20 watts per minute until exhaustion, one week before day 0.  $VO_{2max}$  was  $53.71 \pm 7.9$  ml/kg/min for RE and  $50.7 \pm 12.2$  for group PL, with no statistical significant differences. Fatigue protocols were performed on a cycloergometer (Lode Corival, The Nederland) on day 0 and on day 28; it consisted of: 10 min cycling at 70% of  $VO_{2max}$ , 9 minutes at 50%  $VO_{2max}$  + 1 min at 90% $VO_{2max}$  x 4, ending with 3 min at  $VO_{2max}$  + 7 minutes of cool down, for a total of a 60 min exhaustion test. The subjects were asked to rate the effort using the Borg RPE scale (Borg, 1970) in the last 10 minutes of the trial. Heart rate was measured during the first hour bout and in the 10 subsequent minutes. In order to avoid hemoconcentration, subjects were allowed to drink water ad libitum during the trials. Blood was frozen and then processed with standard laboratory procedure. The following hematological parameters were measured: White blood cell (WBC,  $10^3/ul$ ), red blood cell (RBC,  $10^6/ul$ ), hemoglobin (HGB, g/dl), hematocrite (HCT, %), mean corpuscular volume (MCV, fl), mean content of hemoglobin

(MCH, pg), mean concentration of hemoglobin content (MCHC, g/dl), red blood cell distribution wide (RDW, %), glycemie (mg/dl), transaminases (YGT, GOT and GPT, U/L); HDL-cholesterol and total cholesterol (CHOL), tryglicerides (TRIG), LDL-cholesterol (LDL, mg/dl), blood lactate (mml/L) was measured at rest and at 3 and 6 minute post trial on days 0 and 28 with a portable Lactate Scout System (EKF, Cardiff UK). Pre-post differences after 28 days of continuous road training (the cyclist continued with their regular mileage described above) were analyzed with t-test for paired samples (IBM-SPSS PC v.20.0 statistical package). Significance level was set at 0.05%. Correlations between hematological parameters measured on day 28 and mileage cycled were also performed.

## Results

Body weight remained unchanged over the 28 days in both groups (74.46±7.14 kg on day 0 and 75.9± 6.8 on day 28 in RE group; 73.96± 6.55 kg on day 0 and 73.78± 5.87 at day 28 in PL group). Contrary to findings in sedentary and diabetic population (Banfi et al., 2012), in our sample blood pressure (mmhg) at the 10th minute post exercise did not change significantly between day 0 and day 28 (RE group 111±13/81±13 and 116±8/82±10; PL group 116±18/84±13 and 114±30/78±20, respectively on D-0 and D-28). In order to assess the effect on the effort perception, the subjects were asked to rank the effort in the last 10 minute of the exhaustion trial on a Borg RPE 20 visual analog scale (Borg, 1978). Results showed a close to maximal intensity effort. PL group scored 19±1 on day 0 and 18±2 on day 28, while RE group scored 19±1 and 18±2 without any significant pre-post differences and between the groups. The groups differed significantly for the lactate levels on D-0, but no difference was found on D-28. Resveratrol group started to take 1g/day from the day of maximal test, a week before day 0. Lactate results are reported in Tab. 1.

	MAX	D-0	D-28
Resveratrol	15,87±2,74	11,50±2,55*	7,4±2,23
Placebo	13,60±2.96	8,1±1,86 *	7,3±3,57

Table 1. Max blood lactate (mM/L) measured post the VO<sub>2</sub>max test, after the exhaustion test at baseline (D-0), and after 28 days (D-28) of training, in RE (n=9) and PL group (n= 11). P<0.05.

Anova \* F = 11,602; p = 0.003

The significant results for the pre-post trial of hematological parameter on days 0 and 28 are shown in Table 2.

	Resveratrol			Placebo		Sig. T
	G 0	G 28		G 0	G 28	
GLIC	79.56±24.96	64.11±24.57	0.21*	83.70±15.88	75.22±14.56	0.50*
GOT	27.11±9.28	23.56±7.55	0.22*	25.30±7.62	23.33±5.47	0.39*
CHOL	181.44±23.77	141.75±52.67	0.10*	185.80±23.59	181.67±20.31	0.48*
HDL	63,31±14,82	69,81±18,29	0,63	58,72±15,79	66,21±19,30	0,004*
MCV	94.52±3.11	95.20±2.83	0.02*	90.78±4.99	91.03±4.86	0.92
MHC	31.00±1.22	31.19±1.03	0.43*	29.76±1.68	29.91±1.65	0.89

Table 2. Hematological parameters at baseline and after 28 days of cycling training of 1 g/day. Resveratrol n =9, Placebo n =11

\* = statistically different at t-test, significant level = 0,5%; GLI: Glicemy, mg/dl; GOT and GPT: Transaminases, U/L; HDL: HDL-Cholesterol, mg/dl; CHOL: total Cholesterol, mg/dl; MCV, (fl): Mean Corpuscular Volume; MHC,(pg) : Mean Content of Hemoglobin.

Glycemy, cholesterol and LDL decreased in both groups. Cholesterol and LDL showed a larger decrease in RE group. GOT decreased in both groups, while GPT only in the resveratrol group. MCV and MHC decreased only in the RE group. Not any other statistically significant difference was found between the two groups pre- vs. post 28 day of 1 g/day resveratrol ingestion. Weekly mileage significantly inversely correlated with CHOL (-0.734,  $p = 0.024$ ) and with MCV (-0.693,  $P = 0.039$ ) measured post training, only in RE group.

## Discussion

Resveratrol was indicating as an effective polyphenol to control fat metabolism and to improve performance. It was widely studied in mice, but there is a lack of research in athletes. In our study, we observed an effect on increasing LDL, lowering glycemy. We observed a reduction in the levels of blood sugar and cholesterol after 4 weeks of 1g/day ingestion, as observed previously (Vivancos-Moreno, 2008) and, contrary to other studies, which showed a small increase in these parameters, but with a lower dosage of resveratrol (Voduc et al., 2014). GOT and GPT have been associated with muscle damage (GOT) and liver function (GPT) (Banfi et al., 2012). In our study, GOT decreased in both groups, demonstrating a reduction of muscle damage with endurance cycling, while GPT showed a significant decrease only in the resveratrol group, while an increment occurred in the placebo group, demonstrating a positive effect of resveratrol on liver. CHOL showed a marked decrease in the resveratrol group. These results are also in accord with previous findings in diabetic rats (Yan et al., 2018, Singh & Shashidara, 2018) albeit we did not observe a reduction of body weight. We also observed an effect on reducing plasma lactate levels as previously observed in rodents with 4 weeks of intake (Kan et al., 2016). In the long term, a study in mice observed an increase in WBC with resveratrol intake (Fogacci et al., 2018): we did not observe a modification in WBC after 4 weeks in cyclists. The decrease of MHC and MCV only in the RE group can be explained with an increased utilization of hemoglobin in this group. All other hematological markers remained unvaried. We did not find any effect

on further reduction of blood pressure contrary to other studies in non-athletes and diabetic patients (Banfi et al., 2012). We also observed a subjective improvement in fatigue perception in the Borg Scale after the exhaustion trial in the resveratrol group with concurrent bike aerobic training without any objective (heart rate decrease) sign after 4 weeks of training.

## Conclusions

In conclusion, our study demonstrated a significant effect on free fats control in blood and in reducing perception of fatigue with 4 weeks of 1g/day of resveratrol in men who regularly practice recreational albeit intensive cycling. We also observed a positive effect on liver enzymes and a reduction of lactate levels, but we did not observe a further reduction in blood pressure, white blood cell count, and body weight or recovery heart rate. Our results are partially in accord with previous laboratory findings in mice and provide new data for men. Additional studies in sport are required to better elucidate the role of resveratrol in the recovery process.

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**Conflict of interest:**

The authors declare that there is no conflict of interest that could be perceived as prejudicing the impartiality of the research reported.

**Ethical approval**

All procedures performed in studies involving rats as animal models were conducted in accordance with guideline on the welfare of experimental animals and with the approval of the Ethics Committee on the use of animals of the University of Bologna. The study has been performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

**Informed consent:** was obtained from the participants prior to the study.

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# Age, Educational and Gender Differences in Interest Towards Three Racquet Sports on a Sample of Middle-Aged Adults

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**ABSTRACT**

A research on age, educational and gender differences in interest towards table tennis, badminton and tennis was conducted on an appropriate sample of 920 adults from the Republic of Croatia. The examinees were given the task of evaluating each sport on a five-degree scale, where "1" indicated a sport that the examinees would never, under any circumstances, like to engage in, while "5" denoted a sport that the examinees would surely like to engage in if they had the opportunity to do so. With regard to their age, the examinees were divided into two groups, "younger", referring to the examinees aged between 35 and 49, and "older", referring to examinees aged between 50 and 65. Their level of education was specified by using three different categories, primary school completed or less, secondary school completed and higher education completed. The analysis of differences was completed by the multivariate analysis of variance with three factors in which the groups were determined by gender, level of education and age. The results showed statistically significant differences with regard to gender and level of education (with the relevant level of statistical significance  $p < 0.00$ ), as well as in interaction of gender and level of education ( $p < 0.02$ ). Age did not demonstrate to be a significant factor for the differences in interest, as well as the interactions where age was involved. The

results of this research indicate that gender stereotypes related to sports are still present in this population and that they are demonstrated regardless of age. This research also showed that formal education presents a significant role in forming a more positive attitude towards sports.

**Key words:** tennis, badminton, table tennis, interest in sport

## Introduction

In terms of recreation, sport is conceived as a means for spending leisure time in a more quality way. Adults very often dominantly relate precisely the way of spending their leisure with the quality of life (Korov, 2010). For the above-mentioned reason, sport plays an important role. Individual racquet sports, such as table tennis, badminton and tennis, hold a special place in the family of world sports, as people can satisfy various different needs, desires and interests by engaging in these sports. This is primarily because these sports enable an individual to engage in them starting with early youth and all the way until older age.

Table tennis, badminton and tennis belong to the category of complex sports activities in which acyclic movement structures are employed in conditions of sport competitions both when played individually or in pairs (Milanović, 2010). The above-mentioned racquet sports are characterized by intervals of intense effort (active play) with short rest periods between points (Zagatto, Papoti, & Gobatto, 2008). Table tennis, badminton and tennis highly develop physical and psychological abilities and require concentration and precision (Korov, 2010). It is precisely this high number of movement structures and game situations (technical and tactical options) that imply how efficiency is determined by the level and structure of a large number of abilities, skills and characteristics, among which some can be measured and analysed (Novak, Tudor-Barbaros, & Matković, 2006).

Table tennis is considered as one of less dangerous sports, as there is little risk of injury, stroke or fall. It is especially recommended to individuals recovering from joint injuries or persons with painful joints (Kondrič, Zagatto, & Sekulić, 2013). As table tennis is a cardio activity, it positively affects cardiovascular health and improves general fitness and health. It is recommended to all age groups, regardless of one's current fitness shape. Accordingly, table tennis is therefore recommended to older adults as it decelerates the decline of cognitive functions, as well as it improves reflexes, mental alertness, speed of movement and changes of movement direction (Kondrič, Zagatto, & Sekulić, 2013). Table tennis is one of the favourite sports for people all around the world that does not require a lot of space, expensive equipment and can be played both in indoor and outdoor areas (Langitan, 2018). Badminton is likewise a non-contact sport that is considered as involving a low risk of injury. It includes jumps, lunges, quick changes of movement direction and sharp movements of the arm. This is a quick sport that is played on a relatively small field and with a broad range of movements on the field, as well as racquet movements. The basic goal is to throw the other player(s) off balance and away from the central position, which means that badminton players should be able to quickly react and move around the field a lot. According to the data of the Badminton World Federation (BWF), it is one of the most popular sports in the world with over 200 million players worldwide (Phomsoupha & Laffaye, 2014).

Tennis is currently a world-class sport attracting millions of players and fans across the world. There is a continuous programme of tennis games and events throughout the year (Fernandez, Mendez-Villanueva, & Pluim, 2006). It is most popular in developed countries, however, it is gradually also becoming more popular in lower developed countries. Tennis is played on various surfaces (clay courts, grass courts, hard courts) which requires a certain adjustment by the players and their style of play. Apart from the adjustment to different surfaces, in terms of their physical abilities, players' characteristics related to features of speed (speed, agility, explosive strength, etc.) are those that are most responsible for

achieving efficiency in tennis, whereas in terms of energy, players remain in the anaerobic regime due to the short duration of points. Tennis is a game that is easily accessible, interesting and beneficial for health also for adults of older age. In addition, it is a recreational sport that can be engaged in by individuals with different abilities (Fernandez, Mendez-Villanueva, & Pluim, 2006).

As all three of the above-mentioned sports are attractive activities that everyone can engage in, the aim of this research is to determine age, educational and gender differences in interest towards table tennis, badminton and tennis on a sample of middle-aged adults in the Republic of Croatia.

## Methods

This research was implemented on an appropriate sample of 920 adults from the Republic of Croatia. It is not a representative sample, however; data were collected in all parts of the Republic of Croatia. Measurements were conducted by students of the Faculty of Kinesiology University of Zagreb as part of a research paper for the course Psychology of Older Age. A total of 433 men and 482 women were included in the measurements, while the data on gender are missing for 5 examinees. Their age range is between 35 and 65, with the average age of 49.7 and a standard deviation of 6.55 years of age. The educational level of the examinees was divided into three categories, primary school completed or less, secondary school completed and higher education completed (Table 1). This sample contained less persons with the lowest level of education and more individuals with higher education than what is generally found among adult population in the Republic of Croatia.

Level of education	Frequency	Cumulative frequency	Percentage
Primary school completed or less	60	60	6,52
Secondary school completed	488	548	53,04
Higher education completed	372	920	40,43

Table 1. Structure of research sample with regard to the level of education

The examinees' interest towards table tennis, badminton and tennis was evaluated by using the PS 2 Questionnaire that was developed by Franjo Prot (Prot & Bosnar, 1999). The mentioned questionnaire requires an estimate for a large number of sports (52), so that the examinees were not aware of the aim of this research. Their task was to evaluate each individual sport on a five-degree scale, by circling the mark five (5) for any sport that they would surely like to engage in if they had the opportunity to do so, the mark four (4) for any sport that they would like to engage in, the mark three (3) for any sport that they would engage in occasionally or in the right circumstances, the mark two (2) for any sport that they would not like to engage in, i.e. that they would engage in only if there were no other options, and finally, the mark one (1) for any sport that they would never engage in, regardless of the circumstances.

The analysis of age, educational and gender differences was completed by using the multivariate analysis of variance with three factors, in which the groups were determined by gender, level of education and age. With regard to their age, the examinees were divided into two groups: "younger", referring to the examinees aged between 35 and 49 (52,5% of the overall sample), and "older", referring to the examinees aged between 50 and 65 (47,6% of examinees).

## Results and discussion

As represented below in Table 2, statistically significant differences were determined with regard to gender and level of education, with the relevant level of statistical significance  $p < 0.00$ . Likewise, the interaction of gender and level of education also showed a factor of statistically significant difference, however, with a lower level of relevant statistical significance ( $p < 0.02$ ). Age did not demonstrate to be a significant factor for the differences in interest, as well as any interactions where age was involved.

The results of this research indicate that gender stereotypes related to sports are still present in this population and that they are demonstrated regardless of age. This research also showed that formal education presented a significant role in forming a more positive attitude towards sports.

Factor	Wilks' lambda	Value of F-test	Degree of freedom 1 and 2	Statistical significance
Gender	0,890138	37,068	3, 901	0,000000
Age	0,997417	0,778	3, 901	0,506490
Level of education	0,973706	4,028	6, 1802	0,000515
Interaction gender*age	0,995247	1,434	3, 901	0,231281
Interaction gender*education	0,983007	2,585	6, 1802	0,016969
Interaction age*education	0,992728	1,098	6, 1802	0,361089
Interaction gender*age*education	0,995147	0,731	6, 1802	0,624344

Table 2. Results of the multivariate analysis of variance with three factors

Table 3 demonstrates arithmetic means and standard deviations for the results of all three sports and for each group of examinees defined according to their gender, age and level of education. Statistically significant gender differences were shown by a greater tendency of male examinees towards table tennis, a greater tendency of female examinees towards badminton, and a similar tendency of both gender groups towards tennis. In a research on gender stereotypes conducted with students of the University of Zagreb (Bosnar & Žugaj, 2009), badminton was evaluated as a more female than male sport, presumably due to the fact that in this region badminton is traditionally a recreational sport. The mentioned research also showed that table tennis and tennis were close to gender neutrality, while table tennis was still somewhat slightly oriented towards the male population. The identical presumption can also be made in terms of this research, leading to the conclusion that the demonstrated differences are a result of gender stereotypes that are typically manifested in this region.

The differences related to the level of education can be explained by the lower interest for sport in people with elementary school education. Univariate analysis of variance indicates a statistically lower interest of this group for badminton (value of F-test=9,728;  $p < 0,000$ ) and tennis (value F-test=5,303;  $p < 0,00$ ). The interaction between gender and education interestingly shows that male examinees with elementary school education accept table tennis, however, completely reject badminton, and to a certain degree also tennis. Male examinees with secondary and higher education demonstrate similar results. They show the highest interest for tennis, while they neither accept nor reject badminton. Table tennis is somewhat better accepted in the group with secondary education than in the higher education group. Female examinees revealed a much simpler situation; the higher the level of education, a more positive relationship towards all three sports was demonstrated.

Group	Number of examinees	Table tennis		Badminton		Tennis	
		AM	SD	AM	SD	AM	SD
Total	915	2,931	1,255	3,317	1,254	3,402	1,204
Male examinees	433	3,242	1,186	2,998	1,279	3,393	1,245
Female examinees	482	2,651	1,252	3,604	1,160	3,411	1,167
50 years old or less (younger)	479	2,843	1,275	3,338	1,285	3,457	1,204
50 years old or more (older)	436	3,028	1,228	3,294	1,221	3,342	1,202
Elementary school (ES)	60	2,733	1,247	2,583	1,406	2,983	1,408
Secondary school (SS)	486	2,977	1,244	3,323	1,240	3,356	1,184
Higher education (HE)	369	2,902	1,271	3,428	1,210	3,531	1,177
Male younger	203	3,207	1,201	2,921	1,329	3,320	1,275
Male older	230	3,274	1,174	3,065	1,233	3,457	1,217
Female younger	276	2,576	1,264	3,645	1,162	3,558	1,141
Female older	206	2,752	1,230	3,549	1,158	3,214	1,174
Male ES	33	3,121	1,193	2,121	1,293	2,879	1,474
Male SS	245	3,363	1,117	3,098	1,234	3,416	1,152
Male HE	155	3,077	1,272	3,026	1,284	3,465	1,316
Female ES	27	2,259	1,163	3,148	1,350	3,111	1,340
Female SS	241	2,585	1,246	3,552	1,207	3,295	1,215
Female HE	214	2,776	1,258	3,720	1,064	3,579	1,066
Younger ES	28	2,679	1,219	2,714	1,384	2,929	1,438
Younger SS	244	2,943	1,278	3,295	1,310	3,385	1,217
Younger HE	207	2,749	1,275	3,473	1,218	3,614	1,130
Older ES	32	2,781	1,289	2,469	1,436	3,031	1,402
Older SS	242	3,012	1,210	3,351	1,169	3,326	1,151
Older HE	162	3,099	1,242	3,370	1,200	3,426	1,230
Male younger ES	15	3,000	1,254	2,067	1,163	2,733	1,486
Male younger SS	116	3,345	1,143	2,948	1,331	3,284	1,207
Male younger HE	72	3,028	1,267	3,056	1,310	3,500	1,311
Male older ES	18	3,222	1,166	2,167	1,425	3,000	1,495
Male older SS	129	3,380	1,098	3,233	1,129	3,535	1,090
Male older HE	83	3,120	1,282	3,000	1,269	3,434	1,327
Female younger ES	13	2,308	1,109	3,462	1,266	3,154	1,405
Female younger SS	128	2,578	1,290	3,609	1,212	3,477	1,223
Female younger HE	135	2,600	1,259	3,696	1,108	3,674	1,021
Female older ES	14	2,214	1,251	2,857	1,406	3,071	1,328
Female older SS	113	2,593	1,200	3,487	1,204	3,088	1,177
Female older HE	79	3,076	1,207	3,759	0,990	3,418	1,128

Table 3. Arithmetic means and standard deviations for the results of interest towards table tennis, badminton and tennis in relation to specific groups of examinees

Legend: AM=arithmetic mean, SD=standard deviation, younger=aged between 35 and 49, older=aged between 50 and 65, ES=elementary school completed or less, SS=secondary school completed, HE=higher education completed.

There are no generational differences in interests towards the three racquet sports. In other words, when it comes to interest for table tennis, badminton and tennis, it makes no difference whether you are 40 or 60 years old. A plausible explanation could lie in the fact that these are all sports with long traditions in our region and that this population has a fixed idea on them. The results also indicate action is required for presenting the sports characteristics of badminton, so that it would lose this label of being a female recreational sport.

## Conclusion

Statistically significant gender differences are manifested in a greater tendency of male examinees towards table tennis, a greater tendency of female examinees towards badminton, and a similar tendency of both gender groups towards tennis. The assumption can be made that this research showed the mentioned differences due to gender stereotypes that are characteristic for this region.

The differences related to the level of education indicated that persons who completed elementary school or less generally have a lower interest for sports. There is also a statistically significant lower interest for badminton in persons with elementary school education, while the interaction between gender and education interestingly showed that male examinees with elementary school accept table tennis, however, completely reject badminton, and to a certain degree also tennis. Male examinees with secondary and higher education demonstrated similar results. They showed the highest interest for tennis, while they neither accept nor reject badminton. It can also be observed that table tennis was somewhat better accepted in the group with secondary education than in the higher education group. Female examinees revealed that the higher the level of education, a more positive relationship towards all three sports was demonstrated.

There were no generational differences in interests towards the three racquet sports. In other words, it made no difference whether you are 40 or 60 years old when it comes to interest for table tennis, badminton and tennis.

The results of this research provide a somewhat clearer insight into age, educational and gender differences in interest towards the researched three sports. They can be practically used as a certain guideline for the strategy of future development of the mentioned sports, in terms of encouraging a greater interest for these sports with the aim of increasing the number of active participants of various age, both genders and level of education, all in order to improve their health and the level of quality in spending their leisure time.

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## Functional fitness of older women from Szczecin, Poland

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### **ABSTRACT**

**AIM:** The study aims to assess the level of physical fitness of women aged 60-84 years, who took part in the organized physical activities in fitness clubs in Szczecin, Poland. **METHODS:** Physical fitness performance was assessed using the Senior Fitness Test (SFT) by R.E. Rikli and C.J. Jones (Lifespan Wellness Clinic, California State University, Fullerton). Participants' body mass, body height and BMI were measured. **RESULTS:** In the study group 39% of women had a normal body weight, and most of them were women aged 75-79 years. The highest scores in all SFT items were attained by women aged 60-64 years. A visible, although weak correlation, was found between the Back Scratch test results

( $r = 0.44$ ) and body mass and the results of the 8-Foot Up-and-Go ( $r = 0.30$ ) and 6-Minute Walk ( $r = 0.21$ ) tests. **CONCLUSIONS:** The assessment of physical fitness of older women from Szczecin indicates the need to organize specialist programs of physical activities targeting those motor skills that will contribute to the improvement of life quality at an elderly age; 2. Such programs of physical activities should include education about sound nutrition, as the majority of participants displayed an increased BMI.

**Key words:** senior fitness test, older women

## **Introduction**

Physical activity is indispensable at any stage of human life and in all age groups. The importance of movement changes and evolves with human age, but it always remains one of the main determinants of human health (Kiełbasiewicz-Drozdowska, 2007). Aging is a multidimensional and irreversible process featuring physical impairments, increased risks of falls, and gait disorders caused by a reduced sense of balance (Grześkowiak, Wiliński 2009). A high level of functional fitness has a positive impact on the quality of life of the elderly, makes them less dependent on others, and improves their activities of daily living. The changing mentality of modern societies which does not exclude the elderly from taking part in various activities (Mazur & Umiastowska, 2017, p. 7) has contributed to an increasing participation of senior citizens in sports, recreation or dance groups. Senior citizens cycling or exercising in outdoor gyms are no longer a rare sight. The present study attempts to assess the functional fitness of physically active female senior citizens in view of somatic and motor parameters.

## **Material and methods**

The study used the Senior Fitness Test (SFT) developed by R.E. Rikli and C.J. Jones in the Lifespan Wellness Clinic, California State University, Fullerton. The SFT allows reliable assessment of the variability of functional fitness performance of older adults (Rikli & Jones, 1999). The SFT consists of six items indirectly assessing upper body and lower body strength, flexibility, agility and dynamic balance, and aerobic endurance. The participants performed the following item tests: Arm Curl, 30-Second Chair Stand, Back Scratch, Chair Sit-and-Reach, 8-Foot Up-and-Go, and 6-Minute Step Test. Considering the differences in measuring units, and following other authors from Poland and Europe (e.g. Ignasiak et al., 2009, Grześkowiak & Wiliński, 2009, Różańska-Kirsche et al., 2006), the test battery was adapted to Polish conditions. In particular, the original 5 lbs. (2.27 kg) hand weights for women were replaced with 2kg hand weights. In order to calculate BMI values, the anthropometric measurements of participants' body mass and body height were carried out with the use of Tanita WB380 H digital scales. The statistical significance of differences between age categories was calculated and determined with the Mann-Whitney U test, and the relationship between somatic traits and test samples using Pearson's linear correlation. Two hundred and seven female senior citizens aged 60-84 years took part in the study. They had been regularly involved in specifically designed programs of physical activities, which took place in fitness and community clubs in Szczecin, Poland in 2017.

## **Results**

The anthropometric measurement data were used to calculate participants' BMI. The results of the study revealed similar percentages of women with a normal body mass (39%) and overweight (38%). In the age category of 75-79 years the highest percentage of participants had a normal body mass. On the other hand, every other participant in the age category of 65-69 years was overweight (Fig. 1).

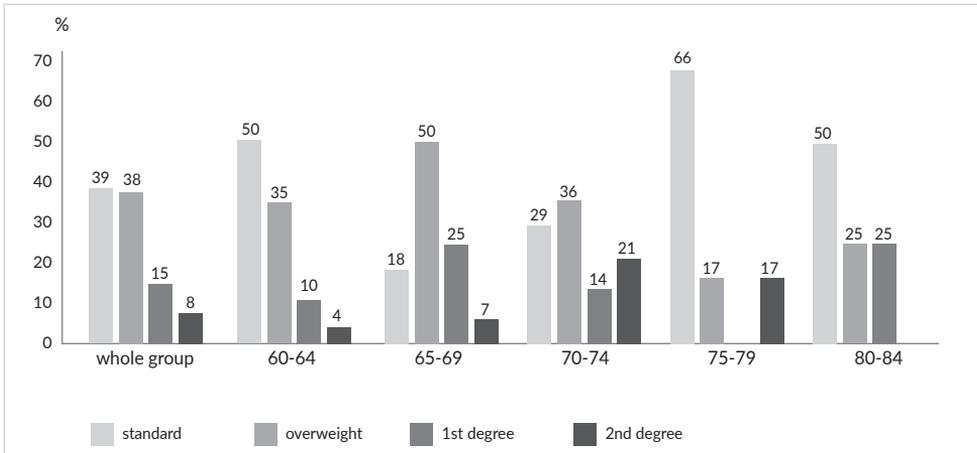


Figure 1. BMI of older women from Szczecin in different age ranges (source: own research).

Figures 2-7 show participants' scores on six SFT item tests.

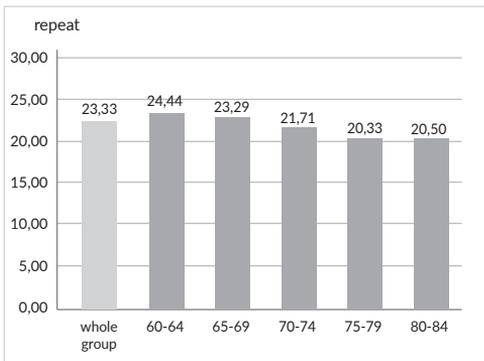


Figure 2. Upper body strength – Arm Curl (source: own research).

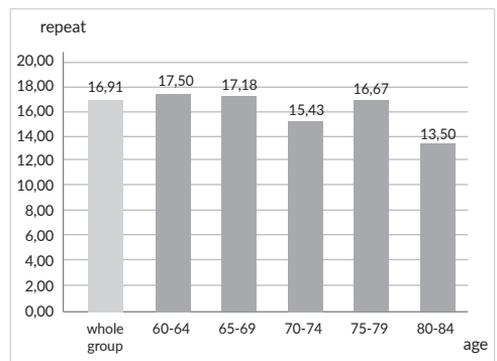


Figure 3. Lower body strength – 30-Second Chair Stand (source: own research).

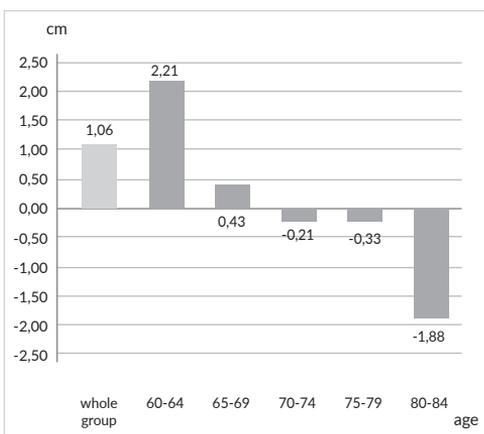


Figure 4. Upper body flexibility – Back Scratch (source: own research).

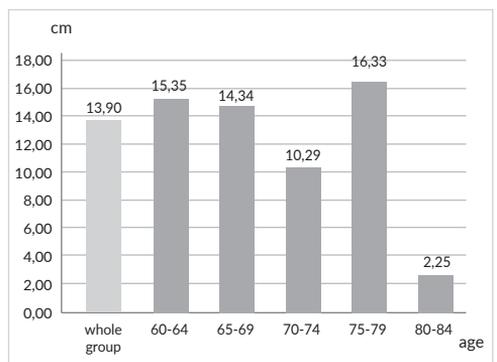


Figure 5. Lower body flexibility – Chair Sit-and-Reach (source: own research).

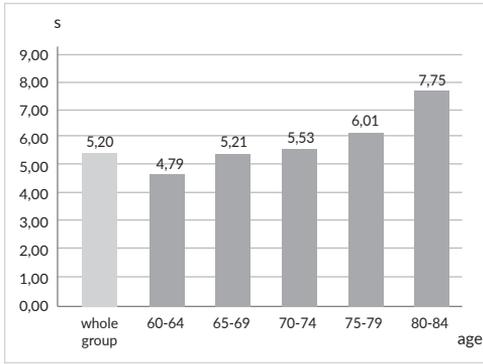


Figure 6. Agility and dynamic balance 8-Foot Up-and-Go (source: own research).

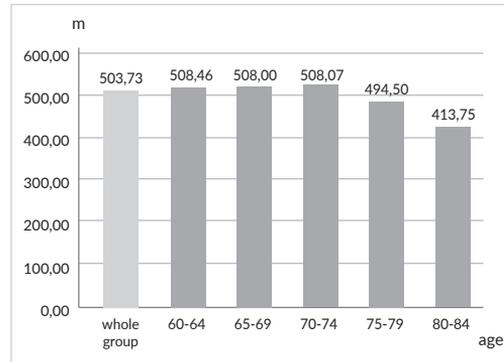


Figure 7. Aerobic endurance - 6-Minute Walk (source: own research).

The most significant differences between the women were noted in the results of the Back Scratch test assessing upper body flexibility. The differences between women in different age categories were statistically significant at  $p = 0.05$ , with the exception of the difference between the age categories of 70-74 and 75-79 years (Fig. 4). In the Arm Curl test, assessing upper body strength using a 2kg hand weight, the best results were attained by the women in the youngest age category (60-64 years). The level of statistical significance was also at  $p = 0.05$ , with the exception of the difference between the two oldest age categories (Fig. 2). The 30-Second Chair Stand test, assessing lower body strength, revealed similar differences between the age categories as in the Arm Curl test. (Fig. 3). The assessment of the women's lower body flexibility (Chair Sit-and-Reach) revealed statistically significant differences at  $p = 0.01$ . The best results of this test were attained by the women aged 75-79 years (Fig. 5). The assessments of agility and dynamic balance (8-Foot Up-and-Go) were shown to decrease with women's age ( $p = 0.05$ ) (Fig. 6). The results of the 6-Minute Walk, assessing aerobic endurance, were at a very similar level in the first three age categories, i.e. in women aged 60-74 years. The differences between these groups were statistically non-significant. Only the differences between them and the group of the oldest participants were statistically significant ( $p = 0.05$ ) (Fig. 7).

Correlations, albeit weak, were found between body height and the Back Scratch test results ( $r = 0.44$ ), and between body mass and the 8-Foot Up-and-Go ( $r = 0.30$ ) and 6-Minute Walk test results ( $r = 0.21$ ).

## Discussion

Studies on functional fitness carried out by Polish and American researchers show that physically active female senior citizens scored higher in tests assessing upper body strength, lower body strength, lower body flexibility and agility and dynamic balance; and scored lower in the upper body flexibility test (Tab. 1).

SFT item	Own study	Grześkowiak Wiliński (2009)	Ignasiak et al. (2009)		Dziubek et al. (2014)		Rikli, Jones (1999)
		RH*	S*	RH	U3A*	SCC*	
arm curl	16.9	9.2	12.4	8.5	5.8	6.9	12.7
chair stand	23.3	10.6	13.9	11.4	15.3	17.0	14.3
back scratch	8.7	-1.62	-1.1	-4.1	7.0	5.9	1.3
chair sit and reach	1.1	-15.5	-3.6	-20.9	4.4	4.8	-1.9
8-foot up and go	5.2	12.5	7.6	14.2	5.8	6.9	6.2

Table 1. Comparison of functional fitness test results of Szczecin older female residents with results of other studies

S – Sanatorium, RH – Residential Home, U3A – University of the Third Age, SCC – Senior Citizens' Club (source: own research using research data and literature)

The lack of other recent research findings regarding senior citizens' physical fitness performance renders any comparative analysis using the results of the present study impossible. Thus it is necessary to carry out a study on a large population that would lead to the development of Polish functional fitness standards for elderly men and women. Studies by R.E. Rikli and C.J. Jones (1999) were conducted among the population that in many ways differed significantly from the European populations. The most similar research results were attained by Z. Ignasiak et al. in a number of sanatoriums (2009).

## Conclusions

1. The assessment of physical fitness of older women from Szczecin indicates the need to organize specialist programs of physical activities developing those motor skills that will contribute to the improvement of life quality at an elderly age.
2. Such programs of physical activities should include education about sound nutrition, as the majority of women under study displayed an increased BMI.

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## Endurance, resistance and combined training effects on the selected health indicators in apparently healthy adults

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### **ABSTRACT**

**PURPOSE:** The objective of this study was to compare adults performing three different modes of training (endurance, resistance and combined) on the selected health indicators (blood pressure, waist circumference, waist-hip ratio, body fat percentage, fat free mass, bodyweight and BMI). **METHODS:** This study used a randomized pre- and post-intervention/treatment design in a quasi-experimental study to compare 8-week effects of three training modes. Population of the study was comprised of male and female apparently healthy adults Batswana in Gaborone between the ages of 22-31 years. Data were analysed using descriptive statistics, ANCOVA and t-test. For comparisons, p-values <.05 were considered statistically significant. **RESULTS:** Endurance training of 8 weeks resulted in improvements in body weight, body fat percentage, diastolic blood pressure, waist circumference, and BMI of apparently healthy adult Batswana, while in combined training, significant effects were found in body weight, systolic and diastolic blood pressure, waist circumference and BMI. The resistance group only had significant effect on lean body mass. When

groups were compared statistically, there was no significant difference in systolic blood pressure, waist circumference, waist-hip ratio, body fat percentage; with the significant differences between training groups only in diastolic blood pressure, BMI, bodyweight and lean body mass. **CONCLUSION:** To improve the selected health indicators, it is advisable for apparently healthy adult Batswana to engage in endurance or combined training programs.

**Key words:** endurance, resistance, combined training, health indicators

## **Introduction**

Relationship between physical activity and health is constantly evolving. In today's world a major public health goal is to increase an individual's participation in regular physical activity. To achieve this, however, Tuso (2015) noted that no single intervention will increase activity rates, but a group of interventions working together in synergy may be the stimulus needed to get individuals moving. There is now a wealth of sophisticated epidemiological evidence to demonstrate that physical activity is associated with reduced risk of coronary heart disease, obesity, type 2 diabetes, and other chronic diseases and conditions (Naci & Ioannidis, 2013). Centre for Disease Control and Prevention (2018) noted that moderate-intensity aerobic activity can lower the risk of these cardiovascular diseases and metabolic syndrome.

Regular exercise and greater physical fitness are associated with lower cardiovascular and total mortality, both in healthy populations and in patients with coronary heart disease (CHD) and heart failure (Stewart et al., 2013). There are concerns that many people are overweight, and sometimes obese, to an extent that they risk diseases like hypertension, diabetes and heart failure (WHO, 2011). According to the National health policy (2011) non-communicable diseases like hypertension and diabetes are not among the top ten causes of disease morbidity and mortality in Botswana; the rates are however increasing. Scientifically-informed recommendations, with a global scope, on the benefits, types, amount, frequencies, intensity, durations and total amount of the physical activity necessary for health benefits are key information for policy-makers wanting to address physical activity at population level and who are involved in the development of guidelines and policies at regional and national levels on the prevention and control of Non-communicable Diseases (NCDs) (WHO, 2011). This study, therefore, sought to provide the much-needed empirical information on the comparative effects of three training modalities on selected health parameters of Batswana adults. The information could help the general public in their choice of activities.

## **Methods**

### **Participants**

The population of the study comprised healthy adults between the ages of 22 and 36 ( $26 \pm 2.7$  years). The participants included both male ( $n=28$ ) and female ( $n=33$ ) apparently healthy adult Batswana living in Gaborone. The age group 22-36 volunteered to take part in the study. After the baseline measurements were taken, participants were randomly assigned to either endurance ( $n=15$ ), combined ( $n=15$ ), or resistance ( $n=16$ ) training group and a control ( $n=15$ ). The participants trained 4 days per week in prescribed training modes for 8 weeks. Before all participants underwent different tests, they filled an informed consent form. The data from this investigation were strictly confidential, as required by the law and research ethics. Permission to conduct the study was requested from the Ministry of Health in Botswana. After 8 weeks of training the same measurements were taken for possible training effects. The three group training modalities were performed in the Botswana National Sports Council gymnasium and supervised by the researchers.

### **Data Collection Procedure**

The anthropometry assessments were done following the procedures of the International

Society for the Advancement of Kinanthropometry (ISAK). Blood pressure measurements were performed in accordance with the ACSM guidelines for exercise testing and prescription (ACSM, 2013). All these procedures were performed by the researchers.

a) Waist circumference (WC) measurements (to the nearest 0.1 cm) were taken by placing the tape at the level of the last rib. Hip measurements were also made using a tape-measure placed horizontally at the point of maximum circumference over the buttocks. Measurements were taken to the nearest 0.1 cm.

b) The height was measured in centimetres and converted to meters using the SECA height measure and participants removed their shoes and stockings. Measurements were taken to the nearest 0.1 cm.

c) Weight was taken (in light clothing and without shoes and stockings) on a Digital electronic scale SECA alpha model 770. Measurements were taken to the nearest 0.1 kg. Height and weight measurements were used to derive the BMI (kg/m<sup>2</sup>).

d) The Harpenden skinfold calliper was used for skinfolds. Each measurement was taken, on the right side of the body, three times and the average recorded. The skinfolds were used to estimate body fat percentage.

e) An automatic Sphygmomanometer Omron M3W was used to measure systolic and diastolic blood pressures after 15 minutes of rest in a sitting position. Measurement was taken from left arm.

f) Omron Body Composition Monitors Digital Weighing Scale, HBF-362 model was used to estimate Lean Body Mass (LBM) using participants' height, weight and age.

Training programmes:

a) Endurance training

The endurance exercise group took part in dynamic activities four times a week; designed specifically to increase aerobic endurance performance. These activities included: running on the treadmill and stationery cycling. Endurance exercise intensity was adjusted based on maximum heart rate for moderate intensity. For the first two weeks the target intensity was 50-60% of maximum heart rate (MHR). From the third week onwards, the intensity progressively increased to moderate level 60-85% MHR.

For the first 3 weeks, the participants did treadmill jogging and cycling for 30 minutes. For the next 3 weeks the participants did 35 minutes and the last 2 weeks the participants did 45 minutes on treadmill and stationery bicycle. The warm-up included slow cycling for 10 minutes or walking on the treadmill; and cool down was performed on a bicycle ergometer in a recovery pace.

b) Resistance training

The resistance training group exercised four times a week in a training programme that involved major muscle groups. The exercises included the bench press, shoulder press, pull-downs, dips, static lower-back extensions, abdominal crunch, biceps curls, triceps extensions, and leg curls. The training program was a progressive total body intervention for the lower and upper body. Each training session included two exercises for the legs (leg press and leg curls); four exercises for the upper body (bench press, triceps extensions, biceps curls and pull downs); core strength exercises (sit ups and back extension) with weights. The individual loads were high-volume (4x10-12 repetitions with ~70%) of one repetition maximum by the strength test at the beginning of the intervention with load of 40-50% of 1RM for the first three weeks. The rest period was one to two minutes, with 2 sets of 8-10 repetitions. For the next three weeks, the load was increased to 50-60% with 2 sets of 10-12 repetitions. In the last two weeks, the participants' loads were increased to 60-80%, with 3 sets of 10 repetitions.

c) Combined training

The combined training mode group did both endurance and resistance trainings on alternate days. The combined group trained four times a week with the first and third days performing endurance training and the second and fourth days performing resistance train-

ing.

Statistical analyses: Data collected were analysed using descriptive statistics, ANCOVA and T-test. The descriptive statistics included the means and standard deviations on assumption of normal distribution. Diet, age and gender were used as covariates in the ANCOVA analyses. For comparisons, p-values <.05 were considered statistically significant.

## Results

### Descriptive differences after training

On average, after 8 weeks of training, BMI reduced by 0.4kg/m<sup>2</sup>. Waist circumference decreased in training groups except the resistance training group. The mean change in lean body mass was 1.1kg. LBM increased in combined training and resistance training, while it was reduced in endurance training. With BMI, a slight decrease was found with endurance training. Systolic blood pressure was reduced following 8 weeks of endurance and combined training and remained the same with resistance and control group.

Training type		Prewt	Postwt	Pre LBM	Post LBM	Pre SBP	Post SBP	Pre DBP	Post DBP	Pre WC	Post WC	Pre %BF	Post %BF	Pre BMI	Post BMI
Combined	Mean	76.4	74.4	18.9	19.9	122	117	81	76.7	78.4	77.1	17.3	17.3	27.1	26.3
	N	15		15		15		15		15		15		15	
	SD	17.0	16.1	10.3	11	11.2	8.0	5.2	5.2	11.5	11.3	6.5	5.7	5.1	4.8
Endurance	Mean	83.8	81.0	24.4	20.2	121	118	82.8	78.6	86.7	85.9	21.4	20.2	29	28.4
	N	15		15		15		15		15		15		15	
	SD	22.3	16.1	15.9	15.8	13.1	9.5	5.1	5.0	13.1	12.4	7.7	7.3	5.1	5.9
Resistance	Mean	71.5	69.6	14.7	16.5	119	119	79.9	79.4	71.8	72.1	15.0	13.8	25.1	25.9
	N	16		16		16		16		16		16		16	
	SD	14.4	14.9	7.2	6.3	7.1	4.4	4.1	3.8	10.9	10.7	4.9	5.3	3.7	3.9
Control	Mean	73	73.5	15.2	15.8	117	117	83.1	83.9	77.1	77.4	14.3	14.4	27.1	27.1
	N	15		15		15		15		15		15		15	
	SD	15.6	15.8	6.3	5.7	8.9	8.2	6.2	6.4	10.7	11.1	4.3	4.1	4.7	4.6
Total	Mean	75.6	74.4	19.2	18.1	120	118	81.6	79.7	78.4	78.1	17.0	16.4	27.1	26.7
	N	61		61		61		61		61		61		61	
	SD	17.9	17.5	10.9	10.4	10.2	7.6	5.1	5.5	12.5	12.2	6.5	6.1	5.0	4.8

Table 1. Pre and Post training measurements

Key: wt. (weight), LBM (Lean Body Mass), SBP (Systolic blood pressure), DBP (Diastolic blood pressure), WC (waist circumference), %BFSK (Percent body fat by skinfolds), BMI (Body Mass Index)

Variable	Difference between groups	Endurance (t-test)	Combined (t-test)	Resistance (t-test)	Control (t-test)
Body weight (kg)	0.00	0.00	0.00	n.s.	0.015
BMI (kg/m <sup>2</sup> )	0.00	0.00	0.00	n.s.	n.s.
Percent body fat (skinfolds)	n.s.	0.008	n.s.	n.s.	n.s.
Total LBM (kg)	0.00	n.s.	n.s.	n.s.	n.s.
Blood pressure			0.09	n.s.	n.s.
SBP	n.s.	n.s.			
DBP	0.000	0.00	0.000	n.s.	n.s.
Waist Circumference (cm)	0.0015	0.00	0.000	n.s.	n.s.

Table 2. Summary of between- and within-group differences

#### Blood Pressure

Blood pressure analysis shows no significant difference ( $P=0.212$ ) in systolic blood pressure whereas there was a significant difference between the groups in diastolic blood pressure; with (p-value of 0.000). The post-hoc results on diastolic blood pressure show significant differences between combined training and resistance training ( $p=.001$ ); between resistance and endurance training ( $p=.001$ ) groups and no significant difference between combined and endurance training modes (.867).

#### Body Composition

There was no significant difference in body fat percentage between the training groups (p-value of 0.110); whereas significant differences were found in waist circumference ( $p=0.015$ ) and BMI ( $p=0.001$ ). Pairwise comparisons showed significant differences between combined and resistance ( $p=0.004$ ); resistance and endurance ( $p=0.000$ ) but no significant difference between endurance and combined ( $p=.254$ ) with BMI. Significant difference was also found in lean body weight ( $p=0.000$ ). The pairwise comparison showed significant results between combined and endurance (.001); resistance and endurance (0.000) but no significant difference between resistance and combined (.340).

There was a significant difference in body weight (p-value was .000). The post-hoc analysis showed significant differences between combined training and resistance training ( $P=.002$ ); between endurance and resistance ( $P=.000$ ), but no significant difference between combined and endurance training.

Results from paired t-test show that endurance training had significant effects on body weight ( $p=.0000$ ); diastolic blood pressure ( $p=.000$ ); waist circumference ( $p=.007$ ) percent body fat ( $p=.0008$ ) and BMI ( $p=.000$ ). Combined training had significant effects on body weight ( $p=.000$ ); systolic blood pressure ( $p=.009$ ); diastolic blood pressure ( $p=.000$ ); waist circumference ( $p=.000$ ) and BMI ( $p=.000$ ). Resistance training had significant effect only on lean body mass ( $p=.000$ ).

## Discussions

The present study supports that there are marked benefits of physical activity on various physical and physiological characteristics (Lemes et al., 2015; Peacock et al., 2016). The results of our investigations indicated that, the endurance training mode had significant reduction on diastolic blood pressure while the combined training significantly decreased both the diastolic and systolic blood pressures. Similar to our study, Iwamoto, Sato, Takeda and Matsumoto (2010) concluded that endurance training seems to be most effective in decreasing blood pressure. The results of this study are also similar to results of Mengistie, Reddy and Syam (2013), where Blacks participated in the study. Mengistie et al. found that there was a significant effect of combined training on the blood pressures of their participants. The findings of this study showed that although there was no significant difference in systolic blood pressure in all training groups but significant difference between the training groups in diastolic blood pressure, there was a reduction in blood pressure following 8 weeks of endurance and combined training. Thus, endurance and combined training modalities can be used to improve cardiovascular health among Batswana adults. At the end of the 8-weeks of training, there were no statistically significant differences in the %BF and WHR but there were some significant differences in body weight, BMI, WC and Lean Body Mass (LBM) when endurance, combined and resistance training groups were compared. Similar to our study, Mengistie et al. (2013), after 12 weeks of training, found significant ( $p < 0.001$ ) changes in body composition variables: body fat percentage, subcutaneous fat and visceral fat from baseline records. Also, Shangani et al. (2013) indicated that mean difference in pre-test and post-test of exercise groups was not significant between groups in WHR.

However, when t-test was computed on the pre and post measurements in the endurance group, significant differences were observed in %BF ( $p = 0.008$ ), WC ( $p = 0.007$ ), BMI ( $p = 0.000$ ) and body weight ( $p = 0.000$ ). This is similar to the study of Ucan (2013), in the aerobic group, where statistically significant differences were observed in %BF and body weight at the end of the 10-week training period. Concerning body composition, the present study shows reduction in body fat percentage estimated by skinfolds within only the endurance training group. This result was supported by findings of earlier study by Perez-Gomez et al. (2013) which showed that a significant decrease in fat mass was obtained after a regular physical exercise. Perez-Gomez et al. concluded that 10 weeks of endurance training decreased abdominal and body fat in young men, while a 10-week resistance training increased total lean body mass. The results of this study showed resistance training to improve only Lean Body Mass. This is in contrast with the results of the study by Papa, Dong and Hassan, (2017) which showed that resistance training offers numerous benefits beyond improvements in muscle strength alone in individuals. The present investigation shows significant differences between training groups only in BMI, body weight and waist circumference. Body weight, waist circumference and BMI showed significant reductions from baseline records within the endurance and combined training groups.

Aerobic-type physical activity is associated with, and recognized as a critical component of, a comprehensive weight loss/weight management program and with a wide variety of health benefits (Sword, 2012). This is also demonstrated by the present study where endurance training showed a significant effect on most of the selected health indicators, followed by combined training.

## Conclusion

Following the results of this study it can be concluded that, apparently healthy Batswana should take part in endurance and/or combined training if they wish to obtain significant training effects on their health variables. Adhering only to resistance training would not guarantee addressing different health and fitness-related problems. Programs that include both aerobic and resistance training modalities can provide most of the health benefits needed by the citizens.

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# Maximal kick speed depends on the momentum of maximum strength of knee flexors and extensors after intermittent load in soccer

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## **ABSTRACT**

**PURPOSE:** The aim of the study was to determine the relationship between strength of knee flexors and extensors at maximum speed kicks after intermittent loading in football players. **METHODS:** Examined participants were 20 football players. The maximum momentum of knee flexors and extensors was measured for the players. On the second day, the maximum kick speed before and after load was examined, and the differences in the shooting speed were then compared based on strength asymmetries. **RESULTS:** No correlation was established between the maximum strength of extensors of the knee and kick velocity after the load. However, the kick speed correlates with the maximum flexor knee strength after the intermittent stress test. **CONCLUSION:** A low level of knee flexor strength may adversely affect kick speed, especially in conditions of fatigue.

**Key words:** fatigue, muscles, shooting, velocity

## **Introduction**

Instep soccer kick is one of the basic and most important football skills and its speed directly depends on the ability to generate effective energy transfer from the foot to the ball

(Anthrakidis, Skoufas, Lazaridis & Zaggelidis, 2008; Kellis & Katis, 2007; Njororai, 2013). The basis of most football moves is muscle strength (e.g. kicks, vertical jump, and speed), the motion manipulation can modify the strength of the lower limbs and asymmetry, which may also be specific to the position (Carvalho & Cabri, 2007; Weber et al., 2010). The ratio between the maximum momentum of hamstring (flexor knee) and quadriceps (knee extensors) - the H/Q ratio is used to describe the strength properties that affect the knee joint and the detection of muscle imbalance (Askling, Karlsson & Thorstensson, 2003). The ratio of strength between these two muscles may result from football-specific skills (Fousekis, Tsepis & Vagenas, 2010). Fatigue during the match can adversely affect football skills as well as kick speeds, the fatigue state causes in the muscles a decrease of muscle activation as well as changes in muscle structure and coordination (Stone & Oliver, 2009). The maximal isokinetic momentum of the flexors and extensors of knee in the fatigue state decreases as well as considerable knee instability (Rahnama et al., 2003), which subsequently adversely affects short-term performance and increases the number of errors in the match (Rampinini et al. al., 2008).

## Methods

Examined participants were 20 football players at the highest league competition in the Czech Republic ( $n = 20$ , age =  $19.4 \pm 0.5$ , height =  $181.1 \pm 10.2$ , weight  $75.4 \pm 8.2$ ). The knee flexor and extensors were measured using the Humac Cybex Norm isokinetic dynamometer in a concentric module at a  $60^\circ$  m/s angular velocity. All players have completed warm-up before testing. One week after, field tests of the maximum speed kick from the penalty area was measured. The players had 3 attempts of kicks with a dominant lower extremity. Speed of the ball was measured using the STALKER ATS radar. After shooting, simulation of intermittent load with Yo-Yo level 2 was followed. The pulse frequency by sport-tester POLAR R480 was measured. Soccer players worked to the full exhaustion. After the load, the shooting on goal by the dominant limb followed, again. We compared speed of the ball before the load and after intermittent test, depending on maximal moment of strength of extensors and flexors of the knee, both for the kicking and supporting legs. To express relations between variables, Pearson's correlation coefficient, regression analysis was used, and we also used individual and comparative player ratings.

## Results

The average kick velocity by the dominant limb before the intermittent stress test was  $30.34 \pm 2.17$  m/s. After the load, the total kick speed dropped to  $29.05 \pm 1.94$  m/s (Figure 1). The decrease in the speed of shooting before the load and in fatigue conditions was 4.25%.

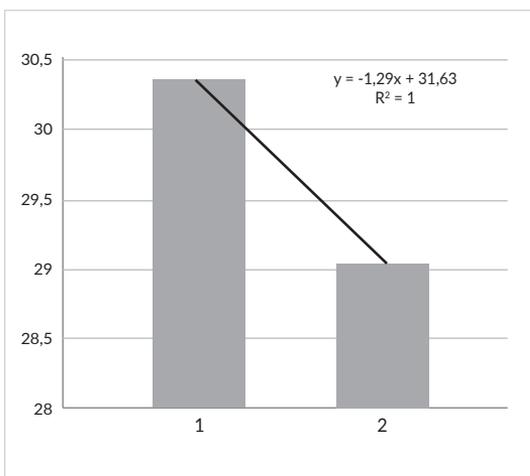


Figure 1. Speed of the ball before the intermittent test (1) and after the test (2).

Speed of the kick significantly correlated with the maximum torque, both in flexors and extensors of the knee before the load (Figure 2).

