

# ACTA KINESIOLOGICA

International scientific journal of kinesiology

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*There are two ways of spreading light: to be the candle or the mirror that reflected its light.*

*(Edit Varton)*

*Dear reader,*

*It took a lot of determination to present this issue of Acta and it took patience. Both are mental concepts and have no material component, although both are visible in material objectified area. Really interesting! But then, as always, Acta goes on in the seventh year of publishing in full sail. Neither this time you are not left without interesting articles. On the contrary, our authors are from Iran, Italy, Serbia, Croatia, Bosnia and Herzegovina, Slovenia, Montenegro and Slovakia. They prepare reports on the management and demographic characteristics, then the obesity of children, functional fitness, mathematical paradigm of training, loads in handball, table tennis analysis, quantitative changes in basketball, handball games segments analysis, polygon sports games for children, self-assessment and performance in volleyball, analyzing the performance of dance content, examination results of Olympic high jump, the organizational structure of football clubs, promoting fitness, karate analysis regarding territorial features, performance in rhythmic gymnastics, hyperoxygenation with running sprints and self-evaluation activities in exercise of pupils. Truly great supplements can serve in many ways as a nice source of interesting topics. Be sure to thank everyone who supported us, and we promise to be wherever we candles and sometimes a mirror.*

*Executive Editor  
Assoc.Prof.Dobromir Bonacin, PhD*

*Postoje dva načina za širenje svjetlosti: biti svijeća ili ogledalo koje reflektira njenu svjetlost.*

*(Edit Varton)*

*Dragi čitatelju,*

*Trebalo je dosta odlučnosti da se iznese ovaj broj Acte i trebalo je strpljenja. I jedno i drugo duševni su pojmovi i nemaju materijalnu komponentu, a u materijalnom se opredmećuju. Zaista zanimljivo! Ali eto, kao i uvijek do sada, Acta ide dalje u sedmu godinu izlaženja i s punim jedrima. Ni ovaj put vas nismo ostavili bez zanimljivih članaka. Baš naprotiv, naši autori su iz Irana, Italije, Srbije, Hrvatske, Bosne i Hercegovine, Slovenije, Crne Gore i Slovačke. Oni su pripremili priloge o menadžmentu i demografskim značajkama, zatim o pretilosti djece, funkcionalnom fitnessu, matematičkoj paradigmi treninga, opterećenjima u rukometu, analizi u stolnom tenisu, kvantitativnim promjenama u košarci, analizi segmenata rukometne utakmice, poligonu sportskih igara za djecu, samoprocjeni i uspješnosti u odbojci, analizi izvođenja plesnih sadržaja, pregledu rezultata olimpijskog skoka u vis, organizacijskoj strukturi nogometnih klubova, promociji fitnesa, karate analizi u vezi teritorijalnih značajki, uspješnosti u ritmičkoj gimnastici, hiperoksigenaciji kod trčanja sprinta i samoevaluaciji i tjelesnoj aktivnosti učenika. Zaita sjajni prilozi mogu vam poslužiti na razne načine kao lijepi izvor zanimljivih tema. Svakako hvala svima koji nas podupiru, a mi obećavamo biti kad god možemo svijeća, a ponekad i zrcalo.*

*Izvršni urednik  
Prof.dr.Dobromir Bonacin*



## AN INVESTIGATION INTO THE RELATIONSHIP BETWEEN PERSONAL AND ORGANIZATIONAL TIME MANAGEMENT SKILLS AND SOME DEMOGRAPHIC TRAITS (AGE, GENDER, JOB HISTORY, EDUCATIONAL MAJOR) AMONG PHYSICAL EDUCATION MANAGERS

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Original scientific paper

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### Abstract

The purpose of this study was to investigate the relationship between personal and organizational time management skills and some demographic traits among physical education managers. The method of the research was correlative. The statistical sample consisted of all the managers of physical education administrations in Fars province, Iran (N= 110). The data was gathered through time management questionnaires, made by Hafezi (2008). Questionnaires' validity was confirmed by the ideas of experts. The reliability was confirmed by cronbach  $\alpha$  after a pilot test. The grades were 0.84 and 0.82 for each questionnaire. Normal distribution was determined by Kolmogorov-Smirnov test. Descriptive and inferential statistics were used to analyze the data. Inferential statistics consisted of Pearson's correlation coefficient, independent T-test and multiple regressions. Software SPSS was used to analyze the data. The findings demonstrated a significant relationship between age and operational planning. Regression coefficient demonstrated no significant relationship in terms of gender. It is suggested to revise the laws making difference between men and women in terms of management principles. Also, it is necessary to think of a two-unit course of time management in the universities to increase the knowledge of time management. Also, it is necessary to pave the way for the youth to come into organizational posts.

**Key words:** management skill, administration management in physical education

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### Introduction

The experts of management put forward a new debate called "effective management" in which one of the main provisions for the effectivity of the managers is time management (Karami, 1995). Time management refers to the skills related to the optimum control of time. Generally, time management skill is separated in two dimensions: personal skill and organizational skill. Personal time management skill includes some general behavioral patterns that people use in their ordinary or personal life in order to manage the time. Organizational time management skill refers to the people who are the manager of an organization and includes the skills that a manager uses in order to manage the time. Organizational time management skill has six subscales: goal setting, priority processing of activities and goals, authority delegation, operational planning, communication management and the management of the meetings. Some believe that personal time management skills include organizational ones. The reason is that if a person is capable of handling his own time, he can manage organization time as well. But, these two skills are not of the same nature. Any person has complete freedom in organizing his time in house environment and at work atmosphere. This sort of organization is based on his assumptions, beliefs, information, experience and culture which are different in house and at work. Therefore, we cannot claim that any manager having personal time management skill necessarily has organizational skill too, vice versa (Zadeh, 1998).

On the other hand, understanding personal and organizational time management skills can be used as a criterion in order to choose effective and efficient managers. Accordingly, some researches have been implemented in order to identify the relationship between personal and organizational time management skills. For example, Karami (1996) claimed that there is a significant relationship between personal time management skill and the six dimensions of organizational time management skill. Hafezi (1997) and Masiha (1999) came to the conclusion that personal time management skill is significantly related with the two dimensions of communication management and priority processing of the activities and goals but no significant relationship between personal time management skill and the other four dimensions of organizational time management skill. Considering that physical education organization is changed into the ministry of sport and youth, the demanding level of the people has increased. Therefore, this ministry, whose main addressees are the youth, should face the problems and difficulties confronted by the youth and should deal with them. So time management is a necessity. Also, according to the expansion of sport programs and an increase in the investments in this field, it seems that the managers need a variety of skills in order to be effective in doing their duties (Jahromi, 1996). Jamieson (1987) and Forsyth and Cately (2007) recommend time management skill as one of the most important ones in this respect.

Accordingly and considering that no research has been implemented regarding the relationship between personal and organizational time management skills at physical education administrations and regarding the fact that similar researches have ended into different results, the researcher decided to investigate about time management skills among the managers of physical education administrations in Fars province in Iran and answer the following questions: Is there any significant relationship between personal time management skills and some demographic traits? Is there any significant relationship between organizational time management skills and some demographic traits?

## Methods

As the researcher in this research is trying to investigate the relationship between personal and organizational time management skills and some demographic traits, the research is correlative in which the criterion variable is personal time management skill and the predictive variable is organizational time management skill. In this research the statistical sample consisted of all the managers in the ministry of physical education in Fars province in Iran including the managers and deputies of the principle ministry of physical education in Fars province, the managers of physical education administrations in the cities and the vice presidents of sport parties in 1390. The sample consisted of 110 managers in all. The instruments of measurement in this research were two researcher-made questionnaires made by Hafezi (1998): 1- The questionnaire of personal time management skill 2- The questionnaire of organizational time management skill.