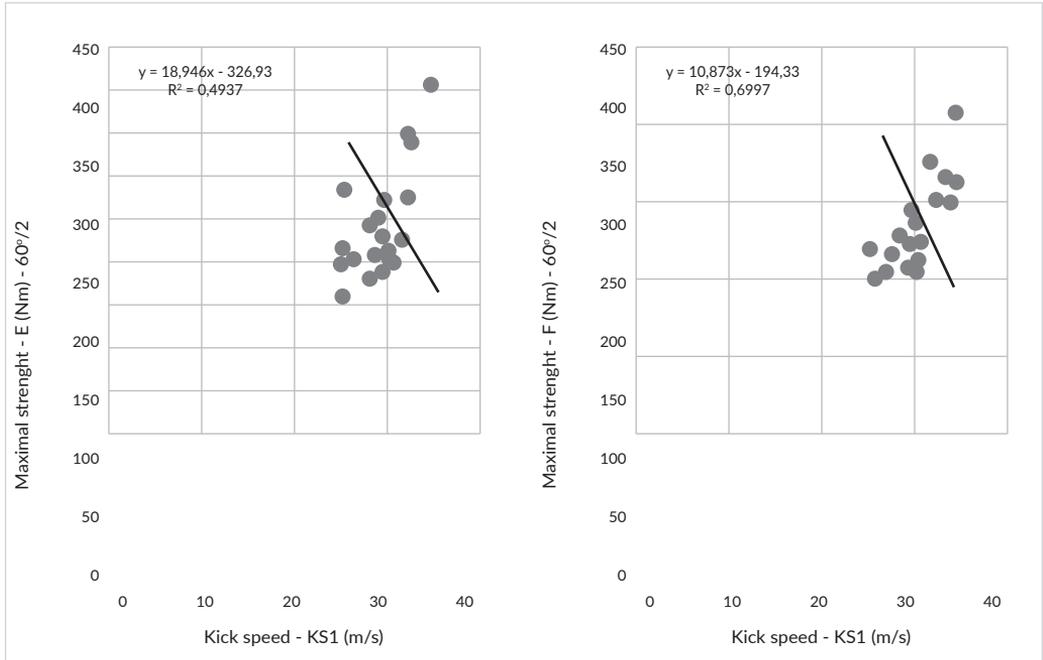


Figure 2. The relationship between ball velocity and maximal strength extensors (E) and flexors of knee (F) before fatigue was induced (KS1).

No dependence between the maximum strength of extensors of the knee and kick velocity after the load was observed. However, the kick speed correlates with the maximum flexor knee strength after the intermittent stress test (Figure 3).

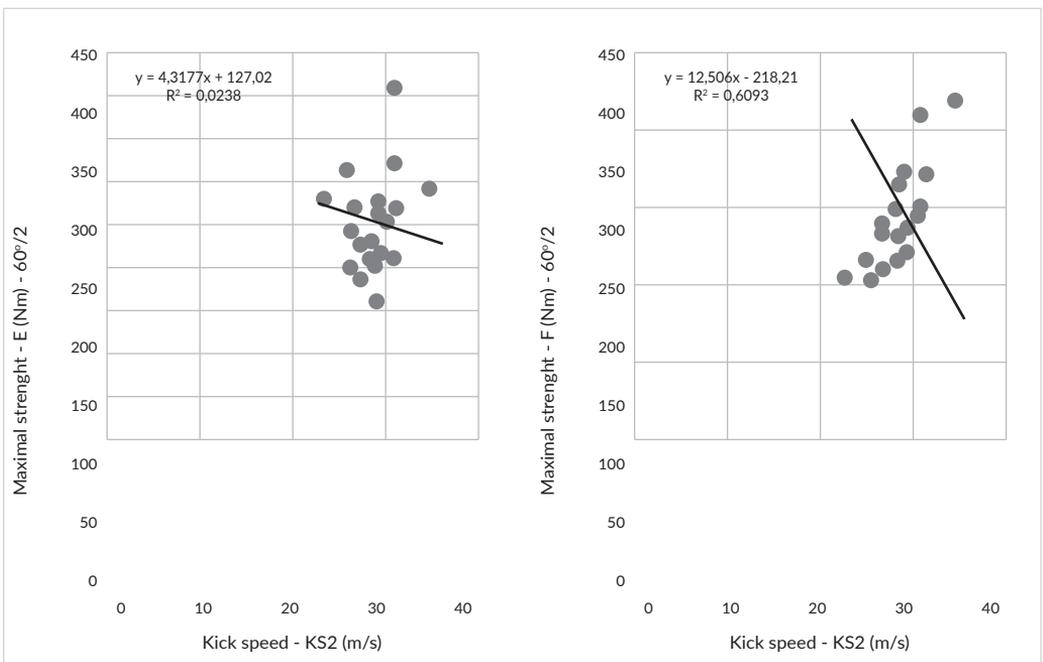


Figure 3. The relationship between ball velocity and maximal strength extensors (E) and flexors of knee (F) after the intermittent load (KS2).

## Discussion

Soccer performance is not possible without basic skill such as a kick (Andersen & Dörge, 2011). One important aspect of it is speed that is especially important if players want to score a goal and to surprise the goalkeeper because ball velocity reduces goalkeeper's chances for the reaction (Ball, 2013). Strength is a key skill in the performance of a footballer, and this fact is very important for players who want to perform at their highest possible potential. In our set, we see a moderate to strong association between the peak kicking speed of the dominant lower limb and the momentum of the maximum force of the knee extensors ( $r = 0.67$ ) and knee flexors ( $r = 0.83$ ) at a  $60^\circ/s$  angular velocity (Figure 2). This relationship indicates that the player's ability to produce a greater momentum of the muscle force of the extensors and flexors of the knee at an angle of  $60^\circ/s$ , the higher the speed of his kick. Several studies looked at the relationship of kick- rate and strength of the lower limbs, where they demonstrated that higher flexor and extensors strength can produce a higher kick rate (Billot, Martin, Paizis, Cometti & Babault, 2010). When measuring the kick speed after an intermittent stress test, Pearson's correlation coefficient expressing the relationship between the maximum kicking speed of the dominant leg and the strength of the knee extensors with weak correlation rate ( $r = 0.15$ ), on the other side with a strong dependence by flexors of knee ( $r = 0.78$ ), which tells us the importance of the strength of flexor knees especially in fatigue conditions (Figure 3). Kellis et al. (2006) found that the velocity of the ball dropped right after intermittent type exercises, Currell et al. (2009) and Russell et al. (2011) did not confirm these changes. The muscular force of the muscles involved in kicking is reduced in the state of fatigue, the strength is changing when the leg is in contact with the ball, which can cause a lower velocity of the ball (Ferraz, Tillaar, Marinho & Marques, 2009; Kellis, Katis & Vrabas, 2006).

## Conclusions

The maximum momentum of the flexors and extensors of the knee has a very important role in fast and explosive kicking. During the match is coming fatigue what leads to worsen coordination and strength skills of players, what also affects speed of the kick, which is very important if the players want to score at the end of the match. In conclusion, players with higher level of strength of the knee flexors resulted ability to produce faster kick after load in compared players who had unilateral imbalances.

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# Improving motor knowledge in preschool-aged children through the application of the polygon with obstacles and frontal form of work

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## **ABSTRACT**

**PURPOSE:** The research was carried out with the aim to determine the effectiveness of various methodical organizational forms of work in the adoption of new motor knowledge in the work with preschool-aged children. **METHODS:** The sample of 40 children, of average age of 5.8 years ( $SD = 0.61$ ), was divided into two subsamples of which one group of children performed motor tasks using the frontal form of work and the other group performed the same motor tasks using the polygon with obstacles. The basic statistics parameters were calculated and for the determination of difference, t-test was used. **RESULTS:** The results indicate that both groups of participants significantly improved new motor skills. **CONCLUSION:** Therefore, regardless of the methodical organizational form of work used, children have the opportunity to adopt new motor skills with the help of appropriate choice of work modality.

**Key words:** preschool children, motor skills, teaching methods

## **Introduction and research problem**

During the preschool age it is imperative to ensure a wholesome and versatile physical development of every child, which is oriented towards health, i.e. towards the development of anthropological characteristics made up of organized systems of all traits, abilities, motor knowledge, and their mutual relationships (Pejčić, 2005). For this reason, it is important to increase the optimum reach of biotic motor knowledge during the preschool age because it is known that, in this period, missed opportunities to influence the development of the quality and quantity of all knowledge and abilities cannot be compensated in later periods of life.

This means, in particular, that all anthropological characteristics of children should be somewhat equally developed by using well-designed and optimally selected kinesiological content, well-chosen work methods, and operators appropriate to children, their interests and abilities (Findak, 1999). One of the important aspects in encouraging the development of various potentials of preschool children is also related to the possible development of the degree of motor knowledge.

Motor knowledge which preschool-aged children acquire should be appropriate to their age and should influence their overall physical development, and the content should be well organized and motivating so that children could acquire it well.

For this reason, children should be motivated to participate in an array of motor activities so as to provide them with quality and long-term stimulus through regular and well-planned and programmed physical activity, as well as to develop all traits, abilities, and knowledge. A well-chosen organizational set of exercises is one that contributes to an increased intensity and optimization of work, and thus the humanization of the exercise process. By using simpler and more complex forms of work, the effective time of exercise is increased and the total workload per hour is achieved as well as the satisfaction with the individualization of the work process (Prskalo, Babin, 2009). Findak (2013) also states that organizational forms of work are determined by the participants' age, their prior knowledge, the current state of health, and the participants' interest in the process of physical exercise. Given the multitude of methodical organizational forms of work, the most commonly used ones in the work with preschool children are the frontal form of work and the polygon with obstacles. Thus, Breslauer and Zegnal (2011) study kinesiological contents that children themselves will introduce into various games and polygons, and they show the impact on the development of biotic motor knowledge and a better socialization of children. Well-designed and well-organized content can certainly contribute to the improvement of motor knowledge by using a variety of methodical organizational forms of work designed as a game that is the most appropriate tool in the work with preschool-aged children. Facilities providing care and education have a very important task, which is to provide spatial, material, and pedagogical conditions for physical activities that are mandatory for normal growth and development of children from the third to the sixth year of life. The aim of this research was to monitor the acquisition effectiveness of learning 10 motor skills using two different methodical organizational forms of work (polygon with obstacles and frontal form of work) to determine which form is more effective in adopting new motor knowledge.

### **Research methods**

The sample of participants comprised a total of 40 children (20 boys and 20 girls) from two mixed preschool classes in the city of Kraljevica with an average age of 5.8 years (SD = 0.61). The total sample was divided into two subsamples: the first subsample included 20 children (10 boys and 10 girls) adopting motor knowledge using the frontal form of work; the second subsample included 20 children (10 boys and 10 girls) adopting motor knowledge with the help of the polygon with obstacles.

The sample of variables consisted of 10 motor tasks (Ball handling, Passing through hula-hoop, Jumping onto and jumping down from a bench, Children's jumps, Transferring plastic caps, Crawling under the bench, Sideways rolling on a mat, Slalom running around stands, Walking backwards on all fours, Walking forwards on all fours), whose implementation was performed using the frontal methodical organizational form of work and the polygon with obstacles. For the purposes of this research a measurement table was created which recorded children's data and the measurement results. Three experts (preschool teachers and kinesiologists) conducted the measurements of children through initial and final checking of the level of gained motor knowledge in the group that was adopting the motor content by means of the frontal form of work and in the second group that was adopting the motor content using the polygon with obstacles.

Measurements of the level of achievement of motor knowledge expanded over the course of three months. Measurements were performed in two experimental groups, of which one group of 20 children performed tasks using the frontal work form while the other group of 20 children performed tasks by means of the polygon with obstacles. At the very beginning, each child from each group was initially measured in ten different forms of motor knowledge. In the period between the initial and final measurement, the children of each group participated in organized physical exercise in the morning with the preschool teachers and the kinesiologist. Two preschool teachers and one kinesiologist, who

participated in the research, had been familiarized with the procedure of observing and evaluating children. The evaluations ranged from 1 to 5, whereby value 1 represented the inability to master the motor task, value 2 the minimum ability to master the motor task, value 3 the average ability to master the motor task, value 4 the correct performance of the motor task, while value 5 represented correctly performed motor task. By the end of the initial measurement, the children of each group had spent a total of 24 hours per 30 minutes in exercise during the three-month period, in accordance with the operational plan and program (Table 1).

After three months, the final measurement of the children was performed so that the initial and final results could be compared, i.e. the progress of the group of children who exercised with the frontal work form and the group of children who exercised using the polygon with obstacles.

Basic descriptive parameters (arithmetic mean and standard deviation, both the minimal and maximum score) were calculated in both the initial and final measurements in both groups. The t-test for the dependent samples was used to determine the difference between initial and final testing, while the t-test for independent samples was used to determine the differences between the groups in the initial and final testing. The level of significance was  $p = 0.05$ .

## Results and discussion

Table 1. shows basic statistical parameters and t-tests for dependent samples in children who participated in the kinesiological program using the frontal form of work.

MOTOR TASKS	N	AS	SD	Min	Max	t	p
Ball handling I	20.00	3.2	0.82	2.00	5.00	-9.43	0.00*
Ball handling F	20.00	4.2	0.73	3.00	5.00		
Jumping onto and jumping down from a bench I	20.00	4.1	0.88	2.00	5.00	-4.95	0.00*
Jump onto and jump down from a bench F	20.00	4.6	0.53	3.33	5.00		
Walking backwards on all fours I	20.00	3.9	0.82	2.33	5.00	-6.85	0.00*
Walking backwards on all fours F	20.00	4.4	0.61	3.33	5.00		
Crawling under the bench I	20.00	4.2	0.64	2.67	5.00	-6.61	0.00*
Crawling under the bench F	20.00	4.7	0.44	3.33	5.00		
Rolling on a mat I	20.00	4.0	0.70	2.67	5.00	-5.98	0.00*
Rolling on a mat F	20.00	4.6	0.47	3.33	5.00		
Passing through hula-hoop I	20.00	4.0	0.60	3.00	5.00	-8.14	0.00*
Passing through hula-hoop F	20.00	4.7	0.34	4.00	5.00		
Walking forwards on all fours I	20.00	3.7	0.67	3.00	5.00	-9.91	0.00*
Walking forwards on all fours F	20.00	4.5	0.41	4.00	5.00		
Slalom running around stands I	20.00	4.0	0.50	3.00	5.00	-9.40	0.00*
Slalom running around stands F	20.00	4.8	0.28	4.00	5.00		
Children's jumps I	20.00	4.1	0.75	1.67	5.00	-6.22	0.00*
Children's jumps F	20.00	4.6	0.55	2.67	5.00		
Transferring plastic caps I	20.00	3.9	0.60	3.00	5.00	-7.80	0.00*
Transferring plastic caps F	20.00	4.6	0.42	3.67	5.00		

\* $p = 0.05$ ; N = number of participants, AS = arithmetic mean, SD = standard deviation, Min = lowest score, Max = highest score, t = t-test, p = level of significance.

Table 1. Descriptive indicators and differences between the initial and final testing of the frontal work group

It is observable from the obtained results that the children did not show low values in the initial measurement and none of the children received a value lower than 3, and this major improvement in the three-month-long exercise was expected.

However, we can notice from the obtained results an improvement of performance, i.e. results in all motor tasks. The biggest improvement in children was recorded in ball handling, even though the children demonstrated good results even during the initial measurement of the three-month-long period of exercise.

The children showed great interest in the assigned motor tasks, and due to their high motivation already in the initial measurement they managed to fully master most of the elements. The children do not have the opportunity to perform these ten motor tasks on a daily basis, i.e. nowadays very few children can perform tasks of basic biotic motor knowledge if they do not practice some sport. Ball-handling as the most complex motor task in this testing proved to be the most interesting to the children, and the children tried to perform it as well as possible, regardless of their previous knowledge. A small number of children had handled the ball prior to this testing, and through exercise during the three-month period they showed significant improvement and interest in performing elements using the ball.

Table 2. shows basic statistical parameters and the t-test for dependent samples in children who participated in the kinesiological program using the polygon with obstacles.

MOTOR TASKS	N	AS	SD	Min	Max
Ball handling I	20.00	2.4	0.89	1.00	3.67
Ball handling F	20.00	3.1	0.98	1.33	4.67
Jumping onto and jumping down from a bench I	20.00	3.6	1.13	1.33	5.00
Jump onto and jump down from a bench F	20.00	4.2	0.78	2.33	5.00
Walking backwards on all fours I	20.00	3.3	0.50	2.33	4.33
Walking backwards on all fours F	20.00	4.1	0.59	2.67	5.00
Crawling under the bench I	20.00	3.6	0.80	2.33	5.00
Crawling under the bench F	20.00	4.3	0.66	3.00	5.00
Rolling on a mat I	20.00	3.5	0.63	2.67	4.67
Rolling on a mat F	20.00	4.3	0.51	3.67	5.00
Passing through hula-hoop I	20.00	3.3	0.56	2.00	4.33
Passing through hula-hoop F	20.00	4.3	0.48	3.00	5.00
Walking forwards on all fours I	20.00	3.6	0.56	2.33	4.67
Walking forwards on all fours F	20.00	4.4	0.47	3.67	5.00
Slalom running around stands I	20.00	3.0	0.45	2.00	3.67
Slalom running around stands F	20.00	3.9	0.46	3.00	5.00
Children's jumps I	20.00	3.4	0.60	2.33	4.33
Children's jumps F	20.00	4.4	0.55	3.00	5.00
Transferring plastic caps I	20.00	3.5	0.58	2.67	4.67
Transferring plastic caps F	20.00	4.4	0.43	3.67	5.00

Table 2. Descriptive indicators and differences between the initial and final testing of the polygon with obstacles group

p = 0.05; N number of participants; AS = arithmetic mean; Min = lowest score; Max = highest score; t = t-test; p = level of significance.

The obtained results of the polygon with obstacles test reveal that improvement of performance has been achieved, i.e. of the results in all motor tasks. Ball handling proved to be the most difficult and most complex motor task in which the children achieved the lowest values and in which no significant improvement was recorded.

The polygon with obstacles is a complex organizational form of work in which the children had to perform one or two topics and six to eight tasks. Since the children did not encounter similar polygons before, mere understanding of what they needed to do was a major progress for them. Regardless of the weaker results compared to the frontal work form, their progress from the initial to the final measurement is of great importance.

This research has confirmed that children adopt new motor knowledge regardless of the used methodical organizational form of work. Marić, Trajkovski, and Tomac (2013) obtained similar results while studying the impact of the organizational form of work on the intensification of the teaching process. They found that, regardless of the use of four different sets, appropriate work form can result in greater workload volume during the physical education class.

## Conclusion

The research was carried out in order to determine the effectiveness of different methodical work forms on the acquisition of new motor knowledge in preschool-aged children. The results have shown that both forms of work are equally effective and can be combined in a variety of ways. Findak and Neljak (2009) state the possibility that the effectiveness of the methodical organizational form of work in the process of physical exercise largely depends on the teacher's preparedness, i.e. the leader to interpret and exploit is in the best possible way. The choice of work modality proved an important segment in the implementation of physical education classes. In addition to the motor-related tasks that were tested, in the near future, more difficult motor tasks should be devised so that the children could further improve their knowledge. Therefore, we propose further research in this area using various organizational methods of work that serve to intensify the process, i.e. the exercise and a better understanding of each of them. Through the application of certain kinanthropological contents, they will help preschool teachers in choosing the most appropriate methodical organizational forms of work for the applied contents.

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# The mediator role of personal resources in the relationship between antecedents of stress and pre-competitive anxiety

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## **ABSTRACT**

**INTRODUCTION:** The main purpose of this paper was to study the mediator effect of personal resources (self-efficacy, self-control, optimism and grit) in synergies between the antecedents of stress and pre-competition anxiety in swimmers. **METHODS:** We conducted a confirmatory and mediator analysis in the context of structural equation modeling to study the data of a cross-sectional survey of male swimmers ( $n = 98$ ;  $M = 18.28$  years;  $SD = 1.33$ ). **RESULTS:** Testing of the model of personality resources showed that the four personal resources constitute a single factor. As a result of the mediatory analysis, the partial indirect effect of personality resources on the state of pre-competition anxiety of swimmers was obtained. **CONCLUSION:** It is established that personality resources have a systemic organization and form an integral factor at the level of empirical indicators. They partially mediate the influence of competitive stress factors at the level of situational anxiety, contributing thereby to its reduction in athletes.

**Key words:** stress, personality resources, structural equation modeling

## **Introduction**

The problem of anxiety, especially the pre-competition anxiety, is one of the most relevant in sports psychology. There are cognitive and somatic components usually distinguished in

an anxiety state. As the studies show, both cognitive and somatic anxiety may have a differentiating effect on athletic performance (Woodman & Hardy, 2003). The most common theory in stress studies in the physiology of sport is Lazarus and Folkman transactional model of stress appraisal and coping (Lazarus & Folkman, 1984). According to this model, the cognitive assessment of the situation as a threat is the key factor in the development of psychological stress. Despite the widespread popularity, the transactional theory still does not answer the question: why do individuals perceive the situation as threatening? The conservation of resource (COR) theory by S. Hobfoll (1989) tries to give the answer to this question. According to COR, the cause of stress is the loss of resources or a threat of their loss. Hobfoll distinguishes four types of resources: 1) objective; 2) social; 3) energy; and 4) personality. The latter are decisive; they play a paramount role in the context of overcoming stress, providing the individual with the ability to adapt.

The present study focuses on four key personal resources: self-efficacy, self-control, optimism and perseverance (grit). A number of studies have shown that these resources are important psychological mediators of the stress in sports (Chiesi, Galli, Primi, Borgi, Bonacchi, 2013; Elumaro, 2016; Englert & Bertrams, 2012; Furley, Bertrams, Englert & Delphia, 2013; Feltz, 2008; Larkin, O'Connor & Williams, 2016). Each of four positive constructs is conceptually independent and has empirically substantiated discriminatory validity. In previous studies, these key personality resources were considered as separate predictors of anxiety, or sports performance. Their effects are moderate. It can be assumed that the combination of these four constructs will have a higher predictive ability than any of them separately. Based on the existing literature and the previous theoretical analysis, we hypothesize:

Hypothesis 1: We assume that the four personality characteristics described above are interrelated by the general factor of higher order – personality resource index.

Hypothesis 2: Personality resources mediate the influence of competitive stress factors on the consciousness and activity of athletes and make them more resistant to stress, able to control the level of pre-competition anxiety. The purpose of this paper was to study the mediator effect of personality resources in synergies between the antecedents of stress and pre-competition anxiety in swimmers.

## Methods

The study involved 98 male swimmers aged 17 to 20 years ( $M = 18.28$  years,  $SD = 1.33$ ). They were moderately experienced and moderately successful. All participants gave their consent before they received the questionnaire. Participants were provided with general information about the study and assured of the confidentiality and complete anonymity of the answers. Filling in the questionnaires, which measured the anxiety antecedents and anxiety states, took place one hour before the start. Antecedents of anxiety were measured using a modified Pre-Race questionnaire (Arapoglou, Bebetos, Pyliaidis & Antonioxi, 2013). The analysis took into account two scales: perceived readiness and perceived complexity of the competition goal. Personality resources were measured: 1) Generalized Self-Efficacy scale; 2) Self-control scale; 3) Dispositional optimism test; 4) Short grit scale; A short Spielberger scale was used to assess the state of anxiety.

To test our hypotheses, we conducted a structural equation modeling that involved the confirmatory factor analysis and mediator analysis using AMOS 21 for Windows. The maximum likelihood method was used to evaluate the model parameters.

## Results

Table 1 shows the means, standard deviations, correlations, and the internal consistencies (Cronbach's alpha) of the variables included in the analyses. As can be seen from this table, all scales show satisfactory Cronbach's alpha.

	M	SD	1	2	3	4	5	6	7
1. Readiness	6.58	1.57	.71						
2. Difficulty of purpose	5.68	1.56	.50**	.68					
3. Self-efficacy	29.97	5.20	.27**	.20*	.80				
4. Self-control	40.13	6.88	.25*	.30*	.57**	.75			
5. Optimism	17.68	3.20	.32**	.33***	.40**	.48***	.78		
6. Grit	29.32	4.14	.31**	.41***	.37**	.65***	.38***	.77	
7. Anxiety state	10.74	3.33	.32**	.24*	-.23*	-.33***	-.34***	-.28**	.87

Table 1. Means, Standard Deviations, Internal Consistencies (Cronbach's as on the Diagonal), and Correlations Among the Variables (N = 98)

Note: \* -  $p < 0.05$ ; \*\* -  $p < 0.01$ ; \*\*\* -  $p < 0.001$ .

To test the hypothesis that 4 indicators of personality resources form a second-order factor, the model was tested (see Figure 1), which demonstrated good agreement with the data:  $\chi^2 = 2.439$  (2);  $p = 0.295$ ; RMSEA = 0.045; CFI = 0.996. To calculate the total index of personality resources (IPR), we used the sum of z-scores on 4 scales that are part of the factor.

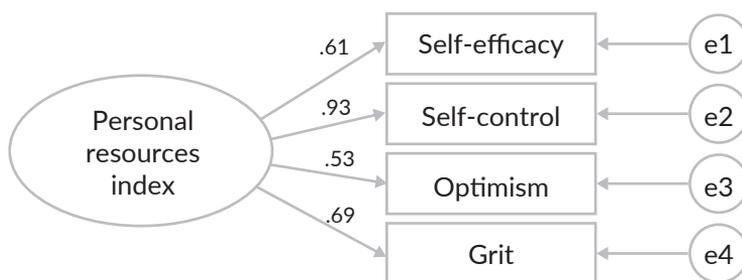


Figure 1. One factor CFI model personal resources index.

Figure 2 shows the results of path analysis. As can be seen, the direct effect of perceived readiness of athletes to compete on pre-competition anxiety is positive and statistically significant ( $\beta = 0.41$ ;  $z = 4.82$ ;  $p = 0.000$ ). The direct effect of the stressor, i.e. complexity of the competition goal on the state of anxiety is also statistically significant ( $\beta = 0.37$ ;  $z = 3.94$ ;  $p = 0.000$ ).

The standardized indirect effect of perceived readiness on pre-competition anxiety through personality resources is estimated as  $-0.16$  ( $z = -1.86$ ;  $p = 0.06$ ). That is, two athletes who differ in one standard unit, according to the evaluated perceived readiness, differ by  $-0.16$  units by the level of competition anxiety in the mediation of personality resources. The bootstrap confidence interval (from  $-0.27$  to  $-0.05$ ) for this indirect effect is confirmed by the following statement with 95% confidence.

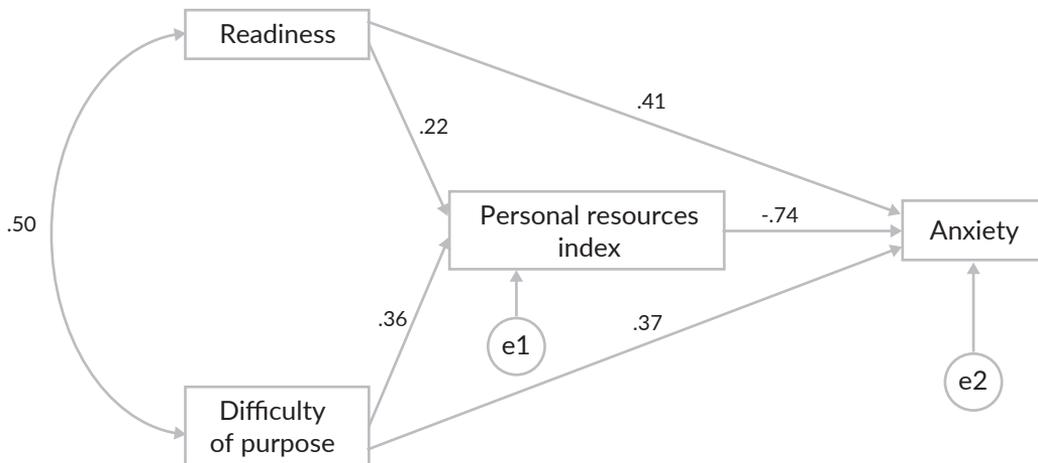


Figure 2. Mediator model of the determination of pre-competitive anxiety.

The indirect effect of the perceived complexity of the goal on the state of competition anxiety, mediated by a personality resource, is estimated to be  $-0.27$  ( $z = -2.93$ ;  $p = 0.003$ ). The bootstrap confidence interval is in the range from  $-0.34$  to  $-0.06$ . Since the direct effects of perceived readiness and goal complexity on competition anxiety are significant, the result is partial mediator effects.

## Discussion

This study deals with the associations between the antecedents of stress and the state of pre-competition anxiety in athletes, mediated by personality resource. The obtained data confirm the first hypothesis concerning the integral factor of personality resources, which determines the interrelation of the studied positive personality traits. Since the personality resources considered in our study are flexible personality traits and have a lifelong genesis, their correlation can be determined by the synergistic effect during the complication of athletes' activity and gain in experience.

A content analysis of the impacts of personality resource indicators on the latent factor obtained in the confirmatory model indicates that the most significant personality resources are self-control and perseverance. Athletes with a high level of self-control can better control their thoughts, regulate their emotions and slow down their impulses compared to those who have low self-control. A high level of perseverance contributes to the ability of athletes to focus on long-term goals and to withstand situational temptations and short-term achievements. These results are consistent with the numerous available data on the importance of self-control and perseverance as factors in resisting stress, self-control of the state of anxiety and competitive performance of athletes (Englert & Bertrams, 2012; Furley et al., 2013; Elumaro, 2016).

The innovative contribution of this study to literature is that four key personality resources have not previously been studied as part of a holistic model of both predictors and mediators of pre-competition anxiety in sports. The study revealed a partial mediator effect of personality resources. Thus, the second hypothesis received partial confirmation. In a situation of sports competitions, personality resources perform a filtering function, mediating the influence of the competition situation on the consciousness and activity of athletes, participating in the assessment of the degree of influence of stress factors, by giving personality meaning to the situation. They alone do not carry an assessment, but their severity transforms the very subjective scale that underlies subjective assessments,

contributing to the assessment of the situation. Personality resources help perceive the requirements of competitions as a challenge and regard them as a complex task, rather than a threat to the psychological well-being of athletes.

Personality resources considered in the study have a lifelong genesis and are correctable and evolvable that can be used in the psychological training of athletes.

### Conclusions

The results of the study showed that the perceived readiness and complexity of the competition goal, which were considered as antecedents of anxiety, are positively and statistically significantly related to pre-competition anxiety in swimmers.

Personality resources have a systemic organization and form an integral factor of personality resources at the level of empirical indicators.

The second-order factor of personality resources partially mediates the influence of competitive stress factors on the level of situational anxiety, contributing thereby to its reduction.

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# Differentiation of muscular effort during stroke of high-level billiard players on game surfaces with different friction coefficients

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## **ABSTRACT**

**PURPOSE** was to improve competitive performance of high-level billiard players by developing their stroke speed control. **METHODS** Twenty members of the national billiard sport team of Ukraine were studied. **Methods of research:** Theoretical analysis and generalization; an expert assessment in this study was conducted to determine the coordination capability of the most significant types of its components in mastering the techniques of the main techniques of the game (30 billiard coaches); pedagogical observation, which envisaged the registration and statistical accounting of the components of training high-level billiard players; pedagogical testing: specialized test for determining the differential threshold of muscular effort was made by billiard players without visual control during the performance of specific impacts of a given force on a cloth with different friction coefficients. Table speed is defined as  $1/\mu_{\text{eff}}(\text{rolling})$ ; motion capture is the process of recording the movement of athletes. A performer wears markers near each joint to identify the motion by the positions or angles between the markers. This method was used to determine the optimal, modeling characteristics of technique and level of speed control of the stroke; methods of mathematical statistics. The correlation coefficient is determined by the Spearman formula:

$$r = \frac{\sum_i (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_i (x_i - \bar{x})^2 \sum_i (y_i - \bar{y})^2}}$$

**RESULTS** It was developed a training program for athletes of the national team, which included exercises for special physical training with the obligatory performance of tasks on tables cloth with different friction coefficients. After two weeks of work on the proposed program, the results of the tests showed a significant reduction in the error in the dosage of impact force on different types of cloth. **CONCLUSION** Analysis of expert opinions (n=30) determined the differentiation of muscular effort as one of the most important coordination ability in billiard sport ( $W = 0.78$ ). The main conceptual idea in developing the content of the program has been: the differentiation of types of loads, rest intervals, coordination complexity, number of strokes and the duration of concentration of attention in the strict regulation of the implementation of technical and tactical elements on game surfaces with different friction coefficients. The use of equipment from various types of billiards for high-level athletes in the special training program allows to increase their level of differentiation of muscular effort and, as a result – level of stroke speed control. After two weeks of training by the proposed program, the results of the tests showed a significant reduction in the error in dosing the force of impact on different types of cloth. It has been proved that in the formation of a comprehensive evaluation of athletes' preparedness the

leading roles are: the criteria characterizing technical preparedness ( $r = 0.81$ ), level of differentiation of muscular effort ( $r = 0.79$ ), concentration of attention ( $r = 0.76$ ), interconnection with the indicators of competitive activities of high qualified billiard players.

**Key words:** program analysis, high level billiard players, pool, coefficient of friction, special physical training

## Introduction

In the modern annual training plan for high-level billiard players, quantitative indicators of competitive loads have increased significantly in comparison with the past decades. The content of training programs to major billiards event was composed mainly of training load performance planning technical and tactical training without a differentiated approach to the development of physical qualities of highly skilled athletes (Nagorna, et al., 2016). The growth of duration and magnitude of static-dynamic loads in the competitive activity of highly skilled billiard players, changes of equipment and rules of games, necessitates the intensification of the process of preparation of athletes by means of special physical training. There is an urgent need to develop a program of special physical training of high-level billiard players as an independent structural unit in the system of multi-year sport improvement, which consists of a differentiated technique taking into account the individual characteristics and reserve capabilities of athletes, the predicted dynamics of sport results, structure, orientation and content training process in the annual cycle. The program of special physical training of athletes for the main competitions of the year should include the focus of the training process on eliminating disproportion in the structure of special physical training by developing the necessary components of motor function, such as special endurance and coordination abilities (Baić, et al 2014).

Coordination of motions, level of spatial and temporal exactness of motions, fineness of differentiation of muscular efforts, vestibular stability, speed of reactions, the level of developing physical flairs and possibilities of their realization is made basis of preparedness of high class sportsmen in such types of sport as billiards.

The criteria of estimation of level of development of different types of coordination capabilities are worked out for the high-level sportsmen in billiards, and also the most meaningful components of coordination capabilities are certain for these types of sport.

Purpose: to improve competitive performance of high level billiard players by developing their stroke speed control.

## Methods

Contingent of research: national billiard team of Ukraine, a total of 20 athletes. Methods of research:

- Theoretical analysis and generalization.
- Expert assessment in this study was conducted to determine the coordination capability of the most significant types of its components in mastering performance of the main techniques of the game (30 billiard coaches).
- Pedagogical observation, which envisaged the registration and statistical accounting of the components of training high level billiard players.
- Pedagogical testing: specialized test for determining the differential threshold of muscular effort was made by billiard players without visual control during the performance of specific impacts of a given force on a cloth with different friction coefficients. Table speed is defined as  $1/\mu_{\text{eff}}$  (cue ball rolling).
- Motion capture is the process of recording the movement of athletes. A performer wears markers near each joint to identify the motion by the positions or angles between the markers. This method was used to determine the optimal, modeling

characteristics of technique and level of speed control of the stroke.

- Methods of mathematical statistics. The correlation coefficient is determined by the Spearman formula:

$$p = \frac{\sum_i(x_1 - \bar{x})(y_1 - \bar{y})}{\sqrt{\sum_i(x_1 - \bar{x})^2 \sum_i(y_1 - \bar{y})^2}}$$

## Results

The World Confederation of Billiards Sports is the umbrella organization that represents the three sports of Pool, Carom and Snooker.

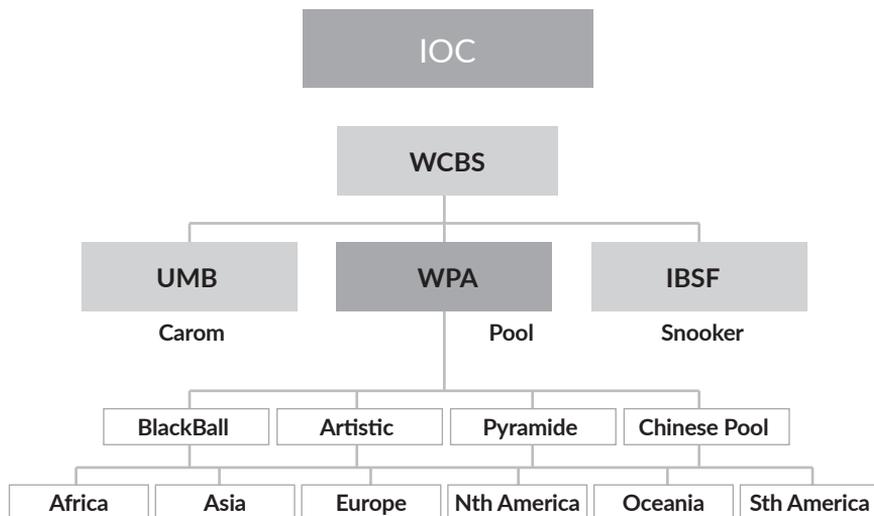


Figure 1. The comprehensive organizational structure of the worldwide associations in billiard sport (2018).

Very often, high-level athletes who specialize in one type of billiards, take part in tournaments for other types of billiards. And even achieve high results with a change in specialization: Pool, Snooker, Carom, Pyramide, BlackBall or Chinese Pool. And this is not surprising, because in all the games of billiards are sufficiently similar technical and tactical elements. Only the rules of games and equipment distinguish the types of billiards.

Chinese Pool was recognized by World Pool Association in 2017. Ukrainian national team was invited to participate in Chinese 8-Ball World Championship 2018. Chinese 8-ball uses standard eight-ball equipment, and similar rules, except with snooker-style pockets, rails and cloth. The change of one equipment to an absolutely different one with its effective use requires the manifestation of a high level of coordination qualities of the athlete. So there was an urgent need to introduce coordination exercises in the training programs of high level billiard players that affect specific coordination abilities, in order to increase the efficiency, quality and economization of movements in order to maximize the individual capabilities of the athlete in the competition.

A distinctive feature of billiards is that the player does not perform the stroke action directly with his hand, but with the help of a special device – cue. That makes the increased requirements for muscular and tactile sensitivity and the ability to objectively perceive and analyze their own movements, to plan specific ways of performing movements in strict accordance with the nature of the assigned motor task. There are around 60 types of strokes in billiard games. But the most difficult action in billiard is speed control, especially on game surfaces with friction coefficient that differs from regular.

First step of our research was to determinate regular friction coefficient of pool table surfaces. The dimensionless quantity table speed is defined as  $1/\mu_{\text{eff}}(\text{rolling})$  and is similarly independent of ball mass. With this definition of table speed, a very slow table is in the range of 50-70. Normal table speed is 80-100. A very fast pool table might have a speed higher than 120. The cloth on a carom table is usually finer and smoother than that on a pool table, and a fast billiard table might have a speed over 150. The force due to rolling resistance is much smaller than that due to sliding friction (Ron Shepard, 1997).

The official rules specify a billiard cloth that is predominantly wool, namely Simonis 860; it may be noted that this is a relatively fast pool table cloth that results typically in table speeds from 100 to 130 when newly installed.

To determine in the structure of the coordination capabilities of the most significant species an expert assessment was conducted, which determined the profile types of coordination abilities for billiard sport: the differentiation of muscular effort, the ability to maintain the stability of the posture (equilibrium) and the coordination of movements ( $W = 0.78$ ). The survey of the best specialists in the field of billiards, analysis of expert opinions and the need for training for a new kind of billiard, resulted to improvement the preparation program of national billiard team. The content of the program includes author's technical and tactical exercises, and exercises that were developed by leading pool trainers in Europe. The main conceptual idea in developing the content of the program has been: the differentiation of types of load, rest intervals, coordination complexity, number of strokes and the duration of concentration of attention in the strict regulation of the implementation of technical and tactical elements on game surfaces with different friction coefficients. For this purpose, in the billiard club of the National University of Physical Education and Sports of Ukraine, was installed on pool tables a cloth with different friction coefficients, with this definition of table speed is in the range of 90-110-125-145.

The performance of a specialized test for determining the differential threshold of muscular effort was made by billiard players without visual control during the performance of specific impacts of a given force on a cloth with a different friction coefficient. After two weeks of work on the proposed program, the results of the tests showed a significant reduction in the error in dosing the force of impact on different types of cloth, Figure 2.

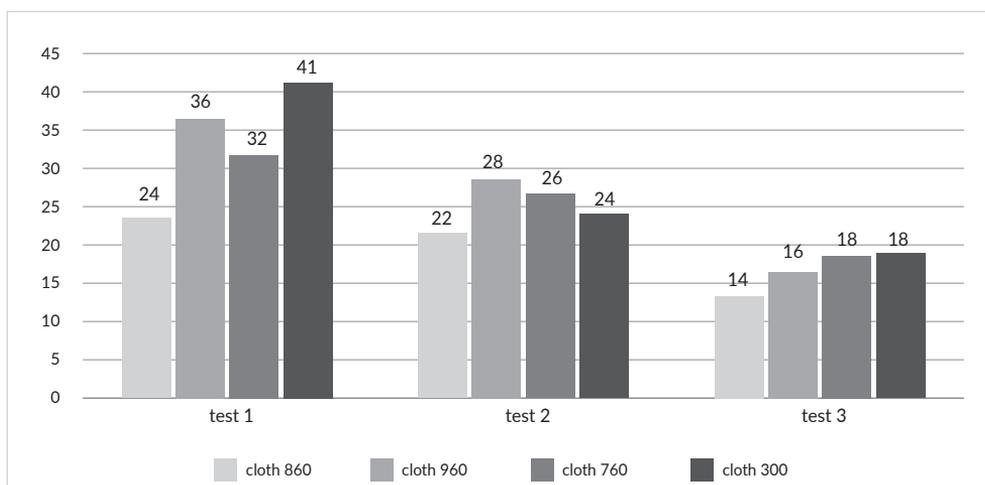


Figure 2. Error in differentiation of speed-strength indicators of high level billiard players (n = 20) after 1 day, 1 week and 2 weeks of training on a special program.

The decreased error in force dosing of stroke on pool tables with different speed characteristics indicates a significant improvement in the quality of differentiation of muscular effort.

It has been proved that in the formation of a comprehensive evaluation of athletes' preparedness the leading roles are: the criteria characterizing technical preparedness ( $r = 0.81$ ), level of differentiation of muscular effort ( $r = 0.79$ ), concentration of attention ( $r = 0.76$ ), interconnection with the indicators of competitive activities of high-level billiard players.

### **Discussion**

Our previous studies proved that the program of special physical training of high-level billiard players should include the special physical training by developing the necessary components of motor function, such as coordination abilities (Baić, et al 2014; Nagorna, et al 2016; Nagorna, et al 2018). Received data indicated the decrease error in dosing the force of stroke on pool tables with different speed characteristics with help of developed training program for athletes of the national team, which included exercises for special physical training with the obligatory performance of tasks on tables with different friction coefficients.

The training program to World Chinese Pool Championship 2018, was composed for high-level billiard players (pool) as an independent structural unit in the system of multi-year sport improvement, which consists of a differentiated technique taking into account the individual characteristics and reserve capabilities of athletes, the predicted dynamics of sport results, structure, orientation and content training process in the annual cycle. The program of special physical training of athletes for the main competitions of the year should include the focus of the training process on eliminating disproportion in the structure of special physical training by developing the necessary components of motor function, such as special coordination abilities. The equipment from various types of billiards that was used in the training program allows increasing the level of coordination abilities of high-level athletes.

### **Conclusion**

Analysis of expert opinions ( $n=30$ ) determined the differentiation of muscular effort as one of the most important coordination ability in billiard sport ( $W = 0.78$ ). The main conceptual idea in developing the content of the program has been: the differentiation of types of load, rest intervals, coordination complexity, number of strokes and the duration of concentration of attention in the strict regulation of the implementation of technical and tactical elements on game surfaces with different coefficients of friction. The use of equipment from various types of billiards for high-level athletes in the special training program allows to increase their level of differentiation of muscular effort and as a result - level of stroke speed control. After two weeks of training by the proposed program, the results of the tests showed a significant reduction in the error in dosing the force of impact on different types of cloth. It has been proved that in the formation of a comprehensive evaluation of athletes' preparedness the leading roles are: the criteria characterizing technical preparedness ( $r = 0.81$ ), level of differentiation of muscular effort ( $r = 0.79$ ), concentration of attention ( $r = 0.76$ ), interconnection with the indicators of competitive activities of high-level billiard players.

In addition, these innovations have significantly helped to achieve good results of the national team's performance at the championships of Ukraine, European and World Championships of Pool, Snooker, Pyramid and Chinese Pool.

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# Anthropological features and comparison of the best junior-cadet water-polo players

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## ABSTRACT

AIM of this study was to compare the somatotype and to describe the morphological characteristics of competing young male water-polo players. The water-polo players of two clubs were playing the final final match of the final tournament of the Croatian Championship for Junior Cadets. Anthropometry and somatotype data were collected from 27 young water-polo players (age M = 12.29, SD = 0.46 years) before the final match. This kind of information helps us to conduct a more accurate selection of athletes. The Jackson and Pollock method (1985) of skinfolds measuring in seven places was used. The RESULTS showed no significant differences in somatotypes between the two clubs. The difference

between two groups of examinees was evident in body height, showing the range of 40 centimeters (min = 147,00; max = 187,00), while the difference in body mass showed the range of 47 kilograms (min = 40,00; max = 87,00). The results are in line with the results of previous studies, confirming that somatotypic characteristics of young sportsmen are very similar to the senior somatotype. Furthermore, the results led to the CONCLUSION that, due to the specifics of the sport, i. e. specific medium in which it is played, the desirable somatotype is mesomorph – endomorph.

**Key words:** junior cadets, anthropometrics, somatotype

## **Introduction**

From the kinesiological point of view, water-polo is a part of the group of polystructural complex sports, in which many cyclical and acyclical movement structures are performed. Success in water-polo is a result of many interconnected factors like, in a hierarchical order: morphological characteristics, motor abilities, functional abilities, cognitive and conative factors, and also social character (Kontić, 2012). Analysis (testing) of the state of different dimensions of players' anthropological status is considered the most important element of transformational procedures in sports and physical exercise in general. One of them is morphological anthropometric measurement: the method of collecting data about the human body structure which is the basis for the determination and assessment of body dimensions as well as of motor and functional abilities (Marinović, 2001). The assessment of morphological characteristics helps in the identification of physical characteristics, in the assessment and monitoring of growth and development of athletes and in monitoring and evaluating training program realisation (Blackburn, 2000, in Marinović, 2001). Besides anthropometric measurements, important parameters for objective description of an athlete are obtained by somatotypological methods. Somatotypological techniques are used to describe body shape and its structure. Somatotype is defined as a quantification of shape and structure of human body. It is shown through three numbers representing endomorphic, mesomorphic and ectomorphic component (Carter & Heath, 1990). For those reasons, anthropometric and somatotypic characteristics of young and prospective water-polo players will be determined and compared to the status of the already elite sportsmen. Also these results will be compared to the data on children not actively involved in any sport with the expectation to improve future-success prediction and selection of children for a certain sport. We presume that results of our research will follow the results of previous research studies.

## **Research methods**

Twenty-seven boys participated in the research (body height:  $M = 165.46$  cm,  $SD = 10.92$  cm), (body mass:  $M = 59.60$  kg,  $SD = 14.77$  kg; age  $M = 12.29$  years,  $SD = 0.46$  years). They were members of the two teams (WC Mornar, Split, and WC KPK, Korčula), the finalists of the final tournament of the Croatian Championship for Junior Cadets; so we inferred they were the best water-polo players in that age category at the state level. The measurement was in both cases carried out at 11:00 a.m. with the 7 days interval. The Jackson and Pollock method (1985) of skinfold measuring in seven places was used. The measurement was carried out in the premises of ŠC Bazen Poljud in Split and at the Natkriveni plivački bazen Gojko Arneri in Korčula. In the research, the following 24 morphological variables were measured:

<i>Body height</i>	<i>Abdomen circumference</i>	<i>Ankle joint diameter</i>
<i>Arm span</i>	<i>Upper leg circumference</i>	<i>Biceps skinfold</i>
<i>Body mass</i>	<i>Lower leg circumference</i>	<i>Triceps skinfold</i>
<i>Leg length</i>	<i>Shoulder width</i>	<i>Back skinfold (subscapular)</i>
<i>Arm length</i>	<i>Hip width</i>	<i>Abdomen skinfold</i>
<i>Upper arm circumference</i>	<i>Elbow diameter</i>	<i>Supraspinal skinfold</i>
<i>Lower arm circumference</i>	<i>Wrist diameter</i>	<i>Upper leg skinfold (thigs)</i>
<i>Chest circumference</i>	<i>Knee diameter</i>	<i>Lower leg skinfold</i>

In the first phase of data processing, basic parameters of the descriptive statistics were calculated: arithmetic mean (M), standard deviation (SD), minimum (Min) and maximum (Max). Furthermore, the body fat percentage (BF%) was calculated through body density (BD) using the following formula (Durnin and Womersley, 1974):

$$BD = 1,162 - 0,063 \log_{10} \sum 4KN$$

in which  $\sum 4KN$  = sum of 4 skinfolds (biceps brachii, triceps brachii, subscapularis and supraspinatus). The result value was used to calculate body fat percentage using Siri's method (1956):

$$BF\% = \left( \frac{4,95}{BD - 4,5} \right) 100$$

From the collected morphological measures, somatotype components were calculated using the Heat-Carter method:

Figure 1 Endomorphic component

$$-0,7182 + 0,1451(X) - 0,00068(X^2) + 0,0000014(X^3)$$

Figure 1. X = sum of the skinfolds of triceps, subscapularis and supraspinatus multiplied by 170,18 / height in cm, according to Carter (2002)

Figure 2 Mesomorphic component

$$0,858(E) + 0,601(K) + 0,188(A) + 0,161(C) - 0,131(H) + 4,5$$

Figure 2. E = elbow diameter , K = knee diameter , A = corrected upper arm circumference, according to formula: A = Upper arm circumference – (Triceps skinfold / 10), C = corrected circumference of lower leg, according to formula: C = Lower leg circumference – (Lower leg skinfold / 10), H = body height, according to Carter (2002)

### Figure 3 Ectomorphic component

The ectomorphic component is obtained of the reciprocal of the ponderal index (RPI), which is obtained by dividing body height in cm with the third root of body weight.

$$RPI = \frac{\text{Body height}}{\text{Body mass}^{1/3}}$$

Figure 3. If  $RPI \geq 40,75$ , then ectomorphy =  $0,732 (RPI) - 28,58$  / If  $38,25 < RPI < 40,75$  then ectomorphy is =  $0,463 (RPI) - 17,63$  / If  $RPI \leq 38,25$  then ectomorphy is =  $0,1$  according to Carter (2002)

The Heath-Carter (Carter, 2002) method was used for the determination of the junior-cadet water-polo players somatotype based on the Sheldon type classification.

### Results

The results indicated no significant differences in somatotypes between the two clubs. However, analysis of individual morphological features revealed the significant differences between individual examinees. The difference between the two groups of examinees is evident in body height, showing the range of 40 centimeters (min = 147.00; max = 187.00), while the difference in body mass shows the range of 47 kilograms (min = 40.00; max = 87.00).

Variable	N	AM±SD	Min	Max
Body height	27	165,46±10,93	147,00	187,00
Arm span	27	168,37±11,90	151,50	198,00
Body mass	27	59,61±14,77	40,00	87,00
Leg length	27	100,62±16,57	65,20	162,00
Arm length	27	77,42±10,96	67,60	111,40
Upper arm circumference	27	26,81±3,90	20,00	33,00
Lower arm circumference	27	24,10±2,38	20,00	29,00
Chest circumference	27	84,08±10,40	58,00	104,00
Abdomen circumference	27	78,08±9,81	62,10	101,00
Upper leg circumference	27	46,73±8,97	30,00	60,30
Lower leg circumference	27	34,16±3,33	28,00	41,00
Shoulder width	27	33,33±3,99	26,80	42,00
Hip width	27	25,95±2,41	20,00	30,00
Elbow diameter	27	6,61±0,49	5,70	7,80
Wrist diameter	27	5,46±0,59	4,70	7,70
Knee diameter	27	9,86±0,64	8,70	11,10
Ankle joint diameter	27	7,03±0,50	6,20	8,50
Biceps skinfold	27	8,09±3,38	3,10	15,20
Triceps skinfold	27	8,73±3,04	4,20	15,60
Back skinfold (subscapular)	27	8,01±3,43	4,20	19,00
Abdomen skinfold	27	11,73±6,05	3,80	22,80
Supraspinal skinfold	27	10,61±5,84	3,40	22,10
Upper leg skinfold (thigs)	27	10,49±3,38	5,50	15,40
Lower leg skinfold	27	12,06±5,15	4,20	21,80

Table 1. Descriptive indicators of the measured morphological features

Note: AM = arithmetic mean, SD = standard deviation, Min = minimal value, Max = maximal value

Analysis of the measured dimensions and their somatotypic characteristics divided the examinees into 6 out of 13 possible categories. The predominant category is endomorph – mesomorph (37 %) followed by ectomorph – mesomorph (22%) and mesomorph – ectomorph (18%). The remaining three categories have from one to three representatives (22%) each. Therefore, the mesomorph component is the dominant one in most of the examinees, then ectomorph, while the endomorph is the least represented.

t – test; N1: Mornar N2: KPK

Variable	AS±SD	AS±SD	t – value	p	N1	N2
END	2,53±1,03	3,04±1,20	-1,18	0,25	14	13
MEZ	4,77±1,38	4,42±1,01	0,77	0,45	14	13
ECT	2,70±1,30	2,78±1,38	-0,16	0,87	14	13
BF%	13,10±4,15	15,45±4,94	-1,34	0,19	14	13
Body height	162,46±9,77	168,69±11,55	-1,52	0,14	14	13
Arm span	165,00±8,76	172,00±14,01	-1,57	0,13	14	13
Body mass	55,99±10,25	63,51±18,09	-1,34	0,19	14	13
Leg length	102,88±17,60	98,18±15,70	0,73	0,47	14	13
Arm length	73,09±3,90	82,09±14,08	-2,30	0,03	14	13
Upper arm circumference	27,06±3,54	26,54±4,39	0,34	0,73	14	13
Lower arm circumference	23,46±1,86	24,79±2,73	-1,48	0,15	14	13
Chest circumference	83,43±7,40	84,78±13,19	-0,33	0,74	14	13
Abdomen circumference	78,15±8,13	78,00±11,70	0,04	0,97	14	13
Upper leg circumference	53,12±5,31	39,84±6,69	5,74	0,00	14	13
Lower leg circumference	33,89±2,96	34,46±3,79	-0,44	0,66	14	13
Shoulder width	35,99±2,39	30,46±3,34	4,97	0,00	14	13
Hip width	26,14±1,63	25,75±3,10	0,41	0,68	14	13
Elbow diameter	6,49±0,40	6,74±0,55	-1,36	0,18	14	13
Wrist diameter	5,52±0,68	5,39±0,50	0,56	0,58	14	13
Knee diameter	9,66±0,49	10,08±0,73	-1,77	0,09	14	13
Ankle joint diameter	7,01±0,56	7,06±0,46	-0,28	0,78	14	13
Biceps skinfold	7,33±3,09	8,91±3,61	-1,22	0,23	14	13
Triceps skinfold	8,36±3,54	9,13±2,48	-0,65	0,52	14	13
Back skinfold (subscapular)	7,23±2,34	8,86±4,26	-1,25	0,22	14	13
Abdomen skinfold	11,51±5,95	11,96±6,39	-0,19	0,85	14	13
Supraspinal skinfold	8,89±4,66	12,48±6,57	-1,65	0,11	14	13
Upper leg skinfold (thigs)	9,89±3,29	11,14±3,48	-0,96	0,35	14	13
Lower leg skinfold	12,31±4,89	11,79±5,61	0,26	0,80	14	13

Table 2. The differences determined between the two clubs in the measured morphological variables and somatotypes using t-test

Note: END = endomorph, MEZ = mesomorph, ECT = ectomorph, BF% = body fat percentage

The water-polo players of WC Mornar from Split pertained to five somatotypic categories, the predominant ones being endomorph – mesomorph (5) and ectomorph – mesomorph (5), whereas the rest categories had one or two representatives each. The values of the mean somatotype were: 2.5 – 4.8 – 2.7. The water-polo players of KPK from Korčula were classified into six categories, the predominant category being endomorph – mesomorph (5), the next mesomorph – ectomorph (3), while the rest of the categories had one or two representatives each. The values of mean somatotype were: 3.0 – 4.6 – 2.8.