The questionnaire related to personal time management skill consisted of 29 Likert 5-option questions (always, frequently, on and off, seldom, never). The grades 1,2,3,4 and 5 were devoted to them. The lowest score taken through this questionnaire was 29 and the highest score was 145. The more the score, the more personal time management skill. Hafezi calculated the reliability of the questionnaire through Cronbacha coefficient that was 0.81. The content validity of the questionnaire was affirmed by the professors and experts in this field. In the present research, having implemented a pilot study and calculated the variance of the questionnaires, the reliability of the questionnaire was 0.84. The questionnaire related to organizational time management skill consisted of 39 Likert 5-option questions (always, frequently, on and off, seldom, never). The grades 1,2,3,4 and 5 were devoted to these options. The questions in this questionnaire measured the six subscales of goal setting, priority processing of the activities and goals, operational planning, authority delegation, communication management and management of the meetings. Hafezi (1998) measured the reliability of the questionnaire through cronbacha that was 0.84 and the content validity of the questionnaire was affirmed by the professors.

In the present research, having implemented a pilot study and calculated the variance of the questions, Cronbach a coefficient was calculated that was 0.82. The statistical methods of Kolmogorov-Smirnov test, correlative coefficient, regression coefficient and independent T were used through the software SPSS, version 18, in order to analyze the data.

## Results

Table 1 Regression coefficients of pure and impure weights of age on organizational time management skill

Source	St err	Regression coefficient	T value	Determination coefficient	p level
Goal setting	0.04	0.06	0.40	0.02	0.68
Priority processing of activities and goals	0.03	0.17	1	0.02	0.32
Operational planning	0.03	0.45	2.71	0.12	0.008
Authority delegation	0.04	0.05	0.32	0.02	0.75
Communication management	0.02	0.21	1.31	0.02	0.19
Management of the meetings	0.04	0.28	1.91	0.02	0.06

According to the results, age is only effective on operational planning and it has no effect on the other subscales of organizational time management skill. Therefore, the subjects of the study getting older, we can predict that operational planning will improve. Determination coefficient demonstrates that 0.12 of the mentioned subscale is effected by age.

Table 2 Regression coefficients of pure and impure weights of job history on organizational time management skill

Source	St err	Regression coefficient	T value	Determination coefficient	p level
Goal setting	0.03	0.2	1.99	0.05	0.08
Priority processing of activities and goals	0.03	0.22	1.23	0.05	0.22
Operational planning	0.02	0.03	0.15	0.05	0.87
Authority delegation	0.02	0.2	1.14	0.05	0.25
Communication management	0.02	0.22	1.23	0.05	0.19
Management of the meetings	0.03	0.1	0.69	0.05	0.49

According to the results, job history is not effective on any of organizational time management subscales mentioned in the table above. According to the results, the observed T at the level of  $P < 5\%$  does not show any significant difference between the averages of organizational time management skill in terms of gender but there is significant difference between organizational time management skill and educational major.



Table 3 Results of independent T test comparing the averages of organizational time management skill in terms of gender and educational major

Variable	Group	Average	St dev	dF	T	p level
Gender	Male	127.12	16.71	144	0.287	0.77
	Female	134.08	12.12			
Educational major	Non physical Education	99.46	7.92	146	2.422	0.01
	Physical Education	99.01	7.6			

Table 4 Results of Pearson correlation coefficient regarding the relationship between personal time management skill of physical education managers and their age and job history

Source	Frequency	R	p level
Correlation between personal time management skill of physical education managers and age	110	0.01	0.89
Correlation between personal time management skill of physical education managers and their job history	110	-0.06	0.52

According to the results, the observed R at the level of  $p < 0.05$  does not demonstrate any significant relationship between personal time management skill of physical education managers and their age and job history.

Table 5 Results of independent T test comparing the averages of personal time management skill in terms of gender and educational major

Variable	Group	Average	St dev	dF	T	p level
Gender	Male	96.57	17.77	146	1.13	0.26
	Female	100.02	17.25			
Educational major	Non physical Education	99.67	17.75	144	0.47	0.64
	Physical Education	98.13	17.75			

According to the results, the observed T at the level of  $P < 5\%$  does not demonstrate any significant difference between the averages of personal time management skill in terms of gender and educational major.

## Discussion and conclusion

The findings concerning the effect of age on organizational time management subscales demonstrated that age is only effective on operational planning and it has no effect on the other subscales. Therefore, the subjects of the study getting older we can predict that operational planning will improve. The reason may be the fact that the older ones have more experience and this factor has a greater effect on operational planning. The managers of different ages have the same skill in goal setting, priority processing of activities and goals, authority delegation, communication management and the management of the meetings. Masiha (2002) reported in his study that organizational time management skill of the employees in different ages is the same that is consistent with the findings of the present research but it is inconsistent with the findings of Truman

and Hartly (1996) and Hurst (1982). Therefore, it is necessary to research about organizational time management skill in terms of age again. The findings regarding the effect of job history (below 10 to over 20) on organizational time management skill did not show any significant relationship and organizational time management skill was the same for all groups. The reason can be the fact that experience is not enough in order to reach success and the managers are required to gain the necessary skills in order to handle time in the best way. The results concerning the relationship between men and women in terms of organizational time management skill demonstrated no difference between them regarding the subscales of organizational time management skill. The organizational time management skill in male and female employees was reported to be the same. The reason may be that the women share greater in making order at home. So, time is more important for them. It is true about the men in other way. They have to settle down the problem out of the house and deal with the family's income. Therefore, they should be aware of time management as well. These findings are consistent with the findings of Samaria (1985) and Masiha (1998). In the mentioned studies, no difference is reported between men and women as well. These findings are not consistent with the findings of Karami (1993) and Keshavarz (1994). The findings did not demonstrate any significant difference between the subscales of organizational time management skill and educational major (physical education and non-physical education). The organizational time management skill of all the subjects was the same. These findings were consistent with the findings of Nezami (1991), Karami (1994), Hafezi (1997), Mohammadian (1998), Ali Rast (2000) and Masiha (2002) while it was inconsistent with the findings of Hafshejani (1998). The reason why there is no significant relationship between organizational time management skill and educational major can be the fact that there is no university course or training related to time management presented to the students of management or physical education in our country. Therefore getting specialty in any major does not necessarily lead to any difference in terms of time management (Rast, 1998). The inconsistency of these findings with those of Hafshejani (1996) can be attributed to the different subjects in the researches. The findings concerning the effect of age and job history on personal time management skill did not demonstrate any significant relationship between them. In other words, the subjects of different ages with different job histories possessed the same ability in personal time management. It is consistent with the findings of Samaria (1985) and Masiha (2002). The insignificant relationship between personal time management and age is inconsistent with the findings of Truman and Hartley (1996). Therefore it is necessary to pay attention to this element in the future researches. The insignificant relationship between personal time management skill and job history is also consistent with the findings of

Karami (1995), Nezami (1991) and Hafezi (1998). The results concerning the effect of gender and educational major on personal time management skills did not demonstrate any significant difference between them. The insignificant difference between personal time management skill and gender is consistent with the findings of Hurst (1982), Hafezi (1998) and Masiha (1998) but it is inconsistent with the findings of Karami (1995) and Truman and Hartley (1996). The reason for this inconsistency can be related to the different subjects in the studies. The findings also demonstrated that there is no significant difference between personal time management skill and educational major (physical education and non-physical education) and personal time management skill was the same in all the subjects with different educational majors. These findings are consistent with the findings of Nezami (1995), Karami (1995), Hafezi (1998), Mohammadian (2002), Rast (1998) and Masiha (1998) while it is inconsistent with the findings of Hafshejani (2002). The reason why there is no significant difference between personal time management skill and educational major can be the

fact that there is no university course or training related to time management skill presented to the students of management or physical education in our country. Therefore getting specialty in any major does not necessarily lead to any difference in terms of time management (Rast, 1998). The inconsistency of these findings with those of Hafshejani (2002) can be attributed to the different subjects in the researches. In the end, according to the findings of the research that men and women make no difference in terms of personal and oganizational time management skills, it is suggested to revise the laws making difference between men and women in terms of management principles and pay more attention to this matter. Also, it is recommended to present a two-unit lesson on time management in the universities so that the students get more familiar with this concept. And also, according to the findings of the research that age does not necessarily make difference in terms of time management, it is recommended to pave the way for the youth in order to inter this field and respect their ability in this field.