	N	AM	Min	Max	SD
Endomorph	27	2,77	1,38	5,01	1,12
Mesomorph	27	4,61	2,57	8,06	1,20
Ectomorph	27	2,67	0,23	4,54	1,30

Table 3. The presentation of descriptive statistics of the somatotypic parameters

Note: N = valued number of examinees, AM = arithmetic mean, SD = standard deviation, Min = minimum, Max = maximum

Nevertheless, some visible differences in the distribution of examinees into the categories still exist. Although the endomorph – mesomorph category is predominant in both groups of examinees, in the water-polo players of WC Mornar the second predominant category is ectomorph – mesomorph (5), as opposed to the water-polo players of KPK who had in that category only one representative.

### Discussion

The differences can be attributed to different biological ages of the examinees in relation to their chronological age, i.e. there were accelerants and retardants. Since we are dealing with the examinees of the same chronological age, such a difference in the values of morphological features shows extreme heterogeneity of the group. Also, body height, i.e. longitudinal dimensionality of skeleton, is an extremely genetically conditioned feature, and its development cannot be significantly influenced by training. According to Carter (1982), in the Olympic water-polo players mesomorph component was also dominant, with the values of the mean somatotype of 2.9 – 5.3 – 2.3. According to the data from previous research (Uljević & Spasić, 2009), obtained from the sample of 29 water-polo players in the age of 12 and 13 years coming from the two Split clubs, and 30 water-polo players of the same age coming from the three clubs working in the Biograd area, the predominant somatotype in the Split water-polo players, i.e. children training through the whole year, was also endomorph – mesomorph (31%), while the next in line was balanced ectomorph (10,4%). In the water-polo players from the Biograd area, i.e. children training only through season (in summer), the predominant somatotype was mesomorph – ectomorph (30%), then mesomorph – ectomorph (16,6%), and finally ectomorph – mesomorph (13,3%) (Uljević & Spasić, 2009). Somatotype characteristics of young elite water-polo players are showing greater ratio of mesomorph component, and it shows the demands of this sport. The somatotypes of boys 12-13 years of age in our research are similar to the results of elite senior contestants (Canossa et al., 2011; Smith, 1998). These results show that the examined have the somatotypic build very close to the somatotypic build of elite senior contestants.

### Conclusion

Many research studies (Uljević & Spasić, 2009; Aleksandrović et al., 2007; Canossa et al., 2011; Kontić, 2012) have determined requirements of the game of water-polo for certain body build of water-polo players since performance of motor elements depend on it (Vila Suarez et al., 2009; Ferragut et al., 2011). The results of this research confirmed that somatotypic characteristics of young athletes are very similar to the somatotype of seniors. Furthermore, the results are leading to the conclusion that, due to the specifics of the sport, i.e. specific medium in which it is played, the desirable somatotype is mesomorph – endomorph. In the equation of performance specification for water-polo, the important factors

are strength (mesomorph – muscle tissue generating force in duels) and buoyancy (endomorph – ballast mass facilitating lift of the body and thus adding to buoyancy). For a more significant determination of morphological models, more extensive research should be conducted, investigating each playing position of water-polo game through all the age categories.

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## Differences among Croatian coaches' workload in different sports according to specific professional activities

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### **ABSTRACT**

**PURPOSE:** Sport coaching as a profession today is getting more and more attention in scientific and professional community. The aim of this paper is to reveal differences among coaches in the selected sports and professional activities. Coaching process is highly practical but yet complex job and it is necessary to define and meet all aspects of coaching. This is exactly why most authors point out education as the key indicator of successful coaching. **METHODS:** A total sample of 351 sport coaches from different sports in the City of Zagreb filled in the questionnaire regarding general information on their status and on their workload in the defined 16 professional activities. One way ANOVA and Tukey's post-hoc test were used to test the set hypothesis. **RESULTS:** Results of one way ANOVA showed that there was no statistically significant ( $p=0.09$ ) difference in coaches' workload between different sports but, there was the statistically significant difference ( $p=0.00$ ) between coaches in different sports according to the workload imposed by different professional activities. **CONCLUSIONS:** Understanding of sports coaches' workload can clarify many aspects of this profession. In Croatian sport there are many challenges that can be solved with carefully conducted investigations of coaches' work.

**Key words:** workload, professional activities, sport coaches

## Introduction

Sport coaching as a profession today is getting more and more attention in scientific and professional community. Importance and role of sports coaches in top level sport as in the development of top-level athletes is supported by numerous studies (Cushion, Armour & Jones, 2003; Côté & Gilbert, 2009; Duffy et al., 2011). Several aspects of coaching are pointed out in recent literature as important for effective management of coaching process. One of them is certainly education of coaches and continuing professional development (CPD) (Nelson, Cushion & Potrac, 2013). According to this research, it is necessary to attend coaching education courses in order to understand coaching process and “improve abilities to practice” (Nelson, Cushion & Potrac, 2013). Since coaching process is highly practical but yet complex job, it is necessary to define and meet all aspects of coaching. This is exactly why most of the authors point out education as the key indicator of successful coaching. It is necessary to learn and to master a great complexity of theoretical and practical knowledge. According to Côté and Gilbert (2009), some authors define successful coaches by the results their athletes achieve, whereas others by years of experience. It is an indisputable fact that theoretical knowledge, harmonized with practical work, are two main features in the development of a successful coach. This is why simply accumulated coaching experience is not automatically translated into knowledge and effective coaching skills (Côté et al., 2007). In the development of a successful coach it is important for everyone to be aware that coaching process is extremely complex, important and responsible job (Milanović, Šalaj & Hrženjak, 2016). This can be corroborated by the assertion of Côté et al. (2007) that high-performance coaches, in order to be excellent, are expected to have competences in the following: sport-specific skills training, maximization of athletes effort and recovery, and preparation for numerous competitions, which includes motivational and other activities.

In order to define coaching job and its duties, Bok et al. (2015) conducted a research among coaches working in different sports in the City of Zagreb, the capital of Croatia. Besides collecting a general information about coaches, the aim in this research was to gather data about workload of coaches over a one-year cycle. The result was the definition of sixteen different professional activities divided into 5 groups of coaching activities during a one-year (season) cycle.

The aim of this paper is to find out are there any differences among coaches' workload with regard to different sports and according to the professional activities performed. It is important to emphasize that this research is not dealing with the amount of time spent in training activities by athletes; it is focused on the issue of how much time coaches spend in specific professional activities during their work. It is known that professional coaches in Croatia often work with several selections (Bok et al., 2015) so the numbers in this paper represent their total workload with all selections.

## Methods

Total sample of 351 (298 male and 53 female) professional coaches from 41 different sports in the Croatian capital, city of Zagreb, were interviewed. Twenty-five questions related to their general status. The estimation of their workload during a one-year cycle was distributed in the already defined 16 professional activities (Table 1). An average age of the interviewed coaches was  $41.46 \pm 9.37$  years. Their average coaching experience was 14 years and most of them (87.74%) had the required qualifications for sport.

SPORTS PREPARATION PLANNING AND PROGRAMMING	TRAINING PROCESs	COMPETITIONS	ADDITIONAL PROFESSIONAL ACTIVITIES	OTHER ACTIVITIES
1	2	3	4	5
Planning and programming of sports preparation	Preparation and inspection of facilities and equipment	Travelling to competitions	Scouting	Meetings with athletes' parents
	Implementation and management of training process	Participation in competitions	Testing	Educational care and health care
	Training analysis	Competition analysis	Meetings with athletes	Motivation of participants
			Preparation for and reporting on professional work	Additional work with the members of national teams
			Professional development and personal exercise	

Table 1. Professional duties of the City of Zagreb sport coaches financed from the Sport Association (adopted from Bok et al., 2015)

A subsample of eight different sports (212 coaches) was selected for this paper. These were TEAM SPORTS: football (86), basketball (33), handball (27) and volleyball (13), and INDIVIDUAL SPORTS: athletics (25), gymnastics (6), tennis (8) and swimming (14).

Descriptive statistical parameters (mean and standard deviation) were calculated for the variables sports preparation planning and programming (PPSP), training process (TP), competitions (C), additional professional activities (APA), other activities (OA) and total (TOT).

One-way ANOVA and Tukey' post-hoc test were used to test the following set hypotheses: "There is the statistically significant difference in the coaches' workload according to different sports" and "There is the statistically significant difference between the coaches' workload in different sports according to different professional activities". Statistical analysis of the collected data was made with statistical program STATISTICA 13 (Statsoft, Inc., Tulsa, OK, SAD) at the University of Zagreb, Faculty of Kinesiology.

## Results

Descriptive statistical parameters for different professional activities are calculated for the total number of 212 coaches in eight different sports (Table 2). Most of the time in their annual professional work coaches spend in training process, on average 1,190.37 hours. Next activity are competitions (291.37 hours), additional professional activities (274.25 hours), planning and programing of sports preparation (260.87 hours) and the least time is spent on other activities (130.00 hours). The total mean value of workload per year is 2,147 hours.

VARIABLE	DESCRIPTIVE STATISTICS				
	Valid N	Mean	Minimum	Maximum	Std. Dev.
PPSP	8	260.87	157.00	359.00	67.08
TP	8	1190.37	953.00	1536.00	247.12
C	8	291.37	202.00	378.00	60.39
APA	8	274.25	168.00	368.00	69.94
OA	8	130.00	79.00	181.00	30.08
TOT	8	2146.87	1836.00	2533.00	230.58

Table 2. Descriptive parameters of hours spent in different professional activities by coaches in different sports per year

Legend: PPSP – sports preparation planning and programing; TP – training process; C – competitions; APA – additional professional activities; OA – other activities; TOT – total

Results of one way ANOVA showed that there was no statistically significant ( $p=0.09$ ) difference between coaches' workload in different sports, but there was statistically significant difference ( $p=0.00$ ) between the coaches in different sports according to workload of different professional activities. Tukey's post-hoc test reveals that the variable training process had the greatest contribute to the difference.

## Discussion

According to the obtained results, coaches are spending most time in their professional annual work in conducting training process. The information goes along with the conclusions of several previous papers on this subject (Milanović, Šalaj, & Hrženjak, 2016; Bok et al., 2015). Coaches' workload differed across chosen sports only partially in different professional activities, but there was no statistically significant difference in the total workload between different sports, although there was tendency to significance. This results indicate similar coaches' workloads in different sports. As any other professional work, sport coaches are in the domain of the Act of Labor with 1840 working hours yearly. Investigation of Bok et al. (2015) revealed that the Croatian coaches work more than this. Average annual sport coaches' workload in the City of Zagreb is 2022 working hours (Milanović, Šalaj & Hrženjak, 2016). This suggests the overloading of coaches with their professional activities during a one-year cycle.

Importance of recognition of sports coaches' work and particularly their workload is the key element in further development of coaching profession. The body of scientific and professional evidence related to the coaching profession is becoming increasingly important and, in some top-level sports, makes the key difference in the success of the coaches and, consequently, in the success of the athletes and the teams which they coach. Limitations of the study are reflected in the limited statistical power of the data used. Analysis of results was made with mean values of all coaches in particular sport instead of results of an every single coach.

## Conclusions

Workload of coaches is one of the most important segment in investigating coaching profession. The amount of workload invested in different professional activities is a reliable parameter in the investigation of some other aspects of coaching profession, such as

burnout, work-family conflict, or economical and organizational aspects of coaching. Understanding of sports coaches' workload can clarify many aspects of this profession. In Croatian sport there are many challenges that can be solved with carefully conducted investigations of coaches' work.

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# The external validity analyses of the Attitude Toward Combat Sport Scale on male and female samples

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## **ABSTRACT**

**PURPOSE:** The aim of this research was to establish external validity of the Attitude Toward Combat Sports Scale (SBS, Bosnar, Sertić, & Prot, 1999). **METHODS:** The research was done on the male and female samples of the adults from the Croatian population. The first sample consisted of 851 males, aged 19 to 81 years; the second sample consisted of 776 females, aged 15 to 78 years. The examinees were measured by the SBS scale along five 7-point scales assessing attitudes toward boxing, karate, taekwondo, wrestling and judo. External validity of the SBS scale was established in two ways, by the correlation of the principal component of the set of items in the SBS scale and the principal component of the five combat sports attitude scales, and by the linear regression analysis with the total score in the SBS scale being the dependent variable and results on the five combat sports attitude scales being the independent variables. **RESULTS:** In the male sample, the correlation between the principal components was high,  $r=-0.653$ ; multiple correlation was even higher,  $\rho=0.703$ . In the female sample, the value of correlation of two principal components was  $r=-0.747$ ; multiple correlation was  $\rho=0.770$ . **CONCLUSION:** The external validity of the SBS scale was examined on the two samples and by two methods. In both samples, the values obtained by the two methods show that the SBS scale is a valid instrument to measure general attitude toward combat sports.

**Key words:** combat sports, attitudes, external validity

## **Introduction**

In the second part of the 20th century new combat sports joined in the West the already developed and recognized wrestling and boxing. Most of them, like judo, karate and taekwondo, were from the non-western background. Many people are practicing them at various standard levels in the range from amateur to professional. Development of combat sports in society depends on attitudes and interests of people. Objective measures of attitudes enable an insight into and understanding of people's behavior. With that in mind, the Scale of Attitudes Toward Martial Sports (SBS) has been constructed (Bosnar, Sertić & Prot, 1996). From the pool of 46 items, satisfying the face, content and theoretical validity criteria, 20 items had been selected for the final scale. Internal metric properties of the SBS scale had been reviewed on several occasions (Bosnar, Sertić & Prot, 1999; Busch et al, 1999; Prot, Bosnar & Sertić, 1999; Sertić, Prot & Bosnar, 1999.; Prot, Bosnar & Sertić, 1998;

Bosnar-Pleša, Sertić & Ribičić, 2002; Prot & Radić, 2010; Crnjac, Brekalo & Šilić, 2013; Bosnar, Deković, Šarić & Prot, 2016). The scale was applied to the samples of different ages, from 11-year-olds to adults, and to both genders. Item analyses showed that the same set of items was appropriate to measure the attitude of different generations of males and females. Reliability of the total result of the SBS scale was regularly well over 0.8. It has been experienced that the same version of the SBS scale is appropriate for children, adolescents and adults. Closely related to reliability is validity, the most important property of a measuring instrument. The 1985 edition of APA standards entitled *Standards for Educational and Psychological Testing*, represented a shift toward shaping a unitary complex concept in validity theory. The 1999 edition of *Standards* and 2014 edition of *Revised Standards* are treating validity as important and complex measurement property. Taking into account the psychometric heritage summarized in *APA Standards* and kinesiometric experience in the first step, we recognize the traditional separation of validities into two major groups, i.e. as validities a priori (in psychometrics aprioristic validities) and validities a posteriori. These two groups are further splitted and divided into several groups and up to four levels, up to the point where concrete data analysis methods and techniques could be recognized for their determination (Prot, 2010). Validity evidence is required for each use of measuring instrument. Validity of the SBS scale was confirmed when applied to groups with different professional interests (Prot, Bosnar & Štimac, 2002). Validations is an ongoing process. One of the necessary sources of validity evidence are relations to other measures. The SBS in this research is going to be externally validated in relation to attitudes toward boxing, wrestling, judo, taekwondo and karate assessed to represent explanatory variables for external validation. Boxing, wrestling judo, taekwondo and karate are currently Olympic sports. These five sports are known to most people.

## Methods

The research was done on the population from different parts of the Republic of Croatia. Quantitative analyses showed marked gender differences in attitudes toward combat sports in the population of Croatia (Bosnar & Prot, 2006; Prot, et al., 2011; Prot, Pak & Prot, 2011; Prot & Radić, 2010). A total sample, consisting of 1627 examinees, was split into male and female subsamples to avoid any possibility of gender-biased results. The male sample consisted of 851 subjects, aged 19 to 81 years, mean age 35.6 years; modal values showed that they dominantly finished high school, and were employed, unmarried and without children. The female sample consisted of 776 examinees, aged 15 to 78 years, mean age 36.1 years; modal values showed that they dominantly had higher school or university degree; they were dominantly employed, unmarried and without children. Apparently, the samples are not representative of the population of Croatia. The examinees were measured by the Attitude Toward Combat Sports Scale (SBS; Bosnar, Sertić, & Prot, 1999) along five 7-point scales assessing attitudes toward Olympic combat sports: boxing, karate, taekwondo, wrestling and judo. External validity of the SBS scale was established in two ways. First, the validity was defined by the correlation of the principal component of the set of items in the SBS scale and the principal component of five combat sports attitude scales. The second measure of external validity was defined as multiple correlation from linear regression analysis (with 871 subjects in male sample and 794 subjects in female sample), with the total score in the SBS scale being the dependent variable and results on five combat sports attitude scales being the independent variables. The data analyses were done by Statistica 64 and IBM SPSS 24.

## Results and discussion

To obtaine the first measure of external validity, correlation matrix of items in the SBS scale and correlation matrix of results on five scales, assesing attitudes toward boxing, karate, taekwondo, wrestling and judo, were computed for both the male and female sample, and

spectral decomposition of correlation matrices was done. The values of the principal component of the correlation matrix of the SBS scale items are presented in Table 1. The variance of the principal component, i.e. first eigenvalue in male sample is 7.726 and it explains 38,63% of total variance; in female sample, first eigenvalue is 8.543 and it explains 42.67% of total variance.

Item	$K_{1M}$	$K_{1Z}$
I would never practice any combat sport, even if there is nothing else.	.736	.727
I do not understand people having fun in beating each other.	.629	.674
I hate boxing.	.711	.641
It is a great pleasure to subdue oponent fighter by your own power and mastery.	-.585	-.664
Combat sports are not more dangerous than many other sports.	-.402	-.496
Combat sports should be forbidden because they spread violence among people.	.738	.790
Karate players are morbidly aggressive.	.567	.655
I like to watch good fights from different combat sports.	-.673	-.705
Combat sports should be thrown out of Olimpic Games, instead of including new ones.	.628	.694
Combat sports are rude and boring.	.773	.797
I will newer allow my child to practice combat sport.	.651	.727
I dream to become „somebody“ in combat sport.	-.206	-.256
It is nice to see well done leg kick.	-.652	-.730
Strong characters are built through fight.	-.550	-.537
Without combat sports our civilisation would be incomplete.	-.331	-.352
I am not attracted to combat sports because there is a possibility to hurt another person.	.692	.676
Only wild person chosese combat sport.	.679	.748
Fighting spirit is noble characteristic of mankind.	-.605	-.580
Nothing can justify savagery exposed in combat sports.	.607	.669
There should be more combat sport broadcasts on TV.	-.700	-.667

Table 1. The values of the principal component of the correlation matrix of the SBS scale items in male sample ( $K_{1M}$ ) and female sample ( $K_{1Z}$ )

The values of the principal component of the correlation matrix of five attitudes toward combat sports are presented in Table 2. The variance of the principal component, i.e. first eigenvalue in male sample is 2.929 and it explains 58.58% of total variance; in female sample, first eigenvalue is 3.297 and explains 65.94% of total variance.

Sport	K <sub>1M</sub>	K <sub>1Z</sub>
Boxing	.728	.775
Karate	.791	.837
Taekwondo	.753	.822
Wrestling	.774	.778
Judo	.778	.846

Table 2. The values of the principal component of the correlation matrix of attitudes toward boxing, karate, taekwondo, wrestling and judo in male (K<sub>1M</sub>) and female sample (K<sub>1Z</sub>)

The correlations of the principal component of items in the SBS scale and the principal component of five combat sports attitude scales in male sample is high  $r = -0.653$ ; in female sample is even higher,  $r = -0.747$ . The principal component correlations show a high percentage of common variance, 43% in male and 56% in female sample, confirming that the SBS scale and five attitudes toward combat sports scales measure the same characteristic.

The results of multiple linear regression analysis on male sample is presented in Table 3, and on female sample in Table 5. A significant multiple correlation was obtained in both samples, 0.703 in male and 0.770 in female sample, respectively. The percentage of variance common to the SBS scale total score and five predictor scales is 50% in male and 59% in female sample, respectively; the values are high and similar to the proportions of common variance in prior analysis. In both samples, the attitude toward boxing has the highest regression coefficients and the highest correlation with the SBS scale total score (Tables 4 and 6). It could be presumed that boxing, with its long tradition, is still a leading representative of combat sports in the general Croatian population.

Predictors	$\beta$	SE $\beta$	b	SEb	t (865)	pt
Boxing	0,474406	0,029777	4,85083	0,304474	15,93182	0,000000
Karate	0,046298	0,034158	0,50645	0,373650	1,35541	0,175642
Taekwondo	0,120781	0,032899	1,29868	0,353746	3,67123	0,000256
Wrestling	0,120882	0,033829	1,22484	0,342773	3,57333	0,000372
Judo	0,108237	0,033474	1,10408	0,341450	3,23350	0,001269
R = 0,703    R <sub>2</sub> = 0,495    F = 169,4824    p <sub>F</sub> = 0,00000						

Table 3. The results of multiple linear regression analysis of total result in the SBS scale, male sample with 871 cases

Legend:  $\beta$  = standardized regression coefficients, SE $\beta$  = standard error of  $\beta$ , b = unstandardized regression coefficients, SEb = standard error of b, t (865) = t-value with 865 degrees of freedom, pt = statistical significance of t-value. R = multiple correlation, R<sub>2</sub> = multiple determination, F = value of F- test of multiple correlation, p<sub>F</sub> = statistical significance of F-value.

Variable	Boxing	Karate	Taekwondo	Wrestling	Judo	SBS
Boxing	1,000	0,461	0,428	0,503	0,423	0,654
Karate	0,461	1,000	0,656	0,429	0,477	0,448
Taekwondo	0,428	0,656	1,000	0,385	0,429	0,447
Wrestling	0,503	0,429	0,385	1,000	0,651	0,496
Judo	0,423	0,477	0,429	0,651	1,000	0,461

Table 4. The correlations of general attitude toward boxing, karate, taekwondo, wrestling and judo scales and total result in the SBS scale; male sample with 871 cases

Predictors	$\beta$	SE $\beta$	b	SEb	t (788)	pt
Boxing	0,423129	0,030150	4,86326	0,346531	14,03413	0,000000
Karate	0,075634	0,036231	0,93307	0,446971	2,08754	0,037160
Taekwondo	0,238767	0,035356	2,87305	0,425430	6,75329	0,000000
Wrestling	0,034979	0,031643	0,41874	0,378801	1,10543	0,269312
Judo	0,156958	0,034129	1,92143	0,417794	4,59900	0,000005
R = 0,770    R <sub>2</sub> = 0, 593    F = 229,8047    p <sub>F</sub> = 0,00000						

Table 5. The results of multiple linear regression analysis of the total result in the SBS scale, female sample with 794 cases

Legend:  $\beta$  = standardized regression coefficients, SE $\beta$  = standard error of  $\beta$ , b = unstandardized regression coefficients, SEb = standard error of b, t (788) = t-value with 788 degrees of freedom, pt = statistical significance of t-value. R = multiple correlation, R<sub>2</sub> = multiple determination, F = value of F- test of multiple correlation, p<sub>F</sub> = statistical significance of F-value.

Variable	Boxing	Karate	Taekwondo	Wrestling	Judo	SBS
Boxing	1,000	0,535	0,485	0,571	0,551	0,686
Karate	0,535	1,000	0,740	0,471	0,603	0,590
Taekwondo	0,485	0,740	1,000	0,481	0,596	0,610
Wrestling	0,571	0,471	0,481	1,000	0,642	0,528
Judo	0,551	0,603	0,596	0,642	1,000	0,600

Table 6. The correlations of general attitude toward boxing, karate, taekwondo, wrestling and judo scales and total result in the SBS scale; female sample with 794 cases

## Conclusion

The external validity of the SBS scale was examined on two samples by two methods. In both samples, the values obtained by the two methods show that the SBS scale is a valid instrument to measure general attitude toward combat sports.

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# Evaluation of cascade influence of morphology and power abilities on performance of the chosen exercise which didactically precedes jump-shot technique in team handball

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## ABSTRACT

**PURPOSE:** The objective of this research was to evaluate influence of morphology and power abilities on performance of exercise didactically preceding jump-shot technique in team handball **METHODS:** Multiple regression analysis was used in order to determine partial influence of explosive throwing power on final grades, and influence of explosive jumping power on final grades – with original results, and with partialized results. Variances of explosive throwing and jumping power were partialized by exclusion of variance related to morphology. **RESULTS:** Influence of explosive jumping power on final grades after partialization of results, ceased to be within set statistical significance (set at  $p < 0,05$ , measured -  $p < 0,09$ ). Furthermore, common variance decreased from 28% to 20%. On the other hand, influence of explosive throwing power on final grades remained the same, statistically significant, with increased shared common variance (from 30% to 40%). **CONCLUSIONS:** Based on results of this research we strongly recommend proposed criteria of evaluation and method of partialization to be introduced in future research of relations between morphology, abilities and knowledge, in handball and other kinesiological activities.

**Keywords:** handball, jump-shot, partialization, pupils, skill acquisition

## Introduction

Knowledge, abilities, morphology, etc., are organized through function, form and contents, and by understanding allometry (McMahon, 1984) and method of partialization (Milas, 2009) power of insight in practical research and applications may be improved (Gruić, 2015). From the kinesiological point of view, motor learning should be permanent changing of the ability and occurs as an outcome of everyday practice or experience (Miletić, 2012). The objective of this research was to evaluate influence of morphology and power abilities on the performance of exercise didactically preceding jump-shot technique in team handball – by the analysis and comparison of both original results, and partialized results without variance related to morphological characteristics of subjects.

## Methods

Participants and procedure. This study was conducted on a sample of 32 pupils of the first grade attending the Industrial Trade High School in Sisak. The pupils were 173.8 cm tall on average and had the average weight of 73.8 kg and at that time they were on average 15.5 years old. All the participants in this research attended regular classes of physical education (PE) and they were completely healthy at testing time. The School Board confirmed that this research complied with ethical principles guiding scientific research with human subjects. The study was conducted during January and February of 2018. The sample of variables in this research included 6 anthropometric measures (body height, body weight, BMI, body fat, body muscle and arm span) and 6 tests for motor skill assessment, directed to power abilities: one-step vertical jump (Sargent 1), two-step vertical jump (Sargent 2), standing long jump – SDM, lying medicine ball throw – BML, medicine throw from the chest – BMS, and ball throw from sitting position – BLS). The percentage of body fat (body fat %), body muscle (body muscle %), weight and BMI were measured with OMRON BF 511 (Omron Healthcare Co., Ltd. Japan). Body height and arm span were measured using anthropometer (cm). During the first stage of this study, in January, experimental study included the initial testing of all the pupils in anthropometric measures and power abilities. After that, in stage two, in February, the video capturing of handball jump-shot technique performances were done. Video capturing was recorded on camera Canon Mini DV MD 255, Japan. Before the video capturing, pupils got an information about the motor task with the standard procedure, which included a description of motor task and a demonstration by the PE teachers and after that methodological guidance focusing on the most common mistakes. Evaluation of motor task performance was done by the two experts with minimal twelve years of experience in school practice. Pupils were awarded grades based on the following criteria in Table 1.

*Statistical analyses.* Data analysis was performed using the statistical package Statistica 13. The basic descriptive parameters were calculated. Normality of the distribution was tested by the Kolmogorov-Smirnov test. Correlation within the variables was established. Multiple regression analysis was used to determine partial influence of explosive throwing power on final grades, and influence of explosive jumping power on final grades – with original results, and with partialized results. Variances of explosive throwing and jumping power were partialized by exclusion of variance related to morphology. Statistical significance was set at  $p < 0.05$ .

Point	Element	CODE	Jump Shot from back position
0	Ball control	K	No ball control (for dropping the ball during performance the subject cannot get points on any other basis)
0/1	Position/posture	S	The throw performed during flight phase (opposite shoulder and hip are at least are little in front of the shutting arm)
0/1	All Phases	F	All phases performed (start-up, take-off, flight, shot, controlled landing)
0/1	Gross coordination	GK	Correct performance – gross coordination (if the element is performed by the game rules) (efficiency, rhythmical cohesion, vertically directed jump, movement amplitude)
0/1	Fine coordination	FK	Correct performance – fine coordination (trunk rotation over 45 °, circular arm swing, successive activation: hip – shoulder – elbow – wrist; ball thrown with elbow above shoulder height - without pushing the ball)
0/1	Performance strength/speed	S/B	Performance strength/speed (using all of one’s capacities ore performing slower/ weaker than 70% of assessed maximum)
0/1	Situational efficiency/utilization	SIT	Situational efficiency (is the performance applicable in the real game/situation with peers)

Table 1. The evaluation criteria of the level of knowledge required for performance of pre-exercise for handball element jump-shot (adjusted from Gruić, 2011)

\*the performance starts from the basic stance (without the assessment of the ball control during catching while moving, i.e. whitout start-up and without the ball by which the subject would already have the start speed higher than 0 km/h)

## Results

The results of the basic descriptive analysis are presented in Table 2.

	Mean	Minimum	Maximum	Std.Dev.	Skewness	Kurtosis
Age (y,m)	15,55	14,11	16,4	0,44	-0,59	2,46
Body height (cm)	173,81	152,00	186,00	7,87	-0,52	0,51
Body weight (kg)	73,81	47,80	123,10	18,26	1,08	0,65
BMI (kg/m <sup>2</sup> )	24,34	18,00	39,30	5,47	1,46	1,82
Body fat (%)	19,38	5,40	38,30	9,05	0,87	-0,19
Muscle (%)	39,18	30,20	45,90	4,20	-0,91	-0,08
Arm span (cm)	178,15	161,00	196,00	8,31	-0,01	0,05
BMS (m)	5,86	0,00	7,88	1,43	-2,08	7,52
BML (m)	9,72	0,00	12,98	2,44	-1,96	6,58
BLS (m)	13,46	0,00	22,07	4,37	-0,43	1,56
SAR 1 (cm)	34,94	7,00	65,00	11,50	-0,03	0,75
SAR 2 (cm)	36,79	9,00	64,00	10,39	-0,19	1,20
SDM (cm)	195,91	100,00	250,00	37,39	-1,18	1,19
Grades (points)	2,60	0,00	6,00	1,80	0,01	-1,16

Table 2. Descriptive statistics (valid N=32; K-S normality test: all variables within normal distributions)

	Age	Body height	Body weight	Arm span	BMI	Body fat	Muscle	SAR 1	SAR 2	SDM	BMS	BML	BLS	Grades
Age	1	0,18	0,04	0,14	0,00	-0,04	0,06	-0,20	-0,29	-0,11	-0,04	-0,10	0,09	-0,02
Body height		1	0,45*	0,77*	0,10	0,04	-0,06	-0,28	-0,26	0,03	0,14	0,34	0,38*	0,00
Body weight			1	0,26	0,93*	0,82*	-0,84*	-0,42*	-0,43*	-0,63*	0,23	-0,13	0,03	-0,18
Arm span				1	-0,03	-0,01	0,00	-0,15	-0,13	0,17	0,13	0,41*	0,24	-0,07
BMI					1	0,90*	-0,91*	-0,37*	-0,39*	-0,72*	0,20	-0,30	-0,12	-0,21
Body fat						1	-1,00*	-0,46*	-0,47*	-0,76*	0,00	-0,44*	-0,39*	-0,26
Muscle							1	0,47*	0,48*	0,77*	-0,02	0,43*	0,37*	0,27
SAR 1								1	0,95*	0,66*	0,50*	0,56*	0,49*	0,50*
SAR 2									1	0,74*	0,51*	0,61*	0,51*	0,51*
SDM										1	0,36*	0,68*	0,49*	0,45*
BMS											1	0,55*	0,58*	0,31
BML												1	0,63*	0,31
BLS													1	0,51*
Grades														1

Table 3. Correlations matrix (marked\* correlations are significant at  $p < .05$ ; N=32)

Influence of explosive jumping power and throwing power on the final grades can be seen from the correlation matrix (Table 3). The greatest influence on the grades had the variables referring to explosive jumping power (SAR 1, SAR 2 and SDM) and one throwing variable, that ball thrown from sitting position (BLS). The same result of the influence was found in previous research by Vrbik, Kasović, Krespi and Badrić (2017), who were considered anthropometric variables, body height and body weight, explaining 7% of the variance of the grade and after considering two motor variables (standing long jump and Sargent test), 26% of the variance was explained by the complete model which was similar to our research (Table 4).

	WITH ORIGINAL RESULTS		WITH PARTIALIZED RESULTS	
<b>THROWING</b>	R= 0,55; R <sup>2</sup> = 0,30; Adjusted R <sup>2</sup> = 0,23		R= 0,63; R <sup>2</sup> = 0,40 Adjusted R <sup>2</sup> = 0,33	
	F(3,28)=4,36 p<0,01*; Std.Err. of estimate: 1,57		F(3,28)=6,31 p<0,00*; Std.Err. of estimate: 1,48	
	t	p	t	p
<b>BMS</b>	0,16	0,88	-0,01	0,99
<b>BML</b>	-0,33	0,75	-0,12	0,90
<b>BLS</b>	2,37	0,05*	3,61	0,00*
<b>JUMPING</b>	R= 0,53 R <sup>2</sup> = 0,28 Adjusted R <sup>2</sup> = ,20		R= 0,45 R <sup>2</sup> = 0,20 Adjusted R <sup>2</sup> = 0,12	
	F(3,28)=3,62 p<0,03* Std.Error of estimate: 1,60		F(3,28)=2,37 p<0,09 Std.Err. of estimate: 1,69	
	t	p	t	p
<b>SAR 1</b>	0,45	0,66	1,57	0,13
<b>SAR 2</b>	0,28	0,78	-0,71	0,48
<b>SDM</b>	0,70	0,49	-0,70	0,49

Table 4. Multiple regression analyses of partial influence of explosive throwing power on the final grades, and influence of explosive jumping power on the final grades – with original results, and with partialized results (excluded contribution of morphological characteristics of subjects)

\*BML - lying medicine ball throw, BMS- medicine throw from the chest, BLS- ball throw from sitting position, SAR 1- one step vertical jump, SAR 2- two step vertical jump, SDM-standing long jump

In Table 4 results of multiple regression analysis of partial influence of explosive throwing power on the final grades showed statistically significant influence with both the original and partialized results. Coefficient of determination and the proportion of common variance was 0.23 with original results and 0.33 with partialized results; therefore variables of explosive throwing power with original results explained 23% of the total variance of the dependent variable and 33% with that partialized results. The most substantial effect on interpretation of the dependent variable was connected with the ball throw from sitting position on both results. Influence of explosive jumping power on the final grades with

original results showed statistically significant influence and they explained 20% of the total variance of the dependent variable, while partialized results explained only 12% of the total variance with no statistically significant influence.

## Discussion

In previous research when Vrbik et al. (2017) evaluated effectiveness of two different teaching methods on the example of basketball two-step jump up, data of regression analysis showed statistically significant influence of anthropological variables on the dependent variable (basketball two-step jump up) in the initial testing. Sargent test (Beta=0.603,  $p=0.012$ ) and body height (Beta=0.361,  $p=0.035$ ) have the most influence on interpretation of the dependent variable in the initial testing and it explained 26% of total variance of the dependent variable.

In this research, correlations (Table 3) between all variables showed a fine structure of relations between morphology, motor abilities and specific knowledge, amongst which the relations between explosive jumping and throwing power with grades were interesting and significant (for SAR1, SAR2, SDM and BLS).

Previous relations were confirmed by regression analysis (Table 4), which revealed statistically significant general influence of explosive jumping ( $p<.03$ ) and throwing ( $p<.01$ ) power on the final grades, covering 30% of common variance (throwing), and 28% of common variance (jumping). Only variable 'ball throw from sitting position' (BLS) had statistically significant partial contribution ( $t=2.37$ ;  $p=0.05$ ) on this general influence. However, when results in the variables describing motor abilities were partialized for morphological characteristics, and then included in the same statistical procedure, regression analyses revealed slightly different outcomes. Influence of explosive jumping power on the final grades ceased to be within the set statistical significance (set at  $p<0.05$ , measured -  $p<0.09$ ). Furthermore, common variance decreased from 28% to 20%. On the other hand, influence of explosive throwing power on the final grades remained the same, with the increased common variance (from 30% to 40%).

Limitations of this and all studies assessing relations among abilities and knowledge/skills often emerge from 'allometry' (McMahon, 1984) and 'multicollinearity' (independent variables of regression model are always, to a certain extent, functionally related to each other). However, variables covering jumping and throwing abilities were chosen within criteria of sufficiently different complex (jumping/throwing) techniques - which would guarantee avoidance of false conclusions and generalizations based on one dominant kinetic chain (instead of all functionally intertwined kinetic chains) which would not cover other kinetic chains used for jump-shot technique. Finally, 'partialization' as a statistical tool was not used only to more precisely and better relate morphology, abilities and knowledge, but to unveil important part of possible erroneous sources for future generalizations.

## Conclusion

Relations between morphology, motor abilities and complex knowledge and skills are intertwined. The evaluation criteria of the level of knowledge required for performance of pre-exercise for handball element jump-shooting (adjusted from Gruić, 2011), was found to be a stable and useful expert framework. Standard measurement protocols have shown consistent output for repeated measurement of all subjects.

However, before generalization of results and conclusions, especially within small and relatively heterogeneous sample of participants, it is important to inspect all possible sources of false argumentation. In this research, motor abilities influenced knowledge (within examination criteria), but not to extent to explain the whole skill of performing jump shot in team handball. Statistical tool and method of partialization of the results - by excluding influence/contribution of specific characteristic which tend to increase heterogeneity (age, sex, longitudinal dimensionality, bilateral asymmetries, time-spatial

parameters, etc.) - may standardize and improve the power of the protocol and method, and final arguments (Gruić, 2015, Gruić et al, 2015).

Based on results of this research we strongly recommend proposed criteria of evaluation and method of partialization to be introduced in future research of relations between morphology, abilities and knowledge, in handball and other kinesiological activities.

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# The connection between the number of medals won at the world and European football championships of European countries and the number of inhabitants, country size and GDP

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## **ABSTRACT**

**PURPOSE:** The purpose of this paper was to establish the correlation between GDP / \$, total population in millions, country size in km<sup>2</sup> and the total number of medals won by seventeen European countries at the world and European football championships. **METHODS:** The analysis included seventeen European countries which won medals at the world and European football championships. Predictor variables in this paper comprised: GDP per capita (\$), country size (km<sup>2</sup>), and total population (million). Data on the predictor variables were collected from the World Bank website and date from 2015. The criterion variable represents the total number of medals won by the European countries at the world and European football championships. **RESULTS:** The value of Spearman correlation coefficient between the total number of European medals won at the world and European soccer championships and the total number of people in a country is 0.523. This coefficient points to the statistically significant correlation between the total number of medals a European country won at the world and European football championships and the total number of inhabitants of the country. This means that the greater number of people in the country means the greater number of medals won at the world and European soccer championships. **CONCLUSIONS:** The results of the research showed that more populated countries, unlike those less populated, were likely to win more medals at the world and European football championships, while the country's size and GDP per capita did not effect sports results. Statistically significant correlation has been established between the total population (million) of a country and the total number of medals won at the world and European football championships.

**Key words:** European countries, football championships, medals, number of inhabitants, country size, GDP

## **Introduction**

World and European football championships are becoming more popular. Today, many countries with different GDP, country size and population size participate in the world and European football championships and achieve various sports results. In this paper sports results are defined by the number of medals won in these competitions. The World Cup was

held for the first time in 1930 in Uruguay (5, 6). Since then the competition has been held every four years. So far, 20 world championships have been played. They are monitored by FIFA. The UEFA European Football Championship is held every four years also. It was first held in France in 1960 as the European Nations Cup and since 1968 it has been known as the European Football Championship (6). The objective of this research is to establish the correlation between the total number of medals won at the world and European soccer championships by the European countries with total population (in millions), country size (in km<sup>2</sup>) and GDP per capita (in \$). The medals were won in the period from 1930 to 2016. So far, correlation has not been researched between the total number of medals won and the weighted number of medals won in the world and European soccer championships with total population (in million), GDP per capita (in \$) and country size (in km<sup>2</sup>). Therefore, this paper will attempt to establish the correlation between the above-mentioned. As an example, there was a research that analysed sports success of thirty European countries defined by the number of medals the at summer and winter Olympic Games as opposed to GDP per capita, the total number of inhabitants and of country size (1). However, it did not distinguish between the countries with a greater number of inhabitants, the size of the country and GDP values by the number of won medals at the summer and winter Olympic Games.

The main aim of this paper is to establish the correlation between GDP / \$, total population in millions, country size in km<sup>2</sup> and the total number of medals won by seventeen European countries at the world and European football championships. Based on the defined aim, the following hypotheses were set:

H1: There is a statistically significant correlation between the total number of medals won by the European countries at the world and European football championships and the total number of residents (million).

H2: There is a statistically significant correlation between the total number of medals won by the European countries at the world and European football championships and country size (km<sup>2</sup>).

H3: There is a statistically significant correlation between the total number of European medals won at the world and European football championships and GDP (\$).

## **Methods of research**

### **Entity sample**

The analysis included seventeen European countries which won medals at the world and European football championships and which vary in per capita GDP (\$), country size (km<sup>2</sup>) and total population (million). However, the analysis did not include the European countries which won medals at the world and European soccer championships and then dissolved and ceased to exist, like Czechoslovakia, Yugoslavia and the USSR.

## Sample variables

	COUNTRY	GDP/\$	SIZE/AREA (km <sup>2</sup> )	TOTAL POPULATION (mil.)	TOTAL NUMBER OF MEDALS WON
1.	GERMANY	41,313.3	357,380	81,413.15	18
2.	ITALY	29,957.8	301,340	60,802.08	10
3.	FRANCE	36,205.6	549,087	66,808.38	7
4.	THE NETHERLANDS	44,299.8	41,540	16,936.52	6
5.	SPAIN	25,831.6	505,940	46,418.27	5
6.	HUNGARY	12,363.5	93,030	9,844.69	3
7.	PORTUGAL	19,222.2	92,225	10,348.65	3
8.	SWEDEN	50,579.7	447,420	9,798.87	3
9.	POLAND	12,554.5	312,680	37,999.49	2
10.	BELGIUM	40,324	30,530	11,285.72	2
11.	ENGLAND	43,876	243,610	65,138.23	2
12.	TURKEY	9,125.7	785,350	78,665.83	1
13.	CROATIA	11,535.8	56,590	4,224.40	1
14.	THE CZECH REP.	17,548.3	78,870	10,551.22	1
15.	GREECE	18,002.2	131,960	10,816.29	1
16.	AUSTRIA	43,775	83,879	8,611.09	1
17.	DENMARK	51,989.3	42,922	5,676.00	1

Table 1. GDP / \$, country size in km<sup>2</sup>, total population in millions, and the total number of medals won by seventeen European countries at the world and European football championships

The data were obtained by sites referenced by numbers 4, 7, 8, 9.

The predictor variables were: GDP per capita (\$), country size (km<sup>2</sup>), and total population (million). Data on the predictor variables were collected from the World Bank website and date from 2015.

The criterion variable was the total number of medals won by the European countries at the world and European football championships and weighted number of medals won by the European countries at the world and European football championships. The medals were won at the world and European soccer championships between 1930 and 2016.

The medals at the world soccer championships were won between 1930 and 2014, and the medals from the European soccer championships were won between 1960 and 2016. Data about the criterion variables were collected from the official FIFA and UEFA sites.

Data processing methods

Data processing was carried out in the SPSS Statistics 23.0 program. Descriptive

parameters, i.e. measures of central tendency – arithmetic mean and standard deviation, were used to describe the variables. The correlation between the two variables was obtained using Spearman correlation coefficient.

## Results

Variables	AS	SD	Number of medals won	Population	Size	GDP
Number of medals won	3.94	4.44	1	0.523*	0.353	0.269
Population	31.490.960	28.533.578		1	0.620**	-0.064
Size (km <sup>2</sup> )	244.374	222.259			1	-0.203
GDP	29.912	14.982				

Table 2 Main descriptive parameters (arithmetic mean – AM and standard deviation – SD), of the predictor and criterion variables and Spearman correlation coefficient of their connection

In Table 2 it can be seen that the arithmetic mean of the number of medals won is 3.94, of population is 31.490,960, of country size 244,374, and of the GDP 29,912, while standard deviations are 4.44, 28,533,578, 222,259 and 14,982, respectively. All standard deviations point to a high dispersion of results, which means that there is a big difference between countries in all four variables.

The value of Spearman correlation coefficient between the total number of European medals won at the world and European soccer championships and the total number of people in a country is 0.523.

## Discussion

This coefficient points to the statistically significant correlation between the total number of medals won by the European countries at the world and European football championships and the total number of inhabitants of the country. This means that the greater number of people in the country, the greater number of medals won at the world and European soccer championships.

For example, Germany is a country that won the most medals at the world and European soccer championships – 18 of them. It won 6 gold, 8 silver and 4 bronze medals. Among the seventeen European countries, it is also the most populated country with 81,413.15 million inhabitants. In addition, the number of inhabitants positively correlates with the size of the country ( $p$  is 0.620) and it negatively correlates with GDP per capita ( $p$  is -0.064). Therefore, we can conclude that the larger the country, the more populated it will be. Consequently, the more populated the country, the greater the number of medals won at the world and European soccer championships.

When determining the correlation between the total number of European medals won at the world and European football championship and size (km<sup>2</sup>), Spearman correlation coefficient was 0.353. This indicates that there is no statistically significant correlation between the total number of European medals won at the world and European football championships and country size (km<sup>2</sup>).

Hence, any small European country stands the same chance to win a medal at the world or European football championships as any European country which is large in size. Therefore, the size or area of a country does not affect chances of medal winning at the world or European football championships. Rich countries invest large amounts of money in sports.

A country's financial power is often seen as one of the key success factors, but so far research have not established such connectivity.

Research show that there is no correlation between GDP and success at the Olympic Games (2). In determining the correlation between the total number of European medals won at the world and European football championships and GDP per capita (\$), Spearman correlation coefficient was 0.269.

This indicates that there is no statistically significant correlation between the total number of medals won by the European countries at the world and European football championships and GDP per capita (\$). Hence, poor countries stand the same chance of winning a medal at the world and European football championships as rich countries.

## Conclusion

Based on the data collected about the seventeen European countries that have won medals at the world and European football championships, it has been observed that they have achieved different sports results, which is defined in this paper by the total number of medals won at the world and European football championships.

The statistically significant correlation has been established between the total population (mil) of a country and the total number of medals won at the world and European football championships. The results of the research have shown that more populated countries, unlike those less populated, are likely to win more medals at the world and European football championships, while a country's size and GDP per capita do not effect sports results.

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# Fitness manager's lifelong learning model

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## **ABSTRACT**

**PURPOSE:** The aim of this pilot study was to examine the structure of the most important professional competencies of a fitness centre manager in order to create the platform for effective lifelong learning in this area, which could promote the development of fitness. **METHODS:** In the online questionnaire, we interviewed 53 experts working in fitness centres and used the Hotelling's factor analysis method of principal components with varimax rotation for data processing. **RESULTS:** We found out the eight-factor model structure of competencies. The model of general competencies consists of 4 factors, i.e., factor of applicability and creativity, factor of general management knowledge, factor of human resource management and factor of information technology and foreign languages (specific skills competency factor). The model of specific competencies is composed of 4 factors: factor of financial resources management, factor of customer management, factor of knowledge of technological processes in fitness and factor of administrative management. **CONCLUSION:** The findings of this pilot study may be used for the development of training programs for personnel in the field of sport management in fitness industry.

**Key words:** management competencies structure, factor analysis.

## **Introduction**

Competency studies in the last decade have examined importance of interpersonal, marketing, financial, human resource and management skills (Pfeffer, Hatano & Santalainen, 1995; Kim, 1997; Toh, 1997; Peng, 2000; Case & Branch, 2003; Horch & Schütte, 2003; Kyungro & Young, 2003; Koustelios, 2003; Barcelona & Ross, 2004; Chen, 2004; Tripolitsioti, et. al., 2007; Retar, 2014). According to Ko (2009) competencies can be primarily used as a basis for designing curriculum to educate students – prospective fitness managers with the necessary skills and knowledge in the sport's field. Secondly, the identification of job-specific competencies can be utilised as a basis for in-service training. Today successful fitness managers having appropriate competencies are needed in fitness more than ever. With their quality sports services those managers can meet the expectations and requirements of consumers, of the staff within sport's organizations and they can satisfy the interests of the owners. Work in fitness organizations should be carefully planned and well organized. It should be lead and supervised by experts of professional sports management who possess competencies in the field of sports, in management and who have technical and social skills. Fitness industry is increasing worldwide. A comparison with Europe and neighbouring countries (Table 1) shows that the Slovenian fitness market is despite the increasing trend, relatively modest and underdeveloped in terms of the number of establishments and members.

State	Annual income (USD \$)	Fitness organizations	Members	Annual income per member (USD \$)
Europe	35.009.912.448 \$	51.299	47.668.950	734,4
Slovenia	43.858.878 \$	84	51.450	852,4
Croatia	143.933.160 \$	656	189.000	761,5
Austria	611.037.000 \$	903	735.000	813,3
Italy	2.819.835.532 \$	6.695	4.326.000	651,8

Table 1. Proceeds of the global fitness industry in 2015 (The 2015 European Health Club Report; The 2015 IHRSA International Report; The Leisure Database; DSSV; Estimates by industry experts, p. 24)

Work in sport is considered to be a regulated profession in Slovenia. General education regarding fitness takes place at the faculties of sport, whereas certified national sports federations and sports organizations carry out special professional training leading towards a working license for fitness coaching (Law on Sport, 1998). However, there is no programme or curriculum, and neither any training aimed at qualifying a candidate for the profession of fitness manager. Thus, the aim of the article is to determine the key competencies, which could help putting in place an adequate study program. For this research we used the following definition of competency in sport: ability to use knowledge, skills, personal traits, experience and motivation in order to perform the expected work or role in one's own way (Retar, Plevnik & Kolar, 2013, p. 83).

## Methods

The study included 53 Slovenian participants (49.1 % women) who were professionally active in the fitness centres; 81.1 % of the participants were aged from 21 to 40 years, 17 % between 41 and 60 years and 1.9 % were 61 years or more. The educational structure of participants was diverse: 52.8% with university / higher education, 20.8 % high school, 9.4 % Master's degree, 9.4 % higher / professional education, 3.8 % higher school, 1.9 % Ph.D. and 1.9 % with completed primary education. Further, 49.1 % of participants in the study were qualified as instructors, 26.4 % as coaches and 22.6 % as trainers. 67.9 % of participants in the fitness organizations performed the job of a coach, and only 35.8 % a managing occupation. Up to 28.3 % of the survey participants were owners of fitness organizations. In addition to that, 26.4 % of participants also performed jobs (trainer, instructor and receptionist). It was found that 43.4 % of the participants were self-employed, 17.0 % were regular permanent employees, 13.2 % were regularly employed for a fixed period, 11.3 % performed work through copyright or by a contract for services, and 11.4 % of the participants were involved in different ways (volunteering, ownership, internship). The average working period of the participants was 9.7 years and the average period to provide certain features in the fitness of the participants was 7.3 years. Up to 38.5 % of fitness centres are registered as an independent company, 36.5 % as a private company (organization registered under the Companies Law), 19.2 % as sports association (an organization registered under the Associations Act) and 5.8% as a private institution (organization registered under the Law on Institutions). In July 2015 the online questionnaire on the website (<https://www.1ka.si/admin/survey/index.php?anketa>) was sent to the e-mail addresses of 80 selected sports organizations from the database of the Fitness Association of Slovenia. There were 53 fully completed questionnaires. The online questionnaire, containing the scales of general and specific competencies of fitness managers and the questions regarding demographic data of participants and the information on fitness organizations. The first scale consisted of 12 general, and the other of

28 specific competencies, which were formed based on research Retar (2014), Kyungro & Young (2003) and Koustelios (2003). The task of the participants was to evaluate the importance of each competence on a scale from 1 (least important) to 6 (most important). Reliability of scales used in this study was high: Cronbach's alpha coefficient of internal reliability for the scale of generalized competency totalled 0.86 to 0.95 (Andrew Pedersen & McEvoy, 2011, p. 202). Data was analysed with the statistical program SPSS 20.0. In the first phase, we checked the suitability of the sample to the Kaiser-Meyer-Olkin test and Bartlett test sphericity. In the second phase we investigated factorial structure of competency fitness managers through a series of exploratory factor analysis, Hotelling's method of principal components separately for the area of general competencies (12 competencies) and the area of specific competences (28 competencies).

## Results

The Kaiser-Meyer-Olkin (KMO) test and the Bartlett's test of sphericity, checking the suitability of the sample (Cencič, 2007, p. 45), showed that the data were suitable for the application of factor analysis. KMO value for the group of general competencies was 0.747, for the group of specific competencies it was 0.754, which, according to Hutcheson and Sofoniou (1999) represents good values to implement factor analysis and to make conclusions on the reliability of calculated factors. The Bartlett's test of sphericity was in both groups of competencies statistically significant ( $p = 0.000$ ), on the basis of which we concluded that the variables are interconnected to a sufficient extent, and that the use of factor analysis was suitable. In the second stage of data processing we tried to determine the factor structure of competencies of fitness managers through a series of exploratory factor analyses along with the Hotelling's method of principal components, separately, the field of general competencies (12 competencies) and for the area of specific competencies (28 competencies). According to the Kaiser-Guttman criterion of eigenvalues greater than 1, the results of the factor analysis of general competence, showed, according to the Kaiser-Guttman criterion of their own values greater than 1, the presence of three factors that together explained 62.10 % of the total variability. Factor loadings of the factor saturation of all 12 items were higher than 0.40 (from 0.42 to 0.76). This criterion is accurate when there are less than 30 variables, and when at the same time the communalities after extraction exceeded the value of 0.70 respectively and when the number is more than 250, and when at the same time the average value of the communality exceeds 0.60 (Field, 2005). Our data did not fulfil this condition, therefore following the recommendations of Field (2005), we also analysed the scree plot, which revealed the four-factor structure. In the continuation we, carried out the factor analysis with -expected four factors that together explained 70.18% of the total variability. In order to achieve cleaner and more transparent structures we used orthogonal varimax rotation. Within the four factor solution with varimax rotation the factor loading of individual items were higher than 0.40 (range from 0.40 to 0.88). The first factor, which we called the applicability and creativity, explained 22.36 % of total variability. The second factor was called the knowledge of general management and explained 18.08 % of the variability, the third factor - management of human resources, explained 17.57 %, and the fourth factor - the management of information technology and foreign languages explained 12.18% of the total variability. The results of analyses of specific competences of fitness managers are presented in Table 4. According to the Kaiser-Guttman criterion of eigenvalues greater than 1, factor analysis of specific competencies showed the presence of 6 factors, which together explain 73.77 % of the total variability. The values of factor loadings of all 22 specific competencies were higher than 0.40 (ranging from 0.40 to 0.87). Since the communalities after extraction did not exceed the value of 0.70, we also analysed, the scree plot, as Field (2005) suggests, which pointed at the four-factor structure. In the continuation we, carried out the factor analysis with expected four factors that together

explained 66.10 % of the total variability. In order to achieve cleaner and transparent structure we used orthogonal varimax rotation. Within the four factor solution with varimax rotation the factor saturation of individual items were again higher than 0.40 (ranging 0.41 to 0.82). The results of the factor analysis of specific competence, showed that the first factor, named the management of financial resources, explained 20.73% of the variability. The second factor - customer relationship management explained 19.06%, the third factor - knowledge of technological processes in fitness, explained 16.58%, whereas the fourth factor - the administrative management explained 9.73% of the total variability. Based on the results of factor analysis we designed the structure model competencies of Slovenian fitness managers, as presented in table 2. The structure of a competency model consisted of eight factors; the model of general competencies formed four factors and the model of specific competencies also formed four factors. The model of general competencies consists of applicability and creativity factor, the factor of basic knowledge of management, human resource management factor and factor of information technology and foreign languages management. Model of specific competencies consist of the factors of management of financial resources, factor of dealing with customers, factor of knowledge of technological processes at the fitness centre and administrative management factor.

<b>GENERAL COMPETENCIES</b>			
<b>Creativity Factor</b>			
Ability of applying knowledge in practice	Understanding ethical and professional obligations of sports manager	Ability to work with people	Managing creativity and innovation
<b>Factor of Business – organisational knowledge and skills</b>			
Basic knowledge of management		Understand ethical and professional obligations of sports manager	
<b>Human resource management factor</b>			
Ability to work in an interdisciplinary team	Basic knowledge of fitness profession	Oral and written communication in the mother tongue	
<b>Knowledge of computer technology and foreign languages factor</b>			
Knowledge of computer technology		Knowledge of foreign language	
<b>SPECIFIC COMPETENCIES</b>			
<b>Factor of Financial-marketing knowledge</b>			
Improving occupancy and controlling fluctuations in demand	Preparation of proposals for financial, staff and program projections for the owners of the centre based on analyses	Organization of work and delegation of tasks	The management of financial resources and expertise to solve financial problems
<b>Customer care factor</b>			
Customer care with maintaining existing users	The understanding and realization of the expectations and wishes of the costumers	Conducting safety control of equipment and accessories	Managing maintenance, security, repair and cleaning of equipment and premises
<b>Knowledge of technological processes in fitness</b>			
Promoting doing business on the basis of good business relations	Application of sophisticated management ICT technology	Implementation in sports or coaching	Mastering project management
<b>Factor of administration knowledge</b>			
Understanding and realization of business objectives	Willingness to change to improve the performance	Analysing the work process and the post as well as the creation of work and tasks	

Table 2. The model of factor structure of Slovenian fitness centres managers' competencies

## Discussion

This study has certain limitations. Analyses were performed on small and not representative sample of the fitness centre managers-participants who were willing to complete the questionnaire. Nevertheless, we believe that the identified model of broader factors of competencies is relatively valid, since the results of KMO and Bartlett's sphericity tests show adequacy of the sample and the participants' responses, while the comparison of our model with other models for fitness managers shows considerable congruence. In the future studies the presented Model of fitness managers' key competencies could be used as the basis for checking the situation of fitness manager's competency and offer them shorter forms of training and enable them to fill the gaps in their own knowledge and competency. Education based on the competencies' model could contribute to the strengthening of Slovenian fitness industry. Additional limitation of this study is that it is based on subjective evaluations of the importance of individual competencies of fitness managers, which means that we do not know whether the reported importance of competencies corresponds to the actual guidelines in the work of fitness managers. This restriction could be overcome by the method of observation. Furthermore, because the present model of competencies is based solely on the perceived importance of fitness managers, it is possible that they focus on selling their services through rapid satisfying of customers' needs and demands. It is reasonable to assume that customers mostly tend toward achieving quick desired results, as for example, weight loss, increased muscle mass, which on the other hand may have negative health effects. In the future, it would seem useful to include further relevant experts in the studies on competencies of fitness managers, for example from the fields such as medicine, nutritional sciences, etc., and check their perceptions of the importance of different fitness managers' competencies. From the model, based on such interdisciplinary assessments of importance of different competencies, we could produce relevant lifelong learning programmes, in which the (prospective) fitness centre managers would acquire a wide range of knowledge and skills that would include improvement or preservation of health and healthy lifestyle, and would thus become competent players in the fitness industry market.

## Conclusion

Nowadays, managers in fitness industry are facing new challenges, such as sustainable development, extraordinary competition, demanding customers, empowered and competent human resources and technological discoveries, which require them to acquire new skills through lifelong learning. In our pilot study, we found out that the role of fitness managers is no longer only to organize and supervise, but also to understand the expectations of the costumers and efficiently manage human resources, as well as managers' motivation for lifelong learning. Modern managers are reorienting towards identifying and developing the most important competencies for successful management in sport, thus, they strengthen the competitiveness of the organizations they lead. Therefore, the aim of the study was to find out what these most important competences in the field of sports management were. If we can define these competences precisely and follow them when selecting their holders, i.e., managers, and take them as priority within the operation process the implementation of activities addressed, then we can expect that success be guaranteed. On the basis of the identified factors of the model structure of competencies it is possible to develop curricula of study and other lifelong learning programs that will be consistent with user expectations in terms of knowledge as well as with the labour market in the field of fitness.

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## Starting school as a critical period for the establishment of postural disorders

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### **ABSTRACT**

**PURPOSE:** This study was aimed at determining whether there were postural disorders of the tested sample and whether they were more prevalent in children who were just starting a school or children who had attended school for a year. **METHODS:** 193 elementary school students of both sexes participated in the study. The total sample was divided into two groups according to age. The first group consisted of 101 respondents of the first grade, age  $7.58 \pm 0.29$  years, while the second group consisted of 92 respondents of the second grade, age  $8.49 \pm 0.35$  years. Respondents were tested for postural status, by the clinical method, which involved assessing body posture by observing all segments of the body frontally and sagittally. To determine the differences between groups of examinees, Chi-Square Test for categorical variables was used. For numerical and percentage distribution of postural disorders in respondents of different ages, Cross Tabulation analysis was used. **RESULTS:**

Respondents grouped by age vary on a statistically significant level in varieties of kyphosis ( $p=0,012$ ), kypholordosis ( $p=0,006$ ) and flat feet ( $p=0,034$ ). Male respondents are classified according to age, they differ in kyphosis, and the female respondents differ in winged scapula and flat feet. **CONCLUSION:** Smaller imbalances are present in subjects who are just starting schooling, while more complex postural disorders occurred in children who were exposed to static stress for a longer time. Creating preventive exercises within regular teaching should be the focus for future researchers.

**Key words:** postural disorders, primary school, prevention

**Conflict of interest:** We declare that we have no conflict of interest.

**Statement of Disclosure:** The authors contributed equally.

## Introduction

Poor body posture is known as the condition of the organism, where there is a disorder of the statics of the locomotor apparatus. The body statics disorder is most often the result of the impact of the external force on the postural muscles. With the long-lasting effect of muscle force, muscle adaptation to changed conditions occurs. Often times this causes loss of elasticity, muscle contraction and hypotrophy. The described changes are most dangerous during growth and development of the organism.

The seventh year of life, when a child starts schooling, is a critical period for the occurrence of postural disorders. It is then that the long-term impact of external forces on postural muscles occurs. The child is exposed to long-term sitting in school benches that are often not individually tailored (Batistão, et al., 2016). From an active children's day, which was filled with elemental movements, static strain in the sitting position takes place.

Muscles have difficulty following the accelerated bone growth, especially if the child is not physically active enough or is not involved in some kind of programmed exercise. The results of previous studies at preschool and school age clearly indicate the occurrence of postural disorders already at that time (Protić-Gava, Šćepanović, & Batez, 2013; Šćepanović, Marinković, Madić, & Protić-Gava, 2017; Protić-Gava, Mikalački, Šćepanović, & Radosav, 2013). It is clear that children who are not sufficiently muscularly prepared for static stresses waiting for them to go to school will find it more difficult to balance the body and save themselves from deviations.

Poor musculature is not able to defy the burden of a school bag. Parents fighting with heavy bags sometimes make the mistake of buying a bag that is pulled on wheels. The choice of such a bag carries the risk of asymmetry due to the rotation of the body during towing. Although the bag seems lighter, it is still not a good choice. The best choice is to work with school and teachers in order to make the bag lighter and strengthen the body muscles that are most burdened (Ruivo, Carita, & Pezarat-Correia, 2016). Therefore, preventive measures related to the problem of school bags are necessary for the preservation of health (Dianat, Javadi, & Allahverdipour, 2011).

This study was aimed at determining whether there were postural disorders of the tested sample and whether they were more prevalent in children who were just starting their schooling or in children had attended school for a year.

## Methods

This is a transversal study. The protocol was approved by the University Ethics Committee in accordance with the Helsinki Declaration. The research covered 193 respondents of both sexes, primary school students in Novi Sad, whose parents gave their consent to their children's participation in the research. The total sample was divided into two groups according to age. The first group consists of 101 first-grade respondents of  $7.58\pm 0.29$  years

of age (BH=128.34±6.03cm, BM=24.14±5.26kg). The second group consists of 92 second-grade respondents, of 8.49±0.35 years of age (BH=132.04±6.96cm, BM=29.26±6.66kg).

The respondents' postural status was assessed by clinical method and recorded with a grading scale with three grades. Zero is good body posture, one is minimum deviation and grade two are great deviations from the proper posture of the observed segments of the body (Radisavljević, 2001). Body posture is viewed from the frontal and sagittal level, and the body segments being evaluated are: the position of the head, shoulders and blades, the spine, the chest, the position of the pelvis, the legs and the feet.

To determine the differences between groups of respondents classified according to age and sex, Chi-Square Test at the significance level  $p \leq 0.005$  was used. For numerical and percentage distribution of postural disorders in respondents of different ages, Cross Tabulation analysis was used. The data were analyzed using IBM SPSS Statistics 20.0 (SPSS ID: 729225).

## Results

Many postural disorders were observed on the test sample (Table 1). Respondents grouped by age vary on a statistically significant level in varieties of kyphosis ( $p=0,012$ ), kypholordosis ( $p=0,006$ ) and flat feet ( $p=0,034$ ). Male respondents are classified according to age, they differ in kyphosis ( $p=0,000$ ), and the female respondents differ in winged scapula ( $p=0,034$ ) and flat feet ( $0,011$ ).

Variable	Total		Male		Female	
	x <sup>2</sup>	p	x <sup>2</sup>	p	x <sup>2</sup>	p
Kyphosis	6,316	,012	19,777	,000	,096	,757
Lordosis	,907	,636	1,587	,452	,975	,614
Kypholordosis	7,576	,006	1,674	,196	3,355	,067
Flat back	,009	,925	1,110	,292	1,564	,211
Scapula alate	3,412	,182	3,996	,136	6,777	,034
Thoraco-lumbar scoliosis	,349	,840	,024	,877	1,081	,583
Compensatory scoliosis	2,151	,142	2,473	,116	,655	,418
Genu varum	,441	,507	,133	,715	,655	,418
Genu valgum	,067	,795	,133	,715	,956	,328
Knee hyperextension	2,598	,107	1,674	,196	,208	,648
Flat feet	6,745	,034	2,302	,316	9,026	,011

Table 1 Significance of differences in the postural status of the respondents between the groups of respondents

Table 2 shows the numerical and percentage representation of statistically significant variables. Kyphotically poor posture is present in 9.8% of the first-grade group of respondents and 16.6% in the second-grade group of respondents. Kypholordosis is more common in respondents who are 8 years old (4.7%). Wing blades in a milder degree, they are present in 20.2% of respondents aged 7 years and 18.7% of respondents aged 8 years. However, in the age group of 8 years, wing blades appear in greater degree - in 1.6% of respondents. Flat feet occurs in a milder degree in respondents aged 7 years - 31.6% and in

a greater degree in 3.6% of respondents. In the group of respondents who are 8 years old, lowered foot arch appears in 20.7%, and flat feet in 2.6% of respondents.

Age Group		kyphosis		Kypholordosis		Scapula alate			Flat feet		
		0	1	0	1	0	1	2	0	1	2
7.58±0.29	n	82	19	100	1	62	39	0	33	61	7
	%	42,5	9,8	51,8	0,5	32,1	20,2	0,0	17,1	31,6	3,6
8.49±0.35	n	60	32	83	9	53	36	3	47	40	5
	%	31,1	16,6	43,0	4,7	27,5	18,7	1,6	24,4	20,7	2,6
Total	n	142	51	183	10	115	75	3	80	101	12
	%	73,6	26,4	94,8	5,2	59,6	38,9	1,6	41,5	52,3	6,2

Table 2. Number and percentage distribution of postural disorders in respondents of different ages

## Discussion

The results of this study have indicated the existence of postural disorders on the tested sample. Kyphosis, wing blades and kypholordosis are more present at older ages. This result can be interpreted by the fact of muscle adaptation due to long-term exposure to various environmental influences. Unless prompting postural disorders and minimal imbalances in body segments are noticed on time, and preventive or corrective are taken, they result in the fixation of the disorder. For this reason, in the group of second grade children, we have a score of 2 in the variable Scapula alate.

Male respondents classified according to age, differ in kyphosis, and female respondents in winged scapula. There are specificities in growth and development. These can be interpreted by different muscular, skeletal structures, but also by varying flexibility (Penha, et al., 2008). Previous research indicates numerous changes in the upper part of the body, related to the position of the shoulders, blades, and weakness of the neck muscles (Radzevičienė, & Kazlauskas, 2016). The head position affects the increase in the muscle tension of the thoracic part, and reduces and restricts mobility (Han, Park, Kim, Choi, & Lyu, 2016).

Children aged 7 and 8 are not able to have postural control as adults (Kluenter, et al., 2008). More and more people have a problem with moving their head forwards. Researchers have come to the conclusion that moving the head is not only a structural problem, but can be a result of proprioceptive function and awareness of body posture (Yong, Lee, H. & Lee, M, 2016). Emotions also affect body posture. If children are shy, especially girls because of obvious changes in the body, they pull their shoulders forward and inside. On the other hand, children who are full of confidence, happy, extravert, have too much postural attitude, and they push the chest forward, which leads to an increase in lumbar curvature. When the child is angry, he pulls his head, raises his shoulders and stretches his knees (Rosário, Diógenes, Mattei, & Leite, 2016).

There are potential limitations in this research. The results obtained cannot be generalized to the population of children aged 7 and 8 years. As a second limitation, we were not able to collect more information about the respondents regarding the weight of school bags, physical activity and nutritional status.

## Conclusion

This study is showing that period of starting school is a very sensitive period in the growth and development of the child, so more attention must be paid to it. In this study, minor imbalances were present in subjects who were only starting school, while more complicated

postural disorders were reported in children who were more exposed to static stress. Creating preventive exercises within regular teaching should be the focus for future researchers. Monitoring of postural status in the first years of education must become a practice, because it is the only way to respond in a timely manner and to act in a corrective way.

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# Motor and functional abilities as predictors of playing position in young soccer players

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## **ABSTRACT**

**PURPOSE:** The main goal of this paper is to identify impact of motor and functional abilities on playing positions in young soccer players. **METHODS:** The subject were 20 U-15 players (13.47±0.67 years of age) who have participated in sport's training from 5 to 7 years. Discriminant analysis was used where the independent variables were motor and functional abilities and the criterion was playing position. **RESULTS:** Results show that motor and functional abilities are not significant ( $p>0.05$ ) predictors of the playing positions among young soccer players. **CONSLUSIONS:** Results are pointing to the fact that position-oriented selection cannot be based only upon motor and functional abilities. Further research is needed for the identification of significant predictors of optimal playing position among young soccer players.

**Key words:** differences, discriminant analysis, optimal playing position

## **Introduction**

In modern soccer, every player has specific tasks which are given in accordance with player's playing position within particular game (Roca, Ford, McRobert, & Williams, 2011). Positions are divided in three groups: defense, midfield and attack and goal keepers as a specific group. Defensive player are: sweeper, central defender, full back, or wing backs. The midfield position can be described as defense, central, attacking or side midfielder (winger). Attackers can be wing forward, support striker and center forward. The forth group consists of the goal keepers whose main task is to prevent the opponent to score a goal. Position-related tasks of the players significantly differ (Di Salv et al., 2007) so every position demands special morphological characteristics (Carling & Orhant, 2010; Matkovic et al., 2003; Perroni, Veterano, Camolese; Giudetti & Baldari, 2015; Rebelo et al., 2013) somatotype categories (Peroni et al., 2015) flexibility aspects (Rodriguez, Sanchez, Rodriguez\_Marroyo & Villa, 2015) selected physiological parameters (Bonaiuto et al., 2012;

Gil, Gil, Ruiz, Irazusta, & Irazusta, 2007; McIntyre & Hall, 2005) kinematic and kinetic parameters (Ferro, Villaceros, Floria, & Graupera, 2014; Goncalves, Figueira, Macas, & Sampaio, 2014) as well as nutritional needs (Iglesias – Gutierrez et al., 2012).

The players are usually selected from the youngest age categories for certain playing positions, taking into the account all the parameters, especially their morphological status (Perroni et al., 2015). Nowadays difference between the players by the playing positions, regarding their motor and functional abilities has never been smaller (Bloomfield, Polman & O'Donoghue, 2007). In accordance with previously mentioned facts, main goal of this paper is identification of impact of motor and functional abilities as predictors of playing positions in young soccer players.

## **Methods**

### **Participants**

Sample of the respondents consisted of N=20 (13.47±0.67 years old) U-15 players who underwent several years of selection. All participants had from 5 to 7 years of training experience and besides school obligations they had 5 trainings per week, played soccer matches on the weekends while one day per week has been day off. They had played from 50 to 60 matches per year (championship, cup, tournaments and friendly matches).

### **Measurements**

First group of variables consisted of three variables for the evaluation of power: standing long jump (SLJ), high jump (HJ) and triple jump (3J). The second group of variables consisted of tests for the evaluation of motor skills: 10 meters sprint (S10), 30 meters sprint (S30), 60 meters sprint (S60) and 5×10 meters sprint (S5×10).

### **Experimental procedure**

All of the tests were performed outdoors on a solid ground at the same time of the day (8-10:30 a.m.) during July. Before the testing, the participants completed 10 minutes of standard soccer-specific warm-up. Measurements lasted for 3 consecutive days. Prior to the measurements, all examinees were familiarized with all testing procedures. One practice trial test was allowed for each test – it was performed in a relatively slow tempo. The participants performed three trials of each test with 1-4 minutes rest between the trials. The same examiner assessed all examinees.

### **Statistical analysis**

All data for overall sample, goal keepers, defense players, midfield players and attackers was presented as mean±standard deviation. Reliability of the data was assessed by using coefficient of variation (Hopkins, 2000) and average inter-item correlation. Normality of distributions was assessed by Kolmogorov-Smirnov test with Lilliefors correction. Multivariate discriminant analysis was used and the dependent variable was playing position, while the independent variables were all quantitative variables. Correlation coefficient of all the variables with all 3 discriminant function (factor structure matrix), Wilks's Lambda ( $W\lambda$ ), centroid projections on the discrimination functions are presented. Type I error was set at  $\alpha=5\%$ . All calculations were performed using data analysis software system Statistica 13.2. (Dell Inc, Tulsa, OK, USA).

## **Results and discussion**

Kolmogorov-Smirnov with Lilliefors correction showed that all variables consistently had distribution that did not differ significantly from normal ( $p>0.15$ ). Reliability of the data, assessed through coefficient of variation was satisfactory ranged from 4.11% to 11.13%. Descriptive statistical parameters: mean and standard deviation (SD), for overall sample and separately for goal keepers, defense players, midfield players and attackers are presented (Table 1).

	Overall (N=20)	Goalkeepers (N 1=3)	Defense (N 2=6)	Midfield (N 3=6)	Attack (N 4=5)
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD
SLJ	193.85±11.16	192.33±9.61	200.67±11.06	187.50±13.44	194.20±5.89
HJ	40.65±5.45	42.00±4.58	42.83±4.79	37.83±5.27	40.60±6.84
3J	600.70±33.09	591.33±12.50	620.33±38.29	591.00±26.74	594.40±39.52
S10	1.99±0.08	1.97±0.00	1.96±0.04	2.06±0.09	1.96±0.10
S30	4.84±0.17	4.76±0.06	4.77±0.08	4.95±0.15	4.83±0.26
S60	8.99±0.36	8.89±0.22	8.82±0.19	9.25±0.42	8.92±0.40
S5x10	12.03±0.39	12.05±0.31	11.79±0.31	12.32±0.46	11.95±0.28

Table 1. Descriptive statistic parameters – mean and standard deviation (SD)

Legend: SLJ – standing long jump, HJ - high jump, 3J- triple jump , S10 – sprint 10 meters, S30 – sprint 30 meters, S60 – sprint 60 meters, S5x10 – sprint 5x10 meters

Furthermore, discriminant analysis was applied and results are presented (Table 2).

Root removed	Wλ	CanR	$\chi^2$
0 (p=0.92)	0.85	0.68	12.59
1 (p=0.98)	0.22	0.42	4.28
2 (p=0.90)	0.13	0.34	1.64
<b>Centroid Projections</b>			
Goalkeepers	-0.15	0.75	0.49
Defense	-0.82	-0.44	0.15
Midfield	1.21	-0.18	0.01
Attack	-0.37	0.29	-0.49
<b>Factor structure</b>			
	<b>Root 1</b>	<b>Root 2</b>	<b>Root 3</b>
SLJ	-0.55	-0.38	5.89
HJ	-0.42	0.01	6.84
3J	-0.34	-0.62	39.52
S10	0.73	-0.30	0.10
S30	0.55	-0.23	0.26
S60	0.64	-0.13	0.40
S5x10	0.70	0.21	0.28

Table 2. Discriminant analysis parameters: Wilks's lambda ( $\lambda$ ), canonical correlation (CanR), Chi-square test value ( $\chi^2$ ), significance level (p), centroid projections on the discriminant functions

Legend: Roots removed – discrimination model with 0, 1 or 2 removed discriminant functions from the model.

## Discussion

Due to a relatively low data variability (Table 1), it can be concluded that the sample was priority well selected. From Table 2, it can be seen that none of discriminant functions achieved statistical significance.  $W\lambda$  coefficient, as group's discrimination measure, did not indicate differences between the observed groups. Similar results were obtained by research dealing with young soccer players (Coelho Sliva, et al, 2010). Furthermore, CanR coefficient did not point to the significant relations between the observed groups. Also, centroid projections additionally showed that there was no difference between the observed groups seen through the structure of discriminant functions. As previous research indicated (Gil, et al., 2007), we also can notice that midfield players had biggest centroid value, which slightly separates them from the other groups in the first discriminant function. Similar observations can be concluded regarding goal keepers in the second and third discriminant function.

## Conclusions

Results, contrary to the expected, indicate to the fact that motor and functional abilities cannot be observed as significant predictors of playing positions among high-quality young soccer players. From the aspect of practice, results indicate to the fact that we cannot assign players to the positions in the team by the motor and functional abilities. Observed groups are different by the biomechanical movement complex and other motor and functional variables but not significantly. In the end, results show us additionally that an expert assessment in the soccer practice is of paramount importance for the identification and development of the young and prospective young soccer players. Further research should include larger samples of different age and quality levels with extended samples of motor and functional tests.

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# The trend of postural disorders in early childhood

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## **ABSTRACT**

**PURPOSE:** Children's growth and development do not take place evenly in all parts of the organism. Rather, it follows a rhythmic pattern characterized by the so-called „growth crises“. During these periods, a developing organism is exposed to various loads that may cause postural disorders. Hence, the aim of this research was to determine the trend of frequency of postural disorders in childhood. **METHODS:** A sample of 1730 both-gender children between 3.5 and 10.5 decimal years participated in the study. The total sample is divided into seven approximately equal centile groups. Postural status was established using the clinical method that includes the assessment of 8 indicators. Testing the differences between male and female children in terms of posture was done using the Mann Whitney U test and differences between age-based subsamples was done using the Kruskal Wallis Test. Assessing the existence of significant trends in the changing of postural status was performed using the Jonckheere-Terpstra test. **RESULTS:** The testing of postural status in groups of children formed according to decimal years has revealed that most indicators show statistically significant difference between the analyzed categories. The maximum change effects account for foot status (Cohen's  $d=.380$ ), shoulder blades (Cohen's  $d=.363$ ) and spine (Cohen's  $d=.311$ ), all of which belong to small-to-medium change effects, according to Cohen's criteria. It is especially noticeable that the highest rise of functional disorders on the cost of normal status occurs during 6.51 - 8.50 decimal years. **CONCLUSION:** Results of this research indicate that it is just the school start period during which postural disorders take place, due to which it is necessary to prevent them by timely engagement of children in different physical activities.

**Key words:** posture; preschoolers; school children

## **Introduction**

Postural disorders are recorded already in preschool children and young schoolchildren as the consequence of influence of various factors and are most often acquired. Fortunately, in the largest percentage, these are functional disorders which hit the muscular system and are possible to be corrected (Protić-Gava, Šćepanović, & Batez, 2013; Protić - Gava, 2015). During growth and development, typical "growth crises" occur in three different periods, one of which is the period of starting school (Kosinac, 2006). With respect to the aforementioned, the objective of this research was to determine the postural status disorder trend in early childhood.

## **Methods**

This is a simple comparative, observational study. The participants and their parents were

fully informed about the nature and purpose of the study, after which the parents and children gave written consent and assent respectively. The study protocol was approved by the University Ethics Committee, and the study was performed in accordance with the ethical standards of the Helsinki Declaration.

Research was performed on 1730 preschool and younger school children, at the age of  $6.57 \pm 1.77$  decimal years (dy) from four towns in Vojvodina, Serbia, i.e. 907 boys ( $6.56 \pm 1.79$  dy) and 823 girls ( $6.58 \pm 1.74$  dy). On the basis of decimal years, the total sample is divided into seven approximately equal centile groups that are used for analysis of differences and frequency trend of postural disorders in children at the age of 3.5-10.5 decimal years.

Postural status was established using a clinical method that includes the assessment of 8 indicators: head posture, shoulder posture, shoulder blades posture, level of chest development, deviation of the spinal column in the frontal plane, posture of anterior abdominal wall, leg shape and feet arch (Wolański, 1975; Maciałyk-Paprocka et al., 2017). Magnitude of postural or structural deviations was ranked as 0= no deviations, 1 = some deviation, and 2 = clear/distinct deviation (Wolański, 1975; Wurth, 1981). Measuring was done by trained measurers abiding by the unique and standard assessment protocol.

Testing the differences between male and female children in terms of posture was done using the Mann Whitney U test and differences between age-based subsamples was done using the Kruskal Wallis Test. Assessing the existence of significant trends in the changing of postural status was performed using the Jonckheere-Terpstra test. The statistical significance was established at the assessment level of  $p < 0.01$ . The data were analyzed using IBM SPSS Statistics 20.0 (SPSS ID: 729225).

## Results

The findings indicate that the gender-related differences are not statistically significant, neither in the total sample nor in particular age categories (Table 1).

Postural Indicators	Male Mean Rank N=907	Female Mean Rank N=823	Z	Asymp. Sig. (2-tailed)
Head Posture	830.01	904.61	-3.713	.021
Shoulder Posture	859.03	872.63	-.649	.517
Chest Development	872.97	857.27	-1.247	.213
Shoulder Blades	875.07	854.95	-.959	.338
Spinal Column	858.96	872.71	-.777	.437
Abdominal Wall	830.91	873.62	-3.376	.043
Leg Shape	850.95	881.53	-1.540	.123
Feet Arch	913.70	852.38	-3.807	.016

Table 1 Differences in indicators of postural status between boys and girls (N=1730)

Consequently, further analyses are done irrespective of gender (Table 2). The testing of postural status in groups of children formed according to decimal years has revealed that most indicators show statistically significant difference between the analyzed categories.

Age Categories	N	Mean Rank							
		Head Posture	Shoulder Posture	Chest Development	Shoulder Blades	Spinal Column	Abdominal Wall	Leg Shape	Feet Arch
3.5 - 4.5	248	814.68	873.64	845.43	741.32	764.49	922.15	949.14	868.60
4.51 - 5.5	247	872.91	944.51	867.58	789.11	869.83	848.14	865.15	858.45
5.51 - 6.5	246	857.29	884.25	839.03	842.41	816.77	830.98	857.36	795.34
6.51 - 7.5	246	855.15	827.28	866.88	897.91	862.06	833.93	828.91	812.39
7.51 - 8.5	246	829.37	813.13	842.87	844.30	869.02	790.88	849.89	778.31
8.51 - 9.5	214	888.82	818.69	852.87	966.67	959.21	831.71	839.64	876.96
9.5 - 10.5	280	924.95	878.23	923.77	966.73	913.02	970.84	855.25	1035.87
Kruskal	X <sup>2</sup>	12.215	16.851	20.206	57.140	41.747	30.728	13.630	62.493
Wallis Test	Sig.	.057	.010*	.003*	.000*	.000*	.000*	.034	.000*
Cohen's	d	.168	.197	.216	.363	.311	.267	.178	.380
Jonckheere-	J-T	2.473	-1.979	2.644	7.062	5.373	.748	-2.450	3.879
Terpstra	Sig.	0.13*	.048	.008*	.000*	.000*	.454	.014	.000

Table 2 Differences in postural disorders in children aged 3.5-10.5 (N=1730)

The maximum change effects account for foot status (Cohen's d=.380), shoulder blades (Cohen's d=.363) and spine (Cohen's d=.311), all of which belong to small-to- medium change effects, according to Cohen's criteria. It is especially noticeable that the highest rise of functional disorders on the cost of normal status occurs during 6.51 - 8.50 decimal years.

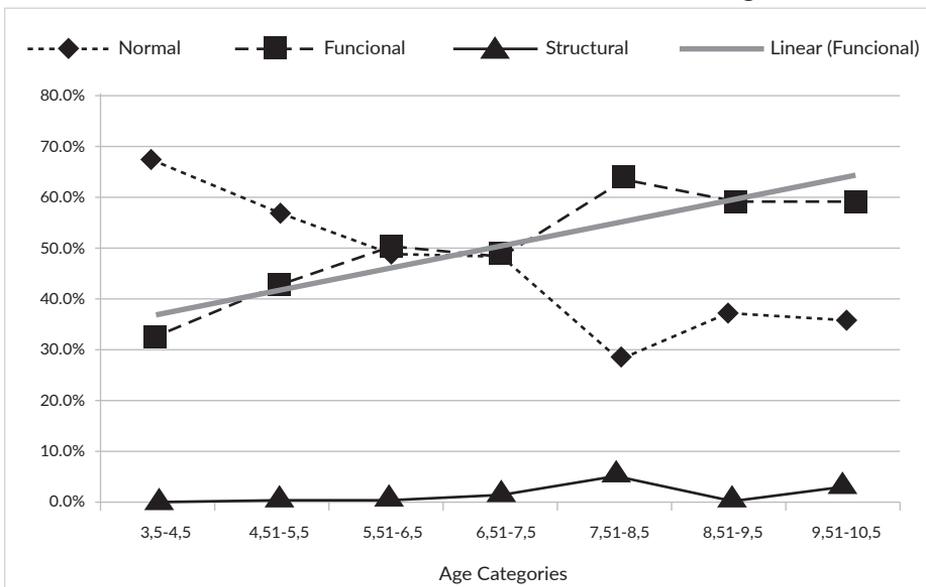


Figure 1. Presentation of the status assessment frequency of shoulder blades and the regression lines regarding the functional status disorder.

Results presented by Jonckheere-Terpstra showed that in terms of the status indicators concerning feet, spine and shoulder blades there is a statistically significant and clearly directed trend of changes, whereas in terms of indicators concerning development of chest and head posture, the trend is also statistically significant but less prominent.

Analysis of the graphic presentation of the status assessment frequency of the given indicators, showed occurrence of the disorder trend (Figure 1). The largest increase in functional disorders is noticeable in the period when children start schooling and during the first grade (marked with a frame in the graph).

## Discussion

Results of the study indicate that as the age category increases, what also increases is the frequency of functional and structural disorders in the postural status of children, which is observed in the presented example of shoulder blades posture. What is especially noticeable is that between the age of 6.51 – 8.50 the largest increase in the frequency of functional disorders occurs at the expense of the normal status of the aforementioned indicators. Concurrently, the increase of structural disorders concerning majority of analysed indicators occurs in the same period. What follows is stagnation but also retention of the increased level of the functional status disorders concerning analysed postural status indicators.

The results of early researches show similar condition of the locomotor apparatus in preschool children (aged 6 and 7), with diagnosed postural disorders of the spine and feet (Obradović, Milošević, 2008; Simov, Minić and Stojanović, 2011). Lowered longitudinal foot arch is recorded in with larger percentage of deviations than the spinal deviations. The authors observe that the fact that a small percentage of postural disorders is localised in the spine is encouraging. Unfortunately, over the previous years, the frequency trend concerning the deviations is showing is rising, as presented by our study. This furthermore indicates additional burdening of children occurring at the beginning of the school period (long and inadequate seated positions, reduced physical activity, heavy school bags, etc.).

The results of our research match the results of the research conducted on the sample of children aged 4.0- 9.2, who were divided into three groups based on their age (Korovljev, Marinković, Roška and Madić, 2015). The increasing trend of the spinal postural disorders percentage was noticed in the oldest groups of examinees, school children in the first and second grade of primary school.

## Conclusion

Preschool and early school period represent the most sensitive period regarding growth and development of children, when the trend of postural disorders of the locomotor apparatus is noticed. During this period, structural disorders increase simultaneously with most analyzed indicators. This is followed by a period of stagnation while the increased levels of functional disorders of the analyzed postural status indicators remain stable.

**Conflict of interest:** We declare that we have no conflict of interest.

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## Muscle damage in intensive preparation period for elite wrestlers – biochemical assessment

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### **ABSTRACT**

**PURPOSE:** Preparation training of elite-class wrestlers is a highly intensive physical activity. Such activity leads to muscle tearing and the raise of concentration of certain biomarkers in blood. Some of these biomarkers indicate heart muscle or liver damage, so what we are interested in is whether biochemical tests can reveal if a highly intensive activity such as wrestling preparations at the elite level is harmful to the heart muscle and liver. **METHODS:** Eleven elite Croatian wrestlers have undergone seven-days preparation and 24 hours after the preparation the subjects had their blood sampled (CK, CK-MB, ALT, AST and GGT). The differences between the level of analysed biomarkers and the upper reference limits have been tested by Wilcoxon Matched Pairs test. Pearson coefficient correlation has been calculated in order to determine the connection between CK and CK-MB in addition to the CK-MB percentage in the total value of CK. **RESULTS:** The research revealed that AST

enzyme was significantly increased ( $Z=2,31$ ;  $p=0,02$ ), but since ALT and GGT enzymes are not, we may conclude there were no liver damages. There is a high correlation between CK and CK-MB ( $r=0,75$ ), while the percentage of CK-MB isoenzyme within the total CK percentage is 2,23%, revealing there were no heart muscle damages. **CONCLUSION:** Based on the conducted research, we may draw a conclusion there is no health risk referring to liver or heart muscle damage in elite wrestlers during the intensive preparation period.

**Key words:** Greco-Roman wrestling, blood biomarkers, muscle damage, creatin kinase.

## Introduction

In previous studies wrestling has been described as an intensive physical activity dominated by the upper and lower body power with a dominant percentage of anaerobic energy resources (Garcia-Pallares, Lopez-Gullon, Muriel, Diaz & Izquierdo, 2011; Karnincic, Tocilj, Uljevic & Erceg, 2009). Aerobic energy resources also contribute in a wrestling fight, but, according to studies, they are not among the key factors for efficiency in wrestling (Horswill, 1992; Yoon, 2002). Wrestling fights cause extreme physiological changes, and wrestlers' adjustment to such states is a certain training phenomenon (Kraemer, Vescovi & Dixon, 2004). Exhaustive trainings with submaximum and maximum loads and frequent tournament fights lead to a significant raise of biomarkers indicating muscle tissue damage in wrestlers (Barbas et al. 2011; Kaya, 2017). Intensive physical activity leads to the damage of striated muscle fibres. Due to greater outer force affecting the muscle, eccentric activities cause the most substantial damages which results in higher permeability of the myocyte cell membrane indicated by the leak of inner cell metabolites into intercell spaces. Creatin kinase (CK), alanine aminotransferase (ALT) and aspartate aminotransferase (AST) are the most frequent "leaking" products used as striated muscle fibres damage markers (Nie et al. 2011). CK is an enzyme found in highest concentrations in heart and skeletal muscles and in slightly lower concentrations in brain as well. It comes in four forms, and we focused on CK-MM – muscle enzyme and CK-MB – heart enzyme. Raised values of CK-MB isoenzyme are one of the main cardiac arrest markers. The total CK value measured in blood serum is a combination CK – MM (95%) and CK – MB (5%). ALT and AST are enzymes in charge of amino acids metabolism and can be found in liver in large quantities and in skeletal muscles in slightly smaller quantities. There is no significant difference in the value of these enzymes between the athletes and non-athletes (Banfi, Colombini, Lombardi & Lubkowska, 2012). In standard biochemical analyses, in addition to ALT and AST as liver damage markers, gama glutamil transferasis (GGT) can also be used, an enzyme not found in striated muscles. As the intensive physical activity causes a stronger liver and heart muscle activity, the question is how sure we are that raised values of CK, ALT and AST in blood serum exclusively indicate the skeletal muscle damage. Thus, the purpose of this research is to determine whether the routine biochemical tests in assessing possible liver and heart muscle damages caused by intensive physical activity such as Greco-Roman style wrestling on the elite level is possible.

## Methods

Eleven elite Croatian Greco-Roman wrestlers (aged  $22,2\pm 3,5$  (yrs); body height  $180,3\pm 8,3$  (cm); body mass  $84,1\pm 10,9$  (kg); body mass index  $25,8\pm 2,0$  ( $m/kg^2$ ); the latest ranking on the state championship  $2,8\pm 1,6$ ; experience  $8,5\pm 3,6$  (yrs)) were selected for this study. The ranking on the last state championship in addition to the wrestlers' experience suggest these are elite wrestlers in addition to the fact they are the members of an extended national team. All the subjects were previously informed about the research and they provided us with their written consent, and the study protocol was approved by the ethical committee of the Faculty of Kinesiology in Split. The sample of variables involves the following biomarkers sampled from the wrestlers' blood: creatin kinase (CK), creatin kinase

heart isoenzyme (CK-MB), alanine aminotransferase (ALT), aspartate aminotransferase (AST) and gama glutamil transferasis (GGT). All data have been processed by statistica 13.3 programme (Staatistika.Ink), due to the small sample (n=11), nonparametric statistics were applied. We calculated descriptive statistical parameters, the differences between the levels of analysed biomarkers and the upper reference limits have been tested by Wilcoxon Matched Pairs test. Pearson correlation coefficient has been calculated in order to determine the connection between CK and CK-MB as well as the percentage of CK-MB in the total value of CK. The level of significance has been set at  $p < 0,05$ .

#### Procedure description and measuring instruments

Seven-day preparation training was done according to the plan in table 1. Twenty-four hours after the preparation cycle had finished, the subjects were taken vein blood samples from cephalic vein. By centrifuging blood samples at 3000 RPM over a fifteen-minute period, we obtained blood serum from which we determined enzyme activities using ABBOTT ARCHITECT ci16200 biochemical auto-analyzer by applying Abbot reagents.

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Morning	Training 1	Training 3	Running	Training 5	Training 7	Running
Afternoon	Training 2	Training 4*		Training 6	Training 8*	

Table 1. Seven-day preparation training plan

\*highest intensity training – high-impact training

## Results

Biochemical markers (reference values)	AS±SD	MIN/MAX	Upper reference limit	Wilcoxon Matched Pairs Test	
				Z	p
AST (11-38 U/L)	50.27±12.39	32.00/66.00	38	2,31	0.02
ALT (12-48 U/L)	36.27±10.71	24.00/54.00	48	2,5	0.01
GGT (11.55 U/L)	19.26±3.44	13.20/3.44	55	2,93	0.001
CK (0-177 U/L)	1276.55±629.96	457.00/2372.00	177	2,93	0.001
CK MB 7-25 U/L)	28.42±7.77	17.00/7.77	25	1,48	0.14

Table 2. Descriptive statistical parameters (arithmetic means and standard deviation AS±SD, minimum and maximum value MIN/MAX) and the differences between biochemical markers and their upper reference limits (Wilcoxon Matched Pairs test).

CK – creatin kinase; CK MB – creatin kinase heart isoenzyme, ALT - alanine aminotransferase; AST - aspartate aminotransferase; GGT - gama-glutamyl transferasis; U/L - units per litre.

Table 2 evidently reveals that the following enzyme values have been significantly raised: aspartate aminotransferase (AST) and total creatin kinase (CK), compared to the upper reference limits. The value of CK-MB isoenzyme is slightly higher than reference values, but without any statistical significance.

The measured value of CK-MB isoenzyme is in significant correlation with the value of total CK on the level  $r=0,75$  and the percentage of CK-MB isoenzyme within the total CK value is 2,23%.

## Discussion

The results of our research reveal there are significantly raised AST values and total CK values in addition to bordering raised values of CK-MB isoenzyme. CK is a marker most frequently used in striated muscle damage, which can also be found in the heart muscle. CK-MB heart isoenzyme has been measured in order to calculate its percentage in the total CK concentration, and this percentage in intensive activities should reach up to 5% if the activities do not damage heart muscle. The total CK value is significantly raised which was expected considering intensity and volume of training. The value of CK-MB isoenzyme is higher than upper reference limits, but not significant which, under certain circumstances, may indicate possible heart muscle damages. CK-MB isoenzyme higher values are frequently measured in marathon runners after the race (Smith, Garbutt, Lopes & Pedoe, 2004). Since the analysis revealed a high level of correlation between CK and CK-MB with the percentage of CK-MB in the total value of CK of 2% only, we may conclude both enzymes are “leaking” products caused by the striated muscle damage and thus we may exclude potential heart muscle damages. Higher AST values may indicate skeletal muscles damage, but can also be a liver damage marker. Higher AST and ALT values have already been measured in wrestlers, but are within reference limits (Alpay, 2013; Ozkan&Ibrahim, 2016). The differences in AST levels may occur due to differences in the intensity and volume of training during competition and preparation period (this study was conducted over a preparation period). Although ALT is frequently used as a skeletal muscles marker (Nathwani, Pais, Reynolds & Kaplowitz, 2005), ALT, in addition to GGT, is also a specific liver damage marker. According to other studies, ALT value is slightly higher after a physical activity which may indicate the existence of ALT in a skeletal muscle, but in a smaller quantity than AST (Lippi et al. 2011; Ozkan & Ibrahim, 2016). As AST, ALT and GGT are as a rule liver enzyme, a higher AST value likely indicates striated muscle damages since liver damage would most likely lead to the higher values of all three enzymes (Rosales et al. 20018).

## Conclusion

The calculated biochemical parameters reveal the expected striated muscle system damages due to the intensive preparation period, while heart muscle and liver damages have not been marked. Thus, we may assume there is no health risk from the aspect of heart muscle and liver damage in elite wrestlers during an intensive preparation period.

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### **Conflicts of Interest Statement**

The authors certify that they have NO affiliations with or involvement in any organization or entity with any financial or non-financial interest in the subject matter or materials discussed in this manuscript.

# Injuries in karate trainers and their connection to former active karate training

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## **ABSTRACT**

**PURPOSE:** Karate has usually been considered as one of the most dangerous sports due to the frequency of possible injuries, but the recent studies prove opposite (Antekolović, L.J., M., Wertheimer, V., 2016). Previous studies have mostly been focused on active athletes' injuries, while the ones occurring in former athletes and trainers have been neglected. The aim of this study was to determine prevalence of injuries of the locomotor system in karate trainers that are no longer actively included in training karate and link it to previous active karate training. This study also compared opinions of trainers and opinions of doctors about correlation between present injuries and previous active karate training. **METHODS:** The sample of study consisted of 152 karate trainers (F=17 / M=125) (mean: 40.20. min: 19, max: 64) who have voluntarily decided to participate in the study. 90% of the respondents have trained karate for more than 10 years. With the aim of collecting data and anamnesis, a questionnaire was conducted and given to the trainers to fill out on their own. **RESULTS:** Results show that a large number of trainers link their current injuries with previous active karate training, especially skeletal (76,92%) and muscular (60%) injuries, while the percentage of axial skeleton injuries is somewhat smaller (40,91%). Injuries prevalence of current age injuries and injuries gained throughout active karate training show statistically significant difference ( $p < 0.05$ ). A large percentage of doctors confirm their patients' (karate trainers) opinions that present injuries are connected to previous active karate training ( $r = 0.90$ ,  $p < 0.05$ ) especially when it comes to joint injuries (57,69%), while the percentage is lower in muscular (40%) and axial skeleton (31,82%) injuries. **CONCLUSION:** Based on the results of this study, it can be concluded that after ending their active karate training career, trainers have smaller risk of injuries, which can be linked to the absence of competitions where injuries mostly occur. Results also show that high percentage of trainers (52,79%) link their present injuries with previous active karate training, while at the same time a high percentage of doctors (40,71%) share their opinion.

**Key words:** present/current injuries, active karate training, absence of competitions

## **Introduction**

Karate is a sport that consists of competitive disciplines named kata and kumite, as well as single and team. According to structural complexity criterion, or according to complexity of motion and situation structures, karate belongs to a group of multi-structural acyclic sports. However, it differs from other combat sports in the fact that karate's main goal, symbolic destruction of opponent, is accomplished with simulated or highly controlled punches and kicks (Sertić, 2004). During the recent years karate has become more and more popular and

with that popularity the number of recreational athletes, competitors and trainers has increased. Espinos (2018) claims that "sport Karate has become a massive phenomenon across the globe involving millions of families spanning countries within all five continents, and thus deeply entrenched in global society". According to data presented by World Karate Federation (WKF), it is assumed that there are approximately 100 million people currently involved in karate (WKF, 2018.). By changing the rules, karate tries to affiliate to viewers, make it more interesting, more attractive and more dynamic. The claim that it is gaining more popularity is proven by its inclusion in the 2020 Olympic Games in Tokyo – for the first time ever, reassuring that karate is an Olympic sport.

Karate is no different from other sports when injuries are taken into consideration. As in any other sport, injuries occur in athletes. Previous studies have mostly been based on the prevalence and distribution of injuries in active athletes, whether they occur during competitions or training process. The results from the study conducted by Shotorbani et al (2012) results indicate that the highest percentage of injuries belongs to lower extremity injuries (53,71%), especially knee injuries with more than 25% of total lower extremity injuries. In a different study, (Destombe et al. 2006) in which 186 athletes from three clubs located in Brest, participated, 48 athletes had an injury. It is important to stress out that 48 of these athletes had 83 injuries, which leads to the conclusion that some athletes have been injured more often during the study. Of total of 83 injuries, 29 of them were lower extremity injuries, or 28,9%. 22 of them, or 26,5% percent, were head injuries, while the lowest percent of injuries (9,6%) went to 8 body injuries. Zetaruk et al. (2000) conducted a study in which they proved that the number of injuries increases with longer karate training, or higher karate training status. The study was conducted in a karate club, where the training process has been observed for 12 months, along with the injuries that have occurred during that period. The total of 68 karatekas of different age took part in the study, aged 6-16. Results have shown that 28% of respondents had an injury. All injuries were characterised as low intensity, thus the necessity for leaving the training was inexistent. The results have also shown a major difference between injuries in brown belts karatekas and the ones in white belt karatekas (probability ratio 6.56). Another study by Halabchi et al (2007) observes injuries in active karate athletes and demonstrates injury distribution in karate athletes. In this study most of the injuries occurred in head and neck area (55.4%), which are followed by lower extremity injuries (21%), upper extremity injuries (12.9%) and body injuries (10.8%).

The aim of this study was to determine prevalence of injuries of the locomotor system in karate trainers that are no longer actively included in training karate and link it to previous active karate training. As a result, data of injury distribution and frequency of injuries that have occurred during the competitions throughout several generations of active karate athletes will be shown in one place.

## Methods

The study was conducted on License exam for trainers of the Croatian Karate Association (HKS) in 2016. The sample of study consisted of 152 karate trainers (F=17 / M=125) (mean: 40.20, min: 19, max: 64) who voluntarily participated in this study. Furthermore, 90% of them have trained karate for more than 10 years. With the aim of collecting data and anamnesis, a questionnaire was conducted and given to the trainers to fill out on their own. Questionnaire was used to determine:

1. general information about the respondent (age, sex)
2. previous and current intensity of respondent's karate training
3. injuries of the locomotor system during respondent's active karate training
4. current injuries of the locomotor system of the respondent
5. opinions of participants and their doctors about linkage between injuries and active karate training

Data were analyzed using Statistica software. The criterion for significance was set using an alpha level of  $p < 0.05$ .

## Results and discussion

The results of this study showed the distribution of injuries gained throughout active karate training which were then divided into 9 categories (Table 1). Knee injuries were recorded in 25 respondents making the prevalence of 16.45% of total respondent group and injury share of 34.72%. Ankle injuries were recorded in 24 respondents making the prevalence of 15.79% of total respondent group and injury share of 33.33%. Hip injuries were recorded in 9 respondents making the prevalence of 5.92% of total respondent group and injury share of 12.5%. Due to the fact that some respondents had more than one injury, we come to the total of 46 respondents with lower extremity injury, making the prevalence of 30,26% of total respondent group and injury share of 63.89%.

Compared to the Halabchi's (2007) study, our results show significantly higher lower extremity injury percentage in trainers and former competitors in comparison with active competitors ( $63.89\% > 21\%$ ), while the difference between Destombe's (2006) study results is somewhat smaller ( $63.89\% > 35\%$ ). Moreover, the difference between Shotorbani's (2012) study results is even less significant ( $63.89\% > 53.71\%$ ). Wrist injuries were recorded in 13 respondents, making the prevalence of 8.55% of total respondent group and injury share of 18.06%. Elbow injuries were recorded in 4 respondents, making the prevalence of 2,63% of total respondent group and injury share of 5,56%. Injuries of the shoulder rim were recorded in 9 respondents, making the prevalence of 5.92% of total respondent group and injury share of 12,5%. Since some respondents had more than one injury we come to the total of 21 respondents with upper extremity injury. The prevalence of upper extremity injury of total respondent group is 13.82% and injury share is 29.71%. Compared to Halabchi's (2007) study, our results show higher injury share ( $29.17\% > 12.9\%$ ). There is again somewhat smaller difference between Shotorbani (2012) study results ( $29.17\% > 25.73\%$ ). And lastly, the smallest difference is between the results of Destombe's (2006) study ( $29.17\% > 28.9\%$ ).

Location of the injury	No. of respondents with injury N	Injury share	Prevalence of total respondent group
Knee	25	34.72%	16.45%
Ankle	24	33.33%	15.79%
Hip	9	12.50%	5.92%
Elbow	4	5.56%	2.63%
Wrist	13	18.06%	8.55%
Shoulder rim	9	12.50%	5.92%
Spine	7	9.72%	4.61%
Muscle	21	29.17%	13.82%
Other	15	20.83%	9.87%

Table 1. Distribution of injuries during active karate training and prevalence of total respondent group

N - number of participants

Recorded results of current injuries were afterwards divided into 4 categories (Table 2). Joint injuries were recorded in 26 respondents, making the prevalence of 17.11% of total respondent group and injury share of 55.32%. Compared to Shotorbani's (2012) study, joints injury share is lower than what our results have shown (55.32% > 36.5%). Muscle injuries were recorded in 10 respondents making the prevalence of 6.58% of total respondent group and injury share of 21.28%. Compared to Shotorbani's (2012) study, our results show lower injury share (21.28% < 44.68%). Comparing results of injuries gained throughout active karate training (N=72) and results of current age injuries (N=47) we have noticed a higher joint injury share throughout active karate training (73.61% > 55.32%) and higher prevalence of total respondent group throughout active karate training (34.87% > 17.11%). Less difference was noticed between muscle injury share throughout active karate training and current age (29.17% > 21.28%) and prevalence of muscle injuries throughout active karate training and current age (13.82% > 6.58%) with higher percentages in active karate training. Injuries prevalence of current age injuries and injuries gained throughout active karate training show statistically significant difference ( $p < 0.05$ ).

Location of the injury	No. of respondents with injury N	Injury share	Prevalence of total respondent group
Joints	26	55.32%	17.11%
Axial skeleton	22	46.81%	14.47%
Muscles	10	21.28%	6.58%
Other	3	6.38%	1.97%

Table 2: Distribution of injuries at a current age of trainers and prevalence of total respondent group

N - number of participants

Anamnestically recorded data from respondents have been used to determine trainers' opinion and their doctors' opinion about the connection between injuries and karate training (Table 3). Trainers' opinions and doctors' opinions show strong correlation ( $r=0.90$ ,  $p < 0.05$ ). Considering all injured trainers, 52.79% of them think that their current injuries are caused by former karate training, while the percentage of doctors who think injuries are linked with karate training is 40.71%. With regards to categories of injuries, 76.92% of respondents with joint injuries think their injury is connected to karate training and perceive karate as one of the causes. For the same type of injuries 57.69% of doctors think injuries are linked with karate training. 40.91% of respondents with axial skeleton injuries think their injury is related to karate training while 31.82% of doctors agree. 60% of respondents with muscle injuries think their injury is linked with karate training while 40% of doctors agree.

Location of the injury	Number of respondents with injury N	Number of respondents who think their injury is linked with karate training N	Linked cases percentage	Number of injuries that doctors think are linked with karate training N	Percentage of injuries that doctors think are linked with karate training
Joints	26	20	76.92%	15	57.69%
A x i a l skeleton	22	9	40.91%	7	31.82%
Muscles	10	6	60.00%	4	40.00%
Other	3	1	33.33%	1	33.33%

Table 3. Percentage of injuries linked with karate training

N - number of participants

## Conclusion

Based on the results of this study, we can conclude that after ending their active karate training, trainers have less risk of injuries, which can be further influenced by the absence of competitions where injuries mostly occur. Injuries prevalence of current age injuries and injuries gained throughout active karate training show statistically significant difference ( $p < 0.05$ ). A large percentage of doctors confirm their patients' (karate trainers) opinions that present injuries are connected to previous active karate training ( $r = 0.90$ ,  $p < 0.05$ ). Results also show that high percentage of trainers link their present injuries with previous active karate training, especially in skeletal injuries (76.92%) and muscular injuries (60%), while axial skeleton injuries have a somewhat lower percentage (40.91%). A rather high percentage of doctors (40.71%) share the trainers' opinions that their injuries are somehow connected to karate training – especially considering joint injuries (57.69%), while muscular injuries (40%) and axial skeleton injuries (31.82%) have a somewhat smaller percentage. In total 52.79% of trainers think their injuries are linked to former karate training, while 40.71% of medical doctors share their opinion.