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## ISTRAŽIVANJE ODNOSA IZMEĐU OSOBNIH I ORGANIZACIJSKIH VJEŠTINA ZA UPRAVLJANJE VREMENOM I NEKE DEMOGRAFSKE ZNAČAJKE (DOB, SPOL, KARIJERA, OBRAZOVNI STATUS) MEĐU MENADŽERIMA TJELESNE I ZDRAVSTVENE KULTURE

### Sažetak

Cilj ovog istraživanja bio je ispitati odnos između osobnih i organizacijskih vještina za upravljanje vremenom i nekim demografskim osobinama među menadžerima tjelesnog odgoja. Metoda istraživanja bila je prikladna. Statistički uzorak se sastojao od svih menadžera tjelesnog odgoja uprave u pokrajini Fars u Iranu ( $N = 110$ ). Podaci su prikupljeni kroz vrijeme upravljanja (autor upitnika Hafezi - 2008). Valjanost upitnika potvrđena je stručnom ekspertizom. Pouzdanost je potvrdio Cronbach  $\alpha$  nakon probnog testa. Stupnjevi su bili 0,84 i 0,82 za svaki upitnik. Normalna distribucija analizirana je Kolmogorov-Smirnovljevim testom. Deskriptivna statistika je korištena za analizu podataka, a zaključivanje je izvršeno temeljem Pearsonovog koeficijenta korelacije, T-testom i regresijom. Softver SPSS je korišten za analizu podataka. Nalazi su pokazali značajan odnos između dobi i operativnog planiranja. Regresijski koeficijenti nisu pokazali značajan odnos u smislu spola. Predloženo je da se revidira pravila i zakone tj. utemelji razlika između muškaraca i žena u pogledu principa upravljanja. Također, potrebno je raspraviti o postavljanju dviju jedinica nastave upravljanja na sveučilištima da se poveća znanje upravljanja vremenom. Također, potrebno je otvoriti put za mlade koji dolaze u organizacijske sfere.

**Ključne riječi:** menadžerska vještina, upravljanje administracijom u tjelesnom odgoju

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## OBESITY 'CHILD, THE PROBLEM OF CHILDREN TODAY

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Review paper

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### Abstract

*One thing certainly alarming that goes away growing exponentially is that children eat too much and hurt. The figure, for about 10 years, is that 15 boys out of 100, in a critical age such as that between 6 and 14 years are obese and, unfortunately, it is not simple overweight: In some cases, we are faced to frankly obese children and 30% of obese children already suffer from diseases that once struck only adults such as hypertension and high cholesterol. Children and adolescents, therefore, should not be left free to eat as much as they want and they may run into errors harmful to their health in the future, therefore, is very important in the case of childhood obesity, the role played by the parents in education and in eating habits, by acquiring the child, their own conscience about what is good or bad for his health, learning to distinguish correct behavior in terms of power. Surely it is difficult to love fruits and vegetables to children, get them to dispense sweets and fats, encourage them to appreciate the variety of foods and get used to not exceed in amount, but it is a necessary effort to teach them not to compromise their health. The purpose of the information campaigns of the Ministry of health in schools for pupils is this: without obsessing and without penalizing or punishing the throat, you have to help them figure out what is best to eat and direct them towards a healthy and balanced relationship with food, making understand their respect for one's body.*

**Key words:** education supply, motor activity, obesity, sedentary lifestyle, nutrition and sports, lifestyles

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### Introduction

One thing certainly alarming that goes away growing exponentially is that children eat too much and hurt. The figure, for about 10 years, is that 15 boys out of 100, in a critical age such as that between 6 and 14 years are obese and, unfortunately, it is not simple overweight: In some cases, we are faced to frankly obese children and 30% of obese children already suffer from diseases that once struck only adults such as hypertension and high cholesterol. Children and adolescents, therefore, should not be left free to eat as much as they want and they may run into errors harmful to their health in the future, therefore, is very important in the case of childhood obesity, the role played by the parents in education and in eating habits, by acquiring the child, their own conscience about what is good or bad for his health, learning to distinguish correct behavior in terms of power. Surely it is difficult to love fruits and vegetables to children, get them to dispense sweets and fats, encourage them to appreciate the variety of foods and get used to not exceed in amount, but it is a necessary effort to teach them not to compromise their health. The purpose of the information campaigns of the Ministry of health in schools for pupils is this: without obsessing and without penalizing or punishing the throat, you have to help them figure out what is best to eat and direct them towards a healthy and balanced relationship with food, making understand their respect for his own body. Definitely not an easy path as the institutional communication for the promotion of correct eating behavior clashes with the overwhelming crowding of advertisements directed at young people and their families promoted by commercial communication, particularly talk about

the consumption of the boys out of the house strongly influenced by the suggestions of advertising and conditioned by the mode of the peer group. However, it is a necessary especially in light of the findings from recent research on the population. The ISTAT surveys on "Eating Habits: evolutionary trends in the population and young people" allow you to examine trends in the feeding behavior of the Italians, especially youth, from 1993 to 2003. In fact, research done over the years specified above, it appears that the very young are those that show the trends less healthy than the rest of the population examined and it highlights both the decrease of consumers and the scarcity of frequencies of consumption for certain products such as poultry, vegetables and fruit. Some of these trends are in the opposite direction compared to current dietary guidelines suggest that at least 5 daily servings of vegetables and fruits and the choice of "white meat" than "red". Unfortunately, there are also some polarizations, i.e. intensifications of the frequencies of consumption of products for which rather it suggests a more content, such as, for example, beef and spirits outside meal. Increase the number of consumers and decrease the frequency of consumption for cereals, dairy products, meats and some alcoholic beverages including wine. In growth we find the fresh pork, fish, eggs and consumption of fizzy drinks and sweets, as well as mineral water. Among young people, adolescents 14-17 years show negative trends with respect to the consumption of cereals, fruit and vegetables, while the rise is the trend in the use of alcoholic beverages. Very high is the preference for the products out meal and soft drinks.

Spreading the culture of proper nutrition is not; however, the only appropriate measures to prevent childhood obesity. At the same time, you must bring children to physical activity since the sport practiced regularly not only allows you to tone muscle mass and exerts a positive effect on mood and levels of self-esteem, but also helps to counter obesity and, more general, plays a protective role for health. In fact, children and adolescents who do not engage in any physical activity are more likely to develop excess weight.

### Investigation data collected

As part of the strategic program "Gaining Health - making healthy choices easier," the Ministry of Health / CCM (Center for Disease Control and Prevention) has entrusted, in 2007, higher institute of health (ISS), the coordination of the project "System of surveys on behavioral risks for ages 6-17 years." The project was realized in collaboration with the Ministry of Education, University and Research, with the regions and local health authorities, the National Institute of Research on Food and Nutrition (INRAN) and the University of Turin, Siena and Padua. According to data from the World Health Organization, 86% of deaths, 77% of the loss of life years in good health and 75% of health care costs, in Europe and in Italy, are caused by chronic degenerative diseases they have in common modifiable risk factors such as tobacco smoking, obesity and overweight, alcohol abuse, poor consumption of fruits and vegetables, physical inactivity. Some of these unhealthy behaviors are established, often in childhood and adolescence. The project, therefore, the need to deepen the knowledge of phenomena in the younger generation has developed three areas of activity: surveillance study and Okkio HEALTH ZOOM8, for primary school children, and the Health Behaviour in School-aged Children, for boys between 11 and 15 years. Everyone has had a specific task to see to and closely monitor various activities: Okkio HEALTH allows you to describe the geographical variation and evolution in time of the state weight of primary school children (6-10 years), of eating habits, of ' habit and exercise of any school initiatives that favor healthy nutrition and physical activity. Started for the first time in 2008, has a periodicity of data collection every two years. The initiative is also part of the project of WHO Europe "Childhood Obesity Surveillance Initiative." Zoom8, INRAN conducted in 2009, was born from the need to deepen some information about primary school children emerged thanks to Okkio HEALTH. In particular, Zoom8 examined the differences between the various Italian regions characterized by different prevalence's of overweight and obesity in children. To gather information on risk behavior in boys, we made use of the instruments of the international multicenter study HBSC (Health Behaviour in School-aged Children - health-related behaviors in children of school age), coordinated by the University of Turin, Siena and Padua. Have been investigated several determinants of health and has given particular emphasis to the four risk

factors (diet, physical inactivity, smoking and alcohol) in the center of the program Gaining health. The frequency of data collection is four years. E 'to stress both on the part of health personnel and school that by households, high adhesion to all these studies, indicating the success of the activities. The periodic repetition of Okkio HEALTH and HBSC will monitor the progress of the determinants of health and to evaluate interventions designed to promote health and communications started. The second collection of Okkio HEALTH provides results do not differ much from those detected in 2008; over 42,000 children were measured terse class of primary school.