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# Assessment of the occurrence of excessive body weight and the level of physical performance among 8-9- year-old schoolchildren in Szczecin's sports elementary schools

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## **ABSTRACT**

**PURPOSE:** Health is one of the greatest human assets. An important element of a healthy lifestyle is physical activity of a human being, of which one of the purposes is to maintain a proper body weight and the proper level of physical fitness as a measure of health. Regular sports activities carried out in school facilities are to increase the biological potential of the body. The aim of the study is comparative analysis of the BMI index, the value of blood pressure and physical fitness capabilities of school-aged children attending to Szczecin's sports schools against the overall population of Szczecin's children aged 8-9. **METHODS:** The research was carried out in 2017. The subject were 4525 children - primary school students and 168 students of sports school were examined. Body mass index (BMI) and WHR index were calculated. Criteria developed by the International Obesity Task Force (IOTF) were adopted. The tests included measurements of basic anthropometric indicators, such as: height and body weight, waist and hip circumference, high blood pressure, body composition analysis, physical performance. To determine the statistical significance of differences, the chi-squared test for non-parametric values was used. **RESULTS:** Excessive body weight was diagnosed in 15.38% of students in non-sports school and in 9.52% of students in sports schools. Abnormal (higher) blood pressure was diagnosed in students in non-sport schools (11.36%) and among sport school students (8.33%). The unsatisfactory level of physical fitness was diagnosed in 65.46% of non-sport school students and 38.1% of sports school students. Differences between students of sports and non-sports schools are statistically significant ( $p \geq 0.05$ ). **CONCLUSIONS:** The fact that there is such a high percentage of excessive body weight among children in Szczecin area, including children in sports schools, and the unsatisfactory physical performance of non-sports and sports students is worrying.

**Key words:** student, health, obesity

## **Introduction**

Health is one of the greatest human assets. In recent years, there has been a significant increase in childhood obesity observed. Research results show that one in five children in

Europe is overweight or obese, and the number of children with overweight and obesity increases each year. Estimated growth in one year is about 400,000 new cases [Czaprowski, Stoliński, Szczygieł & Kędra, 2011]. Obesity has become an epidemic and is a public health problem. In the United States, this is the second cause of illnesses and of the increased risk of premature death after smoking [Mazur, 2011]. In Poland an increase in the occurrence of overweight and obesity was recorded in the mid-90s of the previous century. Obesity formation is usually a long-lasting process. It is influenced by both genetic predisposition and epigenetic factors. The epigenetic factor of obesity is the intrauterine environment, the way the baby is fed by the mother during infancy, the diet and physical activity of the child and his family. Obesity in the family is a risk factor for obesity in children from this family. In addition, obese parents are not aware of the obesity of their child. Further risk factors are both small and large birth weight of the child and maternal diabetes. Dietary factors that cause obesity include high-calorie snacks, sweetened drinks, fruit juices, food products rich in carbohydrates - especially with a high glycemic index, high-fat food products. The dietary factor is also the excess of food consumed, above the standard of the child's needs in a given development period. In addition, over the last few years we have observed lesser physical activity among the children. Children spend increased amount of time watching TV or computer. They spend less time in the open air, less and less often go to school on foot, more and more often the family is transported to school by car. It significantly reduces the energy expenditure of the body, and the lack of exercise contributes to the development of overweight and obesity [Matecka - Tedera E. & Zachurzok - Buczyńska, 2010]. Many epidemiological studies (NHANES-1, First National Health and Nutrition Evaluation Survey, MRFIT. Multiple Risk Factor Intervention Trial) confirm the effect of reduced physical activity on the development of obesity in the world [Prentice & Jebb, 1995].

The aim of the study is to assess the BMI index, the value of arterial hypertension and the level of physical fitness of Szczecin's sports school children versus the same data in overall population of Szczecin's school children aged 8-9 years.

## Methods

From December 2016 to April 2018, 4693 Szczecin children aged 8 and 9 years were examined. There were 4525 children attending non sport schools and 168 students of sports schools. The tests included measurements of basic anthropometric indicators, such as: body height (measured with the stadiometer accurate to  $\pm 0.1$  cm), body weight (measured using a medical weight with an accuracy of  $\pm 100$  g), waist and hip circumference (measured with a sewing tape measure), arterial pressure (measured with an electronic pressure gauge with a cuff fitted to the child's arm circumference), body composition analysis (using electrical bioimpedance method), physical efficiency - using the Kasch Pulse Recovery Test step test, based on rhythmic climbing a 30.5 cm high platform for 3 minutes. This will enable an estimation of the level of physical efficiency based on the frequency of the Heart Rate, and thus the level of physical activity of an aerobic nature, which is the basic element of a healthy lifestyle. Based on the measured anthropometric parameters, the body mass index BMI [(body mass index),  $\text{kg} / \text{m}^2$ ] and the WHR index were calculated. Criteria developed by the International Obesity Task Force (IOTF) were adopted. To determine the statistical significance of the differences, the  $\chi^2$  test for nonparametric values was used.

## Results

Excessive body weight was diagnosed in 696 non-sport school students (380 girls, 316 boys), which is 9.52% of the surveyed population and 16 children of sports schools (8 girls, 8 boys), which accounts for 15.38% of the surveyed population. Excessive weight in girls of non-sports schools constituted a group of 16.5% (380 girls), and sports schools 12.3% (8 girls). No statistically significant relationship found (Table 1). Excessive body mass among

non-sport school boys accounted for 14.2% (316 boys) versus the same data from sports schools 7.8% (8 boys). There is no statistically significant relationship (tab.2). Elevated blood pressure was found in 514 non sport school students (250 girls and 264 boys), which accounts for 11.36% of the surveyed population and 14 students of sports schools (4 girls and 10 boys), which is 8.3% of the population. Elevated blood pressure in girls of non-sport schools was 10.8% (250 girls), and sports schools 6.2% (4 girls). No statistically significant relationship was found (Table 1). Elevated blood pressure among non-sport schools boys occurred in 11.9% (264 boys) and among 9.7% (10 boys) boys in sport schools. There is no statistically significant relationship (tab.2). Parameters of children's physical efficiency are disturbing. The unsatisfactory level of physical fitness (i.e., fair, weak and very weak was diagnosed in 65.46% of non-sport school students and 38.1% of students of sport schools). 2.0% of girls (43 girls) in non-sport schools and 9.4% (6 girls) in sports schools achieved excellent physical fitness, very good physical fitness achieved 13.2% girls (277 girls) of non-sport schools and 28.1% (18 girls) sports schools, good 18.1% girls (380 girls) of non-sport schools and 29.7% (19 girls) of sports schools, a sufficient 30.7% girls (645 girls) of non-sport schools and 21.9% (14 girls) of sport schools, poor 29.9% girls (628 girls) of non-sport schools and 9.4% (6 girls) of sport schools, very poor 6.2% (130 girls) of non-sport girls and 1.6% (1 girls) of sport schools. Statistically significant relationship was found (Table 1). In the group of boys excellent physical fitness was attributed to 2.1% boys (44 boys) in non-sport schools and 21% boys (2 boys) in sport schools, very good 11.5% boys (241 boys) of non-sport schools and 30.5% boys (29 boys) of sports schools, good 23.1% boys (485 boys) of non-sport schools and 22.1% boys (21 boys) ) of sport schools, sufficient 27.0% boys (567 boys) of non-sport schools and 32.6% (31 boys) of sport schools, poor 26.3% boys (552 boys) of non-sport schools and 10.5% (10 boys) of sport schools, very poor 26.3% boys (552 boys) of non-sport schools and 10.5%, (10 boys) of sport schools. A statistically significant relationship was found (Table 2).

Factor	Result	Sport school	Non-sport school	Statistical significance
Excessive body weight	yes	8 12.3%	380 16.5%	$\chi^2 = 0.801$ p = 0.371
	no	57 87.7%	1927 83.5%	
Increased blood pressure	yes	4 6.2%	250 10.8%	$\chi^2 = 1.450$ p = 0.229
	no	61 93.8%	2057 89.2%	
Physical fitness	excellent	6 9.4%	43 2.0%	$\chi^2 = 42.197$ p = 0.000*
	very good	18 28.1%	277 13.2%	
	good	19 29.7%	380 18.1%	
	sufficient	14 21.9%	645 30.7%	
	fair	6 9.4%	628 29.9%	
	very weak	1 1.6%	130 6.2%	

Table 1. Test results of girls

\* - statistically significant relationship  $p \leq 0.05$

Factor	Result	Sport school	Non-sport school	Statistical significance
Excessive body weight	yes	8 7.8%	316 14.2%	$\chi^2 = 3.441$ $p = 0.064$
	no	95 92.2%	1902 85.8%	
Increased blood pressure	yes	10 9.7%	264 11.9%	$\chi^2 = 0.455$ $p = 0.500$
	no	93 90.3%	1954 88.1%	
Physical fitness	excellent	2 2.1%	44 2.1%	$\chi^2 = 42.451$ $p = 0.000^*$
	very good	29 30.5%	241 11.5%	
	good	21 22.1%	485 23.1%	
	sufficient	31 32.6%	567 27.0%	
	fair	10 10.5%	552 26.3%	
	very weak	2 2.1%	208 9.9%	

Table 2. Test results of boys

\* - statistically significant relationship  $p \leq 0.05$

## Discussion

The growing problem of obesity in society drew attention to the health problem of this phenomenon. Literature analysis shows that every seventh child in an early school age has excessive body mass. In 1994-95, in a group of 7-8 year-olds, 4.3% of boys had obesity and 1.8% were overweight. In the girls' group, obesity accounted for 6.4% and overweight 1.5% [Oblacińska, Wrocławska & Wojnarowska, 1997]. Research indicates an increase in sedative behavior among girls and boys aged 7-15 [Czaprowski et al., 2011]. The sedentary lifestyle significantly influences the problem of overweight and obesity as well as the level of physical fitness. In studies on large populations, shortening of life among obese people was observed, as well as higher incidence of type 2 diabetes, heart attacks and strokes, and metabolic syndrome in the adult population. Central obesity is considered to contribute to increased risk of metabolic syndrome. Scientific reports indicate that the metabolic syndrome is also present among children - the age of the child is important. It is noted that younger children diagnosed with lipid disorders should be under medical supervision [Socha, 2011]. Obesity in children can cause a number of endocrine disorders, such as an increase in androgen levels, which increases the risk of developing polycystic ovary syndrome, non-alcoholic steatohepatitis and cholelithiasis. Sleep apnea occur 6 times more often in obese than lean children. Excessive body weight causes disorders in the skeletal and muscular system resulting in flat feet, various deformity, valgus knees, scoliosis, pain in the spine and lower limbs. Obesity is often a problem that coexists with mental problems, for example: depressive disorder, high level of anxiety, high level of fear and aggression, lack of self-acceptance, social isolation [Matusiak, 2011; Zachurzok-Buczyńska, 2011]. The

problem is hypertension - closely related to obesity. Hypertension can cause significant health problems, e.g. in the form of hypertrophy of the left ventricle and damage to arterial vessels. Physical exercise by an obese child with diagnosed hypertension must be graded. They are usually characterized by low physical capacity, so the movement should start with a lower intensity and gradually the duration of physical activities should be increased [Litwin, 2011]. Research on the physical fitness of children with overweight and obesity indicates a reduced level of physical fitness. Among 1421 girls examined from eastern Poland, there was a reduced level of physical fitness in terms of running strength, torso strength, arm strength, flexibility and balance [Popławska, Dmitruk, Hołub, Wilczewski, 2011].

## Conclusions

1. It is unsettling that there is a high percentage of excessive body weight in non-sports school children in Szczecin and sport schools.

There was no statistical significance between the schools.

2. The high blood pressure of students of sports schools in Szczecin is unsettling. There was no statistical significance.

3. Fitness performance results of non-sport students and sports students are unsatisfactory. There is a statistically significant relationship between sports and non-sports schools.

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## Difference between the athletes with knee hyperextension and those without it in body mass and body height

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### **ABSTRACT**

**PURPOSE:** Finding the difference between the athletes with knee hyperextension and those without it in body mass and body height. **METHODS:** Fifty-two healthy male athletes, 27 without knee hypermobility and 25 with knee hyperextension. Measurements were taken with anthropometer, body scale and using the knee hypermobility assessment test. **RESULTS:** Participants with a significant knee hyperextension had  $12.74 \pm 1.97$  hyperextension in degrees, they were  $182.14 \pm 6.95$  cm tall and weighted  $79.87 \pm 11.65$  kg. Participants without significant hyperextension had  $6.65 \pm 2.61$  hyperextension in degrees, they were  $181.91 \pm 7.10$  cm tall and weighted  $80.63 \pm 9.35$  kg. Multivariate analysis test showed no statistically significant difference between the groups ( $F=0.31$ ;  $p=0.73$ ). Univariate analysis tests indicates no statistically significant difference in body mass ( $F=0.03$ ;  $p=0.87$ ) or height ( $F=0.13$ ;  $p=0.72$ ). **CONCLUSION:** No significant statistical difference was found between the two groups in body mass and height.

**Key words:** knee hyperextension, body weight, body height, injury predictor, general joint laxity, proprioception, muscle strength

### **Introduction**

General joint laxity or hypermobility is a condition in which most of an individual's synovial joints have a range of motion beyond normal limits (Smith, Damodaran, Swaminathan,

Campbell & Barnsley, 2005). Hypermobility is one of the main characteristics of Marfan syndrome and Ehlers-Danlos syndrome, which are categorized as collagen disorder syndromes. It is characterized by altered connective tissue, abnormal changes and different biochemical structure of extracellular matrix (ECM) of the joint (Beighton, Grahame & Bird, 2011). Except abnormal range of motion, hypermobility is also connected with impaired proprioceptive ability of the joint. (Mallik, Ferrell, McDonald & Sturrock, 1994) Study of Hall et al. (1995) showed that subjects with knee hyperextension showed worse results in proprioceptive feedback than subjects without knee hyperextension. Muscle strength control and strategy of muscle activation is shown to be significantly different in adults with knee hyperextension (Jensen, Olesen, Pedersen, Kristensen, Remvig, Simonsen & Juul-Kristensen, 2013). Bird et al discovered that joint hypermobility is a common finding amongst patient with rheumatoid arthritis and osteoarthritis. (Bird, Tribe & Bacon, 1978). Rates of knee injuries have increased as the demands and intensity of sport competition have risen to the high level. Acasuso Diaz et al. (1984) confirmed that musculoligamentous lesions were more frequent in individuals with joint hypermobility. Musculoskeletal pain is found to be more often in adolescents with knee hyperextension (Tobias, Deere, Palmer, Clark & Clinch, 2013). The study was conducted among soldier population during a 2-month military training period. Klemp et al. (1993) discovered that ballet dancers with hypermobility tend to injure more than dancers without hypermobility. Ramesh et al (2004) showed a significant correlation between knee hyperextension and anterior cruciate ligament injury.

There is no study related to body mass and height influence on hypermobility of the joints in athletic population. Intention of this study was to prove differences between athletes with knee hyperextension and those without it in body mass and height.

**Methods**

Knee hyperextension was standardized by Beighton scale in which hyperextension above 10° is statistically significant. (Beighton et al, 1998) Participant sits on the floor and puts relaxed extended legs on the 20 cm high bench. Goniometer's stationary arm is located in the centre of the knee joint axis with the fixed arm which is directed towards the lateral proximal ridge of the femur and the other movable arm towards the lateral malleolus of the ankle. We repeat the same measurement for the both legs.

**Participants**

Participants were 52 healthy male athletes without knee injuries in the mean age of 24± 6 years. Participants are divided in two groups. First group is made of 25 participants who have hyperextension in the knee joint which is more than 10 degree. Second group is made of 27 participants without hyperextension in the knee joint which is less than 10 degree.

**Anthropometric measurements**

Body height was measured with anthropometer (Seca 225, Seca, Birmingham, UK), precision 0.1 cm without shoes. Body weight was measured in sport clothing, T-shirt and shorts, using the body scale Tanita BC 420 SMA (Tanita Europe BV, Amsterdam, The Netherlands), precision 100 g.

**Results**

Multivariate analysis test showed no statistically significant differences between two groups in body mass and body height. (Table 1)

Variable	Wilks Lambda	F	p
KHdeg	0.99	0.31	0.73

Table 1 - Multivariate analysis

KHdeg-knee hypermobility degree.

Variable	Multiple correlation	Multiple R <sup>2</sup>	F	p
BM	0.04	0.00	0.13	0.72
BH	0.02	0.00	0.03	0.87

Table 2 - Univariate analysis

BM-body mass; BH-body height.

Variable	Mean hyper	Std.Dev. hyper	Mean nonhyper	Std.Dev. nonhyper
BM	79.87	11.65	80.63	9.35
BH	182.14	6.95	181.91	7.1
KH	12.74	1.97	6.65	2.61

Table 3 - Descriptive statistics of both groups.

BM = body mass; BH = body height; KH = knee hyperextension; Meanhyper = mean of participants with hyperextension; Std.Dev.hyper = standard deviation of participants with hyperextension; Meannonhyper = mean of participants without hyperextension; Std.Dev.nonhyper = standard deviation of participants without hyperextension.

## Discussion

One of the hypothesis was that taller athletes have greater hyperextension; it was driven by the idea of bigger and longer levers, but it was found to be wrong and body height does not affect knee hyperextension. Body mass as a direct mechanical weight on lower extremities does not have any effect on knee hyperextension. Body mass and height does not directly affect knee hyperextension which is found to be one of the factors of patellar dislocations (Rünow, 1983) and worse proprioceptive ability of the knee (Ferrel, Tennant, Sturrock, Ashton, Creed, Brydson & Rafferty, 2004). Knee hyperextension is one of the ACL injury mechanism, very often serious sport injury which requires surgery and serious rehabilitation. It is one of the intrinsic factors which could contribute ACL injury (Ramesh, Von Arx, Azzopardi & Schranz, 2005). Junge et al (2015) found out different muscle activations patterns at children with and without hyperextension during a single leg hop for distance test that could contribute to ACL injuries. Fatoye et al. (2008) investigated joint proprioception and muscle weakness and found out that children with knee hyperextension had worse results than the group without knee hyperextension. It has been shown that musculoskeletal reflex in the knee joint with hyperextension is different compared to knee without hyperextension which confirms theory of altered neuromuscular patterns (Ferrell, Tennant, Baxendale, Kusel & Sturrock, 2007).

## Conclusion

The results of the study indicate that knee hyperextension is not directly connected to body mass and height in male adult athletes. Limitations of the study is the different groups of participants that could include children, women and recreational athletes. Other anthropometric measurements should be taken in notice for determining the cause of hyperextension. More studies are required to make a final conclusion to this hypothesis.

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# Attitudes towards and knowledge of the Croatian wrestling coaches about supplements and doping

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## **ABSTRACT**

**PURPOSE:** The aim of this paper is to define attitudes towards and knowledge of the Croatian wrestling coaches about the permitted supplements and doping in wrestling. **METHODS:** Knowledge and attitudes were investigated by a valid test (17 questions) consisting of questions about knowledge (11 questions) and questions about attitudes (6 questions). Descriptive statistical parameters: mode, mode frequency, percentage frequency of the correct answers and total percentage of the correct answers were calculated. **RESULTS:** Results indicate that majority of wrestling coaches did not answer properly on important questions about diet and 57.5% of them did not check prohibited list of the World Anti-Doping Agency (WADA). It is alarming that 17.5% of wrestling coaches would allow any kind of performance enhancers if they knew the doping control would not test them. **CONCLUSION:** Based on the results of this study it can be concluded that the Croatian wrestling coaches are still not educated enough when it comes to diet issues. Therefore, it is necessary to continuously educate wrestling coaches and wrestlers in diet, supplements and doping. These results could be valuable in prevention, which is known as the best method for fighting against doping.

**Key words:** supplement, test, combat sports

## **Introduction**

Diet, supplements and food intake have the main role in wrestling because wrestling is a sport with weight categories. That is the main reason why wrestlers should take care of

details in their diet. Nowadays, coaches' knowledge is improving due to easier access to information. During 2018 the official weighing has been set on the competition day so the procedure for weight losing protocol has become totally different from the earlier protocol when the weighing was one day before the competition. The changes in the official wrestling rules aimed at reducing an unhealthy weight loss in top wrestlers, especially those who reduce 15% of total body mass (Slačanac, Starčević, & Sajković, 2016). Wrestling trainers have realized that body mass reduction can improve wrestlers' competitive performance. Unfortunately, some wrestlers are very radical; they use all kinds of permitted and even prohibited methods such as taking diuretics (doping) to reduce body weight. It is a very dangerous practice, especially when knowledge about doping is low, which has already been noted among the Iranian wrestlers (Halabchi, Esteghamati, Razzaghi, & Noori, 2011). Unhealthy methods do not just jeopardize health, they may be life threatening. The problem becomes more complex with the fact that top-level wrestlers need to be simultaneously at the highest possible level of their fitness and reduce their body mass to compete in a lower weight category. Results of this study are valuable since they reveal wrestling coaches' knowledge about and attitudes towards dietary supplements and performance enhancers. These results could be valuable in prevention, which is known to be the best method for fighting against doping (Ismaili, Yousefi, & Sobhani, 2013). Aim of this paper is to define attitudes towards and knowledge of Croatian wrestling coaches about the permitted supplements and prohibited performance enhancers in wrestling.

## Methods

Participants were 40 wrestling coaches (18-76 years old) from all parts of Croatia, what is approximately 60% of the total number of wrestling coaches. The research was conducted during the mandatory seminar for the coaching licence renewal, which was attended by trainers of all levels (from the club to the international level). The research was conducted at the Faculty of Kinesiology, University of Zagreb. All respondents anonymously and voluntarily filled in the questionnaire. The questionnaire reliability was determined by the test-retest method. After the items of unsuitable characteristics had been excluded, the satisfactory overlap rate was 80% (Karninčić, Baić, & Slačanac, 2014). In the area of knowledge, the two extracted latent dimensions were: coaches' practical and physiological knowledge. Among attitudes, the three extracted latent dimensions were: critical attitudes towards doping, followed by the affirmative attitudes towards doping and attitudes towards nutrition (Karninčić, Baić, & Slačanac, 2014). The first part refers to the knowledge about nutrition and supplements (11 questions) – the participants were to choose either YES or NO. The second part of the questionnaire is about the attitudes towards doping (6 questions) – participants were offered a 5-degree response scale ranging from the completely accurate to completely incorrect.

### *Questions – Nutrition and supplement knowledge with accurate answers*

1. Basic group of supplements are: keratin, amino acids, CLA, L-glutamine? – Yes
2. Can blood doping develop the risk of bacterial infection? – Yes
3. Is it allowed to use diuretics in wrestling? – No
4. Antioxidants Burn Fat? – Yeah
5. Vitamin E is a powerful antioxidant important for muscle work? – Yes
6. Does the World Anti-doping Agency list a prohibited substance every two years? – Yes
7. Does CLA (conjugated linoleic acid) promote muscle growth? – Yes
8. Glycemic index is equal with level of glucose in blood? – Yeah
9. Carbohydrates are the primary source of energy? – Yeah
10. Do proteins also have a role of injury prevention? – Yeah
11. Protein is a substance that primarily builds muscle cells? – Yeah

### Attitudes towards doping

1. I would recommend to my wrestlers illegal substances if I knew they would not be detected in the doping test.
2. If the wrestlers do not take supplements, they can still have the same intensity and volume of training.
3. Performance enhancers have side effects only if it is taken at a higher level than recommended.
4. Nowadays there is no wrestler who does not use any dietary supplements.
5. Every year I check the list of forbidden substances.
6. I know some wrestlers who use performance enhancers.

### Methods of data processing

Data were processed by descriptive statistics – frequencies of answers and the total percentage of correct answers were computed for knowledge about diet and supplement, whereas for attitudes towards doping mod and frequency of mod were calculated.

### Results

Question	1	2	3	4	5	6	7	8	9	10	11
f	36.0	35.0	36.0	23.0	23.0	8.0	16.0	31.0	28.0	22.0	30.0
%	90.0	88.5	90.0	57.5	57.5	20.0*	40.0*	79.1	70.0	55.0	75.0

Table 1. Frequency and total percentage of correct answers to the questions about diet and supplements – knowledge

f – frequency; % - percentage; \* most participants mistakenly answered

We can see that most participants did not know the correct answer to questions 6 and 7, the total percentage of correct answers was 67.5 percent.

Attitude	1	2	3	4	5	6
Mode	Total	Total incorrect	Mostly incorrect	Mostly correct	Total correct	I am not sure
f mode	27	13	12	17	14	14

Table 2. Modal value and frequency of wrestling coaches' attitudes towards doping

mode – mod; f mode – mod frequency

Most participants responded positively to the assertion: I would recommend to my wrestlers illegal substances if I knew they would not be detected in the doping test (the highest frequency).

### Discussion

Although participants responded correctly to 67.5% of questions, the participants do not have basic knowledge about the key details related to diet and supplementation. Similar results were indicated by Sossin et al. (1997), however, the high-school wrestlers' coaches

showed a lower level of knowledge than the Croatian wrestling coaches. Croatian coaches are slightly better in results because they are better educated and have passed shorter seminars about diet and doping. Sossin et al. (1997) found 59% of correct answers to dietary questions and 64% of correct answers about weight losing protocol. Even 57% of the Croatian trainers answered correctly to the question "Vitamin E is a powerful antioxidant important for muscle work?", while only 20% of them knew that the World Anti-Doping Agency (WADA) updates the list of prohibited substances each year. It is very interesting that 60% of the Croatian wrestling coaches do not believe that CLA promotes muscle hypertrophy. Although most of the coaches mostly responded totally incorrect ( $f = 27$ ), 17.5% of wrestling coaches are generally or completely agreeing to recommend illegal substances to their athletes if they know they would not be detected in the doping test. Almost half of participants, 47.5% wrestling coaches, generally or completely agree that performance enhancers have side effects only if they are taken at a higher level than recommended. In Turkey, the situation is opposite: there most wrestling coaches think that doping is not fair advantage over opponents (Turkcapar, Mine, & Mustafa, 2014). Coaches with a higher educational level showed a higher level of knowledge about doping (Couture et al., 2015) so education is the only way to fight with unacceptable attitudes and poor knowledge.

## Conclusion

Based on the results of this paper, it can be concluded that the Croatian wrestling coaches are not educated enough in the field of allowed dietary supplements and performance enhancers. According to the data, 17.5% of the coaches are generally or completely agreed they would recommend illegal substances to their athletes if they knew they would not be detected in the doping test. The most frustrating thing is that even 57.5% of wrestling coaches do not check the list of prohibited substances (WADA). This study indicates that extra training and seminars are needed to improve knowledge about and attitudes of wrestling coaches, but of wrestlers also, towards diet, supplements and doping. Better knowledge would, hopefully, prevent the use of radical methods of body mass reduction in wrestlers who often radically reduce their body mass before competitions. This knowledge can be very useful for prevention that has already been identified as the most effective way fighting with manipulation with doping.

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# Influence of choreography on the development of first-graders' coordination abilities

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## **ABSTRACT**

**PURPOSE:** To examine the effectiveness of choreography on the formation of coordination abilities in first-graders. **METHODS:** Pedagogical testing: holding posture with open eyes (c); shuttle running 3x10m, (s); running on the spot during 10s, 30s, 60s, (s); walking in the straight line without a visual guide, (s & m); throwing rings on a tripod from a distance of 1.5m, 2.5m, 3.5m, (number of hits); game task "Transmit telegram", (one point); three moves forward with the exit (s); carpal dynamometry in full force and 50% from maximal power, (kg). Methods of mathematical statistics. Research was conducted in the elementary school №7 in Pereiaslav-Khmelnyskyi. In the experiment, 53 pupils of the first form took part (22 girls and 31 boys). **RESULTS:** Purposeful pedagogical influence of choreography on the

informative indexes (girls: differentiation of muscular effort, spatial orientation and coordination of moves; boys: management of temporal, power and spatial parameters of moves; sense of time and sense of balance) effectively enhanced formation of the main components of coordination skills in the first-graders. **CONCLUSIONS:** Significantly higher indexes were found in the experimental group than in controls. The conducted pedagogical experiment confirmed effectiveness of using choreography to promote formation of the main components of coordination abilities in the first-graders.

**Key words:** dance, sense of balance, sense of rhythm, differentiation of muscular effort, spatial and temporal parameters of moves, coordination of moves

## **Introduction**

Scientists emphasize the necessity of early engagement of children in dance activities with the purpose to promote versatile development (Davies, 2003; Sansom, 2013, 2015). Nowadays, dance is extensively used in the domain of physical training of preschoolers (Cone, 2015; Vilchkovskiy & Kurok, 2001), children of school age (Roters, 2007; Fyryleva, 2007) and university students (Rafferty, Redding, Irvine, & Quin, 2007). The issue of dance representation in school and study curricula of physical training has been investigated by El-Sherif (2016), Little and Hall (2017). Choreography, in our opinion, has a strong potential to improve the development of coordination abilities. In junior school-age foundations of movement control should be laid to enable comprehensive formation of motor skills; if that sensitive age has been missed, absence of the foundations cannot be substituted later in life. Therefore, the aim was to establish motor experience and coordination readiness in junior school age.

## **Material and methods**

Pedagogical testing: holding the posture with open eyes (s); shuttle running 3x10m (s); ran on the spot during 10s, 30s, 60s, (s); walking in the straight line without a visual guide, (sm); throwing rings on a tripod from the distance of 1.5m, 2.5m, 3.5m, (number of hits); game task "Transfer a telegram", (one point); three moves forward with exit in v. p., (s); carpal dynamometry with full force and with 50% of maximal power, (kg).

Research was conducted in the elementary school № 7 in Pereiaslav-Khmelnytskyi. Fifty-three first-graders took part in the experimental work (22 girls and 31 boys). Since pupils pertained to the main medical group of health, both groups – controls (1-A class) and experimental group (1-B class), were practically homogeneous. The controls attended their regular PE classes based on the curriculum of Physical Education. In the experimental group elements of choreography were extensively implemented in the process of physical education widely used.

## **Results**

The main pedagogical conditions for effective use of dance moves in the formation of coordination skills in first-graders were established: constant expansion of motor experience; elements from different types of choreography should be used; purposeful development of physical skills that determine the development of coordination abilities; favourable conditions for the optimization of dance moves in the process of Physical Education.

Dance tasks were used in the preparatory part of each lesson like general and specific developing exercises and also in the main part like dance etudes and musical motorized games of choreography orientation by Chuprun (2014). So, five groups of training were formed, each with the characteristic fund of selected moves.

*I. Task: ability formation to evaluate and regulate dynamic and spatial-temporal parameters of moves.*

Means: 1. Elements of classical dance (demi та grand plie, battement tendu, battement tendu jeté, grand battement, turning over, on foot, on feet).

2. Elements of folk-stage dance - (varieties of steps, jumps, hops, etc.).

3. Exercises of musical rhythmic education (tasks for changing speed, tempo, rhythm, direction of movement during walking, running; change kind of movement: walking – running – walking – hops).

*II. Task: ability formation to maintain a stable balance.*

Means: 1. Elements of classical dance (relevé next to bed frame and without stick, arabesque, twists on half fingers, sauté, demi та grand plie in the middle, stand on half fingers in the third and fifth positions, imitating poses of birds and animals).

2. Elements of folk-stage dance (twists stepping over with bluntness, changing tempo of movement, step polka with twist, step gallop combined with hop twists of 360°, movement kolupalochka with twist, pas de basque).

3. Pantomime (poses, which show and express emotions, smooth, wave-shaped movements from main stand in chair, expression chapter with help of hands, body, feet, creation movements of fabulous heroes).

*III. Task: ability formation to feel and assimilate rhythm.*

Means: 1. Exercises of musical rhythmic education (stepping, running, hops, jumps, music and story games, relays to music, exercises on improvisation).

2. Elements of Ukrainian folk-stage dance (claps and heels, triple blunt, holubtsi, kolupalochka, with blunt, percussion, step polka, step gallop, hops).

3. Elements of modern dances.

*IV. Task: ability formation of arbitrarily muscles relaxation.*

Means: 1. Exercises of musical rhythmic education (exercises on improvisation, exercises on changing tension of muscles, changing dynamics of movements, games and games' tasks).

2. Pantomime (smooth, waved-shaped movements from main stand in chair, expression chapter with help of hands, body, feet, showing movements of fabulous heroes).

Conditions: exercises, dance elements and figures are performed at slow pace in the middle from different positions combined with exercises of muscle relaxation.

*V. Task: ability formation to combine movements in motor action.*

Means: 1. Exercises of musical rhythmic education (combined varieties of hops, steps, running, jumps, music and chapter games, relays to music, exercises on improvisation, exercises of rhythmic gymnastics).

2. Elements of classical dance (relevé on half toes, relevé with fixation stand on half toes, demi та grand plie y 1, 2 positions, battement in different variations, sauté, port de bras, combination of these exercises next to bed frame with performance without support in the middle, where transfer doing with twists, steps waltz, balance).

3. Elements of Ukrainian folk-stage dance (dance composition with steps of bihunets, blunts, kolupalochka with triple blunt, steps of polka, gallop combined with hops and twists).

After the implemented of pedagogical experiment, girls of both the EG and CG demonstrated positive changes (Table 1) in the following indicators: sense of balance with open eyes (13% and 5.13%, respectively), sense of time (4.6% and 1.2%, respectively) and precision of movements (5% and 1.7%, respectively), and the ability to manage temporal, power and spatial parameters of movements (9.8% and 3.05%, respectively).

Type of test	Groups	X ±m before experiment	X ±m after experiment	% growth of indicators	D
Holding posture with open eyes,s	E	11.3 ± 0.2	13 ± 0.4	13	<0.05
	C	11.4 ± 2.3	12 ± 0.4	5.13	<0.05
Shuttle running 3x10m, s	E	10 ± 0.1	9.1 ± 0.1	9.8	<0.05
	C	10.03 ± 0.1	9.7 ± 0.1	3.05	<0.05
Ran on the spot 60s, s	E	2.9 ± 0.4	2.2 ± 0.3	4.6	<0.05
	C	2.9 ± 0.4	2.6 ± 0.3	1.2	>0.05
Throwing rings on a tripod from a distance of 3.5 m, number of hits	E	0.2 ± 0.1	0.9 ± 0.3	5.0	<0.05
	C	0.2 ± 0.1	0.5 ± 0.3	1.7	<0.05
Game task «Transfer a telegram», one point	E	3.2 ± 0.2	3.5 ± 0.3	13.2	>0.05
	C	3.1 ± 0.2	3.2 ± 0.3	2.6	<0.05
Three moves forward with exit	E	8.7 ± 0.3	8.0 ± 0.2	8.1	>0.05
	C	8.7 ± 0.3	8.4 ± 0.6	3.5	<0.05

Table 1. Influence of experimental intervention on the formation of the principal components of girls' coordination skills

Also, we observed a significant increase in boys of both the EG and CG in indicators of: precision of movements (6.1% and 1.9%, respectively), sense of rhythm (8.8% and 3.8%, respectively) and ability to manage temporal, power and spatial parameters of moves (6.5% and 4%, respectively), coordination of movements (9.7% and 3.5 %, respectively) and sense of balance (13% and 5.1%, respectively). False growth should be pointed out in CG of indicators of sense of balance. The influence of experimental methodology on the formation of boys' coordination abilities are presented in Table 2.

Type of test	Groups	X ±m before experiment	X ±m after experiment	% growth of indicators	D
Holding posture with open eyes,s	E	11.4 ± 0.4	13 ± 0.3	13	<0.05
	C	11.3 ± 0.3	12 ± 0.3	5.1	>0.05
Shuttle running 3x10m, s	E	9.4 ± 0.1	8.8 ± 0.3	6.5	<0.05
	C	9.4 ± 0.2	9.1 ± 0.3	4	<0.05
Ran on the spot 60s, s	E	1.9 ± 0.3	1.5 ± 0.2	11.2	>0.05
	C	1.9 ± 0.2	1.7 ± 0.2	9.2	>0.05
Throwing rings on a tripod from a distance of 3.5 m, number of hits	E	0.3 ± 0.1	0.6 ± 0.6	6.1	<0.05
	C	0.3 ± 0.1	0.4 ± 0.1	1.9	<0.05
Game task «Transfer a telegram», one point	E	3.1 ± 0.2	3.4 ± 0.1	8.8	<0.05
	C	3.1 ± 0.2	3.2 ± 0.3	3.8	<0.05
Three moves forward with exit	E	7.5 ± 0.3	6.9 ± 0.2	9.7	<0.05
	C	7.5 ± 0.2	7.2 ± 0.3	3.5	<0.05

Table 2. Influence of experimental methods on the formation of the principal components of boys' coordination skills

## Discussion

Successful formation first-graders' coordination abilities conditioned taking into account features of their physical development and principles of physical training, individualization of the process using elements of choreography, combined with the process of formation choreographic skills with special motor training.

## Conclusions

Analysis revealed a significantly higher growth of indexes in the experimental group than in the control group. Pedagogical experimental intervention confirmed effectiveness of using choreography with the purpose of promoting the formation of the main components coordination abilities in first-graders.

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# Technical preparation of young elite gymnasts

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### ABSTRACT

**PURPOSE:** This paper presents the use of a battery of tests to estimate specific technical preparadness level of young athletes and how their skills improve during longer periods of training. **METHODS:** The test was applied three times with six months inbetween each. The participants were nine female gymnasts, aged 10-12 years. The results differences were calculated using the repeated measurements ANOVA. **RESULTS:** The gymnasts have shown a significant improvement in the springs ( $p=0.03$ ) and SNG ( $p=0.01$ ) tests. Other results did

not show any significant improvement between the first and third testing point. **CONCLUSION:** This study showed a battery of tests, consisting of movements specific to artistic gymnastics, which are fundamental for acquiring more complex movements. They can be used to estimate technical preparedness level of young female gymnasts.

**Key words:** artistic gymnastics, testing, training, girls

## Introduction

Artistic gymnastics is an Olympic sport that has a long tradition in many parts of the world. It is practised by men and women and pertains to the category of conventional aesthetic sports (Milanović, 2013). It is a physically very demanding sport which requires high levels of strength, agility, endurance and coordination, as well as spatial awareness (Živčić, 2007). Many agree that involvement in gymnastic training can contribute significantly to the all-around development of a child (Sloan, 2007). Alertness, precision, daring, self-confidence and self-discipline are mental traits that can also be developed through gymnastics (Loken & Willoughby, 1977).

The sport is divided into men's and women's artistic gymnastics. Because of gender differences, men compete on six different apparatuses and women on four. Physical conditioning is important in artistic gymnastics to structure fundamental technical prerequisites for exercises on various apparatuses (Mellos et al, 2014).

To achieve high performance in artistic gymnastics, young gymnasts need to develop complex motor coordination that is associated with technical accuracy, strength, endurance, speed, flexibility and persistence needed to withstand long hours of training (Nunomura & Oliveira, 2013). All of these skills are needed so that a young gymnast can successfully acquire technical skills specific to gymnastics. These technical skills are later used as technical preparation for learning even more complex elements.

In order to evaluate level of technical preparedness of young gymnasts, the Croatian Gymnastics Federation organizes trials twice a year. These trials test the ability of young gymnasts to execute gymnastic elements that are considered fundamental for learning and mastering more complex movements. It was our goal in this research to gather information about how the young gymnasts' technical preparedness improves over time and to compare levels of technical fitness of gymnasts from different clubs.

## Methods

This research was conducted on a sample of nine female artistic gymnasts, aged 10-12 years. The girls tested are the very best gymnasts of their age in Croatia.

Height	137.44 ± 7.73 (128 - 148)	138.89 ± 7.77 (130 - 150)	142.33 ± 8.26 (134 - 154)
Weight	31.22 ± 6.57 (24.2 - 40.6)	32.91 ± 6.64 (25.9 - 41.9)	34.64 ± 7.78 (26.7 - 45.5)

Table 1. Gymnasts' body height and body weight data

They were tested by 14 different tests which are typically used to assess the physical fitness level necessary for artistic gymnastics. The same tests were conducted three times with six-month intervals inbetween. The tests are listed in the table below.

No.	Variable	Variable description	Test description
1.	Springs	Front uprise	Conected uprises on the lower bar TIME
2.	SZUS	Front uprise back swing to handstand	Legs together or straddle to stand NUMBER
3.	ZUS30	Swings to handstand in 30 s	Legs together or straddle to stand NUMBER - TIME
4.	IUSNT	Handstand hold on the floor	Legs together (no walking) TIME
5.	SNG	Press handstand on the beam	From straddle L on the beam, only straight arms and legs! NUMBER
6.	5VEL	5 giants	On the uneven bars
7.	5SNUM	5 standig back tucks	Every somersault must be done in a line
8.	5PRS	5 straddle jumps	Standing, feet to chest, hips inward, knees facing up

Table 2. List of tests with their names and descriptions

The testing was done by the professional gymnastic coaches. The test results were standardized and shown on point scales from 1-5 or 1-10 for some tests. The data were analyzed using the repeated measurements ANOVA.

## Results and discussion

The main results are shown in Table 3.

Variable	September 2016	February 2017	August 2017	F	p
	M±SD (min-max)	M±SD (min-max)	M±SD (min-max)		
Springs	8.67 ± 1.94 (5 - 10)	9.89 ± 0.33 (9 - 10)	9.89 ± 0.33 (9 - 10)	4.57	0.03
SZUS	2.56 ± 2.40 (0 - 8)	3.22 ± 3.23 (0 - 10)	2.89 ± 2.71 (0 - 7)	0.28	0.76
ZUS30	6.67 ± 1.80 (4 - 9)	7.56 ± 1.59 (5 - 10)	7.00 ± 2.29 (3 - 10)	1.05	0.37
IUSNT	5.56 ± 3.09 (0 - 10)	4.78 ± 3.67 (0 - 10)	5.56 ± 3.40 (1 - 10)	0.26	0.77
SNG	3.56 ± 1.67 (1 - 5)	5.78 ± 3.03 (1 - 10)	6.89 ± 3.48 (1 - 10)	5.80	0.01
5VEL	3.00 ± 1.80 (0 - 5)	4.56 ± 2.51 (1 - 10)	3.67 ± 1.00 (2 - 5)	5.48	0.27
5SNUM	3.44 ± 1.49 (0 - 5)	3.56 ± 0.88 (2 - 5)	3.94 ± 0.58 (3 - 5)	0.62	0.31
5PRS	3.83 ± 1.58 (0 - 5)	4.28 ± 0.71 (3 - 5)	4.33 ± 0.43 (4 - 5)	0.68	0.52

Table 3. Descriptive statistics and ANOVA results

Most of the tests did not show significant differences between the girls. The tests that showed a statistically significant difference in results between the gymnasts were springs and SNG. A post-hoc analysis was done on those variables to further explain how the results changed from the first to the last testing point.

Variable	1 - 2	1 - 3	2 - 3
Springs	0.56	0.56	1.00
SNG	0.12	0.01	0.84

Table 4. Post-hoc analysis

In the springs test the girls showed a significant improvement. As an exercise which requires a firm and stable body position while executing an element which is fundamental for later progress, this test is very important. Although it is worth noting that in the second and third phase of testing the results showed almost no variance. Namely, almost all the girls got the maximum score in this test which raises the question if it should maybe be modified for better sensitivity in the future. The SNG test is also very important for it requires the gymnast to be mobile and strong at the same time. The press to handstand is one of the key elements in specific gymnastic conditioning. The girls got better at this skill and this indicates that their coaches pay a lot of attention to this movement during training.

The SZUS, ZUS30, 5VEL, 5SNUM and 5PRS tests showed a small increase in results between the first and third testing. The IUSNT test showed stagnation in scores. As the handstand is the key body position that is performed on every apparatus, the coaches should put more emphasis on perfecting it.

It has to be said that the third testing was held after the summer holidays which means that the girls were not at the best of their abilities. Another factor that should be taken into account is that after many hours in the sea, their skin got softer, which makes it a lot harder to perform some elements especially on the parallel bars. Also, the tested girls were around 11 years of age and some of them have reached their peak growth velocity, which we know has a negative impact on athletic ability (Vuković, 1999). All of this should not be neglected when interpreting the results.

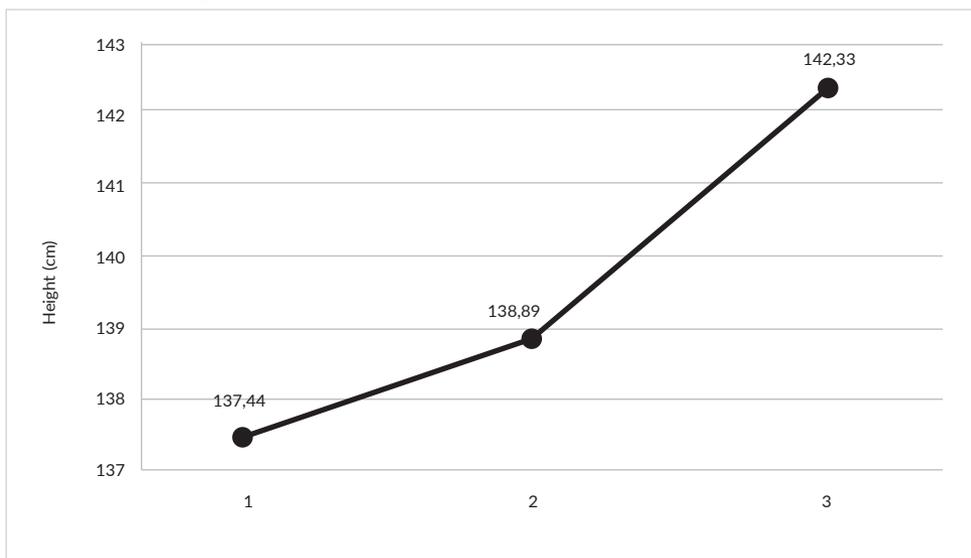


Figure 1. Peak growth velocity

Overall, the test battery showed that the girls improved their technique in the tested elements. Some of the tests showed little or no improvement, which should be a warning for the coaches to work more on these elements. Numerous factors have an impact on the final test results and should all be taken into account before bringing any conclusions about the needed changes.

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# Basic physical preparation of young gymnasts

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## **ABSTRACT**

**PURPOSE:** This study provided an example of test battery assessing level of physical preparedness of young female gymnasts and of how their abilities change during a training period of one year. **METHODS:** Nine female gymnasts, aged 10-12 years, were tested using 14 different tests for estimating their physical fitness level. The testing was repeated three times with periods of six months inbetween each testing. **RESULTS:** The girls got significantly better in the SIP, IUPNR, Sprint, IUOIP, CNJN, Splits and Forward Bent tests ( $p < 0.05$ ). Other tests showed no significant improvement. **CONCLUSION:** This battery of tests has proven to be a useful tool for assessing the development of skills which are required in artistic gymnastics. Factors such as girls reaching their peak growth velocity and at which phase of physical preparation the testing takes place can affect the results. If all of these factors are taken into account when interpreting the results, coaches can get a clear picture of their gymnasts progress.

**Key words:** artistic gymnastics, tests, girls

## **Introduction**

Gymnastics is a sport which was part of the first Ancient Olympic Games and since then has been practiced around the world in many different forms. Artistic gymnastics is a sport in which aesthetically shaped acyclic structures are valued according to the prescribed convention of movements which are defined by the Code of Points (Živčić, 2000). It is an excellent mechanism for teaching basic motor skills and promoting health-related fitness in children of all ages (Coelho, 2010). Also, it combines physical skills such as body control, coordination, dexterity, gracefulness and strength with tumbling and acrobatic skills, all performed in an artistic manner (Strauss, 2018).

In women's artistic gymnastics there are four competitive events: vault, uneven bars, balance beam and floor exercise. Each of the four require a lot of skills that are fundamental to all gymnastic movements. Gymnasts are characterized by very high levels of strength, power, flexibility and muscular endurance combined with speed and coordination (Jemni et al. 2006). All of these are basic prerequisites for successful learning and mastering of different gymnastic techniques.

Artistic gymnastics is a specific sport regarding the age at which children can join (Kunješić, 2012). If a child is considered capable by a coach, it can start training at the age of four, and by the age of six it already trains four times a week (Šolja, 2014). Girls at the age of 10 years already train six days a week for two to three hours a day and perform difficult elements that require a high level of physical fitness.

For prosperous young gymnasts the Croatian Gymnastics Federation organizes physical and technical fitness trials twice a year. These trials are intended to test the basic physical

fitness of 10-12 year old gymnasts. In this research we have compared the test results of nine girls through three testing cycles with a goal to see how their test results have changed over a year of training. Furthermore, we are interested to see which test would show the most variability between girls.

## Methods

This research was conducted on a sample of nine female artistic gymnasts, aged 10-12 years. The girls tested are the very best gymnasts of their age in Croatia.

	September 2016	February 2017	August 2017
Height	137.44 ± 7.73 (128 - 148)	138.89 ± 7.77 (130 - 150)	142.33 ± 8.26 (134 - 154)
Weight	31.22 ± 6.57 (24.2 - 40.6)	32.91 ± 6.64 (25.9 - 41.9)	34.64 ± 7.78 (26.7 - 45.5)

Table 1. Gymnasts' height and weight data

They were tested by 14 different tests which are typically used to assess the physical fitness level necessary for artistic gymnastics (HGS, 2015). The same tests were conducted three times with six-month intervals inbetween. The tests are listed in the table below

Number	Test	Test name	Test description
1.	SIP	L-sit to V-sit from hang	Swedish ladder (on the border between two ladders), no time limit, legs straight, NUMBER
2.	ZGN	Overhand grip pull-ups	In 30 sec (on the swedish ladder), straight body and legs, NUMBER - TIME, the number of pull-ups can equal the number of points
3.	SIV	V-sit from hang	On the swedish ladder in 30 sec with straight legs; must touch the bar NUMBER - TIME
4.	UBN	Rope without legs	5m from straddle sit, legs straight and must not do "scissors" TIME
5.	IUPNR	L-sit hold on paralleltes	With a 1kg weight (tied to the legs), legs must not be under bar height TIME
6.	Sprint	Sprint	Sprint 20m with jump in to pit TIME (2 attempts, better result counts)
7.	IUOIP	Front and side leg hold	Both legs, hold has to last at least 3 sec, hold a bar or beam but no body tilt
8.	SUV	High jump	Standing high jump METER
9.	CNJJN	One leg squat	In 30 sec (on the floor) hands and otherleg must not touch the ground NUMBER-TIME
10.	Splits	Splits	20cm above the floor, measured in still position held at least 10 s METER
11.	Bridge	Bridge	Evaluated according to the scheme
12.	Forward Bent	Forward bend	Forward bend while standing on a block (legs straight), hold a stick and bring it as lower from feet level as possible
13.	Shoulder circles	Shoulder dislocate with under - and overhand grip	Lying down face down and holding a stick with both hands as narrow as possible bring the stick from front to back
14.	KRUNO	Leg circles	From standing supportwith oneleg in front (foot above pelvis height), circle through lateral to back position (maintain foot height) evaluation is done by estimating deviation from ideal movement

Table 2. List of tests with names and descriptions

The testing was done by the professional gymnastic coaches. The test results were standardized and shown on point scales from 1-5 or 1-10 for some tests. The data were analyzed using basic descriptive statistic methods and the repeated measurements ANOVA.

## Results and discussion

The main results are shown in Table 3.

Variable	September 2016	February 2017	August 2017	F	p
	M±SD (min-max)	M±SD (min-max)	M±SD (min-max)		
SIP	6.22 ± 2.28 (2 - 9)	7.89 ± 1.76 (5 - 10)	7.56 ± 2.01 (4 - 10)	7.00	0.01
ZGN	8.78 ± 1.86 (6 - 10)	8.78 ± 1.48 (6 - 10)	8.89 ± 1.36 (7 - 10)	0.06	0.16
SIV	8.67 ± 0.87 (7 - 10)	8.56 ± 1.01 (7 - 10)	8.22 ± 0.83 (7 - 9)	2.08	0.37
UBN	7.22 ± 3.35 (0 - 10)	9.56 ± 1.33 (6 - 10)	8.33 ± 2.06 (5 - 10)	3.41	0.06
IUPNR	3.56 ± 2.01 (1 - 7)	3.56 ± 1.51 (2 - 7)	4.89 ± 1.97 (2 - 8)	4.27	0.03
Sprint	6.56 ± 2.96 (1 - 10)	9.67 ± 0.50 (9 - 10)	9.89 ± 0.33 (9 - 10)	11.16	0.00
IUOIP	3.56 ± 0.77 (2.5 - 5)	4.22 ± 0.62 (3 - 5)	3.19 ± 1.27 (1 - 4.5)	8.72	0.00
SUV	5.33 ± 1.50 (4 - 9)	5.44 ± 1.33 (3 - 8)	5.89 ± 1.17 (4 - 8)	1.60	0.23
CNJJ	6.22 ± 2.00 (2.5 - 9)	6.56 ± 1.33 (5 - 9)	7.22 ± 1.50 (4 - 9)	3.73	0.05
Splits	7.33 ± 2.92 (2 - 10)	6.00 ± 2.87 (1 - 9)	6.60 ± 2.82 (2 - 9.4)	5.04	0.02
Bridge	4.78 ± 0.44 (4 - 5)	4.56 ± 0.73 (3 - 5)	4.44 ± 0.53 (4 - 5)	1.93	0.18
Forward Bent	4.67 ± 0.50 (4 - 5)	4.33 ± 0.71 (3 - 5)	2.67 ± 0.71 (2 - 4)	62	0.00
Shoulder circles	2.17 ± 1.30 (1 - 5)	2.39 ± 1.65 (0 - 4.5)	2.17 ± 1.62 (1 - 5)	0.39	0.68
KRUNO	3.78 ± 0.75 (2 - 4.5)	3.72 ± 0.44 (3 - 4)	4.06 ± 0.68 (2.5 - 4.5)	0.75	0.49

Table 3. Descriptive statistics and ANOVA results

Most of the tests showed the significant differences between the testing points, which means that they had improved their abilities. Although some tests did not show statistically significant differences, we can still say that the girls improved a little in those skills as well. The tests that showed the statistically significant differences in the results between three testing points were: SIP, IUPNR, sprint, IUOIP, CNJN, splits and forward bent. The post-hoc analysis was done on those variables to further explain how the results changed from the first to the last testing.

Variable name	1 - 2	1 - 3	2 - 3
SIP	0.01	0.04	1.00
IUPNR	1.00	0.07	0.07
Sprint	0.00	0.00	1.00
IUOIP	0.05	0.50	0.00
CNJN	1.00	0.05	0.28
Splits	0.02	0.30	0.52
Forward Bent	0.31	0.00	0.00

Table 4. Post-hoc analysis

In the SIP test the girls improved significantly. This specific exercise is one of the best indicators of core and hip strength and is considered to be an irreplaceable part of conditioning for young gymnasts. Results also show a significant improvement in the IUPNR test, which is a good indicator of hip strength and endurance. The girls have also shown significant improvements in the sprint and CNJN tests, which predominantly assess lower body speed and strength. This is very important because three of the four apparatus that make up the women's all-around are leg dominant. The elements in these events are mostly jumps and leaps. The IUOIP, splits, bridge and forward bent tests showed lower results in the third testing than in the first testing. A possible explanation could be that the girls were at the peak growth velocity phase in their development (Figure 1). Research suggests that this has a negative impact on overall athletic ability of children (Vuković, 1999).

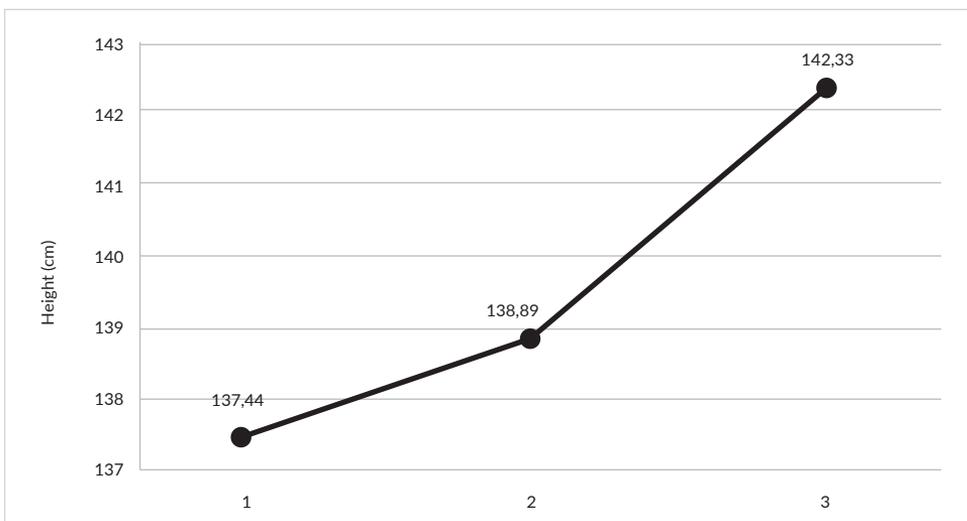


Figure 1. Peak growth velocity

It is important to state that the third testing phase was held in August, after the girls were at their summer break from training. Because of this, stagnation of physical ability between the second and third testing is understandable and should be taken into account when interpreting the results.

In conclusion, we can say that the girls improved their basic physical fitness level. Especially when we take into account the summer break and the peak growth velocity that affected the results. Some tests that have shown little difference in results between testing should maybe been modified.

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# Differences between two types of community and preschool environment on children's motor skills and abilities

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## **ABSTRACT**

**PURPOSE:** Influence of the environment is an important factor in child development. The purpose of this study was to determine the differences in motor skills and abilities of preschool children attending kindergartens in two different community size environments: medium vs. large city. **METHODS:** Participants in this research were 444 preschool children from the capital, large urban city, and one medium size city. For the assessment of motor abilities and skills six tests were used from the Bruininks-Oseretsky Test of Motor Proficiency, second edition (BOT2). Besides that, two tests were adapted from the ALPHA Health-Related Fitness test-battery (standing long jump and 40m sprint test). **RESULTS:** Main results of this research show significant differences in some motor abilities and skills of children from different places of residence. Children from the capital city achieved better results in the test of alternative ball dribbling with hands ( $F=10.52$ ;  $p<0.05$ ) and in the test of running 4x10m ( $F=13.73$ ;  $p<0.05$ ). Further, girls from the medium size city were better in standing long jump ( $F=7.92$ ;  $p<0.05$ ). Previous research has shown some specificity in motor abilities of kindergarten children living in different areas, but the results were not consistent. **CONCLUSIONS:** In general, there is some evidence of small city areas benefits for motor competence. It is important to detect possible differences related to community characteristics and influence on specifically very early in the child development when implementing effective interventions for physical activity and health improvements.

**Key words:** city, motor development, physical activity

## **Introduction**

Influence of the environment is an important factor in child development. The environment full of different opportunities for children will have a positive impact on their cognitive and motor development at the earliest age (Venetsanou & Kambas, 2010). Previous research examined impact of various environmental factors on physical activity and motor competence of children, such as family's socioeconomic status, mother's educational level, father's physical activity habits, existence or absence of siblings, school physical activity related policies and time spent outdoors, preschool centers with adequate equipment and appropriate care, prosperity index of the municipality, type of housing or, for example, street traffic (Ferreira et al., 2007; Venetsanou & Kambas, 2010; Cools et al. 2011; Barnett et al. 2016).

Differences in motor performance of children in relation to physical environment or size of community was also interest of several studies (Ferreira et al., 2007; Greier, Brunner & Riechelmann, 2013). In parent's reports, availability of play spaces and frequency and time spent playing outside were very important correlates of child's physical activity (Sallis, 1993;

Ferreira et al., 2007). A few studies examining this association in children have demonstrated that time spent outdoors was associated with the observed physical activity and that preschool centers with larger indoor play areas tended to have higher step counts than centers with smaller indoor play areas (Trost et al., 2010). Research of Sallis and associates (2001) indicated a possibility that school area size, equipment availability and adult supervision could affect child's physical activity. Within the broader neighborhood, environmental factors such as living in an apartment block with a courtyard, living near a park and the age of the neighborhood were positively associated with children's independent mobility (Prezza et al., 2001).

In studies examining the relation of community or population size of the place of the residence following categories were determined: rural areas (less than 5 000 inhabitants), small city (between 5 000 and 20 000 inhabitants), medium city (between 20 000 and 100 000 inhabitants) and urban/large city (more than 100 000 inhabitants) (Greier, Brunner & Riechelmann, 2013). There were no consistent results on different communities' influence on children's movement competence. Possible negative influence of large cities include, unlike in rural areas, reduction of areas suited for movement and physical activity caused by population density and traffic. Children in rural areas have a twice as high chance of being active outdoors at least four times per week (Greier, Brunner & Riechelmann, 2013).

The purpose of this study was to determine the differences in motor skills and abilities of preschool children attending kindergartens in two different community size environments: medium vs. large city.

## Methods

Participants in this research were 444 preschool children average age of  $4.13 \pm 1.60$ . The children were divided in two subgroups by the place of residence, Zagreb ( $n=223$ ) and Virovitica ( $n=221$ ). Capital city Zagreb has around 800 000 inhabitants and will be considered as large urban city, and Virovitica has around 50 000 inhabitants and will be considered as a medium city. The parents have signed written informed consent for children's participation in research. The research was conducted in accordance with Declaration of Helsinki and was approved by Institutional Ethical Board.

Prior to motor testing, verbal information and demonstration was given to a child and he/she had one non-recorded trial. For the assessment of motor abilities and skills, from the Bruininks-Oseretsky Test of Motor Proficiency, second edition (BOT2), six tests were used. Test of Motor Proficiency has previously shown very good reliability (0.86 to 0.89) (Cools et al., 2009). Tests were standing on one leg with eyes open, standing on one leg with eyes closed, one-leg stationary hop, dropping and catching a ball – both hands, dribbling a ball – alternating hands and sit – ups. Test is suited for children from 4 up to 21 years of age and measures motor precision, motor integration, ambidexterity, manual coordination, balance, bilateral coordination, speed, agility and strength. Furthermore, two tests were adapted from the ALPHA health-related fitness test battery: standing long jump and 40m sprint test described in detail previously (De Miguel-Etayo et al. 2014).

Data was processed by Statistica software package, version 13.2. (Statsoft, Inc., Tulsa, OK, USA). Central and dispersive parameters were calculated for all variables. Analysis of variance (one-way ANOVA) and Bonferroni post-hoc tests were used for determining differences in motor skills and abilities between children of different places of residence. Level of statistical significance was set to  $p < 0.05$ .

## Results

Main results of this research show significant differences in some motor abilities and skills of children from different place of residence. Children from the capital city achieved better results in the test of alternative ball dribbling with hands (2.43 vs. 1.5;  $F=10.52$ ;  $p<0.05$ ) and in the test of running 4x10m (18.12 vs 19.49;  $F=13.73$ ;  $p<0.05$ ). Further, girls from the

medium city are better in standing long jump ( $F=7.92$ ;  $p<0.05$ ) and balance ( $F=4.18$ ;  $p<0.05$ )(Table 1). There were no other significant differences in motor skills and abilities of children in various age groups that can be attributed to different place of residence.

	Medium size city				Large urban city			
	girls		boys		girls		boys	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Horizontal jump	73.71*	23.41	76.88	25.48	63.73	28.79	73.48	32.57
Balance - eyes open	7.92*	2.98	6.87	3.28	7.03	3.47	6.94	3.49
Balance - eyes closed	3.87	2.53	3.50	2.68	4.18	2.89	3.92	2.81
Dynamic balance	20.24	15.02	17.50	13.93	18.97	15.36	19.24	16.22
Ball drop and catch	2.64	1.98	2.70	1.97	2.57	2.10	2.87	2.13
Ball dribble	1.51	1.77	1.49	1.82	2.10	3.09	2.65**	4.14
Abdominal strength	6.54	4.25	5.93	4.68	5.57	4.97	6.06	5.31
Shuttle run 4x10m	19.72	3.02	19.20	3.59	17.73**	4.07	18.44	3.95

Table 1. Results of motor skill and abilities testing in girls and boys in medium and large city

\* significantly better compared to girls in a large urban city ( $p<0.05$ )

\*\* significantly better compared to girls/boys in a medium sized city ( $p<0.05$ )

## Discussion

Main results of this research show specific motor competence profile of children living in different community size areas. Children from large urban cities were better in manipulative skills and short running with changes of directions, while in medium city areas children had some advantages in explosive power performance. Previous research has shown some specificity in motor abilities of kindergarten children living in different areas but the results were not consistent (Joens-Matre et al. 2008; Tinazci & Emiroglu, 2009; Greier, Brunner & Riechelmann, 2013; Chillón et al. 2011). In general, there is some evidence of rural and small city areas benefits to motor competence. Children from small cities generally reported higher level of physical activity (Joens-Matre et al. 2008). Rural Spanish children and adolescents had overall a healthier profile than their urban peers in terms of cardiorespiratory fitness, upper- and lower-limb muscular fitness and adiposity, while they performed worse in speed-agility and flexibility (Chillón et al, 2011). In Germany, children from rural areas achieved higher scores in explosive power and balance compared to the kindergarten children from large cities (Greier, Brunner & Riechelmann, 2013), while in Cyprus higher flexibility, muscle endurance and strength was reported for rural children (Tinazci & Emiroglu, 2009). In our study we can see some benefits of medium city place of residence for girls in explosive power test standing long jump. Over the years, the standing long-jump has become the most frequently adopted test by a variety of sports professionals to measure and evaluate athletic performance and success. We can presume that level of standing long jump performance reflects general motor competence of children worldwide, and it might be indicative in urban cities to focus on explosive power performance. It is important to detect possible differences related to community characteristics and influence specifically very early in the child development.

Environmental background play important role in physical activity of children and

consequently motor skills and ability of children as well. Parents of children in rural environments reported more space available in the garden and in the neighbourhoods, and safer neighbourhoods than parents of children in urban schools, whereas children in urban schools had more exercise equipment available at home and were transported more frequently to places where they could be physically active (Loucaides, Chedzoy & Bennett, 2004). More equipment available at home or in the child care environment was possible reason for results in our study where children in urban city had higher levels of manipulative skills. Further, more children in medium city lives in houses with larger outside spaces for free play, but the availability of organized sport programs is better in large cities.

Also, attitude toward physical activity and exercise could have influenced on observed differences. Attitude of preschool parents from Virovitičko – podravska county and Zagreb county differ (Iveković, 2017). Parents in our medium city area are more prone to let children play outdoors and in different weather conditions (Iveković, 2017). Therefore, the place of residence should be taken into account when implementing effective interventions for physical activity and health improvements.

To increase children's motor skills and physical activity in general it is important to create childfriendly communities and provide skills to safely negotiate the environmental surroundings for children (Timperio et al., 2006). The challenge for researchers and practitioners wishing to promote motor skills, physical activity and prevent obesity in preschool children is to identify what types of environments best promote regular physical activity in child care, school and home settings.

## Conclusion

This study suggests some specific relation of environment to motor skills and abilities of children. It seems that urban environment of capital city offers better surrounding for development of manipulative skills and short distance running.

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# Formation of value attitudes towards own health in the process of tourist regional work

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## **ABSTRACT**

**PURPOSE:** examine influence of tourist regional work on effectiveness of formation value attitude of older teens towards own health. **METHODS:** generalization of pedagogical experience, pedagogical experiment, interrogation (questionnaire, testing, interviewing), conversations, evaluation, pedagogical observation and experiment for examining effectiveness of developed methodology and determination of levels of formation older teens' value attitude for own health in the process of tourist regional work. Methods of calculation of integral estimates for quantitative and qualitative analyze of empirical dictates, in particular methods of mathematical statistics (Pearson criterion (method  $\chi^2$ ) and F-test) for cultivation of the research findings and interpretation results, their scientific generalization. Experimental work was conducted on the basis of Pereiaslav-Khmelnyskyi local Station of young tourists of Kyiv region, Pereiaslav-Khmelnyskyi schools № 1, 2, 5, 7 Pereiaslav-Khmelnyskyi Gymnasium Liubartsi school of I-III degrees, Kyiv region; Cherkasy secondary schools of I-III degrees № 6, 27; gymnasium in Kremenets, specialized school of I-III degrees №2, Kremenets, Ternopil'ska region; Hvardiisk study educational complex "Secondary school of I-III degrees, gymnasium" and Davydkovets secondary school of Khmelnytskyi District Council of Khmelnytskyi region. The research covered 251 elder teens. **RESULTS:** experimentally examined effectiveness of methodology of formation elder teens' value attitude for own health in the process of tourist regional work, which include: study educational content, forms, methods, methodological means and pedagogical conditions of formation researched phenomenon; it was defined criteria with indicators: knowledgeable, value-motivational, activity-behavioral and was defined levels (low, middle, sufficient, high) of formation researched phenomenon. It was defined, that in the process of implementation methodology levels of formation value attitude for own health are grown. **CONCLUSIONS:** it was found, that population growth in experimental group higher than in control. In this manner, conducting experiment confirmed effectiveness of using tourist regional work with purpose of rising level's formation in elder teens value attitude for own health.

**Key words:** intellectual, emotionally-holistic, activity-practical component, elder teens.

## **Introduction**

Attention is paid to the leading topic of educational activity of institutions different types that appears as formation of moral values, where value of health is interpreted as leading value of older teens Andriushchenko T.K (2007), Belenov V.N.(2000) Values as social problem was an object of research Schwartz SH (2001), Wagner CC, Sanchez FP. (2002),

Yezhova O.O. (2013). Values' formation of older teens as psychological problem was a subject of research Miller W. (2004), Nahin, J. Dahlhamer, B. Taylor (2007). There are a lot of works and researches dedicated to the problem of saving individual's health due to understanding by him of the value of people' live and understanding of intransitive value of health, following the healthy life style Moe EL, Elliot DL, Goldberg L, Kuehl KS, Stevens VJ, Breger RK, (2002). In scientific works found reflection the developing aspects of organization and realization of tourist regional work, activation child's creative potential in the process of such work and some historical pedagogical aspects of the problem Kravchenko T.P. (2015).

### Material and methods

Generalization of pedagogical experience, pedagogical experiment, interrogation (questionnaire, testing, interviewing), conversations, evaluation, pedagogical observation and experiment for checking effectiveness of developed methodology and determination of levels of formation of elder teens' value attitude for their health in the process of tourist regional work. Methods of computing integral estimates for quantitative and qualitative analyze of empirical dictates, in particular methods of mathematical statistic (Pearson criteria (method  $\chi^2$ ) and F-test) for processing of received results and interpretations research's results, their scientific generalization. Experimental work was conducted on the basis of Pereiaslav-Khmelnyskyi local Station of young tourists of Kyiv region, Pereiaslav-Khmelnyskyi schools № 1, 2, 5, 7; Pereiaslav-Khmelnyskyi Gymnasium, Liubartsi school of I-III degrees, Kyiv region; Cherkasy secondary schools of I-III degrees № 6, 27; gymnasium in Kremenets, specialized school of I-III degrees №2, Kremenets, Ternopil'ska region; Hvardiisk study educational complex "Secondary school of I-III degrees, gymnasium" and Davydkovets secondary school of Khmelnytskyi District Council of Khmelnytskyi region. The research covered 251 elder teens. Were made control (CG) and experimental (EG) groups, practically the same by characteristics. Lessons in control group were conducted according to the educational program. Into experimental group were introduced in educational process experimental educational program of elective course «Value of own health» and «Methodological recommendations of educational-methodical providing the process of formation elder teens' value attitude for their health at schools in the process of tourist regional work» for pupils of 7-9<sup>th</sup> forms.

### Results

In accordance to periodization of the age development the most common in modern psychology and pedagogy older teen's age – from 13 to 15 years, so mainly these are pupils of 7-9<sup>th</sup> forms Kravchenko T.P. (2015).

In the process of pedagogical research and analyzing processed data was defined and characterized own classification of components formation of value sphere of elder teens of saving and improvement own health, which are:

- *intellectual component*: accumulates in itself formation of systematic and logic knowledge appropriate it elder teens' skills and abilities about realization tourist regional work and varieties forms and events about saving and improvement their own health and denotes intellectual activity of individual in the process of cognition and activity environment;
- *emotional value component*: according to its essence represents the system of elder teens' emotional feelings about understanding the problem of formation their value orientations and the system of values and attitudes for own health, determined on their base of motivation, convictions and responsibility about participating in different forms of tourist regional work or events about saving and improvement their own health;
- *activity-practical component*: its base consists from formed skills and abilities that regulate educational-cognitive activity and elder teens' practical tourist regional work in the environment with purpose of its studying and appropriate forms and events directed at

saving and improvement their own health.

In its turn the criteria of formation elder teens' value attitude for own health in the process of tourist regional work were defined. They are:

- *Knowledgeable criteria*, indicators of which is a level, deep and thoroughness acquired by elder teens logically learned knowledge about realization tourist regional work and formation in its limits value attitude of growing personality for own health.

- *Value-motivational criteria*, indicators of which are formed value orientations of elder teens about saving and improvement their own health, their emotional attitudes as for participating in tourist regional work as in forms of saving and improvement the system of individual's values and emotional sphere.

- *Activity-behavioral criteria*, indicators of which are formed skills and practical abilities of elder teens about application acquired knowledge about realization tourist regional work and in its limits of forms and events about saving own health based on compliance health saving behavior and activity in circular or sectional activity.

In the context the last criteria of level formation elder teens' value attitude for their own health by its nature is not only reflection in their consciousness knowledge in laws, rules, ethics, but specific activities about recognized forms and rules by society. Hence, we actualized thought that criteria can't be universal because each specific educationally-behavior and social environments has its own ethics and rules and appropriate their indicators of educated growing personality.

In its turn analysis of data give basics to characterize the essence once more tendency, which confirms that implementation in practice of developed methodology of formation elder teens' value attitude for own their health in the process of tourist regional work promotes enhancing emotional perceptions by growth personality understanding its value as the most important, and such which began considered by elder teen as personal determinant all his acting, behavior and activity, which considered at saving and improvement own health. Beside this exactly emotional perception by elder teens environmental activity, history, objects of environment, ethnographic attractions of modern social cultural problems of their district as content component their tourist regional work, intensify responsibility of elder teens regarding objects of environment and their influence on state of conservation and improvement own health. They begin understand that their health it's a pledge of quality their activity in tourist regional circles, sections and squads (Competitions and games: «Assembling a bag», «Who is the first to put the tent», «The model of health», «The pathway of health»). Analyze of research's results showed fairly noticeable rising number of pupils in experimental group which achieve high level according to the value-motivational (26,32% in experimental group against 15,73% in control group. According to the activity-behavior criteria to 26,32% in experimental against 17.98% in control.

However, installed, that reduction of number elder teens on the middle, especially on low levels to 9,47% in experimental against 21,35% in control group within value-motivational and 9,47% in experimental against 16,85% in control group within activity-behavior criteria. Such tendency according to our thoughts confirm effectiveness proposed educational study forms and methods of formation elder teens' value attitude for own their health in the process of tourist regional work. Thereby ensuring: extrapolation in consciousness of elder teen moral ethics and his acting, moves and activity with preservation own health; taking into account individual features in growing personal development, getting the system of knowledge and worked out skills and practical abilities with preservation and improvement own health as determinative system-forming factor of formation elder teen's value sphere. In aggregate all this is a positive consequences of implementation in practice the methodology of formation elder teens' value attitude for own health in the process of tourist regional work.

For checking getting results according to the Pearson criteria and making the last conclusions we used for experimental indicators of F-test. This criterion is universal, but it is the most powerful instrument exactly in the process of analyzing one sample in the different conditions, before and after experiment. F-test was used only for experimental group. Elect criteria give the possibility to appreciate credibility of differences between percent parts of two samples. It's important to admit, that our sample is full of joining, as measures were made before and after experiment. In general, the essence of F-test (it is also called Fisher corner transformation) is to transform percent part in the indicator of central corner, which, as we see, measure in radians. More percent part is suitable bigger corner, and lower percent part – lower corner, but relation here isn't linear.

Also, we put forward zero and alternative (H1) hypothesis. Zero hypothesis is that influence of implemented methodology on the level of value attitude of elder teens for own health in the process of tourist regional work is insignificant and didn't bring desirable result. As opposed to, alternative hypothesis is that implemented methodology of formation value attitude of elder teens for own health in the process of tourist regional work bring desirable result, thus will rise a level of formed researched phenomenon.

So, detailed analyze and mathematical calculations according to the F-test certificated, that implemented methodology gave desirable result, so the level of value attitude of elder teens for own health in the process of tourist regional work is raised, and getting results are reliable at the level of significance 0,05 (with probability 95%). Results of calculations present on graphic (p. 1), where: 3 – knowledgeable criteria, VM – value-motivational, AB – activity-behavior criteria.

Analyzing graphic, presented on picture 1, we can make such conclusions, that in the result of experiment quantitative size of teens on the low level is decreased, and on the high level essentially raised. Quantitative sizes of middle and sufficient levels, unfortunately graphically can't show all effect because these levels are intermediate between low and high. Such conclusions we can make, proceeding from that on graphic straight line – its critical meaning of Fisher. Estimated indicators of high and low levels situated above this line.

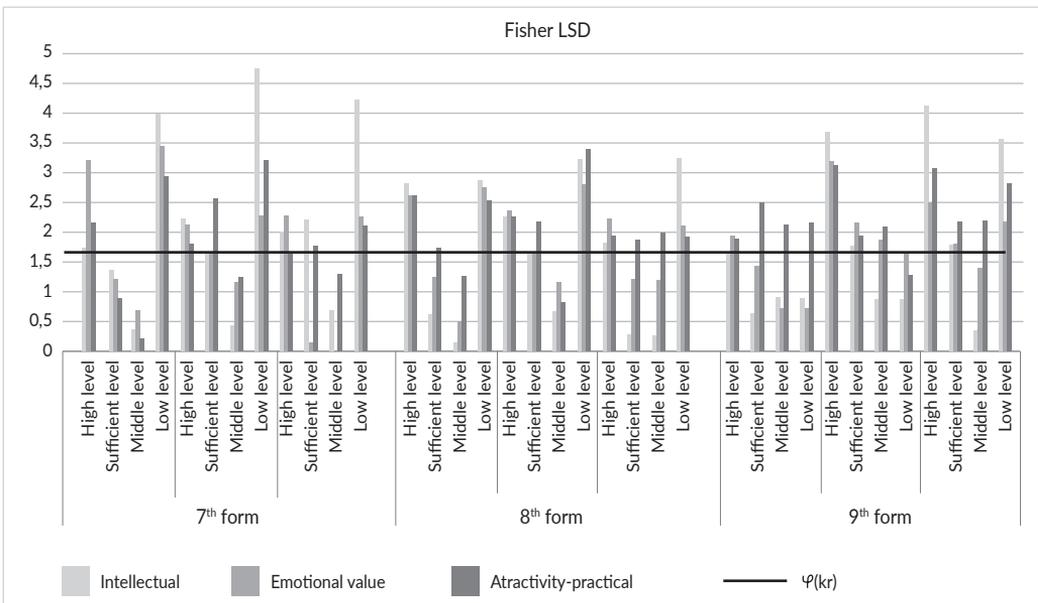


Figure 1. The results of calculations effectiveness of methodology on the level

So, formation older teenagers' value attitude for own health in the process of tourist regional work is considered as one of effective elements of growth personality in socialization and at one time as the most important characteristic of subject's activity, that develop in unity with reproductive process of cognition by themselves the nearest environment in manifolds ties and interdependence. According to the results conducted research, in aggregate, it provided the conditions of transfer from simple perception and contemplation by individual environmental reality, from simple its reproduction to heuristic and creative understanding problems of preservation and improvement own health and finding own «I» and its place in educational study environment of institutions and directly in environment as base specific features of a process self-knowledge and self-affirmation of growth personality.

It was installed, that intensity of this process directly pro rata link with the level of formation the base culture of personality and also as one of its elements – value attitude for own health. Unlike the subject with low level of formed this important personal category activity of which directed at the simple reproduction by itself in its conscience and results activity need of preservation own health in the process of realization studying tasks of tourist regional direction, subject with high level of formation value attitude for own health directed at improvement itself in unity with feelings and conviction in necessity its preservation and improvement.

### **Discussion**

Success of formation older teens' value attitude for own their health predetermined of development their value sphere and formation value of health, using elements of tourist regional work, joining the process of formation knowledge about value of health and practical implementation them in life.

### **Conclusions**

In the process of analysis conducted pedagogical experiment was detected, that increase of indicators in experimental group a lot higher than in control. So, conducted pedagogical experiment confirmed effectiveness of application tourist regional work with purpose of raising the level of formation older teens' value attitude for own health.

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# Usefulness of simultaneous measurement of heart rate and blood pressure for the reliability evaluation of the modified Ruffier's "test"

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## **ABSTRACT**

**PURPOSE:** Repeatability of simultaneous measurement of heart rate (HR) and blood pressure (BP) during a modified Ruffier's test in compliance with the conditions for determining its reliability was examined. **METHODS:** 30 students of the School Master of Sports were investigated twice. The measurements were separated by a 9-day intermission. Students performed a modified Ruffier's test with simultaneous measurements of HR and BP. Each measurement was carried out in a sitting position: at rest, immediately after the test completion and three minutes after the completion of the test. Heart rate was measured over 15 s and the result was multiplied by 4, whereas the arterial blood pressure (BP) was measured by the Korotkov method. A spring sphygmomanometer with a deflated cuff was placed on the arm of the subject tested throughout the test. The test consisted of 30 full squats performed in 30 s with the maximally flexed legs in the knees and the feet shoulder-width apart. When obligatory time of the test (30 s) was exceeded, 0.1 point was added to the outcome of the test for each second extra. The physician and the nurse simultaneously measured using the phonendoscope. The data were processed by the descriptive statistics: arithmetic mean, standard deviation, correlation coefficients. **RESULTS:** Immediately after the exertions there were high correlations between HR and scores of Ruffier's (0.814 and 0.879). Slightly higher values of HR on average have been recorded during the second measurement, which resulted in the increased Ruffier's index (from 6.7 to 7.4). Likewise, systolic (BPs) and diastolic (BPd) blood pressure measured in the same conditions were correlated (0.890 and 0.932) with the Ruffier's index. A similar trend was observed 3 minutes after the test – correlations were 0.839 and 0.750. In the Ruffier's test verification it was found that: the higher the BPs and the BPd, the lower the Ruffier's indexes. Very low values of BPd recorded in few cases immediately after the test were responsible for the elevated Ruffier's index. **CONCLUSIONS:** 1. A high level of reliability of the modified Ruffier's test found on the basis of measurements of HR and BP allows a more accurate assessment of the state of preparation of the cardio-vascular system to the effort and provides the basis for a fair interpretation of the results of the test. 2. It is recommended to use the described modifications of Ruffier's test for the assessment of the cardiovascular system performance in preparation for the effort, and at the same time, the health of athletes in the training process, and especially – in the qualifications of candidates to sports.

**Key words:** students, phonendoscope, spring sphygmomanometer, correlation, performance

## **Introduction**

The Frenchman James-Edward Ruffier (1875-1964), a medical doctor, introduced the efficiency test indicating the status of heart fitness for effort to medical research on athletes at the Military School of Fencing and Martial Arts in Fort Antibes in the year 1945. After five years, J. Dickson made the first modification of Ruffier's test (Dickson, 1950). In the medical and sports literature currently there are about 20 modifications to this test and all of them only measure heart rate (HR). Researchers working on adapting the sample to a variety of disciplines: M. Bytniewski (2003), S. Sulisz, T. Ulatowski, S. Pilicz, W. Starosta (2002), W. Timoshenkov (2002), E. Gajewska, K. Gliniewicz, P. Chmiel, S. Tuzinek, H. Lamers, A. Wasiluk. Modified were a run-time test, the number of performed squats, sometimes half-squats and their performance techniques, body position when measuring HR, time of HR measuring, and diversity of scales of ratings a numeric result obtained in a trial. In available literature the authors have not found any reliability and validity studies of the test, probably due to many of its varieties.

In our studies, conducted annually for the last 25 years, collected the material from the study of young people qualified to study in master school of sport (Anioł-Strzyżewska, 2010). About 1400 people has been tested. Performed was 42 anthropometric measurements, the medical examination and the resting ECG, spirometry, and the last test was the exercise Ruffier's test. Because the subjects were qualified to rowing-persons have been reported with high growth and substantial weight. It was noted that many candidates had a high heart rate and blood pressure in conditions of rest, often-obesity, and in interviews of family hypertension. For a more precise qualifications for the sport in terms of performance of the cardiovascular system heart rate measurement in an attempt to Ruffier's test added measurements of blood pressure tested by sphygmomanometer, performed at the same heart rate measurement. Assumed that version of trial to Ruffier's test: 30 squats in 30 seconds with all the measurements of heart rate (HR) and blood pressure (BP) performed in the sitting position. HR were measured over 15 s and the results was multiplied by 4, arterial blood pressure was measured using Korotkov method. A spring sphygmomanometer with a deflated cuff was placed on the arm of the subject and worn throughout the test. The test contained 30 full squats performed during 30 s with a maximum flexed legs in knees and feet extended on the width of the shoulders. When obligatory time of the test (30s) was exceeded, by each second 0.1 point was added to the normal outcome of the test. The physician and the nurse simultaneously measured using phonendoscope.

Measurements were performed at rest, immediately after 30 squats, and 3 minutes after the completion of the effort. Priority was execution of all 30 squats, whereas time (30 s) was secondary. It was decided, that test modified in this way will be investigated in the terms of reliability. Repeatability of the simultaneous measurement of HR and BP during a modified Ruffier's test performance in compliance with the conditions for determining its reliability was examined.

## **Methods**

Thirty students of the School Master of Sport were investigated twice. The measurements were separated by a 9-day intermission, which was too short for the establishment of training progression. They were not forewarned about the date, or on the character of the study - the modified Ruffier's test according to the above requirements, with the simultaneous measurement of HR and BP. Both times the measurements were performed individually, in the doctor's office, from 9.00-13.00.

The statistical analysis consisted of the computation of arithmetic mean, standard deviation and correlation coefficients.

	Age (y)	Body height (cm)	Body weight (kg)
$x \pm SD$	$15.00 \pm 0.61$	$177.6 \pm 7.41$	$69.3 \pm 12.81$

Table 1. Characteristics of students (n = 30)

## Results

Heart rate measured immediately after the completed effort in both terms was highly compatible with the results obtained in the sample ( $r = 0.814$  and  $r = 0.879$ ) (Fig. 1)

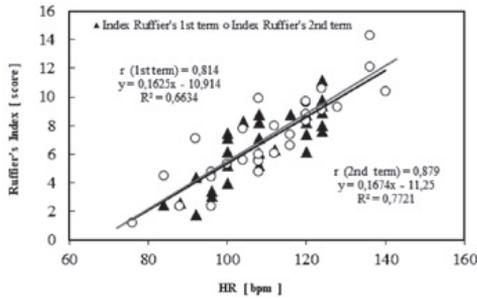


Figure 1. The relationships between HR in the 1<sup>st</sup> minute post exercise and scores of Ruffier's Index in the 1<sup>st</sup> and 2<sup>nd</sup> term

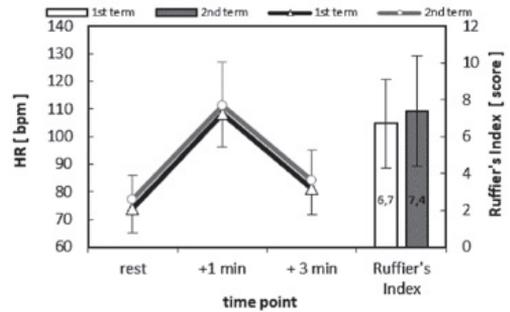


Figure 2. Changes in HR during Ruffier's test resulted in changes of the Index in the 1<sup>st</sup> and 2<sup>nd</sup> term (mea $\pm$ SD)

Slightly higher HR values recorded in the second term increased their Ruffier's index from 6.7 to 7.4 points (Fig. 2).

Changes in the value of systolic and diastolic BP during the Ruffier's test are shown in Fig. 3.

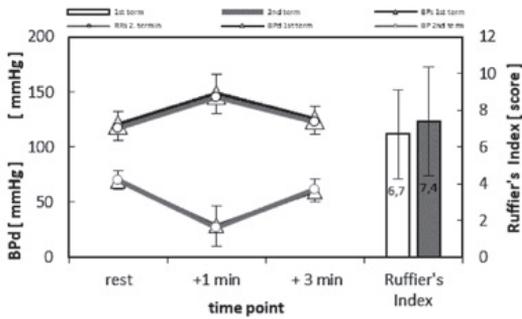


Figure 3. Changes in BPs and BPd during Ruffier's test and results of Ruffier's Index in the 1<sup>st</sup> and 2<sup>nd</sup> term (mean±SD).

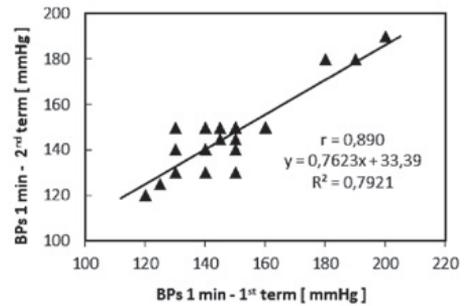


Figure 4. The relationships BPs of the 1<sup>st</sup> minute post exercise in the 1<sup>st</sup> and 2<sup>nd</sup> term

The values of BP highly correlated in both terms of research. Immediately after the test the correlation coefficient systolic was 0.890 BPs (Fig.4), and after the third minute 0.839 BPs (Fig. 5).

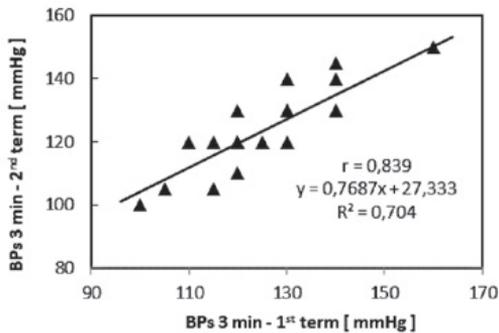


Figure 5. The relationships of BPs of the 3<sup>rd</sup> minute post exercise in the 1<sup>st</sup> and 2<sup>nd</sup> term.

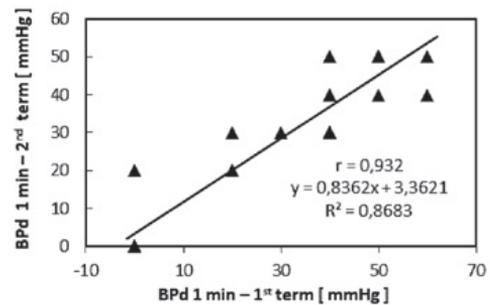


Figure 6. The relationships of BPd of the 1<sup>st</sup> minute post exercise in the 1<sup>st</sup> and 2<sup>nd</sup> term.

For diastolic BP ratios were: immediately post-exercise 0.932 (Fig. 6) and 3 minutes post-exercise 0.750 BPd (Fig. 7).

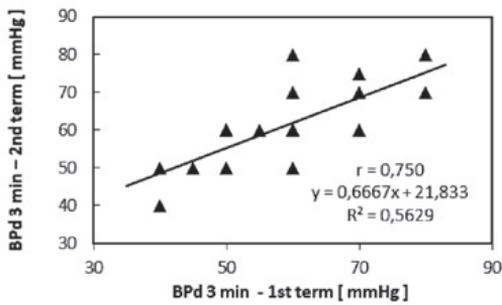


Figure 7. The relationships BPd of the 3<sup>rd</sup> minute post exercise in the 1<sup>st</sup> and 2<sup>nd</sup> term.

The results obtained in two attempts of Ruffier's test allowed to state the following relationship: the higher the systolic and diastolic BP in the first minute after the test, the lower the rate of Ruffier's test (Fig. 8, 9).

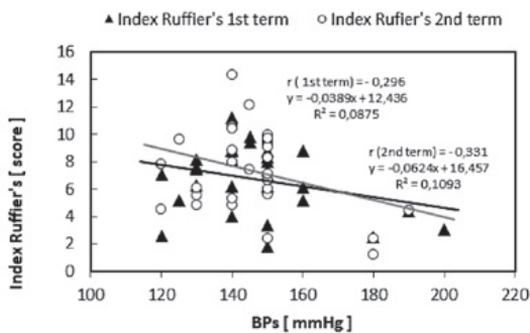


Figure 8. The relationships BPs of the 1<sup>st</sup> minute post exercise and scores of Ruffier's Index in the 1<sup>st</sup> and 2<sup>nd</sup> term.

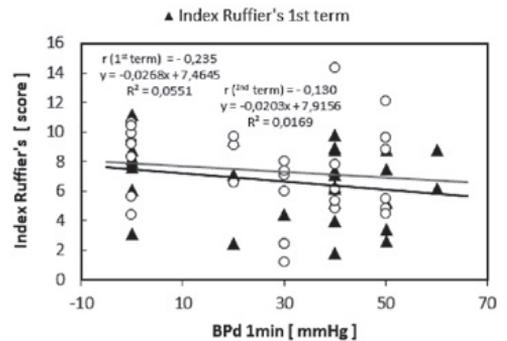


Figure 9. The relationships BPd of the 1<sup>st</sup> minute post exercise and scores of Ruffier's Index in the 1<sup>st</sup> and 2<sup>nd</sup> term.

In a few cases "zero" diastolic pressure was found measured immediately after the trial, which was characterized by a person with a high Ruffier's Index.

## Discussion

The observed average HR spike immediately post exercise in both terms of research was almost identical (2.8 beat/min) and was long seen as an exponent of the functional capacity of the cardiovascular system.

Systolic and diastolic BP values, however, measured simultaneously with HR, showed, on average, in both terms a slight difference between the absolute values: 1.7 mm Hg for systolic and 1.4 mmHg for diastolic (Tab. 2).

Parameter		1. term	2. term
HR [ bpm ]	rest	73,3 ± 8,51	77,1 ± 8,99
	1 min	108,4 ± 12,18	111,2 ± 15,67
	3 min	81,1 ± 9,33	84,1 ± 11,14
BPs [ mmHg ]	rest	119,8 ± 12,14	117,3 ± 10,96
	1 min	147,5 ± 18,46	145,8 ± 15,82
	3 min	124,7 ± 12,45	123,2 ± 11,41
BPd [ mmHg ]	rest	69,7 ± 7,30	70,0 ± 8,20
	1 min	28,7 ± 21,29	27,3 ± 19,11
	3 min	60,0 ± 10,91	61,8 ± 9,69

Table 2. Arithmetic mean and standard deviation of HR, BPs, BPD

The resulting better (lower) result in a sample of Ruffier's test was dependent on the higher blood pressure, both systolic and diastolic, measured immediately after the attempt. In both terms the value of "zero" diastolic blood pressure was found several times in the participants with labile nervous system. The results of heart rate, systolic and diastolic in both test dates, shown in the figures, in relation to the Ruffier's index may constitute about fairness of the trial.

## Conclusions

1. A high level of reliability of the modified Ruffier's test found on the basis of measurements of HR and BP allows a more accurate assessment of the state of preparedness of the cardio-vascular system for effort and provides the basis for a fair interpretation of the results of the test.
2. It is recommended to use the described modification of Ruffier's test for the assessment of the level of performance of the cardiovascular system in preparation for the effort, and at the same time, the health of a athletes in the training process, and especially-the qualifications of candidates to sports activities.
3. More than 70 years have passed since the publication of the Ruffier's trial, found at least 20 modifications only in heart rate, and our observations lasted continuously for 25 years, hence in obtaining such high correlation to ask for recognition of measurements blood pressure as a parameter of the lifting the value significantly for performance evaluation of the cardiovascular system.
4. On the basis of the studies, we find that the Ruffier's trial can be called Ruffier's Test.

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# The challenge of running

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## ABSTRACT

Movement, one of the basic human needs, has become a great challenge for all age groups in contemporary society. Many studies showed correlation between physical inactivity and many noncontagious diseases, while physical activity, especially natural movements such as walking and running, proved being useful in maintenance of optimal psycho-physical health status. Walking, the movement learnt in the earliest life stage, and running, a somewhat more complex aerobic activity, are irreplaceable forms of physical exercise in almost all models of recreational sport due to their applicability, effectiveness and simplicity. Many recreational associations started different projects with the health promotion goal. One of them is the so called "running school" which makes popular training models available to almost everyone. A great number of running schools that are ever more popular throughout the world is evident in the increasing numbers of recreational runners. It is exactly this type of physical activity promotion and awareness raising on its usefulness that make running schools top recreational projects in Croatia as well.

**Key words:** recreational program, health promotion, training model, running school

## Introduction

Walking and running are the most appropriate forms of recreational exercise at every life stage (Babić, 2010). Availability and effectiveness of walking and running, as well as relatively low costs of these forms of recreational exercise contribute to their popularity regarding psycho-physical health promotion. Physical inactivity, on the one hand, and increased calorie-intake, on the other, lead to the activation of pathophysiological mechanisms and development of chronic noncontagious diseases (Biswas et al., 2015). Walking is easy, effective, and safe and is ever more popular injury-low-risk aerobic activity, effective for all age groups and training levels as well as for pregnant women (Babić, 2010). Many research studies have proven usefulness of walking and running, which as aerobic activities have a positive influence on physical and mental health, act preventively on cardiovascular and respiratory diseases, diabetes type 2, high blood pressure and obesity, decrease stress and depression, activate the whole body muscles, increase circulation and improve bone density.

In their "National walking program", Costa Branco et al. (2015) investigated advantages of physical activity, one of them being influence of physical activity on depression symptoms in older age. The results of this study, after six months of the walking program implementation, showed improvement in overall health status of older individuals, including decrease of depression symptoms and anthropometrical measures, as well as improvements in physical fitness. As such, these results are very important for informing older population and scientific community about advantages of walking programs in older age.

Pilot study conducted by Wanderley, Oliveira, Mota and Carvalho (2010) investigated effects of moderately intensive walking program on blood pressure, body composition and functional fitness in older women. Results showed that a four-year walking program with progressive duration and moderate intensity can ameliorate blood pressure and lower extremities' muscle endurance in older women.

Research study done by Melzer, Benjuya and Kaplanski (2002) on effects of regular walking on postural stability in older individuals established that healthy older individuals, who regularly engaged in walking until retirement, had better postural control, especially static balance, compared to those individuals who did not engage regularly in walking. Additionally, laboratory results revealed that older individuals who regularly engage in walking had not experienced falls.

Weuve, Kang, Manson, Brettyler, Ware and Grodstein (2004) showed that a long-term regular physical activity, including walking, increased cognitive function and lowered cognitive decrease in women aged 70 to 81 years. Health advantages of physical activity in older individuals include decreased risk of coronary arteries disease, stroke, diabetes, hypertension, large colon cancer, breast cancer and depression.

In her book, "Get back to race", Sara Wells, led by the current scientific findings, focused on health and advantages of running in fighting against aging. Her book explored several diseases' risks that are decreased by running, effects of running on mental health and examples of running training programs as well as advices for beginners.

Primary goal of this paper was to outline usefulness of walking and running at every life stage, which is confirmed by many research studies, as well as to promote walking and running as recreational type of exercise which promote health.

Sport activity enables every individual to satisfy his/her basic human needs: need for movement and play, for order and discipline, for belonging, for self-respect and self-actualization (Milanović, 1997). In modern society, people are more and more sedentary and therefore, engagement in any form of physical activity is no longer only biological human need but a great challenge. Raising awareness of importance and usefulness of physical activity, especially of walking and running as natural movement forms

in every life stage, is extremely important for all the above-mentioned reasons.

### **Recommended levels of physical activity according to age (WHO, 2010):**

**Children and youth (5 to 17 years of age)** – Minimum of 60 minutes of daily moderate to more intensive physical activity. Most of daily activity should be aerobic. More intensive physical activities (muscles/bones strengthening) at least 3 times a week. Recommended activities include play, sport activities, walking, running, recreation sports, physical education, planned exercises and all activities present in family, school and local community.

**Adults (18 to 64 years of age)** – Minimum of 150 minutes weekly of moderately intensive aerobic physical activity or minimum of 75 minutes weekly of more intensive physical exercise or an equivalent combination of semi-intensive and intensive physical exercise. Muscle strengthening physical activity should include the biggest muscle groups twice or more times a week. Physical activity in adult individuals includes engaging in physical exercising during free time, during commute (walking or bicycle riding), physical activities at work, physical activities within household chores, games, sports, planned exercises and all activities present in family, school and local environment.

**Elder (+ 65 years of age)** – 150 minutes of moderately intensive physical exercise weekly or 75 minutes of a more intensive physical activity weekly or an equivalent combination of moderate and more intensive physical exercise. Minimal intervals of aerobic activity should be 10 minutes. Muscle strengthening physical activity should include the biggest muscle groups twice or more times a week. Individuals with decreased mobility should engage in physical exercise twice or more times weekly in order to attain better balance and prevent possible falls. When elder individuals are not capable to engage in recommended physical activity due to health issues, they should be as physical active as their abilities and health status permits. Physical exercising is recommended during free time, during commute (walking or bicycle riding), during work time, physical activities within household chores, games, sports, planned exercises and all activities present in family and local community. From these physical activity recommendations it can be concluded that walking and running, as aerobic activities, can and should be present in sport programs of all age groups; at younger age to promote proper growth and development, whereas at older age to promote health and prevention of many noncontagious diseases.

### **Projects and popularization of recreative walking and running**

In 1973 American trainer Jeff Galloway invented training method called Run Walk Run in order to help beginner runners and to enable almost every individual to run some of the long distances during life, and all that to promote engaging in physical activity until 100 years of age. It is the walking intervals inbetween running distances that enable every runner to control tiredness, by eliminating significant number of specific running injuries. With the help of his training method, over 350 000 runners made their running dreams come true.

One of the first actions of recreative running promotion in Croatia, organized by the Samsung Electronics Zagreb and Zagreb Athletic Federation, is sports-humanitarian manifestation Samsung Running Festival. This manifestation has been present since 1995 in about ten middle European countries and is simultaneously being held in about twenty European cities. Samsung Running Festival includes all age groups and is characterized by togetherness through sport and healthy lifestyle.

Recreational running availability and its influence on health status of all age groups has

resulted in ever more popularity of this type of physical activity, especially since 2010, as much in world, so in Croatia. With the goal of promoting recreational running as healthy lifestyle, the Sport Recreational Association Active Life has initiated project called "running school". The running school idea has probably originated from some world and European cities in which similar associations have been existent for many years. The first running school in Zagreb, called Adidas Running School, started with its practice in 2011 and operated from May until October with 89 runners. Today, that same school practices are held in three additional locations; in Rijeka, Split and Osijek, whereas only in Zagreb this year more than 1 000 runners have been signed up. These data imply increased numbers of recreational runners in Croatia. Popularity of this recreational exercising form has been used by many in order to gain personal profit. Namely, nowadays in Croatia there are more than 30 different running schools, some of which act independently and some operate within certain athletic clubs. Prior to "running schools", recreational running, especially that of older population, was being promoted through veteran athletic clubs. One of the oldest veteran athletic clubs was AK Veteran, which subsided through AK Dinamo from Zagreb.

### **Running schools training model**

Running school is organized as the summer and winter school, dependent on time period. Beginners most commonly sign up to the summer running school, whereas runners with experience can join at any time or in any period (Žužak, 2012). Running plan and the program realization begins in the beginning of March with three predicted training days weekly, in duration from 45 to 90 minutes. Training timeslots are adjusted to runners so that during workdays training is in the afternoons, on Saturdays training is in the morning. Running school offers its runners different training locations, which decreases crowd during training, as well as travelling time in big cities. Training groups are made of 20-30 runners, each group training with different intensity and volume, depending on whether runners are beginners or experienced runners. Runners are classified into groups according to the initial testing results, which is conducted at the beginning of running school (in its third week). Group training is what motivates a great number of runners, but is also crucial in crisis situations when runners might want to give up on running, by making them feel togetherness, belonging and emotional detox from daily obligations.

Training microcyclus is composed of combination of interval aerobic training method which is mostly being conducted twice a week, and continuous training method which in most running schools is being conducted the last training day in the week. At the very beginning of training process interval method is dominantly being used in which workload is small and equal to active break – walking. Walking intervals are gradually decreasing whereas workload, that is; running, gradually progressively increases in order for runners to be able to run continuously for thirty minutes after period of two to three months. Most running schools end with a half-marathon race. It is the goal of running a half-marathon which appears impossible to many, at the same time it is very tempting and therefore challenging to many future runners and is often the main reason why individuals engage in running schools. Still, there are running schools which do not support the idea "from the couch to half-marathon in 7 months". These running schools set more realistic goals for their runners, in their opinion, practically this means their schools end in running 5 and 10 km races in the first running school season, whereas runners begin to prepare for half-marathon only after a year of training adaptation. In this way, the injury rate in those runners is decreased to minimum. Running schools often organize trips to races and various educational lectures for their runners, related to running technique, diet, equipment and similar. Many running schools advertise some sport equipment brand in their name which ensures their runners discounts on needed sport equipment. Runners have also an option to consult a physician in regards to injuries prevention and treating.

The greater the number of running schools, the greater competition, which makes novelties

necessary in order to attract new runners. Therefore, some running schools offer trail running, nordic running, family package which includes athletic school and daycare for children whose parents are runners. In cases where runners have not been active in training process for some time due to illness, vacation or similar, running school organizes for them the so called return group. In order to prevent injuries during training, running schools organize strength training once a week, while for learning correct running technique running schools organize instructions on running training methods. Upon completion of running school, runners are awarded certificate and can thereafter join athletic club and continue with a higher intensity training. The cost of engaging in a running school is 150-200 kn monthly and as such, does not present a great cost which makes one of the reasons why thousands of people decide for this type of recreational.

CENTRAL TRAINING PART				
MONDAY	WEDNESDAY	FRIDAY	MONDAY	WEDNESDAY
2-8-1km T: 5:20 - 4:50-5:20min/km + holds	Interval training 6-8x1 km T-4:15min/ km P- 4 min	Continuous slow running 60-70 min T: 5:45-6:00min/ km	10-12 km T-5:00-5:10min/ km	Uphill 8-10x200 m T: 39-40" R - Return

Table 1. Example of central training part of 13th week of preparatory microcyclus\* of Brooks Running Academy (Slavko Petrović)

\* Microcycle refers to central training part of advanced running school group which prepares for 10km race

Monday /savski nasip / 19h Tuesday / Maksimir / 18:30h	Wednesday / savski nasip / 19h Thursday / Maksimir / 18:30h	Friday / savski nasip / 19h Saturday / Maksimir / 9h
Preparatory part • Warm up: from head to feet 6 min • Dynamic flexibility exercises: 4 min	Preparatory part • Warm up: from head to feet 6 min Dynamic flexibility exercises: 4 min	Preparatory part • Warm up: from head to feet 6 min • Slow running: 1km • Dynamic flexibility exercises: 4 min
Central part A+: 45 min in conversational tempo with tasks A: 45 min in conversational tempo with tasks B: 45 min in conversational tempo with tasks C: 45 min in conversational tempo with tasks D: 40 min in conversational tempo with tasks Emax: 40 min in conversational tempo with tasks E: 2x18 min in conversational tempo with 1 min break with tasks	Central part A+: surprise training A: surprise training B: surprise training C: surprise training D: surprise training Emax: surprise training E: surprise training	Central part A+: 15km - 12km at 5:10km/km + 3km at 4:50min/km A: 15km - 12km at 5:50km/km + 3km at 5:30min/km B: 15km - 12km at 6:20km/km + 3km at 6:00min/km C: 15km - 12km at 6:45km/km + 3km at 6:25min/km D: 14km - 11km at 7:15km/km + 3km at 6:55min/km Emax: 14km - 11km at 7:30km/km + 3km at 7:10min/km E: 7km at 7:50km/km
Closing part • Stretching: 10 min	Closing part • Stretching: 10 min	Closing part • Stretching: 10 min
SATURDAY: Trčaona trail SLJEME at 16h		

Table 2. Example of 12th week of preparatory microcyclus of running school "Trčaona" (Marinović)

In the table 1 is presented the central training part of the 13th week of preparatory microcycle of the advanced running group of Brooks Academy Slavko Petrović for 10 km race. Table 2 shows 12th week of preparatory microcyclus of running school Trčaona for half-marathon in October 2018.

### **Advantages and disadvantages of running schools**

With increasing number of recreational runners and need for group running, the number of running schools increases as well. There are many advantages to running schools, however with their increasing number, their disadvantages are unavoidable as well. These are some of the advantages and disadvantages of running schools with the goal of better understanding of their running plan and program.

Running school advantages:

- Group training is motivating
- Semi-individual approach to school runners
- Positive effects on psycho-physical health of runners
- Weight loss and obesity prevention
- Stress decrease
- Feeling of satisfaction
- Socialization
- Positive habit
- Availability
- Price

Running school disadvantages:

- Injury risk due to previous sedentary lifestyle
- Great number of runners in one group
- Increased number of running schools, decreased number of competent trainers
- Personal profile
- Short preparatory period for completely inactive individuals for psychologically and physiologically demanding event such as half-marathon
- Too ambitious goals of trainers compared to actual status of runners

### **Conclusion**

Physical inactivity is one of the greatest health issues of the 21st century (Blair, 2009). Human need for movement is jeopardized by fast living tempo, sedentary lifestyle, inappropriate diet; all of which leads to stress, depression, obesity, general dissatisfaction, and occurrence of various noncontagious diseases. Engagement in recreational exercising such as walking and running is today available to almost everyone and is very effective in the prevention of the above-mentioned negative effects which occur due to inactivity. Project named "running school" is definitely one of the biggest projects in the domain of sports recreation. Since the first running school establishment in Croatia in 2011 to this day, training models have evolved together with variety of options of recreative exercising within running schools; from nordic walking, recreative and trail running to competitive running. It is the variety of programs of certain running schools that make them available and applicable at every life stage. Positive effects of sport recreational on human psychophysical balance and its role in socialization and connection with natural surroundings make sport recreational favorable for general status of individual and with

that, for overall health (Andrijašević, 2004). Recreative running effects and many advantages of running schools contribute to ever growing popularity of these natural forms of movement, and therefore it is not surprising that running has become a challenge to great number of individuals and that all age groups engage in this type of recreative exercising.

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# Formation of positive attitudes towards physical activity as a factor of professional and personal development of students

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## **Introduction**

The present stage of social development in Russia is strongly characterized by the aspiration to detect and re-affirm identity of individualistic persons contrary to the previous notion of persons as mere members of a group. Therefore, interaction research methods applied to work with students must have a corresponding character, i.e. they must consider their compliance with certain social categories like: age, sex, social class, profession, etc. (Collins, 2004: 47-49). On the other hand, the stability of social development depends on reasonable behavior of every individual person, on the development of his/her potentials concentrated in the organic unity of intellectual, emotional and psychophysical nature of an individual. Each student is supposed to have opportunities to acquire and develop the set of means and methods promoting the formation of desired, excellent human qualities, features and states manifested in intelligence, health, knowledge, quality and productive work as well as active lifestyle. In this regard, the introduction of consecutive updates of professional and personal development in all variety of person's activities seems particularly important.

The research objective is to develop students' abilities within the educational space of physical culture, important professional qualities, based on individual positive hereditary factors, that will lead to the formation of habitual lifelong physical exercise.

## **Methods and organization of the research**

Training sessions were conducted in the form of lectures, practical, individual and independent classes. Students were informed by their teachers about the following:

- human psycho-physical conditions, health criteria and methods for assessing its dynamics;
- nature of physical activity and its impact on human behavior;
- interaction features and methods of transferring the acquired skills to the professional communication;
- methods of maintaining physical motor activity, practical use of exercise systems, methods and options for self-management and self-action;
- motivation and transfer of value attitude to physical training in the practice of future professional activity.