Remains high prevalence of overweight (23%) and obesity (11%)

We continue to identify unhealthy behaviors:

- 9% do not eat breakfast
- 30% makes it unsuitable
- 1 in 4 children do not eat fruits/vegetables daily
- About 50% consume sugary drinks or sodas during the day
- 1 child 2 has the TV in the room
- 1 in 5 children plays sport for no more than one hour per week.

Parents do not always have an accurate picture of their child's weight status: among mothers of children overweight or obese, 36% do not believe that their son is in excess weight.

The study was conducted in-depth Zoom8 INRAN in a sample of 2100 children of 8-9 years and has deepened some aspects investigated by OKkio to health.

Among other things, the study showed that:

- Approximately 70% of children not in the habit of going to school on foot
- 26.8% of children play more than two hours a day in the open air, weekdays

In addition, the time spent by children playing outdoors is related to the safety of the environment surrounding the house and the lack of adequate facilities, especially in the South. For parents, the main source of information on proper nutrition are the figures as pediatricians and other health care professionals and, therefore, we highlight levels of knowledge more in the North and high educational attainment of parents. To improve the welfare of their children, parents suggest reducing advertising on packaged foods, to increase the hours of physical activity undertaken at school and to enhance the public sports facilities. The Health Behaviour in School-aged Children (HBSC), however, was a multicenter study sponsored by the WHO, which aims to collect data on health behaviors in pre-adolescent (11-15 years). The study carried out in collaboration between the ISS, the University of Turin, Padua and Siena, involved for the first time all regions. The study 2009-10, with regard to children between the ages of 11 and 15 years (77,000 children) indicates among other things:

- A percentage of 40% of males and 24% of females aged 15 who claim to consume alcohol at least once a week;



- A decrease of excess weight with age: the frequency of overweight and obese boys ranging from 29.3% in males and from 19.5% in females olds, 25.6% in males and 12, 3% in females of 15 years. Emerges a lower daily consumption of vegetables in the South and among males;
- A 19%-olds (male and female) who say they smoke at least once a week;
- The carrying out of less physical activity among boys of 15 years (47.5% of males and 26.6% females) compared with thirteen (50.9% of males and 33.7% of females).

### Model construction set

At a time when the diet does not produce the expected results, we introduce a therapeutic discourse, as the therapy goes beyond the diet: we must look not to the pound but the person who is made of experiences, ideas and beliefs that are almost always cleared. Must make it clear to all parties that you can change your weight by changing their diet, compared to a normal and not a restriction. The energy expenditure in obese individuals is often or almost always higher than the expenditure of the people of normal weight and this belief would be enough so as not to feel the obese a different, one that must have restrictions than others. With regard to the normal food intake is able to bring back the pounds to the weight that is healthy to the weight that is right for that individual originated mainly of thoughts, ideas and state of health behaviors. If you cannot reach satiety are unable to control himself, but when it stimulates hunger fight becomes uneven and you have a loss of control, therefore, it can be deduced that the primary objective of treating obesity is not the weight loss but the ability to control and can be reached by replacing the diet with the rule which provides the breaking. Obviously, the offense should be planned in advance and is not to be avoided. In fact, if programmed, in a psycho-educational program, and the training for its management, it is able to experience the pleasure of the control, so as to be able to experience the pleasure to control, reaching, so a degree of satisfaction due to the success of part of the obese to get out of its continuing failure and guilt. Consequently, this small step will follow each other and creating a virtuous circle that starting from the management capacity of the transgression does not arrive at the loss of control and therefore avoidance in binge: this represents a strong injection of antidepressant that becomes the point hinge of a series of positive thoughts that have as affect the acquisition of control food, leading to weight loss and the ability to keep forever. Surely it is a difficult and long, but at the same time, possible. The management of this program cannot be left up to the individual but to operators (doctor-dietician and psychologist) who take charge of the whole person, as the obesity problem must be cared for by health professionals. The diabetic, the hypertensive, the cancer never dream to heal themselves, so even the obese, as well as the pounds and the problems, it can also take on some of his illness.

### Considerations

The problem of childhood obesity is common in Italy and the data is receiving from the boys of wrong information about a healthy lifestyle, outlined by an equally good nutrition and exercise. We deduce, therefore, that a sedentary lifestyle and eating the wrong way of the child, affecting the quality of life of the future adult and you have to educate children from an early age in order to offer them the opportunity to create the conditions for a better quality of life. Important task is assigned to the parents, the first proponents of the quality of life of their children, but in the world we live in, where the work and the various commitments take your time for families, it is difficult to handle this delicate situation. As a result, the boys are "parked" in front of the television, the PC in the company of snacks and sodas. You have to turn the page, you must replace the snacks more healthful foods, such as milk shakes, fresh fruit, nuts, yogurt, and raw vegetables and / or cooked. Addition, we must accustom the child to consume at least 5 meals a day, without consuming an excessive amount of food. To promote the dissemination of accurate information to families of children in primary schools and promoting informed choices, it would be appropriate to also arrange also communication tools aimed at boys and many are involved professionalism. In fact, as stated in the literature, interventions for prevention and health promotion are the ones most appropriate intersect oral and multidisciplinary, involving the direct involvement of families, schools, health professionals, promote not only healthy eating but also the ' physical activity, parent training and run for several years. The moment you have with a hush of obese subjects, we must surely begin a journey that few are able to do, that is, we must insist on the very knowledge of this disease, what are the risk factors, as you might feel better if you care, all simply through a healthy lifestyle, of course with the right combination of diet and physical activity. Of course, after the fact-finding phase, you enter the next one, or to an actual programming of motor activity and a nutrition plan. Surely you must start working on based monitoring to the failure of weight maintenance achieved, the establishment of an impairment of the psychological and behavioral, such as feelings of guilt, failure, low self-esteem, shame, depression and inability to control him often resulting in binge and sometimes vomiting. It was found that nowadays increasingly gaining power disorder called binge eating disorder. The binge eating disorder (DAI) corresponding to the Binge Eating Disorder (BED) of the Anglo-Saxon is related to the continuing failure by crash dieting (YoYo's syndrome). The imposition of a rigid control inevitably leads to loss of control resulting in a caloric intake is not planned nor controlled, and therefore, the failure of compliance with the prescribed food plan: the experience of the individual is certainly characterized by a sense of ashamed of, which, among other, enhances the thoughts of weakness and lack of will already

widely tested by the same, establishing, thus, bankruptcy and guilt-ridden thoughts that affect the quality of life itself. Obviously we talk about this disease, unfortunately, too late, and you intervene even so late, changing the habits of individuals,

causing an imbalance in their lives, wrong. Our thoughts, so it is open to all parents to teach their children to plan a healthy diet and constant motor activity, in order to obtain a good quality of life to which all will benefit in the near future.