Stages of research were: diagnostic, analytical, motivational, and value designing one.

At the *diagnostic* stage, students evaluated their general functional state according to the cardiovascular system indicators (heart rate, arterial pressure, PD, minute blood volume) and other simple functional tests.

Also, the respiratory system reserves were studied by students. In particular, they determined the reserves of oxygen in the body, lung capacity and the nature of external respiration.

Physical development level and general metabolic processes of the body were determined by identifying indicators of body length and weight, life index, etc.

Professionally relevant qualities and abilities were diagnosed according to the tests named "black-and-red table" and "compasses", reaction time to the visual signal and reactions to the moving object, which allow to evaluate attention, memory, reproductive and spatial thinking, mobility of mental processes, sensitivity thresholds of the visual analyzer, coordination of fine movements.

In the pedagogical process, priority was given to samples and tests, which do not require the participation of qualified personnel, special stands and complex equipment. The above tests allow assessing the functional stability of the body in a complex way. Thus, an integral information about somebody's psycho-physical state is derived from the individual measures and assessments of cardiovascular system and respiratory function indicators, of physical development and of intellectual characteristics of an individual.

At the second, *analytical stage* of the study, the main goal is to form the foundations of self-knowledge (the process of determining one's abilities and capabilities, one's strengths and weaknesses). The students carried out the analysis of their physical development and of their psycho-physical status (to the level of regulating mechanisms).

At the third *motivational and value stage*, the search for methods to eliminate deviations (from the optimum, ideal state) in the students' psycho-physical states was carried out. As a result, an individual program of self-development and self-improvement is formed. Students created personal projects of healthy lifestyle in the process of their chosen practical course and independent studies. Thus, the skills of self-control and the skills to determine effectiveness of means, methods, organizational forms and the positive attitude to physical activity were formed.

At the fourth, *design stage*, the search was conducted for the methods of transferring the personal positive attitudes towards physical activity into another environment, in particular to the process of interaction with other people during the pedagogical practice.

Many students of numerous state universities participated in the experiment during the period from 2015 to 2018.

## Results and discussion

Daily educational, industrial and household activities impose high demands on the human body. The effectiveness of the functioning regulatory systems, which work under different living conditions, is determined by the level of compensatory capabilities of the body. The results of the experiment showed that the students could independently and quickly identify the initial signs of violation of the regulatory mechanisms of homeostasis due to fatigue or violation of the adaptation regime and to establish their impact on the effectiveness of educational and professional activities (Makeeva, Barkalov, & Gerasimov, 2017: 127-130). Thus, students can identify the nature of adaptive reactions of the body and health, the body's resistance to physical stress, adaptation to the climatic conditions of the region, to search for methods and means of recovery through their own educational and scientific research and based on the analysis of theoretical sources.

Information about the nature of changes in the psycho-physical state contributes to the purposeful process of physical self-improvement for optimal preparation for the professional work, forms a social setting for the physical self-education of the student.

Own experience of participation in the evaluation of psycho-physical conditions as a result of pedagogical influence contributed to the expansion of the scope of awareness of personal needs, desires, feelings, which are coded in different physical states, prepare for a realistic resolution of internal conflicts for the reorganization of cognitive sphere. This

increases the ability to understand and change the structure of motor activity. During the pedagogical practice, students in interaction with others, within the framework of group presence, transferred their experience, created a general positive emotional attitude, focused on motor activity as a means and method of management of psycho-physical conditions, the target of which is to improve performance and health. Following the logic of Collins (2004: 47-49) the fulfilment of these conditions triggers a ritual of interaction and promotes group solidarity. Belonging to a group becomes valuable, emotionally colored and acts as a goal of group morality and ultimately contributes to the accumulation of emotional energy in the person (student), as the ability and skill of professional activity to engage in interaction, which is accompanied by a sense of confidence and enthusiasm (Collins, 2004: 49). Physiologically, this is described as "... the human nervous system's mood for rhythmic involvement in interaction with other people" (Collins, 2004: 49).

From the point of view of professional growth, it is important that person can control a situation here and now, to use the place and time of an entity in their cultural conditionality. According to Alexander "formation of the strong connections happens at the expense of 'emotional forces': difficult awakening of mechanisms and conversion of human emotions" ... through "the main emotions (happiness, grief, fear, anger) and their different combinations" are involved in interaction. Through emotions interaction is made, and the social system "is set". People enter interactions having different "transactional needs": announcement itself, result of the instrument of interaction (the positive exchange payments), belong to group, feeling of the reality of events (feeling of reliability) (Turner, 2002: 98-147).

Results of our research with all proofs allow to suppose what personal and professional formations of the student is reached in the course of interaction during physical activity. Process changes representation and professional operation on orientations, organizational and methodical training, structure of control of this process, switching on in the system of transaction of the solution of the unit of situational tasks which connected to the forthcoming professional activity; the organization of professional activity in educational institution at the voluntary free beginning; creation of professional association of the student where students under observation by the qualified experts, provide professional services to students of other organizations results of activities of each participant and also responses, recommendations and assessment of educational institution are included in a briefcase and can be used by future expert in income to work.

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## **ABSTRACTS**

# The effect of developmental gymnastics on motor abilities of pre-school children

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## **ABSTRACT**

The AIM of the research was to determine the differences in motor abilities (MS) among the respondents who are engaged in developmental gymnastics and their peers who do not do this type of physical activity. **METHODS:** The survey was conducted on a sample of 64 pre-school respondents, aged 5-6 years: 41 respondents attended a sports school – experimental group, and 23 respondents of the Novi Sad kindergartens who do not do any additional physical activity – control group. Respondents from different groups were equated with anthropometric variables: body height, body mass and BMI ( $p>0.05$ ). MS of the children who participated in the study were measured with Körperkoordinationstest für Kinder (KTK): walking backwards (WB), moving sideways (MS), hopping for height (HH) and jumping sideways (JS). **RESULTS:** Univariate analysis of variance (ANOVA), based on the previous distribution normalization, found that there were statistically significant differences in all four motor variables and at the highest level of statistical inference of ( $p>0.05$ ), in favour of children attending the sports school. **CONCLUSION:** It can be noted that there are major differences in motor abilities between children involved in developmental gymnastics programs and their peers who do not do this kind of activity. Thus, developmental gymnastics programs in early childhood facilitate improvements of basic abilities (coordination) in children.

**Key words:** preschoolers, KTK test, level of activity, differences

# Effects of two different programs for improving motor fitness in preschool children

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## **ABSTRACT**

**PURPOSE:** The aim of this research was to determine the effects of multi-sport program and soccer program on motor fitness in preschool girls. **METHODS:** This study was performed on a sample of 56 healthy preschool children that were divided into two groups: the multi-sport (n=29) and soccer group (n=27). The average age of the multi-sport group at the beginning of the treatment was  $5.28 \pm 0.29$  years, whereas the children of the soccer group had  $5.46 \pm 0.64$  years. Motor fitness tests were used from several test batteries: 20m dash, obstacle course backwards, standing broad jump, arm plate tapping, seated straddle stretch, bent arm hang, sit ups. Training program for multi-sport and soccer groups lasted 12-week. The basic characteristics of multi-sport training program were: station and circuit work and obstacle courses two times a week lasting for 60 min with intensity around HR 150-180bpm. Soccer training consisted of standard warm-up (15min), three different combinations of games (10 min) and technical drills (30 min) twice a week. **RESULTS:** After the training intervention, the multi-sport training group showed significant ( $p < 0.05$ ) improvements in almost all the parameters analyzed (e.g., obstacle course backwards; standing broad jump; arm plate tapping; bent arm hang and sit ups) compared with the pretest values, with the percentages of change and ES ranging from 13.3% to 48.2% and from 0.64 (moderate) to 1.20 (large), respectively. No significant changes were observed in the soccer group after the training intervention except for standing broad jump ( $p=0.01$ ) and 20m dash ( $p=0.02$ ). **CONCLUSION:** This study provides evidence about the effectiveness of multi-sport programs for the optimal development of young children's motor fitness.

**Key words:** motor skill, soccer, preschool, impact

# Fit4Work: measurement and motivation for physical activity of people over 55

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## **ABSTRACT**

The Fit4Work is the research and development international project implemented as a part of the Ambient Assisted Living (AAL) programme. The aim of the presented investigation titled Fit4Work is to develop an easy-to-use, innovative and unobtrusive system supporting older adults in managing their health-related fitness. The system is a tool for older adults that helps them prevent deterioration of their health; it monitors their physical activity, but also influences their attitude towards it by increasing motivation for physical activity. The system combines novel artificial intelligence mechanisms to monitor people's physical activity, exposure to mental stress and quality of their workplace environment. These mechanisms are available via an intuitive smartphone application connected to a smart band worn on the wrist of the user and simple all-in-one indoor environment monitoring station. The system is capable of identifying user's physical activity and its intensity with accuracy of up to 95% and detecting over 90% of stressful events. It also uses machine learning to predict potential changes in the workplace environment parameters depending on the potential actions taken by the users, thus enabling them to improve environment quality by over 10 % points. This intelligence allows the system to propose personalized recommendations for short- and long-term lifestyle changes, based on scientifically proven evidence such as the World Health Organization recommendations regarding amounts of physical activity giving positive impact on one's health or mental stress relief exercises. Fit4Work includes also a set of exercises and a guide to do them at home. The system was developed with the help from the direct participation of target end users. The requirements concerning the way which such a system as Fit4Work should help the end users were based on a study involving over 250 participants aged 50+ in five European countries. The end user interface was co-designed by representatives of target population, with them helping to adapt the look and feel of the user application to the actual needs and requirements of older adults. Finally, the system was used by 20 Dutch and Polish older adults in a pilot trial, which confirmed usability of the system and its potential for supporting the prevention of people's fitness deterioration. It is expected that the product should be available on the market within two years from the end of the project.

**Key words:** older adults, physical activity, mental stress, workplace environment

# Reliability of the maximal anaerobic power estimation indicators during interval sprint testing for indoor team games

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## **ABSTRACT**

**PURPOSE:** In our opinion, the tests used so far in the practice of amateur sport are burdened with the following systematic errors significantly distorting the assessment of maximal anaerobic power level in locomotive activities:

- 1) the necessity to perform a series of too difficult or too specific movements, e.g.: falls (falling onto the ground), jumps (jump to throw, attack or block) or actions with the ball (dribbling, throws, passes) – the final results are then significantly influenced by specialist's skills.
- 2) the efforts are too long and exceed 20 seconds, which prevents correct diagnosis, e.g. at which moment of the test do fatigue and decrease in power occur?
- 3) the tasks pose injury risks and cause fear in the tested subjects, e.g. changing direction of movement – from running backwards to running forwards, rapid braking after sprints and changes in running direction performed in one or two steps – the results are then not reliable.

The aim of the study was to develop a test adapted to the needs of sports control which would estimate the maximal anaerobic power indicator as well as its maintenance during short-distance sprints at repeated intervals.

**METHODS:** The tests were performed by a group of students from the University of Physical Education in Kraków (Poland), actively practicing team sports on academic teams (amateur level). Forty-three men were examined (age 20-24 years). The time of 10 x 12 m runs at a sprinting pace was measured. The athletes had 15 s for one run (approx. 2 s of sprinting + approx. 13 s for braking and low intensity rest jogging). The safety area behind the finish line, designed for braking, was 9 m long. In addition, the running distance was divided into 4 sections of identical length (3 m each) to measure split times. The used measuring tool was a set of SmartSpeed photocells from Fusion Sport Australia. Accuracy of the measurements was verified via the cinematographic method – video recording at 100 fps using the Sony DSC-RX100M4 digital camera. The numerical data were processed with the repeated measures ANOVA, the significance of the differences was calculated via the contrast analysis method. **RESULTS:** Very frequent cases of reduced running pace in the final 3-meter section of the run were observed, therefore, the final mathematical indicators should not take the running time to overcome this segment into account (30.9% of events). Only a few measurement errors occurred in the case of the first 3 m section – after the start, which was effectively eliminated by choosing appropriate mathematical formulas. The variance of the results was reduced by almost 50% - to a level such as the variation of the

others lap times. **CONCLUSIONS:** The proposed mathematical test indicators have correct characteristics – consistent with the model of changes in anaerobic power observed in the recognized laboratory tests. The calculated indexes had the expected change model at a statistical significant level (ANOVA:  $F=30.02$ ,  $p<0.001$ ).

**Key words:** sport controll, sprint test, volleyball

**Conflict of interest:** Authors state no conflict of interest.

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## Previous physical education experiences and physical activity of adults

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### **ABSTRACT**

**PURPOSE:** Physical education (PE) is considered to be a vital social strategy of lifelong physical activity promotion, yet research on associations between PE experiences and physical activity participation in adulthood is lacking. The aim of this study was to examine the relationship between PE experiences during schooling with the current physical activity behavior of adults. **METHODS:** The sample consisted of 110 adult participants (70 males, 40 females), aged 18-50 years ( $30.2\pm 7.4$ ). The participants were recruited by the one-on-one approach in their local community. Physical education experiences, including attitudes towards PE teacher and PE classes, were assessed by two Osgood semantic differential scales (Đorđić, 2013). The short version of the International Physical Activity Questionnaire, IPAQ (Craig et al., 2006) was used to assess walking, moderate-intensity activities, vigorous-intensity activities and total physical activity score. Data were analyzed by descriptive statistics and correlation analysis ( $p\leq 0.05$ ). **RESULTS:** The significant positive Pearson correlations were identified between attitudes towards PE teachers and walking score ( $r(108) = 0.21$ ,  $p = 0.026$ ) and between attitudes towards PE classes and total physical activity score ( $r(108) = 0.19$ ,  $p = 0.043$ ). **CONCLUSIONS:** Positive previous PE experiences in adults were weakly associated with higher walking and total physical activity scores, suggesting that quality PE might contribute to physical activity behavior in adulthood.

**Key words:** adulthood, physical education classes, physical education teacher

# Characteristics of injuries in youth soccer players participating in training programs of Soccer Academy

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## **ABSTRACT**

**PURPOSE:** Football (soccer) is one of the most popular team sports in the world. Playing football, both at the amateur and competitive level, in spite of benefits is also linked to risk of various types of injuries. It was observed that younger and younger players are injured. The objective of the study was to characterize mechanical and strain injuries in players of the Soccer Academy to draw up prevention program. **METHODS:** The material consists of a group of 200 players of the Soccer Academy in Poznań (Poland) in the autumn round of the 2016/2017 season. The method involved daily reports of players' strains and injuries made by the medical staff, with special emphasis on the motor system. On the basis of daily reports, an aggregate report was prepared presenting quantitative and qualitative analysis of the reported injuries of the Academy members. The results were analysed using standard statistical tools. **RESULTS:** The data analysis showed that more than half of the 200 observed players were injured. The most frequent injuries included following health problems (number of accidents): head injuries (1), bone injuries (15), muscle injuries (12), joint and ligament injuries (12). The tissue analysis of strain injuries indicated that they occurred at: ankle joint (3), pelvic girdle (3), shoulder girdle (6), adductors (5), knee joint (6), back muscles (6), thigh muscles (19), lower leg muscles (9). **CONCLUSIONS:** It was stated that such a high number of strain and mechanical injuries among the observed players points to the necessity of: changes in training loads application, preparation of the special prevention set of exercises together with the design of appropriate recovery system. Also, training intensity must be adapted to actual biological maturation level of soccer players.

**Key words:** football, youth, epidemiology, injuries, prevention, team games

# The effects of two different types of feedback on the performance of double back tuck somersault, after the round-off on the balance beam

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## **ABSTRACT**

**PURPOSE:** Teaching gymnastic skills with a minimal amount of repetition is a major challenge for coaches. Feedback provided to the learner attempting to acquire a new motor skill is a crucial factor in motor-learning process. There is a lot of research providing experimental evidence about such factors as frequency of feedback, types of augmented feedback, organization of feedback, forms of knowledge of result (KR) or knowledge of performance (KP). Different studies have shown that beginners and experienced performers need diverse amounts of feedback. As athletes improve their performance, feedback is given less and less often. To date, researchers have found some evidence that the reduced KR frequency can result in a more effective learning compared to feedback provided after every single trial. However, the aforementioned studies have involved relatively simple skills. The purpose of this study was to gain knowledge about the effects of two different types of feedback on the performance of double back tuck somersault after the round-off on the balance beam. **METHODS:** Sixteen top-level female gymnasts participated in the study. Mean values of body height, mass and age were as follows: group A – 159±3.3 cm, 51.3±2.1 kg, 20±2.2 years; group B – 156±3.1 cm, 50.7±2.4 kg, 20±2.5 years. The gymnasts were randomly assigned to one of the two groups: group A – feedback on only key elements (n=14), or group B – 100% feedback (n=14). Group A was provided with error information regarding the key elements of movement techniques only. Group B received feedback on all errors made. Technical performance (performance of particular routines) was evaluated by experts (3 judges). **RESULTS.** At the beginning of the experiment (pre-test), the differences between the key elements and the mean values obtained by groups A and B for the double back tuck somersault performance after the round-off on the balance beam, were not significant ( $p>0.05$ ). The experiment effect was analysed using ANOVA with repeated measures (Group x Test Time). The post-hoc comparison indicated significant differences between the feedback applied in both groups during the retention test ( $p<0.05$ ) and the delayed retention test ( $p<0.05$ ) in favour of group A. **CONCLUSIONS:** Providing too much verbal feedback during the learning of the complex gymnastic skill, the double back tuck somersault, performed after the round-off on the balance beam, proved to be less effective than the limited verbal feedback on only the key elements of movement techniques. Verbal feedback on errors about the key elements of movement techniques was more effective than 100% feedback of the movement performance.

**Key words:** feedback, learning, gymnastics

No **conflict of interest** is declared.

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# Examination of the relationships among visually impaired individuals' perspectives of serious leisure tranquility happiness and meaning in life

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## **ABSTRACT**

**PURPOSE:** The purpose was to examine the relationships among visually impaired individuals' participating in sports activities during their leisure time, perspective of serious leisure related to sports activities they participated in, tranquility, happiness, and meaning in life. **METHODS:** This study population consisted of visually impaired individuals who lived in Konya and participated in sport during their leisure (N = 150). The goal was to reach the entire population as a sample group (n = 135). This study sample comprised 82 men (Mage = 18.43, SD = 3.80) and 53 women (Mage = 17.52, SD = 3.61) who participated in goalball, judo, weightlifting, swimming, football, athletics and chess during their leisure time. For data collection Serious Leisure Inventory (Gould et. al., 2008; Akgül et. al., 2016), Tranquility Scale (Demirci & Ekşi, 2017), Oxford Happiness Questionnaire short form (Hills & Argyle, 2002; Doğan & Çötök, 2011), and Meaning in Life Questionnaire (Steger et. al., 2006; Demirdağ & Kalafat, 2015) were used in this study. The internal consistency coefficients of the scales for the current sample were found to be 0.95 for Serious Leisure Inventory, 0.77 for Tranquility Scale, 0.72 for Happiness Questionnaire, and 0.85 for Meaning in Life Scale. To examine the relationships among variables correlation and regression analysis were conducted in data analysis. IBM SPSS Statistics 22.0 was used for data analysis. **RESULTS:** There was no significant relationship between the participants' scores of serious leisure, happiness ( $p > 0.05$ ,  $r = -0.121$ ) and meaning of life ( $p > 0.05$ ,  $r = -0.030$ ). However, However, there was a significant positive correlation between participants' leisure time and peace scores ( $p < 0.01$ ,  $r = 0.474$ ). Furthermore, regression analysis was conducted to reveal the role of serious leisure to predict tranquility of the participants. It was found that serious leisure considered as a significant contributor for explaining 23 % variance of participants' tranquility ( $p = 0.000$ ). **CONCLUSIONS:** It can be said that visually impaired individuals participating in sports activities during their serious leisure perspectives have a significant role in predicting the level of tranquility.

**Key words:** serious leisure, tranquility, happiness, meaning in life, visually impaired individuals.

# Sports leisure time and its impact on health-related fitness among scholars

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## **ABSTRACT**

**AIM:** Leisure represents a complex human need, of variable definition, which is fulfilled through the consumption and production of leisure experiences (Daniel Wheatley & Craig Bickerton, 2017). From this context this study aims to investigate the effects of sports activities levels on health-related fitness among Algerian high school students. **MATERIAL AND METHODS:** Data were collected from 108 voluntary participants (age=16.70±1.04) high-school students tested by the ALPHA-Fitness Tests battery to score their physical health levels. To attain this objective, the homogeneous groups were formed on school age (second year of secondary education), sex: male and leisure sport practice after school: (group 1/PROSA (plus PE lessons practice a regular outdoor sports activity in association sportive) - group2 / PEAC (its practice sport based on Physical Education and Sports Lesson) - group3/ PEAC+ST (participate in PE lessons plus school teams engagements). **RESULTS:** Results of this study reveal that outdoor sports activities PROSA or PEAC+ST was more significantly correlated with top scores on ALPHA-Fitness Test Battery norms in comparisons with Algerian PE Curriculum (PEAC). **CONCLUSION:** Based on the design of study and applied ANOVA and LSD to classify the groups. Our results are in favor of out-school-based sports practice. For the interest of a regular outdoor sports activity. Prof that guide us to suggests for Algerian based schools to be developed based on leisure sport activities. Record in the benefits of Outdoor Sports Activities Practice (PROSA) or PEAC+ST as missing time sports practice to improve the fitness relates to general health among our scholars. Needing from our PE teachers and based schools to encourage the practice of leisure sport after daily time school. This suggests our students to consider outdoor leisure sport as quality lifestyle. Showing by (Tannehill, Deborah, MacPhail, Ann, Mars, Dr Hans Van Der, 2013) as strategy for 15-16-year olds through two hours of high quality PE in schools and three hours of physical activity outside of school.

**Key words:** Sports Leisure, Physical and health, Students

## **References:**

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# The effect of garlic supplementation on inflammatory and enzymatic indices of oxidative stress response after an incremental aerobic and resistance exercise in young inactive females

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## **ABSTRACT**

**OBJECTIVE:** Extreme sports activities are the factors influencing the physiology of the body, which can produce oxidative stress and free radicals in athletes or sedentary people who have begun exercising recently, damage cell structure. On the other hand, it seems, the use of herbal supplements such as garlic, has the ability to boost the antioxidant system. Accordingly, the present study aimed to investigate the effects of garlic supplementation on inflammatory and cell damage responses caused by oxidative stress to intense aerobic (IAE) and resistance (IRE) exercise in young inactive females. **METHODS:** This quasi-experimental study as an interventional double blind (garlic or placebo) was conducted with pre-test and post-test. In this study, 39 inactive young female volunteers (mean age,  $23.8 \pm 2.5$  years, BMI  $23.2 \pm 1.4$  kg/m<sup>2</sup>, maximum oxygen consumption (VO<sub>2</sub>max)  $30.31 \pm 3.94$  mL/kg/min) were randomly divided into two (IAE) and (IRE) groups. After a 14-day period of supplementation (500 mg garlic tablets every 12 hours), the subjects participated in a protocol of a bout of (IAE) and (IRE). Changes in plasma inflammatory markers (WBC, IL-6, hs-CRP) and the cell damage enzyme (ALT, AST, LDH, CPK) were measured in four phases. Data obtained were analyzed with ANOVA for repeated measurements, MANCOVA repeated measurements and independent t-test by using SPSS software, ver. 21. The significance level was 0.05. **RESULTS:** Results showed that supplementation of garlic significantly reduced indicators of hs-CRP (phase 2), lymphocytes and neutrophils (phase 2, 3, 4), ALT (phase 3 and 4), AST (phase 2, 3, 4) and CPK (phase 3) in (IAE) group and hs-CRP (phase 2, 3, 4), IL-6 (phase 4), ALT and AST (phase 2, 3, 4) in (IRE) group ( $p < 0.05$ ). While there was no significant change in other phases or indicators ( $p \geq 0.05$ ). **CONCLUSION:** Based on the research findings, it seems that garlic can reduce cell damage and inflammation indices effectively.

**Key words:** garlic, exhaustive aerobic exercise, oxidative stress.

# Examining the Physical Education Lesson Sportsmanship Behaviors of Secondary School Students: Konya Province Example

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## **ABSTRACT**

This is a descriptive research study conducted to determine the unfair behaviors of secondary school students. The study was carried out on secondary school students studying at government schools in Konya province in 2017/2018 academic year. Totally 669 students (435 females, 234 male) volunteered to participate in this research study. The average age of the female participants was detected as 12.25, and that of male participants as 12.02. "Physical Education Lesson Sportsmanship Behavior Scale", which was developed by Koç (2013), was used in data collection. SPSS 22.0 statistical package program was used in the analysis of the data obtained. As per the method, arithmetic mean, One-Way analysis of variance (ANOVA) for the multi-group average score comparison, Independent samples t-test for dual groups were used. As the CONCLUSION of the research study, it was determined that secondary school students had high scores in physical education lesson sportsmanship behaviors; female students much more tend to refrain from improper behaviors compared to male students; the higher grade and older the student, the less sportsmanship behaviors are observed; receiving sports education does not have an effect on sportsmanship behaviors; students, whose family members do not deal with sports, much more tend to refrain from improper behaviors; students of male physical education lesson teachers much more tend to refrain from improper behaviors.

**Key words:** physical education, secondary school, student, sportsmanship

# Kinematical analysis of successful and unsuccessful snatch lifts in female weightlifters

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## **ABSTRACT**

**PURPOSE:** The purpose of the study was to compare the kinematics of successful and unsuccessful snatch lifts of different barbell loads. **METHODS:** Eight young female weightlifters ( $n=8$ , age= $18.8\pm 1.1$  years, height= $161.3\pm 4.3$  cm, body mass= $59.8\pm 13.5$  kg) participated in the study. The weightlifters performed successful (barbell mass=  $78.5\pm 6.4$  kg) and unsuccessful (barbell mass=  $81.3\pm 8.2$  kg) snatch attempts in competition condition. The kinematical differences were compared between the successful attempts that is light lift and unsuccessful attempts that is heavier lift by using a paired t-test. **RESULTS:** Significant kinematical differences were found between the successful and unsuccessful snatch lifts ( $p<0.05$ ). Barbell load was significantly higher in unsuccessful attempts than successful attempts ( $p<0.05$ ). Barbell height was significantly lower in the first pull of heavier snatch lift ( $p<0.05$ ). Barbell vertical velocity was significantly lower in both the first and the second pull of heavier snatch lift ( $p<0.05$ ). **CONCLUSIONS:** The most important kinematic change was seen in the vertical displacement and velocity of the barbell between successful and unsuccessful snatch lifts.

**Key words:** work, power, velocity, displacement

# Body mass differences and correlation with phase angle in athletes and non-athletes

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## **ABSTRACT**

**PURPOSE:** We wanted to determine what body mass characteristics show correlation with phase angle in athletes and non-athletes aged 19-31 years, as well as what differentiated men and women regarding the level of physical activity. **METHODS:** Research took place at the College „Lavoslav Ružička“ on 66 student volunteers, athletes and non-athletes during 2017. Bioimpedance measurement was conducted at 8:00 a.m. according to the standardized preparation of examinees, space and equipment. **RESULTS:** showed no statistical differences between women athletes and non-athletes, whereas men athletes and non-athletes differentiate significantly in extracellular/intracellular ratio and phase angle values. Positive correlation was found between phase angle and body mass index, fat-free mass, percent muscle mass, total body water, intra and extracellular water, bone mass and basal metabolic rate. Negative correlation was found between phase angle and percent body fat, extracellular/intracellular ratio and impedance. Regression analysis showed that the best predictors of phase angle values in athletes and non-athletes age 19-31 are percent muscle mass, body mass index, the amount of intracellular fluid and impedance. **CONCLUSION:** Phase angle values can be used as a simple and economic measurement in athletes and non-athletes hydration and general health status follow-up.

**Key words:** extracellular/intracellular ratio, percent muscle mass, body mass index, impedance

**Conflict of interest:** Authors state no conflict of interest.

**Statement of Disclosure:** No funds were given for this research.

# Reliability and Validity of the Turkish Language Version of the Mental Skills Questionnaire

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## **ABSTRACT**

**PURPOSE:** The aim of the present study was to examine the psychometric properties of the Bull's Mental Skills Questionnaire (BMSQ) (Bull et al., 1996) on the Turkish athletes. BMSQ was designed to measure seven psychological skills of athletes: self-confidence (SC), anxiety and worry management (AWM), concentration ability (CA), relaxation ability (RA), imagery ability (IA), mental preparation (MP), and motivation (M), from which a total scale score was derived. **METHODS:** The sample consisted of 163 males (mean  $\pm$  SD: age  $22.12 \pm 3.22$  years) and 131 females (age  $21.42 \pm 3.85$  years); 294 athletes in total (age  $21.25 \pm 4.87$  years) participated in the study. Athletes completed 28-item mental skill questionnaire. Afterwards, Confirmatory Factor Analysis (CFA) was conducted by Analysis Moments of Structures (AMOS) 23 according to the criterion of fit indices given in the literature. **RESULTS:** Seven-factor model explains 62% of the total variances. Cronbach's alpha for the total scale is .72 and .72 for SC, .63 for AWM, .71 for CA, .69 for RA, .73 for IA, .52 for MP and .64 for M. CFA results provides the fit indices as  $X^2=541.2$ ,  $df=328$ ,  $X^2/df=1.65$ , RMSEA= .05, CFI= .95 GFI= .90, NFI= .89, NNFI= .90 with 28 items and 7 sub-dimensions. **CONCLUSIONS:** The fit indices of the scale were at an acceptable level. Accordingly, the original 7-factor solution received support with Turkish athletes. Results show that Turkish version of Bull's Mental Skills Questionnaire is valid and reliable instrument for Turkish athletes.

**Key words:** confirmatory factor analysis, mental skills, athletes

# A comparison of attitudes towards active video games according to Body Mass Index in primary school children

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## **ABSTRACT**

**PURPOSE:** Obesity is one of the world's leading issues today and the number of obese children is growing daily. Causes should be sought in poor diet, stressful lifestyle, sitting activities and mostly hypokinesia. Positive benefits of physical activity for children are numerous and well-known (Hackney, 2006). It is necessary to be consistent in long-term moderate or high intensity physical activity because change of diet is not enough to improve health and weight (Ischander et al., 2007). A good substitute for outdoor PA is playing active video games which are electronic games that allow players to interact physically (hands, feet or entire body) with images on a TV or canvas screen. Our behavior is determined by our attitudes and beliefs, which can be changed as a function of experience. The aim of the study was to assess the emotional component of children's attitudes towards the concept of active video games according to their BMI. **METHODS:** For this purpose we designed the Osgood semantic differential scale with 7-point Likert scale (Osgood, Suci, Tannenbaum, 1975). Participants were elementary school children aged 11-12 years (N = 73, female 52% and male 48%), with a permission of their parents. Their body measures for calculating the BMI; weight and height were measured with an Omron BF 511 scale and anthropometer. Data was analyzed statistically with descriptive measures suitable for a semantic scale. **RESULTS:** Reported attitudes towards the active video games are mostly positive; overweight children report slightly more positive attitudes than average-weighted or underweight children, and underweight children reported slightly more positive attitudes than the average-weighted. But we found no statistically significant differences with t-test between underweight, average and overweight children. Today parents are very sceptical toward video games and their attitudes are affecting their children's attitudes and behavior. **CONCLUSIONS:** We assume that parents do not know the important difference between active video games and the ordinary ones so they do not allow children to play them. Awareness and information level can be raised among parents and their children through further education so their attitudes can be more positive and therefore children will play more active video games when it is appropriate.

**Key words:** semantic differential scale; healthy lifestyle; overweight; physical activity

# Multisensory activity monitor accuracy during stairs climbing and stepping exercises

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## **ABSTRACT**

**PURPOSE:** The purpose of the study was to evaluate ability of multisensory activity monitor to count steps by normal stairs ascending-descending and during stepping exercises. **METHODS:** Eight healthy subjects ( $29.5 \pm 17.5$  years) participated in this study. All of them wore multisensory monitor during 8 times stairs climbing-descending and during stepping exercise. All participants had one trial of familiarisation before testing. Numbers of steps collected by multisensory monitor were compared with actual number of steps collected by manual step counter. Mean absolute percent error was calculated. **RESULTS:** The results revealed that multisensory monitor underestimated number of step counts during stairs climbing and descending (MAD 45.7) as well as during stepping exercise (MAD 104.4). MAPE was much lower during stairs climbing-descending (15.4 %) than during stepping exercise (29.5 %). Box Plot shows a greater variability of multisensory monitor steps estimation in both tests. **CONCLUSION:** The advantage of multisensory activity monitors consists in possibility to integrate information from multiple sensors and estimate energy expenditure and daily physical activity. However, they did not show good accuracy in counting steps especially during stepping activities.

**Key words:** motion sensor, validity, steps counting

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**Conflict of interest:** In this study there's no conflict of interest.

**Statement of disclosure:** This study was supported by Faculty of Kinesiology, University of Zagreb, which enabled use of BodyMadia FIT sensors.

# The proportion of fifth grade non-swimmers in Požega-Slavonia county

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## **ABSTRACT**

**PURPOSE:** The aim of this paper is to determine the proportion of non-swimmers in the fifth grade of primary school and possible gender differences. Additionally, the research attempted to establish the number of pupils who attended swimming lessons, but did not learn how to swim and the reasons for still not being able to swim. **METHODS:** The research was carried out on a sample of 619 fifth-graders (335 male and 284 female pupils) in primary schools in Požega-Slavonia county, Croatia. The respondents completed a questionnaire designed for this research which contained five questions. Frequency and percentage of answers were calculated and  $\chi^2$  test was used for determining differences. **RESULTS:** The results indicate that 29.24% (n=181) of pupils do not know how to swim and 70.76% can swim. Significant differences between genders were not observed since 56.90% of non-swimmers are boys and 43.10% are girls ( $\chi^2$  0,799; p= 0,371). Out of the total number of non-swimmers, 81.21% tried to learn how to swim, whereas 18.78% never attempted to learn to swim. The most common reasons for not being able to swim are lack of interest (38.25%), no opportunities to learn (30.87%), fear of water (13.42%) and other reasons (17.45%). The pupils stated that they were taught how to swim by their parents (38.68%) or by a professional swimming teacher (15,32%), and others (64,00%). **CONCLUSION:** The research shows that almost 305 of pupils in grade five still do not know how to swim and the main reasons are the lack of interest, not having the opportunity to learn and fear of water. Since swimming has numerous health benefits and is also an important skill for personal safety, since it is one of the main causes of children dying tragically, it is essential to make the public aware of its importance and to decrease the number of non-swimmers.

**Key words:** swimming, non-swimmers, swimming lessons

# Trait Anxiety Levels of Elite Basketball & Football Referees: A Comparative Analysis

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## **ABSTRACT**

**PURPOSE:** Refereeing is a very crucial position in every competitive sports. Consequently, referees need to be well prepared, both mentally and physically. Physical part of the preparedness is well known and visible, but mental part is not as clear as physical part. To understand referees' trait anxiety levels is crucial to guess their performance in sport. Therefore, the aim of this study was to compare trait anxiety levels of elite basketball and football referees. **METHODS:** The sample of study consisted of 47 elite soccer referees ( $M \pm SD$ :  $39.62 \pm 4.8$ ) and 47 elite basketball referees ( $37.54 \pm 4.82$  years), in total 94 referees ( $38.10 \pm 4.81$  years) voluntarily participated in the study. Independent sample t-test was used to determine the difference in trait anxiety levels among referees, and LSD Test was used for determining the differences across groups through SPSS Package 22.0. **RESULTS:** There was a significant difference in the scores for elite football referees ( $M=36.30$   $SD=5.03$ ) and elite basketball referees ( $M=33.55$   $SD=5.97$ ) conditions;  $t(92)=2.41$ ,  $p= .018$ . **CONCLUSIONS:** Elite football referees' scores of trait anxiety levels were significantly higher than the scores of elite basketball referees. Specifically, these results introduce that elite football referees are more anxious community than elite basketball referees in Turkey.

**Key words:** elite football referees, elite basketball referees, trait Anxiety, mental skills

# The effects of change in resistance training type on muscle power level of handball players

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## **ABSTRACT**

**PURPOSE:** The aim of the study was to check whether it was possible to maintain the lower limb muscle power level during the starting period by means of plyometric exercises. **METHODS:** During the preparatory period, three professional handball players (1st Polish division) underwent a resistance training programme using a weight bar (11 weeks/3 workouts a week: developing muscle mass – 4 weeks, developing maximal strength – 4 weeks, developing maximal power – 3 weeks). During the starting period (14 weeks), resistance training was changed to plyometric training (2 workouts a week). The tests were carried out at the beginning and end of preparation and starting period. The maximal and relative power of the countermovement jump (CMJ) and the squat jump (SJ) were measured on a dynamometric platform. **RESULTS:** In all tested competitors, there were high decreases in the maximal power of the lower limbs (from 6% to 17% of CMJ maximal power decrease, from 6% to 15% of CMJ relative power decrease, from 15% to 19% of SJ maximal power decrease and from 15% to 16% of SJ relative power decrease). **CONCLUSIONS:** It has been demonstrated that maximal muscle power developed during the preparatory period by means of heavy resistance training, cannot be maintained during the starting period by means of plyometric training.

**Key words:** plyometric training, periodisation, cmj, sj

**Conflict of interest:** Authors state no conflict of interest.

# Vertical jump – correction of measurement errors in typical tests used for sport practice

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## **ABSTRACT**

**PURPOSE:** Vertical jump measurement is a very popular sports test for the assessment of leg extensor muscle power level during short-duration explosive concentric work. The most popular methods measure either the maximal vertical arm reach (e.g. a measuring scale placed on a wall or on a special stand with a set of measurement lines) or flight time (extensometer or optical platform). The obtained values are a source of mathematical calculations estimating the levels of MAW and MAP. However, both methods do not give identical results. The results recorded on an extensometer or optical platform are lower than those based on arm reach measurements. Finding systematic errors of the most popular measurement methods and the indicator correcting this error would enable standardization of the obtained results and increase the reliability of the estimated MAW and MAP values during the vertical jump. **METHODS:** The tests were performed by a group of amateur athletes – volleyball players from the academic team of the University of Physical Education in Kraków (Poland). The value of the vertical jump on the extensometer platform and by the measuring wall was verified using the cinematographic method measuring the displacement of center of gravity. Statistical calculations were conducted using the multiple correlation method. Body height and maximal vertical arm reach in standing position were introduced as accompanying variables. The FitroJump tensometric platform (the Czech Republic) was used along with the Sony DSC RX100M4 digital camera, video recording at 100 fps. **RESULTS & CONCLUSIONS:** 1. Vertical jump values for particular measuring methods are significantly different in statistical terms. 2. The calculated corrective indicators improve the reliability of test results as well as the values of MAP and MAW calculated on their basis.

**Key words:** sport controll, volleyball, muscle power

**Conflict of interest:** Authors state no conflict of interest.

**Statement of Disclosure:** The research was funded by the Ministry of Science and Higher Education, Poland, No. of project: RSA4 00954.

# Maturity status, morphology and fitness discrepancies between higher and lower ranked prepubertal male tennis players

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## **ABSTRACT**

**PURPOSE:** The aim of this study was to determine the discrepancies between higher and lower ranked prepubertal (maturity offset =  $-2.6 \pm 0.4$  years) tennis players regarding their biological maturity status, morphology, and motor fitness. **METHODS:** Thirty-six male players, 10.3 - 11.2 years of age ( $10.8 \pm 0.3$  years), were divided into two groups on the basis of their national ranking. They were tested on stature, sitting height, body mass, skinfolds (triceps and medial calf), maximal isometric grip strength, and hexagon agility test. Age at peak height velocity, body mass index (BMI), and body fat percentages (BF%) were calculated accordingly. Their weekly training (tennis and fitness) volume, age to start playing tournaments and the number of tournaments played until the onset of the study was recorded. **RESULTS:** Independent sample t test results showed no significant differences between groups in chronological and biological ages. Similar results were also observed on stature, sitting height, body mass, BMI, BF%, and weekly tennis training volume. On the other hand, upper ranked players performed significantly superior scores on agility and grip strength measures and have greater amounts of weekly fitness training than their lower ranked counterparts. Moreover, they start playing tournaments at earlier ages and have attended more tournaments. **CONCLUSION:** Results of the study highlighted potential positive influences of sports-specific experience duration and volume of weekly fitness training on the ranking and various functional capacities in prepubertal male tennis players born in the same calendar year.

**Key words:** biological age, maturity offset, tennis, anthropometric measurements, fitness, ranking

# Effects of biological maturation on body composition, muscular strength, and agility in female tennis players

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## **ABSTRACT**

**PURPOSE:** The purpose of this study was to examine the influences of biological maturation on body composition and motor fitness among young tennis players. **METHODS:** Forty-seven female players, 10.6 - 13.2 years of age ( $11.5 \pm 0.7$  years), were tested on stature, sitting height, body mass, skinfolds (triceps and medial calf), maximal isometric grip strength, and hexagon agility test. Body mass index (BMI) and body fat percentages (BF%) were calculated accordingly. Number of years of experience in regular tennis training, weekly training (tennis and fitness) volume and self-reported parental heights were recorded. According to their maturational status, estimated by percentage of predicted adult stature (PAS), they were classified into two groups as prepubertal (< 85% of PAS) and early pubertal (>85 - 90% of PAS). **RESULTS:** ANCOVA results, when chronological age was controlled as a covariate, revealed that early pubertal players were significantly taller and heavier and have higher values on BMI and BF% than their prepubertal counterparts. However, there were no significant differences between groups in grip strength and agility performances. Similar results were also observed on sports-specific experience duration and volume of weekly tennis and fitness trainings. **CONCLUSION:** Results of the study suggest that young female tennis players from distinct maturity stages may not differ in their muscular capacity and agility performances, but may differ in their body size and composition when they are trained similarly.

**Key words:** biological age, body composition, fitness, tennis

# Correlations between sports level and the level of selected muscle power parameters in handball players

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## ABSTRACT

**PURPOSE:** The aim of the study was to search for muscle strength indicators of handball players showing the strongest relationship with sports level in this discipline. **METHODS:** The sports level of 33 professional handball players (1st and 2nd Polish division) was assessed using the expert method. This method consisted in preparing a ranking of competitors based on observation and evaluation conducted by each of the coaches of the teams participating in the research. The coaches had sufficient knowledge regarding all players because during the previous two seasons, these teams were in one league and played many matches against each other. First place (rank 1) was awarded to the best player, and last place to the player characterized by the lowest sports level. The final ranking of the players was created on the basis of the average rating from all three coaches' rankings. Then, correlations were found between the ranking of the players and the results of selected tests examining their speed and strength capabilities (Counter Movement Jump parameters, Squat Jump parameters, parameters from a 10-second trial on a cycloergometer and the speed of a ball thrown towards the goal). **RESULTS:** The tests that showed a statistically significant ( $p < 0.05$ ) correlation with the sports level of the tested handball players were: CMJ maximal power ( $R=0.42$ ), speed of the ball during stand throw ( $R=0.72$ ), speed of the ball during jump throw ( $R=0.64$ ) and speed of the ball during leaning back throw ( $R=0.63$ ).

	X	R	p
CMJ height [m]	0.485	-0.103	0.5692
CMJ maximal power [W]	<b>5791</b>	<b>-0.420</b>	<b>0.0149</b>
CMJ relative power [W/kg]	66.9	-0.224	0.2109
SJ height [m]	0.442	-0.189	0.2912
SJ maximal power [W]	4781	-0.248	0.1637
SJ relative power [W/kg]	55.1	-0.096	0.5940
Cycloergometer maximal power [W]	991	-0.107	0.5535
Cycloergometer relative power [W/kg]	11.5	0.071	0.6951
Stand throw [km/h]	<b>83.6</b>	<b>-0.720</b>	<b>0.0000</b>
Leaning back throw [km/h]	<b>89.2</b>	<b>-0.639</b>	<b>0.0001</b>
Jump throw [km/h]	<b>85.6</b>	<b>-0.625</b>	<b>0.0001</b>

**CONCLUSIONS:** The high degree of correlation with the athletes' sports level was demonstrated by the speed of the ball thrown towards the goal and CMJ maximal power. These results should be taken into account when planning motor training of handball players and during the selection of tests designed to examine the level of their preparation for starting in competitions.

**Key words:** CMJ, SJ, ball-throwing velocity

**Conflict of interest:** Authors state no conflict of interest.

# Physical activity and health in pregnancy: intensity and various types of activity and health behaviours

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## **ABSTRACT**

**PURPOSE:** The aim of this study was to analyse self-assessment of intensity and different types of physical activity in pregnant women and their health behaviours. **METHODS:** The research was conducted on a sample of 162 pregnant women in the third trimester of pregnancy. The tool used for assessing the physical activity was Pregnancy Physical Activity Questionnaire – Polish version (PPAQ-PL) (Krzepota, Sadowska, Pelczar & Sempolska, 2017; Krzepota & Sadowska, 2017). The PPAQ allows pregnant women to self-assess their total activity in the current trimester. The questions investigated time devoted to various types of activity related to household/caregiving, transportation, sports/exercise in their free time, occupational activity and inactivity. Based on the average weekly energy expenditure, each of these activities is classified by intensity: sedentary activity, light, moderate and vigorous intensity activity. The methodological basis for investigating health behaviours was the Health Behaviour Inventory (HBI) (Juczyński 2001). Four categories of health behaviours were analysed separately: Positive Thinking, Proper Nutritional Habits, Health Practices and Preventive Behaviours. The General Index of Intensity of Health Behaviours (GIIHB) was calculated by adding the results for all the 24 statements included in the HBI. Differences in physical activity depending on the level of health behaviours were evaluated by means of the Kruskal-Wallis ANOVA. Relationships between the variables were analysed using Spearman's rank correlation test. **RESULTS:** The analysis revealed that the GIIHB was high in 50.0%, average in 35.8 % and low in 14.2% of pregnant women. However, GIIHB was not a factor that significantly differentiated intensity or types of physical activity. Notwithstanding statistically significant positive relationships were observed between Health Practices (HBI) and two categories of PPAQ-PL: total activity of light intensity and above ( $R=-0,172$ ) and moderate intensity activity ( $R=-0,177$ ). **CONCLUSIONS:** In light of the literature review this is the first research carried out in this group based on the Pregnancy Physical Activity Questionnaire and Health Behaviour Inventory. Drawing conclusions about the presence of a correlation between physical activity and health behaviours in pregnant women in the case of such a low number and low strength of the documented correlations requires a very careful interpretation of the results. It seems necessary to repeat the examinations in a bigger group of women in all trimesters of pregnancy while using other research tools in order to better understand or confirm the correlations.

**Key words:** PPAQ-PL, Questionnaire, Health Behaviour Inventory, pregnant women, energy expenditure

# Effect of exercises on the selected rheological properties of blood of people with Parkinson's disease

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## ABSTRACT

**PURPOSE:** The aim of the study was to determine the effect of systematic exercises using the Smovey Vibroswing System (SVS) on morphological and rheological properties of blood in a group of people with Parkinson's disease (PD). **METHODS:** A randomized controlled trial studying 18 people with PD was performed. The study involved 18 people with PD: 9 participants (5 men and 4 women; age:  $60.7 \pm 3.65$ ), who took part in a 3-month systematic exercise programme using the SVS (three therapy sessions a week, for one hour) and 9 participants (5 men and 4 women; age:  $62.8 \pm 1.61$ ) who were assigned to the control group. Inclusion criteria were: Hoehn and Yahr stages II-III, the ability to walk independently without any aid and continuous pharmacological treatment with no change in doses for the last 3 months. The rheological blood properties were evaluated from venous blood sampled prior experiment as well as after completion of the 3-month systematic exercise programme. **RESULTS:** Comparison of trained group to control group of people with PD showed significantly higher mean values of erythrocyte elongation index (EI) at 60.30 Pa shear stress level in untrained group before the training. After completion of three-months exercises using the SVS, we observed significantly higher mean values of EI at 60.30 Pa shear stress level in trained group in comparison to the baseline level. No significant differences in mean values of aggregation indices (AI, %), the half time ( $T_{1/2}$ , s) and amplitude and total extent of aggregation (AMP, arbitrary units) between groups were observed. After regular exercises mean corpuscular volume (MCV, fl) was significantly lower, and the level of mean corpuscular hemoglobin concentration (MCHC, g/dl) was significantly higher in trained people with PD. **CONCLUSIONS:** Systematic exercises using the SVS revealed positive effects on the selected rheological properties of blood.

**Key words:** red blood cell aggregation, red blood cell deformability, physical activity, neurodegeneration

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**Conflict of Interest Statement:** The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

# Recording human locomotion control using non-invasive electroencephalography

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## ABSTRACT

Within the last decade we can observe rise of the need to qualitatively and quantitatively link measurable biomarkers (like the electrical activation patterns of human brain by means of electroencephalography (EEG), magnetoencephalography, polysomnography, functional magnetic-resonance imaging or surface electromyography of skeletal muscles activation) during movement to the behaviour of the biomechanical system. The reasons for this increased attention can be found in two parallel processes: more accessible and functional measuring systems and new investigations that opened new horizons for researchers and practitioners. **PURPOSE:** This study presents an evaluation of wearable non-invasive EEG data acquisition system in recording human locomotion control with the aim to extract markers. **METHODS:** In preliminary phase two subjects were parallelly tested using 7 EEG sensors system (of which two are for the references) with semi-dry polymer electrodes together with additional 9 axis sensor (3 axis gyroscope, 3 axis accelerometer, 3 axis magnetometer), and 18 EEG sensors system with saline soaked felt mats (of which two are for references) respectively for validation of the first device. Further six subjects where to be tested likewise just with first EEG sensory system. Two batteries of tests were carried out with five repetitions each for each of the subjects; one for easy locomotor motion task, the other for complex locomotor motion task. **RESULTS:** measurement results obtained from subjects for AF3, AF4, T7, T8, Pz points and two test where acquired, the collected raw data are subjected to filtering and statistical analysis and the computed artefacts (markers) were compared. Although the results showed significant differences between these two types of locomotor motion, without additional testing it is not possible to form a strong statements. **CONCLUSIONS:** It was found, that non-invasive electroencephalography may be a very useful tool in information extraction for further biomechanical analysis. Downside is possibility of uncertainty present in interpretation of results obtained by non-invasive EEG measuring system, which could be improved by acquisition and including other available measurements.

**Key words:** non-invasive EEG, biomechanics, locomotion, biomarkers

# Functional movement screen differences between male and female young triathletes

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## **ABSTRACT**

**INTRODUCTION:** Number of young participants and schools of triathlon has grown exponentially in the last years (1). Triathletes need well-developed balance, core stability, and neuromuscular control to safely and effectively perform the necessary movements of the three disciplines of the sport (2). Previous studies used Functional movement screen as a tool to assess movement patterns and side-to-side symmetry (3). **PURPOSE:** The purpose of this study was to identify differences in composite FMS scores as well as differences in individual FMS task scores between male and female young triathletes. **METHODS:** 21 young triathletes (11 males and 10 females) (age  $13.8 \pm 0.9$  years; stature  $1.6 \pm 0.8$ m; weight  $50.4 \pm 12.3$ kg) performed seven tasks of the FMS. Test took place during their training sessions. Two raters, both of whom had 2 years of experience using the FMS in clinical practice, scored participant performance on the movement tasks. **RESULTS:** The average score of all the sample was 13.95. Female triathletes slightly (14.1) higher than male triathletes (13.8). The triathletes obtained the best score in the shoulder mobility task (95% of the participants obtained three points). On the other hand, the worst score was recorded in the trunk stability push-up (67% of the participants scored one point). In addition, the triathletes showed difficulties in the rotating stability, since none obtained three points in this task. **CONCLUSION:** Although women triathletes scored higher than men, a large difference was not observed in the FMS test. Some tests such as rotating stability or trunk stability push-up presented a greater difficulty for the young triathletes.

**Key words:** quality of movement, risk of lesion, sport

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# Trainability of coordination motor abilities of team sport and martial arts athletes in the aspect of gender differences

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## **ABSTRACT**

**INTRODUCTION.** Scientific research on the trainability of coordination motor skills of athletes in various sports disciplines and at various stages of sports improvement in the aspect of sexual differences has been done little. There is a supposition that "In all, high-ranking players are equally well-trained in the process of mastering exercises and technical habits requiring a high level of coordination regardless of gender" (Issurin 2010, p. 95). **Purpose.** Presentation of own experimental research and analysis of the research of other authors in the field of coordination motor skills trainability of team sport players and martial arts athletes in the aspect of gender differences. **METHODS:** 1) Analysis of the trainability of different coordination motor skills in male football players aged 11-19 years and female footballers aged 15-18 years in the process of longitudinal research and pedagogical experiments (Lyakh, Witkowski 2010); 2) Sexual dimorphism in the trainability of various coordination motor skills of taekwondo athletes – male and female, aged 18-27 years, during a two-year pedagogical experiment (Sadowski 2000); 3) The pace of improvement of various coordination motor skills in female basketball players aged 13-14 years and 17-18 years in two-year targeted coordination trainings (Lyakh 2009); 4) Analysis of the level of development of various coordination motor skills in male wrestlers (freestyle and greco-roman) as well as female freestyle wrestlers – aged 10-13, 14-16, 17-20 years (Gierczuk 2008). **RESULTS.** The average total increase of coordination motor skill rates among female footballers from 15 to 18 years of age was 28.5%, and for male football players only 23.5%. The average generalized increase of coordination motor skill for female taekwondo for 1 and 2 years of targeted coordination training was 10.3-16.9% and 24-37.3%, respectively, and for male athletes 9.1-4.3 and 17.6-30.3 %. In two years of targeted coordination training, the rate of improvement of coordination motor skills in female basketball players aged 13-14 has reached the level of 35.2, and their older colleagues aged 17-18 years – 18.2% years. At the same time, under the influence of only coordination exercises, the growth of coordination motor skills in 13-14 years old female basketball players within two years was 27.2, and in 17-18 year old basketball players - 8.8%. Improvement of coordination motor skills (generalized data of 22 indicators) of freestyle and Greco-Roman wrestlers aged 10-13 to 17-20 was equal to 21.7 and 20.1% respectively, and in the female free style wrestlers – 24.9%. **CONCLUSIONS.** With the age and seniority of general practice, there is a decrease in reactivity (reduction of coordination motor skills trainability) of representatives of both sexes to identical training loads. Each competitor has his own dynamics of motor skill trainability, which is incompatible with other skills of this type and does not always agree with the general tendency of their changes with

age. The young and qualified female athletes stand out against their peers for greater reactivity to identical coordination training programs.