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## PRETILO DIJETE, PROBLEM DJECE DANAS

### Sažetak

Jedna pojava koja svakako alarmira i nastavlja eksponencijalni rast je da djeca jedu previše i povrijeđuju se. Izgled djeteta, za otprilike uzrast od 10 godina, je takav da 15 od 100 dječaka, u kritičnoj razvojnoj dobi (od 6 – 14 g.) je pretilo, a nažalost to nije jednostavna prekomjerna težina: U nekim slučajevima stvarno smo suočeni sa činjenicom da oko 30 % pretile djece već pati od bolesti koje su jednom napadale samo odrasle, a to su hipertenzija i visoki holesterol. Djecu i adolescente, dakle, ne treba pustiti da jedu koliko žele jer ih to može odvesti u pogreške koje izazivaju štetne posljedice po zdravlje u budućnosti. Stoga je jako važna, u slučaju dječje pretilosti, uloga roditelja u edukaciji i stjecanju prehrambenih navika, kao i osobna svijest o tome što je dobro ili loše po zdravlje u terminima intenziteta, odnosno količine. Sigurno je teško voljeti voće i povrće, dobiti ih da izbjegavaju slatkiše i masti, potaknuti ih da cijene raznoliku hranu i naviknuti ih na se ne prelazi potrebna količina, ali je prije svega važno da nauče kako ne kompromitirati svoje zdravlje. Svrha održavanja informativnih kampanja Ministarstva zdravstva u školama za učenike je slijedeće: bez opsjednutosti i bez kažnjavanja treba im pomoći shvatiti što je najbolje jesti i usmjeriti ih prema zdravom i uravnoteženom odnosu s hranom, gradeći poštovanje za tijelo i fizički izgled.

**Ključne riječi:** edukacija, motorika, pretilost, sjedeći životni stil, prehrana i sport, životni stilovi

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## FUNCTIONAL FITNESS CHANGES REGARDING THE LEVEL OF PHYSICAL ACTIVITY IN OLDER ADULTS

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Original scientific paper

### Abstract

The aim of this study was to determine the differences in the components of functional fitness regarding the level of physical activity in adults between 60 and 80 years of age. Senior Fitness Test (SFT) was used in a sample of 497 men and 446 women in order to determine the level of functional fitness, while International Physical Activity Questionnaire (IPAQ) was used to determine the level of physical activity. The analysis of variance (ANOVA) showed that old male subjects who belonged to high activity group had statistically significant results in comparison to the low activity group, in terms of upper and lower body muscle strength and lower body flexibility. Female subjects in high activity group also had statistically significant results in terms of strength and dynamic balance performance, compared to the women in the low activity group. Based on the obtained results and their analysis, it can be concluded that older people who belong to the high activity group have higher level of functional fitness in comparison to the low activity group. In this way, the old adults who are physically active can be functionally independent for a longer period of time while performing the activities of daily living, thus reducing the risk of falls and injuries.

**Key words:** functional independence, physical activity, fitness, differences

### Introduction

The aging process is a biological reality that has its own dynamic, largely beyond human control, which is why the period between 60 and 65 years of age is considered as the beginning of old age in many developed countries (Gorman, 1999). Changes that occur during the aging are greatly affected by the inherited or genetic factors (Chodzko-Zajko, 1998), as well as by external factors such as diet, stress, smoking and physical activity (Bokovye & Blair, 1994). In order to be physically independent and able to take care of themselves, elderly must have certain level of motor skills, such as muscular strength, aerobic endurance, flexibility and agility / dynamic balance.

These abilities are associated with functional fitness, which is according to Rikli & Jones (2001) defined as a physical *capacity to perform normal everyday activities safely and independently without undue fatigue*. By improving the level of functional fitness, the elderly can get physical, social and economic benefit (Brill, 2004). Adequate physical activity and exercise programs are necessary for improving motor skills which are part of functional fitness (Nelson, Rejeski, Blair, Duncan, Judge et al. 2007, ACSM, 2009b). Physical activity refers to body movement produced by the contraction of skeletal muscles that result in energy expenditure (Caspersen, Powell & Christenson, 1985; ACSM, 2009a). According to the World Health Organization (WHO, 1997a), physical activity has positive and long-term effects in improving muscle strength, aerobic endurance, flexibility and balance performance in older people. Physical activity also limits the impact of secondary aging through restoration of functional capacity in previously sedentary older adults (ACSM, 2009a).

The lack of physical activity is considered as one of the biggest public health problems of modern society (Pedišić, Jurakić, Rakovac Hodar & Dizdar, 2011). The lack of adequate level of physical activity can lead to a decline in physical and physiological function of man, which can have negative impact on their normal daily activities (Collins, Rooney, Smalley & Havens, 2004). It is known that inactivity is associated with many types of chronic diseases such as coronary artery disease, stroke, hypertension, Type 2 diabetes, and osteoporosis (Katzmarzyk, Gledhill & Shephard, 2000). Although physical activity statistically significantly reduces the risk of chronic diseases associated with the advancing age (ACSM, 2009a), a small number of old adults are physically active.

According to the Department of the Environment, Sport and Territories in 1995, in Australia, only 13% of males aged between 60 and 69 and about 12% of females of the same age are vigorously active. For people aged between 70 and 78 years, 16% of males are vigorously active in comparison to only about 4% of females (Daley & Spinks, 2000). According to the data from the National Health Interview Survey (NHIS) in 2002, 74% of U.S. adults aged between 65 and 74 years did not engage in any regular leisure-time physical activity; 83% of those aged over 75 were not regularly active (Collins et al., 2004). According to the data from 2002, in Europe, 79.6% of people over 65 were not involved in any vigorous physical activity during one week (European Opinion Research Group, 2003). The aim of this paper is to determine the differences in the components of functional fitness regarding the level of physical activity in people aged between 60 and 80 years.

**Methods**

*The sample of examinees*

The sample comprised of 943 people aged between 60 and 80 years, living independently in the community on the territories of the city of Niš and city of Kruševac in Serbia. Of the total number of subjects, there were 497 men and 446 women. All subjects were mentally and physically able to participate in the study.

*The sample of measuring instruments*

*Senior Fitness Test (SFT)*

Senior Fitness Test was used to assess functional fitness (Rikli et al., 2001). SFT is a battery of tests that measure the physical capacity of older adults to perform the activities of daily living. This battery of tests can be used in independent-living people aged 60 to 90 years and more. For the purposes of this study, 5 tests that are part of SFT batteries were used. Those were the following tests: 1. Chair Stand Test (to assess lower-body strength), 2 Arm Curl Test (to assess upper-body strength), 3. 2-Minute Step Test (to assess aerobic endurance), 4. Chair Sit-and-Reach Test (for assessment of lower-body flexibility) and 5. 8-Foot Up-and-Go Test (to assess the agility / dynamic balance). Rikli & Jones (1999a) established the adequate reliability of all test items used in the SFT test.

The validity of test items in the SFT test has been confirmed by the great number of authors (Rikli et al., 2001). There were two people involved in SFT measurement, one was writing down the data while the other was explaining the method of conducting the tests. All subjects were familiar with the research aim and its implementation, and there were no contraindications for SFT. The study was approved by the Ethics Committee of the Faculty of Sport and Physical Education, Niš, University of Niš, in accordance with the Helsinki Declaration of 1975 (WMA, 2008).

*IPAQ questionnaire*

A long version of International Physical Activity Questionnaire (IPAQ) for self-assessment was used to assess levels of physical activity. It includes four domains of physical activity: work-related, transportation, housework / gardening and leisure-time activity (IPAQ, 2002). Reliability and validity of IPAQ questionnaire has been confirmed in 12 countries (Craig, Marshall, Sjostrom, Bauman, Booth et al., 2003). Pedišić et al. (2011) determined the appropriate reliability of the Croatian version of IPAQ questionnaire. On the basis of the guidelines for calculating results of IPAQ questionnaires (IPAQ, 2005), the subjects were divided into three categories according to the level of physical activity: low, moderate and high. The difference in functional fitness among subjects has been determined according to these three categories.

*Statistical analysis*

Collected data have been analyzed in statistical program SPSS 17.0 (SPSS Inc., Chicago, IL). Each variable is represented by mean value and standard deviation (mean ± SD). To determine statistically significant differences in the components of functional fitness according to three levels of physical activity (low, moderate and high), we used univariate analysis of variance (ANOVA). Bonferroni test was used to determine which of three levels of physical activity distinguishes the subjects the most. To accept a statistically significant difference, significance level  $p \leq 0.05$  was used.

**Results**

The results in Table 1 show that in men aged between 60 and 80 years, depending on the level of physical activity, there are statistically significant differences in three tests used in the SFT battery of tests, and those are: Chair-sit and reach test, Chair stand test and Arm curl test. Observing the differences in groups, men who belong to the low activity group had statistically significant weaker results in Chair-sit and reach test, in comparison to the moderate and high activity groups.

In Chair stand test, males in low group had statistically lower results than males in high activity group. In Arm curl test, men who belonged to high activity group had statistically better results in comparison to those in low and moderate group.

Table 1 Differences in the components of functional fitness depending on the level of physical activity in men (Mean ± SD)

Men (N=497)	Low	Moderate	High	p
Chair sit and-reach test (cm +/-)	-1.81±12.69*O	4.46±11.41O	1.16±9.43*	0.00
8-foot up-and-go test (sec)	6.95± 1.59	6.98±1.39	6.75±1.63	0.46
Chair stand test (no. of stands)	11.81± 5.07*	13.70±5.12	14.11±5.81*	0.00
Arm curl test (no. of reps)	15.27± 6.30*	14.45±4.79#	17.50±6.94*#	0.00
2-minute step test (no of steps)	91.14±24.97	93.23±24.10	91.46±23.44	0.93

\*- determines statistically significant difference between low and high activity group  
 O- determines statistically significant difference between low and moderate activity group  
 #- determines statistically significant difference between moderate and high activity group

The results in Table 2 show that in women aged between 60 and 80, depending on the level of physical activity, there are statistically significant differences in three tests used in the SFT battery of tests: 8-foot up-and-go test, chair stand test and Arm curl test. Observing the differences between the groups, in all three tests, women who belonged to the low activity group had significantly lower results in comparison to the high activity group.

Table 2 Differences in the components of functional fitness depending on the level of physical activity in women (Mean  $\pm$  SD)

Women (N=446)	Low	Moderate	High	p
Chair sit and-reach test (cm +/-)	1.78 $\pm$ 15.15	3.33 $\pm$ 11.94	2.03 $\pm$ 10.78	0.718
8-foot up-and-go test (seconds)	7.25 $\pm$ 1.49*	6.93 $\pm$ 1.33	6.74 $\pm$ 1.44*	0.02
Chair stand test (no. of stands)	11.30 $\pm$ 5.28*	12.95 $\pm$ 4.28	13.48 $\pm$ 5.42*	0.00
Arm curl test (no. of reps)	10.64 $\pm$ 5.15*	12.55 $\pm$ 5.71	13.79 $\pm$ 6.14*	0.00
2-minute step test (no of steps)	80.54 $\pm$ 25.30	79.75 $\pm$ 26.60	81.85 $\pm$ 24.37	0.87

\*. determines statistically significant difference between low and high activity group

## Discussion and conclusion

The results obtained in this research prove that in both male and female high activity group, the subjects had greater upper and lower body muscle strength than those in the low activity group (Table 1 and 2). The strength is a motor ability that manifests itself in almost all physical activities (Jorgić & Radovanovic, 2010), and is therefore extremely important for independent daily functioning of elderly people. According to Zatsiorsky & Kraemer (2006), the results of cross-sectional and longitudinal data proved that, in the period between 60 and 70 years of age, strength level drops by about 15% and then by 30% in the following age period; therefore, it is extremely important to develop and maintain strength in older people. According to Radovanovic & Ignjatovic (2009), the studies in which older people had relatively intensive trainings show that people in this age have the ability to increase their muscle power and strength performance by regular training. Lower body muscle strength is important for performing daily activities such as: climbing stairs, walking distance, rising from a chair, etc., while the upper body muscle strength is important while carrying food supplies and for many other common tasks (Rikli et al., 2001). Due to the above mentioned daily activities in which muscular strength of elderly is expressed, high level of physical activity is important because they increase and maintain muscle strength, but also allow them to function independently for longer period of time. Male subjects who belonged to high and moderate activity group had higher flexibility in comparison to the subjects from the low activity group (Table 1). Aging is associated with changes in the elasticity and compliance of connective tissue, which results in statistically significant decreases in flexibility and range of motion (Chodzko-Zajko, 1998).

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Irregular shape, tighter meshing and decreased linear pull in collagen tissue leads to decreased flexibility with aging (Daley et al., 2000). Sit and reach test shows that flexibility declines about 15% per decade, while the greatest decline can be noticed in elderly people (Spiriduso, Francis & MacRae, 2005). If the decline in flexibility and range of motion are caused by aging, there is evidence which prove that the reduced flexibility is the result of reduced physical activity of elderly persons (Campanelli, 1996). According to Spiriduso et al. (2005), a decline in flexibility appears due to physical inactivity. Together with the strength loss, declining flexibility plays an important part in increasing the risk of falls and injuries among elderly people (ACSM, 2006). Therefore, as it is the case with muscle strength, it is necessary to maintain a higher level of physical activity among elderly in order to preserve flexibility and range of motion. Physical activity should include exercises of moving the joints through their complete range of motion (Spiriduso, et al., 2005) and tretching exercise is recommended (Rider & Daly, 1991).

Female high activity group had better-developed dynamic balance compared to the low activity group (Tbl 2). With the aging process, there are also changes in musculoskeletal and sensory system that disturb the balance and postural status, which can lead to undesirable falls in the elderly (Lord & Ward, 1994). Balance impairment has been identified as a primary risk factor in the occurrence of falls (Tinetti, Speechley, Ginter, 1988).

According to Voorrips, Lemmink, et al. (1993), the *more active the individual, the less the degree of postural sway*. This is one more reason why physical activity in older adults is important. Rikli & Busch (1986) found that *older females who participated in vigorous activity from periods ranging from 6 weeks to 10 years showed better balance performance than inactive females of the same age*. On the basis of the results and their analysis, it can be concluded that older people who belong to high activity group have higher level of functional fitness in comparison to the low activity group. Higher level of physical activity contributes to higher values of functional fitness, in other words - greater development of motor skills, especially strength, flexibility performance and the dynamic balance. In that way, physically active older people can be independent in performing the activities of daily activities for a longer period of time, also reducing the risk of falls and injuries.

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## PROMJENE FUNKCIONALNOG FITNESA U ODNOSU NA RAZINU TJELESNE AKTIVNOSTI STARIJIH OSOBA

### Sažetak

Cilj ovog istraživanja bio je utvrđivanje razlika u komponentama funkcionalnog fitnesa u odnosu na razinu tjelesne aktivnosti odraslih osoba uzrasta između 60 i 80 godina. "Senior Fitness Test" (SFT) je korišten na uzorku od 497 muškaraca i 446 žena s ciljem utvrđivanja funkcionalnog fitnesa, a "International physical Activity Questionnaire (IPAQ) je korišten za utvrđivanje razine tjelesne aktivnosti. Analiza varijance (ANOVA) pokazala je da stariji muškarci koji pripadaju grupi jako aktivnih imaju statistički značajne rezultate u usporedbi sa grupom slabo aktivnih u smislu snage gornje i donje muskulature tijela, kao i fleksibilnosti donje gđijela tijela. Žene u grupi jako aktivnih također imaju statistički značajno bolje rezultate u smislu snage i izvođenja dinamičke ravnoteže u usporedbi sa ženama slabo aktivne grupe. Temeljem dobivenih rezultata i analiza, može se zaključiti kako starije osobe koje pripadaju grupi jako aktivnih osoba imaju višu razinu funkcionalnog fitnesa u odnosu na grupu slabo aktivnih. Na taj način, tjelesno aktivne osobe starijeg uzrasta mogu biti funkcionalno nezavisne u duljem razdoblju vremena dok se bave zadaćama svakodnevnog življenja, kao id a reduciraju rizike pada i povreda.

**Ključne riječi:** funkcionalna nezavisnost, tjelesna aktivnost, fitnes, razlike

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## MATHEMATICAL PARADIGM OF CONTROL PARAMETERS OSCILLATORY TANGENTIAL TRANSFORMATION PROCESSES IN KINESIOLOGY AND EDUCATION

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Original scientific paper

### Abstract

The aim of this article was to present the preliminary setup of a new model and sub-models, mathematical definitions of control oscillation processes in kinesiology (education, economics, medicine,...). From these examples, it is clear that the transformation process can decompose into its component sub-processes. In advance, the article has offered a different decomposition, and it refers to a specific way of managing and controlling oscillation processes, i.e. a way to recognize cumulative sub-processes, and short-term effects, and finally a quick response. It is obvious that the presented model in this article, is potentially a very powerful tool for the identification processes of any kind, especially in kinesiology.