**Key words:** coordination motor skills, trainability, gender differences, team games, martial arts.

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# The effects of whole-body cryostimulation on nitric oxide synthase in older marathon runners

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## ABSTRACT

**PURPOSE:** Nitric oxide is a reaction product of nitric oxide synthase. It is a signaling molecule in the regulation of many biochemical processes as well as a vasodilating factor. However, in too high concentrations, it may act adversely by triggering nitro-oxidative stress. Whole-body cryostimulation is increasingly used in the elderly as a complement to therapy and in the biological renewal of athletes. The aim of the study was to assess the effect of multiple systemic cryostimulation treatments on the nitric oxide synthase concentration in a group of older marathon runners compared to non-training men. **METHODS:** 10 males training marathon running (55.9±5.5 years, training experience 6.7±5.8 years) and 10 men characterized by a low physical activity (62.0±5.8 years) underwent 24 whole-body cryostimulation treatments at a temperature of -130°C. Each treatment lasted 3 minutes. Treatments were performed every other day. The concentration of induced nitric oxide synthase and its endogenous inhibitor – asymmetric dimethylarginine as well as nitrotyrosine as a nitrooxidative stress indicator – were determined in the plasma. Venous blood was collected before the first treatment and after 12 and 24 whole-body cryostimulation procedures. **RESULTS:** In both groups, after 24 whole-body cryostimulation treatments, there was a significant increase ( $p < 0.05$ ) in nitric oxide synthase from 3.48±0.23 ng/mL to 3.90±0.54 ng/mL in marathon runners, and from 3.45±0.27 ng/mL to 3.79±0.32 ng/mL in the non-training group. There were no changes in asymmetric dimethylarginine concentration or nitrotyrosin in either group. **CONCLUSIONS:** A series of 24 whole-body cryostimulation treatments has beneficial effects on the vasomotor function of blood vessels in older males. By activating the expression of induced nitric oxide synthase, it increases the level of endogenous nitric oxide without causing nitrooxidative stress. This effect is independent of the level of physical activity.

**Key words:** nitrogen oxide synthesis, nitrooxidative stress, nitrotyrosine, whole-body cryotherapy, endurance training

**Conflict of interest:** No conflict of interest has been declared.

**Statement of Disclosure:** The study has been carried out within the grants funded by the University of Physical Education in Krakow (No. 37/BS/KRK/2013, and No. 41/BS/INB/2013).

# Relationship between kick frequency, balance and flexibility, and anthropometric variables in kickboxing athletes

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## **ABSTRACT**

**AIM:** The purpose of this study was to determine the relationship between kick frequency measured by the Kick test (KT), stork balance test (SBT), flexibility in bent knee drop out test (BKDO) and some anthropometric variables (body height, body mass and BMI) in kickboxing athletes. **METHODS:** Sixteen male kickboxing athletes of regional rank from one club volunteered to participate in this study (age  $21.9 \pm 6.39$  years; body height  $1.82 \pm 0.07$ m; body mass  $77.66 \pm 12.31$ kg). All of them were right-handed and right-leg kick dominant, which means they were holding the left guard (left boxing stance). Maximum number of kicks performed in 30s on boxing bag, total time in seconds of SBT and distance in meters of BKDO test, all on right and left leg, and anthropometric characteristics were measured. **RESULTS:** There is a statistically significant ( $p < 0.05$ ), moderate and positive ( $R = 0.598$ ) correlation between SBT with the left leg and result on the right leg KT which is understandable since in left boxing stance right leg takes longer distance from floor to contact with boxing bag, therefore better balance is needed on the left leg. Furthermore, there is a statistically significant, moderate and negative ( $R = -0.538$ ) correlation between BKDO test on the right leg and result on the left leg KT. Finally, there is a statistically significant, moderate and negative correlation between athlete's height and right/left leg asymmetry in KT. Regression analysis established there is a statistically significant ( $p = 0.022$ ), moderate and positive ( $R = 0.567$ ) linear relationship between body height and asymmetry in KT. The result was expected since taller athletes in left boxing stance use their front (left) leg more often during the fight to maintain distance to opponent, while shorter athletes use their left foot to approach closer to the opponent and perform more kicks with the right leg. **CONCLUSIONS:** Balance on the ball of the foot and hip flexibility affect kick frequency in kickboxing athletes. Athletes shorter than 1.71m have a higher asymmetry to the right KT, and those taller than 1.74m have a higher asymmetry to the left KT. Athletes of body height between 1.71m and 1.74m are most likely to have symmetrical results on KT. This information can assist the coach in making the adjustments in training to improve athlete's kickboxing performance.

**Key words:** martial arts, performance, height categories, boxing stance, kicking asymmetry

**Conflict of interest:** Authors state no conflict of interest.

**Statement of disclosure:** The research was funded by authors.

# The effects of tissue flossing on perceived knee pain and jump performance: A pilot study

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## **ABSTRACT**

Tissue compression and partial vascular occlusion using band flossing results in reperfusion of blood to the muscle tissue that may ultimately reduce joint pain and increase range of motion, enhancing prevention from or rehabilitation of injury. However, the extent of research examining the effect of tissue flossing in an athletic setting is currently very limited, and the effects of band flossing on knee pain and jump performance has not yet been investigated and remain unclear. **PURPOSE:** Therefore, the aim of this study was to investigate the effect of band flossing on perceived knee pain and vertical jump performance in recreational athletes with knee pain. **METHODS:** Five young male recreational athletes with previously reported knee pain took part in this study (age  $22\pm 0.5$ ; height  $184\pm 6.8$ cm; weight  $79\pm 1.5$  kg; BMI  $23.34\pm 1.2$  kg/m<sup>2</sup>). Participants performed a number of tests pre and post intervention, with the application of a floss band on the knee joint. The experimental protocol consisted in the performance of countermovement jump (CMJ) tests (3 sets of 3 jumps each one, with 1-minute rest between sets: firstly, without occlusion, secondly, with occlusion, and finally, after occlusion). Pre and Post intervention measures included a perceived knee pain and CMJ jump height, time in the air, velocity, jump power, and force. Perceived knee pain was measured with 0-10 analog visual scale (AVS), and CMJ using a force platform. **RESULTS:** The application of flossing bands in knee joint resulted in enhancements in all test measures pre to post intervention (percentages of test improvements: 10% jump height; 4.5% time in the air; 5% jump velocity; 13% jump power; 7.5% jump force). In addition, participants reported a 3.5-point pain enhancement in AVS during performance of CMJ tests. **CONCLUSION:** The results showed that flossing bands caused a reduction in perceived knee pain and improved vertical jump performance in young male recreational athletes.

**Key words:** flossbands, vascular occlusion, joint pain, countermovement jump

# Age-related changes in vertical jump performance of young soccer players

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## **ABSTRACT**

**PURPOSE:** The purpose of the study was to compare jumping performance according to age in young soccer players. **METHODS:** Totally, 76 young soccer players from different age groups participated in the study. Age groups included U14 (n=19, height=169.57±8.05 cm, body mass=55.96±7.58 kg), U15 (n=19, height=174.89±5.32 cm; body mass=63.61±5.20 kg), U16 (n=22, height=174.65±5.53 cm; body mass=63.82±5.26 kg), and U17 (n=16, height=173.31±4.95 cm; body mass=65.66±3.90 kg). Each player performed squat jump (SJ) and countermovement jump (CMJ) two times each, after a warm-up. Jumps were recorded using an iPad mini (Apple Inc., USA) high-speed camera. The app My Jump 2 was used to calculate jump height, flight time, jump velocity, force, and power of both jumps. The variables of the best jump performance were used in comparisons. One-way ANOVA was used to compare the jump performance according to age factor, and Tukey's HSD post-hoc test analysis was performed to test the differences between pairs. **RESULTS:** Significant differences were found between the ages in terms of physical characteristics ( $p<0.05$ ). Height, body mass, and BMI of soccer players were significantly higher in 15-, 16- and 17-year olds than in 14-year olds ( $p<0.05$ ). SJ height, flight time, velocity and power were significantly higher in 16- and 17-year olds than in 14- and 15-year olds, except for force ( $p<0.05$ ). Only, CMJ force and power output were significantly higher in players of 17 than that of players in 14 years of age. **CONCLUSIONS:** Squat jump performance showed a significant increase from 16 years of age when compared to earlier ages. Although 17-year-old players produced higher force and power than 14-year olds during CMJ, significant changes were not observed between age groups in terms of other parameters related to CMJ performance.

**Key words:** jump height, flight time, force, power

# Long-term effect of different physical activity levels on subclinical atherosclerosis in middle-aged men: a 25-year prospective study

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## ABSTRACT

The purpose of the study was to investigate the influence of lifetime physical activity (PA) on selected indices of atherosclerosis in longitudinal observation of middle-aged men. **METHODS:** The subject of the study was a cohort of 101 men (mean age  $59,7 \pm 9,0$  years), free of cardiovascular symptoms and treatment, participating in follow-up examinations in the years 1985/90-2011/12. Self-report PA was assessed by interviewer-administered Seven-Day PA Recall and Historical PA questionnaire. Subclinical atherosclerosis was measured by assessing the coronary artery calcification (CAC) according to Agatston's method using multi-slice computed tomography; the carotid intima-media thickness (IMT) using high-resolution B-mode ultrasound; and the reactive hyperemia index (RHI) using peripheral arterial tonometry (EndoPAT2000). The participants were initially divided into three groups according to tertiles of exercise-related energy expenditure (EE) in kcal/week at baseline, i.e. <2050 (low-to-moderate;  $n = 33$ ), 2050-3840 (high;  $n = 34$ ), >3840 (very high;  $n = 34$ ). **RESULTS:** The low-to-moderate, high and very high PA groups were comparable in terms of age and atherosclerosis risk factors at baseline. No linear relationship was found between PA and CAC, IMT and RHI. Men who maintained low-to-moderate ( $n = 26$ ), high ( $n = 21$ ) and very high ( $n = 15$ ) PA level had the mean CAC of  $286.1 \pm 361.9$ ,  $10.7 \pm 28.9$ , and  $106.1 \pm 278.3$  ( $p < 0.001$  for low-to moderate vs high;  $p < 0.05$  for low-to-moderate vs very high); the mean IMT of  $0.751 \pm 0.19$  mm,  $0,641 \pm 0.26$  mm, and  $0.750 \pm 0.60$  mm ( $p > 0.05$ ); and the mean RHI of  $1.69 \pm 0.4$ ,  $2.00 \pm 0.4$ , and  $2.13 \pm 0.5$  ( $p$  for trend = 0.050), respectively. No cases of  $CAC > 400$ ,  $IMT \geq 0.9$  and  $RHI < 1.67$  were noted only among men with maintained high PA level. At final examination men with high and very high PA had more favorable cardiometabolic profile than men with lower PA. **CONCLUSIONS:** Maintaining regular high PA level through young and middle adulthood may protect against atherosclerosis as measured by CAC, IMT and RHI.

# The effects of a single anaerobic effort on the level of the selected adipokines in the blood of women and men

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## **ABSTRACT**

**PURPOSE:** The increase in metabolic rate during anaerobic exercise may result in changes in the levels of adipose tissue hormones, the function of which is also associated with glucose metabolism. The aim of the study was to evaluate the changes and sex-related differences in leptin, adiponectin, irisin and asprosin levels in the blood of women and men during the first hour after completion of a single anaerobic effort and after a 24-hour resting period. **METHODS:** 10 men (21.64±1.22 years, body fat 18.36±2.99%, BMI 23.71±1.58 kg/m<sup>2</sup>) and 9 women (21.82±1.44 years, body fat 24.31±1.66%, BMI 21.44±1.94 kg/m<sup>2</sup>) performed a 20-second maximal cycling sprint test. Blood samples were collected before exercise and at the 3rd, 15th, 30th and 60th minute of resting, as well as 24 hours after completion of the exercise. The concentrations of lactate, glucose, leptin, adiponectin, irisin and asprosin were determined in the blood plasma. The results were adjusted to the changes in the plasma volume. **RESULTS:** Before exercise, only leptin concentrations were significantly different ( $p < 0.05$ ) in the compared groups and were higher in the group of women (7.68±3.67 ng/mL) compared to men (1.27±1.02 ng/mL). The increases in lactate concentration after anaerobic exercise were statistically significant ( $p < 0.05$ ) and comparable in both groups. In none of the groups were there any significant post-exercise changes in the concentration of leptin, adiponectin or asprosin. In the female group, the irisin concentration increased significantly ( $p < 0.05$ ) during the 15th and 30th minute after anaerobic exercise from 0.88±0.99 µg/mL before exercise, and was 2.39±1.33 µg/mL and 2.04±0.73 µg/mL, respectively. At the same time, 30 minutes after exercise, the blood glucose level in women was significantly lower ( $p < 0.05$ ) compared to baseline (3.46±0.56 mmol/L and 4.75±1.10 mmol/L, respectively). The increase in irisin concentration correlates positively ( $r = 0.65$ ,  $p < 0.05$ ) with body fat (%), while correlating negatively with lean body mass ( $r = -0.67$ ,  $p < 0.05$ ). In the group of men, there were no changes in the concentration of irisin or glucose in the blood after exercise. **CONCLUSIONS:** Single anaerobic exercise does not induce the changes in blood levels of leptin, adiponectin and asprosin in men and women. There are sex-related differences regarding response to anaerobic exercise in the concentration of irisin. The increase in irisin concentration due to anaerobic exercise in a group of women may be associated with a decrease in glucose concentration as an energy substrate, a higher content of adipose tissue and lower lean body mass in comparison to men.

**Key words:** cycling sprint, sex-related differences, leptin, adiponectin, irisin, asprosin

**Conflict of interest:** No conflict of interest has been declared.

**Statement of Disclosure:** The study has been carried out within the grant No. DEC-2017/01/X/NZ7/00135, funded by the National Science Centre (Poland).

# Gender differences in the quality of functional movement patterns among 16-year olds

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## **ABSTRACT**

**PURPOSE:** This study aimed to describe functional movement patterns in a representative sample of urban adolescents as well as to assess gender difference in total functional movement screen™ (FMS) score and individual movement patterns. **METHODS:** This investigation is a part of the CRO-PALS study which is a longitudinal study conducted in a representative sample of urban youth in Zagreb (Croatia) between 2014 and 2017. Analyses for this study are based on 733 adolescents from the CRO-PALS cohort with data on functional movement (365 boys; age:16-17years). The participants performed a standardized FMS test protocol and one-way ANOVA was used to examine differences between genders in total score, number of asymmetries and individual tests. **RESULTS:** Girls exhibited slightly higher total FMS score compared to boys ( $12.7 \pm 2.3$  and  $12.2 \pm 2.4$ , respectively;  $F=8.26$ ,  $p<0.01$ ), while no significant difference in the mean number of asymmetries was found ( $1.4 \pm 1$  in boys and  $1.3 \pm 1$  in girls;  $F=1.66$ ,  $p < 0.05$ ). Differences between genders in individual FMS test are depicted in Figure 1. Girls scored higher in inline lunge ( $F = 27.4$ ,  $p < 0.01$ ), shoulder mobility ( $F = 20.4$ ,  $p < 0.01$ ), and active straight leg raise ( $F = 102.9$ ,  $p < 0.01$ ) while boys performed better in pushup ( $F = 127.6$ ,  $p < 0.01$ ). On the other hand, performance in deep squat, hurdle step and rotary stability was similar in both genders. **CONCLUSION:** Although total FMS score differed only marginally, girls were superior in tests challenging flexibility and balance (ASLR, shoulder mobility and inline lunge), while males outperformed females in the test that challenges reflex core stabilization (trunk stability pushup). The results of the present study need to be considered when using FMS as a diagnostic tool among adolescent school-aged population.

**Key words:** sex, adolescence, puberty, FMS

# Physical activity and the condition of bone tissue of students of the Faculty of Physical Education and Sport in Białą Podlaska

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## **ABSTRACT**

Numerous publications prove that physical activity has a beneficial effect on bone mass maintenance and increase. Until recently, osteoporosis was considered to be a chronic disease of the elderly, especially of women. However, it affects both the elderly, young people and even children, and increasingly men, with its prevalence rising worldwide, irrespective of latitude. Recent studies show surprising results regarding the number of bone fractures in men as a result of osteoporosis. Based on epidemiological data, it is believed that the increased risk of bone fractures is due to decreasing physical activity. **PURPOSE:** The aim of the study was to determine the level of mineralization (BMC) and bone density (BMD) of young men depending on the level of their physical activity. **METHODS:** The research involved 120 students of the Faculty of Physical Education and Sport in Białą Podlaska, studying Physical Education (n=80) and Physiotherapy (n=50) at the age of 19-22. Students were a selected group of people who systematically participated in practical programme activities resulting from the field of study and at the same time declared lack of systematic physical activity outside physical classes at the university. In the case of the Faculty of PE, it was 7 hours a week on average, during which students took part in such classes as: gymnastics, athletics, team games, swimming. The number of hours they spent on a week of physical activity as part of practical classes at the university was 4, and these were swimming classes, games and physical games. BMC mineralization (g) and BMD bone mineral density (g/cm<sup>2</sup>) were determined in the lumbar region of the spine (L2- L4) by Dual Energy X-ray Absorptiometry (DEXA) with HORIZON Ci (USA). **RESULTS:** A significant difference was found in the mean values of the BMC parameter in the group of physical education students as compared to physiotherapy students. The BMD parameter did not differentiate between the groups studied, however, it was found that its values were lower in the group of men studying physiotherapy. Individual analysis of the results also showed that according to the WHO criteria (Z-score index), the results of the study in 20 of the studied men (8 PE students and 12 physiotherapy students) indicated low bone density in relation to the calendar age, which ranged from -1.1 to -2.0. **CONCLUSIONS:** The level of physical activity has a significant impact on bone tissue mineralization in the men studied.

**Key words:** mineralization and bone density, physical activity, young men

**Acknowledgment:** The work was carried out as part of a research project carried out by the Faculty of Physical Education and Sport in Białą Podlaska, the Academy of Physical Education of Józef Piłsudski in Warsaw - DS. 248, financed by the Ministry of Science and Higher Education.

# Respiratory parameters of two volleyball teams (professional and university team)

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## ABSTRACT

**PURPOSE:** The differences in respiratory parameters among young athletes could be influenced by biological development itself or they could appear under the impact of the training stimulus that is characteristic for a certain type of sport. This study is conducted to examine how high intensity training can affect the respiratory parameters of volleyball player, in two groups with 6 months training. The aim of this study was to show the differences in respiratory parameters (VC (L), FVC (L), FEV1 (L), BEF (L/min), MIP (cmH<sub>2</sub>O), MEP (cmH<sub>2</sub>O) between two volleyball teams (professional first division team and university team).

**METHODS:** This research includes 40 male players divided in two groups: professional volleyball team of the first division – PT (n1=22, age 25.18±4.00 years, body height 186.91±10.17 cm, body weight 79.01±9.69 kg) and volleyball university team – UT (n2=18, age 20.50±1.01 years, body height 180.00±6.94cm, body weight 75.5±5.82kg). Players in PT had been training 10.59±4.32 years, now 10.72±0.96 hours per week. They have physical conditions training, anaerobic training, physical circuit training and swimming pool exercise. Most of players work in Army and perform extra training with army team in the morning during the week. Players in University team had been training 4.28±1.15 years, now 4 hours per week. They have volleyball drills with aerobic training. All university players had training at university team except some of them did one session more in their club during the weekend. The research was conducted in the laboratory for functional diagnostics in Sultan Qaboos University in Muscat, Oman. Measuring of the respiratory parameters was done on Schiller-spirovit-spirometry-machine. For comparison of measured parameters, Student T-test was used. **RESULTS:** By applying the Student T-test on two small independent samples we notice high statistically significance difference in respiratory parameters VC (PT 5.30±0.29L vs. UT 4.16±0.31L), FVC (PT 5.08 ±0.28L vs. UT 3.83±0.30L), FEV1 (PT 4.81±0.30L vs. UT 3.50±0.33L), BEF (PT 9.31±0.49L/min vs. UT 6.74±0.38L/min), MIP (PT 99.92±5.75cmH<sub>2</sub>O vs. UT 65.35±2.36cmH<sub>2</sub>O), MEP (PT 112.14±7.92cmH<sub>2</sub>O vs. UT 89.79±3.52cmH<sub>2</sub>O) between these two teams (p<0.001 for all). **CONCLUSIONS:** The long period of physical training develops lung functions, which seems to improve function of respiratory muscles and lung capacities. These results show that training stimulus leads to some adaptive changes of the respiratory system. Professional volleyball team have higher VC, FVC, FEV1, BEF, MIP and MEP then university volleyball team, which has affected on their performance.

**Key words:** respiratory parameters, volleyball, training

# Method of informing students about student sports activities: case study of the Faculty of Education in Osijek 2014-2018

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## **ABSTRACT**

The aim of this paper is to explore methods of informing students about student sports activities. Research has been conducted among the students of the 2nd year of the undergraduate university study of the Faculty of Education in Osijek. The collected survey data was compared with the same research on the same sample from 2014. with the aim of determining possible differences in given values. It is considered that the comparative data is representative in the context of comparing two time periods. With the aim of providing better quality comparison and a more accurate presentation of the level of information, the research also involved questions about method of informing students about general student activities which have been compared with the method of providing information about sports activities. The survey was conducted on 31 students through a survey questionnaire. The survey used a Likert scale where students shared their attitudes of agreement with certain statements in positions ranking from 1 to 7. Answers rated with mark 1 indicated that survey respondents were not entirely consistent with the stated statement, and the answer rated with 7 stated they were fully agreed with the given statement. Comparative analysis of attitudes about the method of informing students about general and sport activities, compared to 2014 and 2018, shows a drop in the average rating on the method of informing students directly on the Faculty (general activities from 4.77 to 4.32 and sports activities with 5, 32 at 5.00). The largest increase in average ratings still keeps informing students via social network Facebook (general activity from 5.65 to 6.42, sports activities from 3.35 to 4.16) and also direct information received from colleagues and friends (general activities from 5.94 to 6, 42 and sports activities from 4.00 to 5.35). Information through offline media, such as newspapers and radio, keeps the lowest average rating with a very small difference in the 2014 and 2018 surveys (general activities 2.26, sports activities 1.74). Based on the data obtained in the research it can be concluded that an identical trend of growth or decrease in some ways of informing about all student activities is visible, while there is a noticeable increase in all digital means of information, and most notably through Facebook. This leads to a conclusion that educational institutions have recognized the importance of social networks in the methods of informing students, whereas students have accepted receiving information through them.

**Key words:** students, sports activity

# Virtual reality exercise increases serum brain-derived neurotrophic factor level in elderly people. A pilot study

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## **ABSTRACT**

**PURPOSE:** The aim of this study was to determine whether twelve weeks of virtual reality training affects the total BDNF concentration in the elderly. **Participants and methods:** Volunteers were randomly divided into Virtual Training Group (mean±SEM: age 64.78±0.95 years; body mass 76.03±1.28 kg; body height 166.27±3.89 cm) and Control Group (age 62.33±0.99 years; body mass 77.31±5.60 kg; body height 168.80±3.65 cm). Virtual reality training using Nintendo Wii consisted of 60 min sessions, mainly of moderate intensity (60% of maximal oxygen uptake), performed three times per week. Venous blood samples were taken before and at the end of twelve weeks of virtual reality training. **Results:** Basal serum BDNF in the Virtual Training Group before training amounted to 21.49± 2.31 ng/mL and after 12 weeks of training has increased to 30,55±4.47 ng/mL (P<0.05). No significant changes in basal serum BDNF were observed in Control Group (before training 27.29±2.83 ng/mL, and after 25.09±2.08 ng/mL). **Conclusions:** These results showed a neuromodulation of balance exercise and supports the need for a larger sample size.

**Key words:** balance exercise, neurotrophins, physical activity

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**Conflict of Interest Statement:** None declared.

# Adaptation of coach-athlete attachment scale to Turkish: a pilot study

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## **ABSTRACT**

**PURPOSE:** This study is conducted to determine whether 19-item and 3-factor structure of Coach-Athlete Attachment Scale (CAAS), which was developed by Davis and Jowett (2013), is applicable to Turkish subjects. **METHODS:** 103 athletes and 105 coaches volunteered to participate in the study. First of all, lingual equivalence of the scale was applied. In order to determine the factor structure of the scale, the results of the applied explanatory and confirmatory factor analyses were taken as reference and the scale manifested a three-dimensional structure and 19 item. **RESULTS:** According to the results of item analysis for coaches and athletes, the scale took its final form in a structure with 19 items and 3 sub-dimensions. According to the data obtained from the coaches, it was 62 % of the total variance. For athletes total variance was 60 %. It was determined that the attachment and its sub-dimensions for coaches were highly reliable with reliability coefficients such as 0.805 for the avoidant attachment, 0.887 for the anxious attachment, 0.918 secure attachment and 0.832 for the total attachment. It was determined that the attachment and its sub-dimensions for athletes were highly reliable with reliability coefficients such as 0.817 for the avoidant attachment, 0.827 for the anxious attachment, 0.919 secure attachment and 0.866 for the total attachment. **CONCLUSION:** Coach-Athlete Attachment Scale is a valid and reliable scaling means in measuring the attachment behaviors of the coaches and athletes in Turkish society.

**Key words:** coach, athlete, attachment scale

# The outcomes of comprehensive cardiac rehabilitation in CAD patients after CABG or PCI

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## ABSTRACT

**PURPOSE:** The study aim was to evaluate and compare the influence of comprehensive cardiac rehabilitation program (CCR) based on regular aerobic training on hemodynamic and anthropometric parameters, physical capacity and left ventricular function in men with coronary artery disease (CAD) treated with revascularization procedures like percutaneous coronary intervention (PCI) or coronary artery bypass graft surgery (CABG). **METHODS:** The study population consisted of 131 male patients with CAD aged 34 to 78 years (mean age  $56\pm 8.6$  years) prospectively and consecutively admitted to an outpatient CR after PCI  $n=72$ , or CABG  $n=59$ . Participants performed cycle ergometer interval training for 45 minutes 3 times a week for 8 weeks. At baseline and after 8 weeks, all patients underwent medical examination, exercise test and echocardiography. **RESULTS:** The study participants included 131 male CAD patients, aged 34 to 78 years (mean age  $56\pm 8.6$  years), who were consecutively enrolled after successful cardiac intervention procedures. The PCI group consisted of 72 patients and the CABG group of 59 patients. The examined subjects did not differ significantly in parameters of age, clinical history, frequency of coexisting disease and CAD risk factors. BMI and waist circumference were statistically significantly higher after 8 weeks of CCR in CABG group while in PCI group the values did not change significantly. Echocardiographic parameters were similar in PCI and in CABG group at baseline examination and did not change after 8-week CCR in both groups except a significant improvement of left ventricular ejection fraction in PCI group ( $p=0.017$ ). Among hemodynamic parameters at rest: heart rate, systolic and diastolic arterial blood pressure, only the heart rate was significantly decreased in CABG survivals after 8 weeks of CCR compared to the measurements at baseline. The RPP at rest, calculated as HR x systolic arterial BP, was statistically significantly lower after 8 weeks of CR in both examined groups. Also, workload during the last stage of the exercise test improved after 8 weeks of observation in both groups. **CONCLUSIONS:** Outpatient 8-week CCR program based on regular aerobic training improved physical ability to exercise and modified hemodynamic parameter in CAD patients treated with CABG and PCI. This might result from the fact that 8 weeks is insufficiently long to indicate morphological and functional changes in the heart muscle.

**Key words:** cardiac rehabilitation; CABG; PCI.

# General assessment vs. individualization of training – the need to concentrate on individuals in team games

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## **ABSTRACT**

**PURPOSE:** One of the most important principles of optimal player preparation is individualization of training. Individualization is largely applied by many coaches and scientists; however, application is largely dependent upon mean values which are used to design training loads for all players. Nevertheless, it is a challenge to coaches to address and accommodate individual differences among players in an effort to build a strong team. The objective of the study was to verify a specific model based on individual player assessments to improve the training system. **METHODS:** Subjects were 17 members of the National Polish U16 Youth Field Hockey Team who were training for the “EuroHockey5's Championship 2017”. Means and standard deviations for age, body mass, height were and estimated percentage fat were, respectively,  $15.6\pm 0.5$  years,  $65.4\pm 5.9$  kg,  $175.6\pm 6.1$  cm, and  $16.7\pm 2.1$  %. Several sport-specific tests for field hockey motor abilities were administered to all players, and included running speed with and without a hockey stick, the vertical jump, agility, aerobic endurance and speed-endurance. Z-scores were calculated using mean and theoretical norms, as well the standard deviation for the 17 players. **RESULTS:** The results are presented in three steps. First, mean motor performances of the players were compared to the norms for each test. Second, rankings of the players based on individual performances on each of the sport-specific motor skill tests were used to prepare an optimal individualized training program. Third, based on the preceding, the data were converted to linear and radial graphic formats to characterize the motor-profile of individual players. **CONCLUSION:** The proposed model of data analysis for individual players permits the individualization of field hockey training. In addition, changes in observed motor parameters can be estimated and visualized during the entire macrocycle in an effort to appropriately individualize and optimize the training process and decrease the risk of overloads and injury.

**Key words:** training optimization, prevention, methodology, praxeology, data modeling

# Impact of proposed exercises to develop motor intelligence for pre-school children aged 5-6 years (pilot study)

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## **ABSTRACT**

**PURPOSE:** The research aim is to identify the effectiveness of the proposed exercises for the development of motor intelligence for children aged 5-6 years. **METHODS:** The subjects of the study were (n=16) children. They have been divided into two groups - experimental group (n=8 children) and control group (n=8 children). In EG they were practicing the proposed exercises for the development of motor intelligence, whereas CG practiced the classic PE exercises in two training per week for six weeks. Following the completion of the training programs, subjects were re-evaluated to determine change in total. **CONCLUSIONS:** The results of this study that experimental group were trained in proposed program approbation more than control group in traditional way.

**Key words:** impact, proposed exercises, development, motor intelligence

# Self - concept and sport performance level of candidates for enrollment at the Faculty of Sport and Physical Education

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## **ABSTRACT**

**PURPOSE:** The aim of this study was to examine the differences in the dimensions of the self-concept of adolescents of both genders, candidates for enrollment at the Faculty of Sport and PE, aged  $18.75 \pm$  (n=121) in relation to the achieved level of sport – international (n=48), national (n=41) and local (n=32). **METHODS:** The adapted version of the Questionnaire Self-Perception Profile for Adolescents was applied (Harter, 1988), which contained nine subscales: Scholastic Competence, Social Competence, Physical Appearance, Job Competence, Romantic Appeal, Behavioral Conduct, Close Friendship, Global Self-Worth. To determine the differences between the system variables of three groups of respondents, international, national and local athletes, a one-way ANOVA was applied. **RESULTS:** The results of the univariate ANOVA indicate that there are statistically significant differences between the respondents in relation to the level of sport in the scores on the scale of Athletic Competence:  $F(2,118)=3.42$ ,  $p<0.05$ . Analyzing the results of the arithmetic mean of the above subscales, it can be noticed that the highest scores were reached by the respondents involved in sports activities at the international level. The results of the analysis also showed that, although the differences are not statistically significant, respondents who do sports at the highest, international level have the highest scores in all other observed variables, especially on the scale of Job Competence, where the difference between the three levels of athletes is marginal:  $F= 2.53$ ,  $p=0.08$ . **CONCLUSION:** Respondents who do sports at the highest, international level have the highest scores in all other dimensions where a high score is a desirable result compared to the athletes at national and local levels. This is especially reflected in the scale of Athletic Competence and then Job Competence, which potentially points to the greater probability and the possibility of professional development of a sports career among adolescent athletes of international level.

**Key words:** self-esteem, sports rank, adolescent, sport, competition

# Is it possible to improve postural stability in basketball during ten days?

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## **ABSTRACT**

**PURPOSE:** Dynamic Neuromuscular Stabilization (DNS) provide an effective training method of improving core and postural stability in sport-specific environments and rehabilitation. The aim of this research was to determine the effects of DNS training methods on postural stability in junior basketball players. **METHODS:** A total of 60 (30 girls) junior basketball payers, aged  $21.0 \pm 1.16$  years (weight:  $68.20 \pm 10.75$ kg; height:  $175.63 \pm 8.87$ cm) participated in this study. DNS Training sessions were conducted once per day for a total of 10 days. The postural stability of the participants was estimated by the following tests on footplate (Footscan system): Double leg stability test, Left leg stance test, Right leg stance test. Measuring were conducted to determine initial and final results followed by two check-up tests. General linear model repeated measures analysis was used to investigate the effects of DNS training on postural stability parameters. **RESULTS:** The group had once per day DNS training for 10 days in a row. Compared with the initial testing, there was a significant ( $p < 0.05$ ) improvement in double leg stability test ( $p < 0.05$ ), while in other two stability tests there were no significant improvement. **CONCLUSION:** Findings from the present study indicate that DNS training, instructed by qualified professionals, can result in improvements in postural stability components in basketball players, but consequently not at the significant level. DNS is a cost-effective and beneficial training method for stimulation of postural stability in basketball training programs, but more research is required to determine ideal training methods routine for quality improving of postural stability in young basketball players.

**Key words:** balance, stabilization, core training, postural control

# Changes of the static balance level of canoeists in the training macrocycle

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## **ABSTRACT**

**PURPOSE:** Performance effectiveness in water sports is to a large degree dependent on good balance during training and competition. Rowing and paddling takes place on rickety boats and kayaks as well as additionally the disturbed balance is a move of waves and the wind as well as an escalating tiredness. Determining the level and changes of the static balance of canoeists in the annual macrocycle and depending on the sports level of competitors was a purpose of research. **METHODS:** In examinations 13 canoeists participated in the age of 14-27 years representing the diversified sports level (intermediate group = 6 and high-advanced n = 7). In statics they made measurements of the balance with the application Stabilometer Biodex Balance SD System. Examinations were performed standing in the position on both feet and on the right and left leg. The measurement lasted 3 times during 20s. Examinations were being carried out three times in the training macrocycle: at the beginning of the preparatory period, at his ending and in the competition period. Results of measurements were being analyzed with essential statistical methods considering the diversified sports level of competitors. **RESULTS:** Examined competitors were characterized by the highest level of the balance. At competitors about the sports highest level was 0.34 (result 0 is indicating the highest level of the balance) however at intermediate took was 0.47 at the beginning of the preparatory period. In consecutive times of examinations results underwent the improvement to the level, appropriately: 0.32 and 0.37. At most of competitors moving of the center of gravity were stated put on back and to the right of the center of the platform. **CONCLUSION:** Observed changes of the balance of canoeists in the training macrocycle could be caused of the changes of administered training loads, of particularly including paddling on the canoe at the end of the preparatory period and in the competition period. Stated moving the center of gravity can be connected with a specificity (asymmetry) of paddling on the canoe.

**Key words:** static balance, canoeing, optimization, coordination

# Structure of physical fitness among young female handball players (trends of changes in 2007-2013)

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## **ABSTRACT**

**PURPOSE:** The aim of the present thesis was to establish trends in changes of somatic build and physical fitness in young female handball players. These changes were examined with respect to requirements of specific training adopted as typical for targeted sports training stage. **METHODS:** The research material was collected in the period 2007-2013 among young handball players selected to Greater Poland junior team. The study evaluated 188 girls (mean  $\pm$  SD: age =  $14.2 \pm 0.5$  years; height =  $166.9 \pm 6.1$  cm; weight =  $58.6 \pm 8.7$  kg). Measurements of height, weight, and body fat were conducted, also BMI was measured. The level of motor skills was established in regard with the International Physical Fitness Test. The data were analyzed using standard statistical tools. To establish the differences among years of observation ANOVA was used and to assess tendency of changes, regression analysis was used. **RESULTS:** The study found a negative trend of increase in body fat with constant decrease in weight-height ratios. It was noticed that speed, endurance, intensity, and flexibility decreased, while only strength increased. **CONCLUSION:** The results may affect the observed regression in general physical fitness of young handball players. The phenomenon enters into the tendency for regression in motor modifications across generations that have been observed among populations.

**Key words:** young athletes, body composition, physical fitness, handball

# Small-sided games versus interval training in adolescent soccer players: effects on agility and change of direction speed

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## **ABSTRACT**

**PURPOSE:** The aim of this research was to determine the effects of small-sided games (SSG) vs. interval training (HIT) on agility and change of direction (COD) speed in adolescent soccer players. **METHODS:** A total of 55 adolescent male soccer players (age:15.6±0.6 years) were recruited. Players were assigned to SSG, or HIT group during 8 weeks of pre-season. In addition to the usual technical and tactical sessions, the SSG group performed 3 vs. 3 and 4 vs. 4 SSGs, whereas the HIT group performed intermittent runs in the form of 15 seconds of effort interspersed with 15 seconds of passive recovery (15s-15s), and 10s-10s. Pre- and post-training players completed a test battery involving change of direction (COD) sprinting (COD-left, COD-right), Illinois test and reactive-agility test (RAT-human, RAT-light). **RESULTS:** A significant ( $p<0.05$ ) interaction was detected for all COD tests and RAT-light. A within-subject difference was observed in RAT-light test ( $F=8.509$ ;  $p=0.005$ ) in the SSG group. The SSG group showed significantly better improvements ( $p<0.05$ ) compared to the HIT group in agility tests reaction time. **CONCLUSION:** Agility performance and reaction time amongst adolescent soccer players could be improved using SSG training.

**Key words:** football, conditioning, pre-season, effects

# UTE MRI sequence as a recent option in the tendon and entheses imaging

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## **ABSTRACT**

Tendinopathy with its symptoms is one the most common orthopaedic injuries in the population. After the thorough clinical examination, Magnetic Resonance imaging, due to its noninvasiveness and high resolution, is a widely used diagnostic method for the evaluation of the morphology and signal intensity changes in the injured tendons. The practical issue is that tendons and entheses are highly organized collagen structures and contain a high fraction of components with "short" and "ultrashort" transverse relaxation times. Consequently they appear black in almost all spin echo (SE) pulse sequences. Recently, new sequences have been developed, so called "UTE", which provide TE values less than 1 msec and allow direct visualisation of the short T2 tissues in tendons and entheses. This technology holds promise of answering questions like early degeneration and inflammation, post-outcome predictions etc. where conventional MRI is rather limited. **PURPOSE:** to present the studies which showed the advantages of the UTE MRI sequence over the standard MRI protocol while assessing structures of the musculoskeletal system. **METHODS:** in each study, recently developed UTE MRI sequence was used for imaging of the highly organized collagen structures and bones. Qualitative and quantitative values were measured and differences were analyzed. **RESULTS AND CONCLUSION:** 3D-UTE – Cones sequence provides high resolution morphological and comprehensive quantitative imaging in the musculoskeletal system.

**Key words:** new sequence, magnetic resonance, short and ultrashort transverse relaxation time, fibrocartilage, tendon insertion

# Blood oxidant-antioxidant status and markers of bone metabolism in trained and untrained men

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## **ABSTRACT**

Physical activity is recommended as a preventive and therapeutic strategy against osteoporosis, which affects both women and men. However, the specific mechanisms by which exercise influences bone metabolism and remodeling are still not thoroughly understood. It has been suggested that dynamic bone formation and resorption throughout human life may depend on the severity of oxidative stress or decreased levels of low molecular antioxidants and the activity of antioxidant enzymes. On the other hand, regular physical activity may improve the oxidant-antioxidant status. The AIM of the study was to assess the impact of high level of physical activity associated with competitive sports on resting oxidant-antioxidant status and markers of bone metabolism in blood. **METHODS:** A total of 134 students of the Faculty of Physical Education and Sport in Biała Podlaska, aged 19-22 years, took part in the study, including those practicing high-performance sport – football, handball and mixed martial arts (MMA) (T, n=64) and other students stayed in control group (C, n=70). The students of the control group did not practice high-performance sports and their organized physical activity was limited to practical classes included in the study curriculum. Blood samples from the ulnar vein were taken in the morning, after overnight fasting. Total antioxidant potential (TAC), lipid hydroperoxides (LOOH) – as an indicator of oxidative stress and oxidative damage to lipids, uric acid (UA) and phosphates (P) concentrations were measured in plasma, whereas serum was analyzed for the activity of alkaline phosphatase (ALP), as well as the level of calcium (Ca), osteocalcin (OC) and total 25-OH vitamin D (25-OH D). The activity of glutathione peroxidase (GPx) and superoxide dismutase (SOD), as representatives of enzymatic antioxidant system (neutralizing free radicals and reactive oxygen species), were determined in whole blood, and in erythrocytes, respectively. **RESULTS.** Significant differences were found between the groups in the following parameters: GPx activity, LOOH, Ca and UA. Higher GPx activity was found in T group as compared to C group ( $P < 0.05$ ). In turn, in T group, LOOH level was lower than in C group ( $P < 0.05$ ). In addition, higher Ca and lower UA concentrations were observed in T group in comparison to C group ( $P < 0.001$ ). No significant differences were observed between the groups in SOD and ALP activities, as well as in TAC, P, OC and 25-OH D concentrations. **CONCLUSIONS.** Regular training in athletes increases enzymatic antioxidant protection and reduces oxidative stress at rest. However, it does not affect the markers related to bone tissue metabolism.

**Key words:** oxidative stress, physical activity, students, bone metabolism

No conflict of interest is declared.

The work was carried out as part of a research project carried out by the Faculty of Physical Education and Sport in Biała Podlaska, the Academy of Physical Education of Józef Piłsudski in Warsaw – DS. 248, financed by the Ministry of Science and Higher Education.

# Dynamics of indicators of competitive activity in the Greco-Roman wrestling at the Olympic Games

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## **ABSTRACT**

**PURPOSE:** To carry out a study and comparative analysis of the competitive activity indicators of the Greco-Roman style wrestlers of a high level of skill at the Olympic Games to identify trends in the dynamics of technical actions and technical and tactical preparedness. **METHODS:** Analysis of protocols and videotapes of the final fights of Greco-Roman wrestlers at the Olympic Games (1996, 2000, 2004, 2008, 2012, 2016 years). In total, 117 final matches of high-qualified athletes were analyzed, the following indicators were recorded: duration of bouts; number of technical actions; efficiency of standing and parterre techniques; effectiveness of defense in standing and parterre; productivity of standing and parterre techniques. **RESULTS:** Analysis of technical arsenal of wrestlers at the Olympic Games made it possible to identify 12 main technical actions that are most often used: turnovers (32.7% of all technical actions), reverse turnovers (4.9 %), back belt throws (15.1 %), reverse belt throws (5.3 %), counter hold in parterre (8.5 %), pins (4.1 %), takedowns (5.7 %), twisting throws (2.,0%), back arch throws (2.5 %), knocking over (10.2 %), pushing out of mat (5.7 %), counter hold in standing position (3.3 %). Analysis of the competitive activity of wrestlers at the Olympic Games showed: the composition of effective technical and tactical actions was significantly reduced and the tactics of conducting the bout became simpler; offensive actions prevail in the composition of competitive technology, the pace of fight is constantly high; holds are carried out after the previous preparation and in that case if the athlete is sure that hold will be performed; high-class wrestlers conduct more technical and tactical actions in parterre than in standing position, all this significantly reduces the entertainment of the modern Greco-Roman wrestling. **CONCLUSIONS:** It has been established that for now there are significant problems for Greco-Roman wrestlers in the need to modernize competition rules in order to increase the effectiveness and spectacularity of wrestling bouts.

**Key words:** elite wrestlers, comparative analysis, technical actions, technical and tactical preparedness.

**Conflicts of interest:** the authors declare that there is no conflict of interests.

# Effect of combined endurance-resistance training and soy extract supplementation on expression of eNOS gene in rats

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## **ABSTRACT**

**PURPOSE:** The decline of endothelial nitric oxide synthase (eNOS) activity and/or expression is directly associated with various cardiovascular events. Estrogen induces nitric oxide (NO) level release in vascular endothelial cells. At the same time, menopause is an independent risk factor for cardiovascular disease. The purpose of this study was to investigate the effects the combined resistance and endurance (RE) training and soybean (SOY) supplementation, both known to improve endothelial function, on expression of eNOS gene in the heart ovariectomized (OVX) rats. **MATERIALS AND METHODS:** Fifty female Wistar rats were divided into five groups: 1) sham (SHAM); 2) ovariectomy (OVX); 3) ovariectomy with soy extract supplementation (OVX+SOY); 4) OVX with RE training (OVX+RE); 5) and ovariectomy plus RE training with soy extract supplementation (OVX+RE+SOY). RE training and soy extract supplementation were administered alone or in combination for six weeks. The effects of these treatments on cardiac eNOS expression were measured using real-time PCR. **RESULTS:** Ovariectomy down-regulated cardiac eNOS gene expression, however, six weeks SOY treatment or RE training reversed this effect. The combination of SOY plus RE was greater than RE or SOY alone in reversing estrogen-deficiency-caused eNOS down regulation. **CONCLUSION:** Our results suggest that the combination of soy extract supplementation and regular RE training has greater cardiac protective effect in ovariectomized rats than either treatment alone.

**Key words:** combined endurance-resistance training, soy supplementation, nitric oxide synthase

# Cerebrovascular risk factors and social anamnesis after stroke

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## **ABSTRACT**

**PURPOSE:** Stroke recurrence may be prevented by removing major risk factors (Bašić-Kes, Demarin, 2014). The aim of this study was to investigate social anamnestic factors and specific risk factors for cerebrovascular disease in stroke survivors. **METHODS:** 60 ischemic stroke convalescents (30M+30F) were included in the study. All participants had a mild neurologic deficit (NIHSS 5-15). The patients mean age was 71 years (min 45 – max 81). A neurologist recorded risk factors for cerebrovascular disease and social anamnesis during medical examination. **RESULTS:** Insufficient daily physical activity and high stress levels were present in 72.2 % of participants. BMI values and waist-hip circumference values were above the upper limit in both women and men ( $p < 0.05$ ). Arterial hypertension was present in 84.8% of the patients. 21.8% of patients smoked and males smoked more ( $p < 0.05$ ). Significant gender differences were found in social anamnesis. Men dominantly lived with their partner, while women lived alone ( $p < 0.05$ ). Men were retired while women were not ( $p < 0.05$ ). Multifactorial regression analysis found that over 63% of patients had two or more risk factors for stroke recurrence with the risk increasing with age ( $p < 0.05$ ). **CONCLUSION:** The obtained results indicate a high prevalence of modifiable risk factors for a stroke recurrence in stroke survivors (Bos et al., 2014), sedentary lifestyle being the most common. There is a real need to educate stroke survivors how to change key living habits in order to prevent stroke recurrence, especially how to be more physically active. Since the risk seems to worsen with age, greater attention should be given in educating older people.

**Key words:** stroke survivors, risk factors, sedentary lifestyle

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# Traditional Karate as a Means of Shaping of Values, Lifestyle and Life Philosophy of Martial Arts

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## **ABSTRACT**

**PURPOSE:** The study aims to verify the existence of a relationship between the formation of an individual's identity and the study of traditional karate for the needs of everyday life. **METHODS:** The analysis of the literature and the subsequent comments aim to summarise and identify the key aspects involved in the process of achieving each person's identity in society, and to discuss them from the perspective of the lifestyle and life values. In order to answer the research questions, we have chosen a questionnaire survey of intentionally selected respondents as the basic strategy. The data were summarily described and the relationships between the variables were then examined. The research design describes the way the research is conducted. Our research plan uses a combination of quantitative and qualitative methods. The evaluation of changes in the individual variables of the ILS questionnaire was performed by comparison using the nonparametric paired Wilcoxon t-test. Already at the beginning, we determined the size of effect and, at the same time, the level of statistical significance = 0.1. Due to the exploratory nature of the research we consider this chosen level of statistical significance to be useful. In the search for the relationship between the resulting mark, groups and individual variables of the ILS questionnaire, we used the nonparametric Kruskal-Wallis variance analysis for multiple independent selections that determines the statistical significance of the difference (at the level of = 0.1) of the averages in the subsets. **RESULTS:** The research sample included respondents practicing karate. We managed to get data from 58 men and 23 women. These are trained karate trainees, experienced instructors, referees, long-time coaches with at least 20 years of experience. We had chosen these individuals because they have sufficient experience to relevantly consider and assess the impact of karate on the lifestyle and the choice of these karate fighters was targeted. For a more general overview and variety of responses, we again intentionally contacted foreign instructors and coaches with long-term experience. **CONCLUSIONS:** All the research has shown that the impact of the study of traditional karate on the formation of lifestyle values is positive, especially in terms of functioning in everyday life. We can say that the study and training of traditional karate acts as a means of shaping values of each individual and that it greatly affects the lifestyle and life philosophy. Furthermore, the identification of key aspects involved in the process of achieving the ideal identity of each person in society and the shaping of lifestyle values in the context of traditional karate was demonstrated. Through traditional karate, an individual acquires a social role, learns skills, values, creates opinions, attitudes, ideology, shapes up primarily from the mental or moral point of view, develops character traits and, thanks to interactions, also interpersonal relationships.

**Key words:** karate, martial arts, shaping of Values, lifestyle

# Characteristic of musculoskeletal injuries among drivers and co-drivers participating in different levels of motor race competitions

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## **ABSTRACT**

**PURPOSE:** The observations and personal discussions showed that the racecar and rally drivers, as well their trainers, have largely been left to their own devices to figure out the areas of specific training focus without any other support of functional training. During stage rallying, musculoskeletal injuries may be provoked by the high magnitude of vibration to which the driver and co-driver are exposed. Drivers and co-drivers experience almost the same exposure to their whole body mechanical shocks and vibration, but different exposure to hand/wrist stressors. Very often it could be “taboo” because drivers must “just steer and win” and very rarely once speak about risks and consequences. The aim was to characterize whole body and hand/wrist symptoms of musculoskeletal injury of drivers and co-drivers who participate in different levels of motor races. **METHODS** The research group consisted of 25 professional and 68 amateur stage rally competitors (female and male). As the research tool, the questionnaire consisting of 18 questions, including closed and open questions, was used. The questionnaire investigated whole body and hand/wrist symptoms of musculoskeletal injury. For data analysis the standard statistical tools were used. **RESULTS** The most common problems for drivers were in the lumbar spine, cervical spine, shoulders and thoracic spine. There was a higher level of discomfort in the hands and wrist for drivers than co-drivers. Low back pain in rally participants (professional and amateur) is higher than reported for workers exposed to whole body vibration. **CONCLUSIONS** Mostly rally and race drivers and co-drivers report symptoms of musculoskeletal injury. There were much more reported symptoms of musculoskeletal injuries by amateur stage rally competitors. It is obvious to refer to the frequency of occurrence of trauma symptoms to the extreme environment of a rally car. There is urgent need to prepare special prevention training program adapted to stated problems.

**Key words:** low back pain, hand and wrist symptoms, professional drivers, rally drivers, race drivers, co-drivers, vibration

# Pregnancy gaze behavior changes during locomotion

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## **ABSTRACT**

**PURPOSE:** Walking, stair climbing, and stair descending are everyday activities; however, with advancing pregnancy these activities become more challenging, and the number of studies of pregnancy-related changes of the visual input, highly relevant for safe stepping, is lacking. **METHODS:** 33 pregnant women participated in this study at 27, 32, and 37 weeks of gestation (g.w.). An eye-tracking glasses system was used to monitor their gaze location as they walked up a 15-meter long path on a flat surface, then descending a 22-tread staircase and after a short U-turn path downstairs ascending back the staircase, taking the staircase one tread at time. **RESULTS:** The results showed that during advancing pregnancy participants located their gaze more towards the stairs during both stair ascent and descent, and more forward throughout gait on a flat surface. However, between 32 and 37 g.w. a tendency to return to the values of 27 g.w. was observed in most of the analyzed variables. **CONCLUSION:** A gaze located more towards the stairs during stair walking may possibly optimize stepping accuracy, and a gaze located more forward during a gait on a flat surface may possibly enhance stability by minimizing eye and head movements. A tendency to return to the values of 27 g.w. during 37 g.w. may suggest that the gaze location changes may be influenced by the uterus height, which falls in the last month to the level of the 7th or 8th month of pregnancy, constituting a similar mechanical obstacle restricting the full simultaneous visual feedback of the limb, and foot-floor position.

**Key words:** eye-tracking, gait, stair locomotion, pregnant women

# Physical activity of children aged 7-9 years in Republic of Croatia

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## **ABSTRACT**

**PURPOSE:** The aim of this research is to show the level of physical activity among children aged 7-9 in Croatia. **METHODS:** This study is a part of the Childhood Obesity Surveillance Initiative, research initiated by the World Health Organization Regional Office for Europe. In Croatia, it was conducted in 182 randomly selected second and third grade classes from 164 mainstream elementary schools. The assessment of a total of 5664 students included various measurements and assessments including questions related to physical activity. In order to establish if children meet the recommended level of physical activity, variables of participation in sports clubs, active play, sedentary behaviours excluding screen time, the use of passive transportation to school, screen-time and the average sleep time. active play, sedentary behaviours excluding screen and screen time were assessed for weekdays and weekends separately. Scores on these variables were analyzed. **RESULTS:** Regular physical activity, measured by participation in sports/dance activities through membership in clubs is more frequent in boys than girls, 70.5% and 65.9% respectively. Overall, the number of children participating in sport/dance activities exceeds two thirds of all 8-year-old-children. Active play habits data show that 54.3% of children, both boys and girls, spend between 2 and 3 hours in active play during weekdays. However, the frequency of active play with a duration of 3 hours or more increases during the weekends. The average number of hours of sleep of surveyed children is between 9 and 11 hours of night sleep, according to parents' statements. During the working days children spend somewhat less time in front of the screen, while over weekends, more than half of children achieve over 3 hours of screen time. **CONCLUSION:** These results emphasize the importance of free time physical activity in children and its promotion as an accessible disease prevention and a health enhancing tool.

**Key words:** childhood obesity, active play, sedentary, screen time

**Conflict of interest:** Authors state no conflict of interest.

**Statement of Disclosure:** The research was funded by the World Health Organization.

# Characteristics of internal loads in Female Hockey 5's – the new version of youth field hockey competition for U16 players

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## **ABSTRACT**

**PURPOSE:** The International Hockey Federation modified the format of competition for youth under 16 years of age (U16) in 2015. The number of players on the pitch was reduced from 11 to 5, with 5 players in reserve. The first U16 European Cup was held in Poland (boys) and in France (girls) in July 2017. The new rules introduced a smaller pitch, three 10-minute periods of play, and 3-minute breaks between periods. The aim of this study was to characterize the internal physiological loads associated with the small-sided "Hockey 5's" games in female U16 players. **METHODS:** Subjects were 18 females comprising the Polish Youth National Team U16 (age  $15.1 \pm 0.70$  yrs; height  $164.4 \pm 4.83$  cm; weight  $56.6 \pm 7.11$  kg; %Fat  $26.1 \pm 4.43$ ; muscle mass  $39.4 \pm 3.56$  kg), who played in two international matches, 9 attacker, 7 defenders, and 2 goalkeepers. Internal loads of the 16 field players during active time of play were estimated with a Polar Team 2Pro unit. **RESULTS:** Average (HR<sub>ave</sub>) and maximal (HR<sub>max</sub>) heart rates during the two matches were, respectively,  $183.5 \pm 7.98$  bpm and  $191.6 \pm 6.50$  bpm. The only difference between players by position was noted in total HR<sub>max</sub> across the three periods (approached significance,  $p=0.06$ ) and in HR<sub>max</sub> during the first period. Attackers had a higher HR<sub>max</sub> than defenders during the game ( $p=0.04$ ). During active play, the field players spent most time in HR Zones Z4, Z5 and Z3. However, when converted to energetic cost (kcal), the highest energy expenditure occurred during HR Z5, and then in HR Z4 and Z3. Differences in energy cost by position were not significant. **CONCLUSION,** effort expended during observed during the new version of small-sided field hockey games can be characterized as very heavy exercise. The results have implication for coaching and training. Coaches must consider the appropriate balance in training to prepare the youth players for the aerobic and anaerobic demands in order to optimize time for rapid recovery during matches and before the next competition. The results highlight the need to modify training to optimize the adaptation of youth players and to protect them from excessively high loads.

**Key words:** heart rate, heart rate training zones, energy expenditure, training optimization, youth sports



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*” Movement is able to substitute nearly every kind of medicine, but all medicines together will never substitute movement.”*

**W. Oczko**

physician in ordinary of the doctor  
of Polish kings, XVI century



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