**Key words:** processes, oscillations, control, parameterization, mathematics

### Introduction

Training is a process that can be defined in many ways, but it is methodologically justified to describe it as a process which is aimed at minimizing the distance between the forecast and the final state of the state obtained with the help of operations that we have implemented. These operations or individual operators, have multiple power and range, and some local, some global and some example of an occasional nature. Seems to be of crucial importance to identify the parameters of such transformation processes in order to better understand the processes in general. This is especially true for oscillatory processes and transformation processes in kinesiology, education, including medicine, economics etc., that are regularly just like that. Their oscillatory character seemingly limited ability to monitor and control, but that is the case only until you turn mathematical tool and methodological paradigms that tool positioned in a place where the oscillatory motion can at least be controlled, and with adequate methodological knowledge it also can be controlled and ultimately managed (Bonacin, 2010).

### Methodological conception

Here we can point to some important rules and objective behavior in any situation is possible only when there is a function whose extreme can be found, either minimum or maximum. Another problem is the relationship between the state achieved in the earlier sequences and conditions for which the operator was just created. Generally, the rule is that the situation in any measured point depends on the conditions in the previous paragraphs. Thus, the process of training is one stochastic process, and this situation can be called and described as Markov chains or similar operations (Lozovina et al., 2011, 2012). However, if the rule worth (and it worth!) that status of any

measured point depends on the conditions in the previous points then issue stochastic is not the real issue, but the real question is precisely the question of accumulation and that they are not only Markov chains but certainly the process parameters accumulation. It can present in two ways. The first way: Concurrent monitoring process with at least proportional, derivative and integration response - Figure 1 (Bonacin, 2009). In this case there are two systems integration training process and are labeled base summarizing the entrance (after the setpoint) and output from the process. At the entrance you are trying to act on the error, and the output that examines the results achieved. Of course, training is always multidimensional system with a starting position that establishes criteria for achievement (setpoint). Another way: Universal cognitive continuum within with oscillating local sides (transitive) values "in the direction of back and forth" as achievement (Bonacin, 2005). The totality of this presentation requires the knowledge of some parts of mathematics without which it is impossible to solve these problems. The next problem to be solved is: Problem of kinesiological transformation volume. Another problem is the devices through which we can gather information about the changes that are in our profession extremely primitive. Reasons: 1) take a lot of time, 2) their reliability is low, 3) validity worse.

This is an area that solves kinesiometry (Measurement Theory). Under the volume of work in training, in modern physiology and psychology we involve the cumulative composite intensity and extensiveness, and the energy equivalent is mainly volume (Trninić et al., 2009; Lozovina et al., 2011). Under the names of the "load" or "intensity" or scope usually includes only energy terms talking about the amount of work, the amount of effort, work duration or the other energy components.

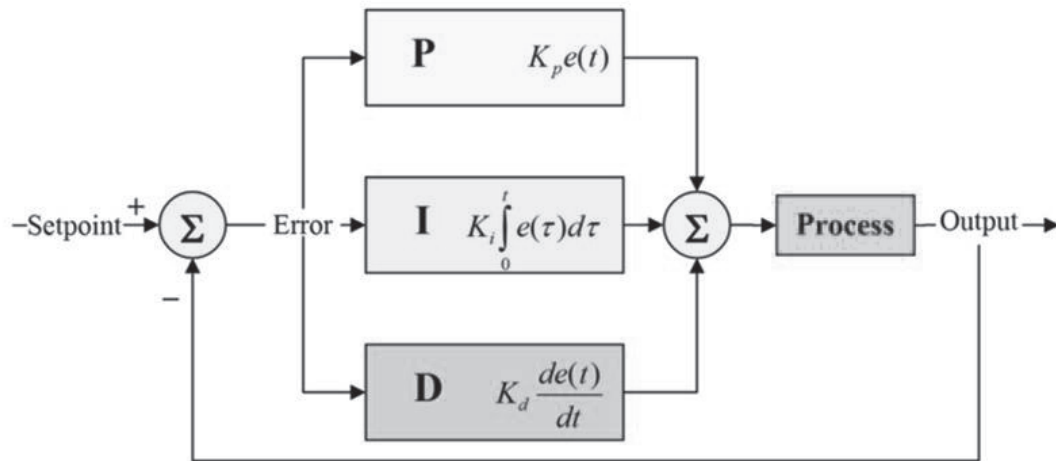


Figure 1. Universal process regulators (Bonacin, D., 2009)

However, volume is to be composed of three components: 1) energetic, 2) information, and 3) synergy. In mathematics, the derivative function with integrals main fundamentals of calculus, which is widely used in all scientific and many other areas where the required budget development function at a specified interval and kinesiology transformation processes are just that. Geometric interpretation of this problem is described as derivation slope of the tangent to the function at some point, which gives the response speed of training sub-processes, i.e., local stability of the process whereby the coefficient of m is direction

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$

and since the

$$m = \frac{f(x+h) - f(x)}{(x_0+h) - x_0} = \frac{f(x+h) - f(x)}{h}$$

because

$$(x_0 + h) - x_0 = h \text{ i } \Delta x = h.$$

the function derivation is

$$Df = \lim_{h \rightarrow 0} \frac{f(x_0+h) - f(x)}{h}$$

The slope (direction) is closely associated with the derivation of the reason that when the interval  $x_2 - x_1 = h$  tends to zero, the line becomes a tangent function, and limes of its slope coefficient becomes directional derivative of  $f$  in point  $(x_0, f(x))$ .

Derivation function therefore is nothing more than stability in the training process in part being analyzed, in this case the synergy integrative sub-processes in relation to the final state defined superimposed values of the current situation in relation to the limit which describes the actual or total final state. So figure 2 shows how these parameters reflect knowledge of process behavior.

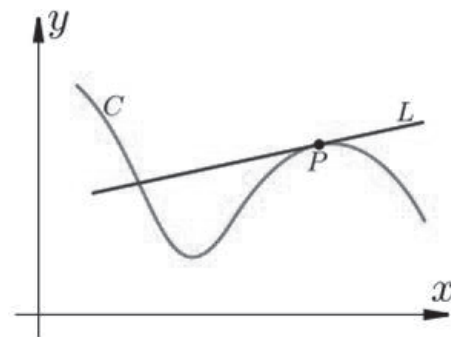


Figure 2. Derivatives of oscillatory processes (Bonacin et al., 2012)

(The line  $L$  tangent function  $f$  in point  $I$  whose derivation corresponds to the slope of  $L$  in point  $P$ )

If, in this regard, synergistic component designate as an interaction which includes some continuous intervention options with derivatives aspiring affine function, and assuming its knowledge then solves the problem still influenced by the energy and information component. In a similar way one can "turn of " any component that interests us, just as it is possible in the same way and discover the correctness of any of the sub-processes in the overall training.

**Solution**

It is realistic to assume that every serious global training process includes discontinuous progressive overload (Figure 3). This is because a continuous linear progress is impossible, and without rest, relaxation, compensation and super-compensation quickly leads to major drop functions, and in general to a violation. However, if even superficially examine the image in Figure 3, we can see oscillatory inevitable in any Kinesiology or pedagogical process (Bonacin, Da., 2010). From this it necessarily follows that the oscillations are actually programmed, deliberately controlled unstable phase of the process, in order, through the exercise of homeostasis and adaptation at a higher level functions.

It is obviously a key issue in the programmed instability needs to be addressed precisely the question of stability, how the process would not be out of control and turned into destruction. This problem can be solved in several ways, but all of these methods must include respect for the former states, because in these processes cumulative effects are always present and can never fully brought under control, just as it is often not an irreversible process in which return to a previous state is not possible due to realized irreversible effects. Pursuant to the foregoing, as well as taking into account the facts and circumstances described in Figure 2, on the one hand, it is necessary to define a mathematical framework for rescaling the oscillations more easily understandable model, and on the other, the operative acceptable form. That is why for the progressive discontinuous loads parameterization we use coefficient direction or derivative function of the partial segment in some training stages i.e. for explication appropriate state

athletes and treated the subject in the process. Of course, there are two sub models, one that deals with only one segment are needed to identify the current state of athletes form and the other - cumulative, needed in order to identify future training operators which seek to achieve target states (Bonacin et al, 2008, 2012). As can be clearly seen in Figure 4, the position and direction of the partial tangent will depend on the general orientation, or curvature of acute training stages, or mathematically speaking on the degree of affinity or linear segments within the entire process. If the whole global process of growing (as in the picture) can be a suitable simple function (linear trend, ...) to calculate the tangent angle with respect to the abscissa, which is defined by the speed of the growth or training technology speed changes of selected parameters for evaluation. This essentially corresponds derivative controller with Figure 1. That is the essence of these regulators.

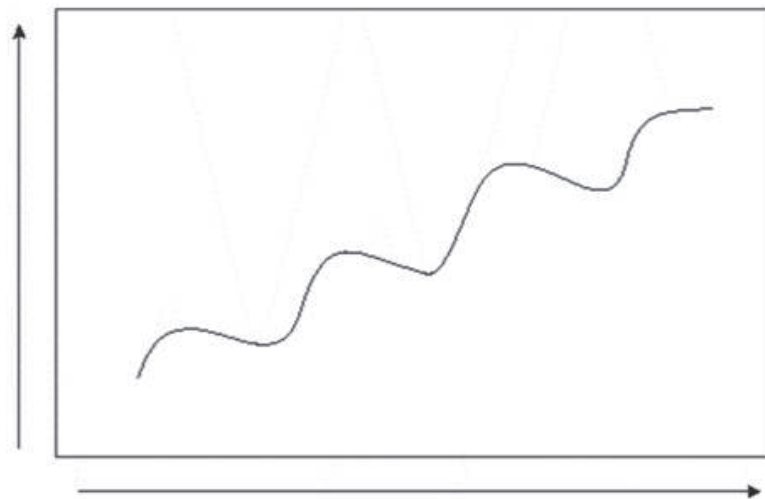


Figure 3. Global view of progressive discontinuous load (Bonacin, Da., 2010)  
(Abscissa = time, Ordinate = intensity)

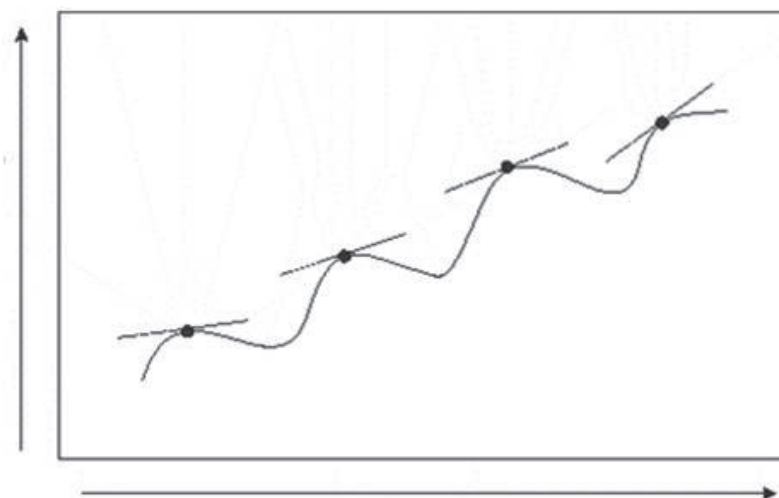


Figure 4. Partial tangential segmentation of transformation process  
(Abscissa = time, Ordinate = intensity)



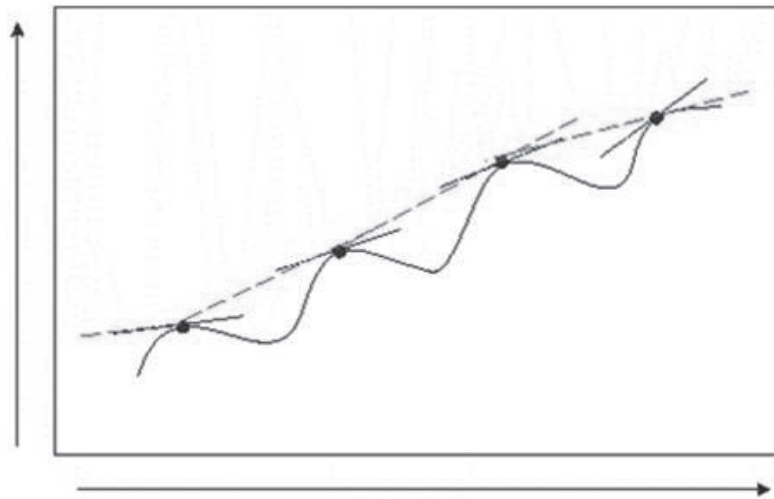


Figure 5. Cumulative tangential explication of transformation process (Abcissa = time, Ordinate = intensity)

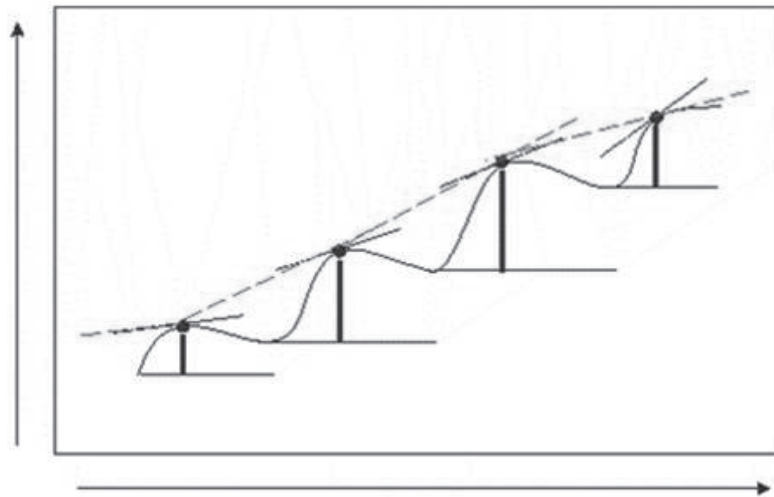


Figure 6. Speed of response to the stimulus within the segments of the transformation process (Abcissa = time, Ordinate = intensity)

It can be most simply described as a way to derivative controller, in this case described tangential segmentation registers or "rehabilitate" the current error status differences, and thus shows the possibility of redistribution of content that need to be integrative tissue of the whole process, but not current ad hoc effects that can be produced.

### Conclusion

It is designed and proposed mathematical model paradigm of control parameters tangential oscillatory processes in kinesiology and education. From these examples, it is clear that the transformation process can be decomposed into its component sub - processes at least in two ways. By one method it is to be performed in accordance with expectations from planning through transformation as energy, information and finally synergistic components i.e. proportional, integration and derivative identification and control (Figure 1). However, this article is offered a new,

different decomposition, and it refers to a special management and control of oscillatory processes. According to Figure 6, we see the short-term effects and quick response, i.e. acute reaction of entity that is subject to treatment. In the example above it is obvious that the reaction is very turbulent in the central part of the treatment, while at least at the outset. According to Figure 5, however, we see the long-term effects of the process that shows a constant tendency to increase but in the fourth chord checkpoint least though tangential tilt it the most, which certainly suggests approaching the limits permitted stimuli. It is obvious that the overall curve has a logarithmic course and it is logical that the second inflection point occurs on lower slope because it is a stage of supra-liminal total workout. Finally, Figure 4 also shows that local processes are very active, but they are practically equal in "nature" because they are segmented effects very similar. It is obvious that the presented model in this article, is a very potentially powerful tool for the identification process of any kind, especially in kinesiology.

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## MATEMATIČKA PARADIGMA KONTROLE TANGENCIJALNIH PARAMETARA OSCILATORNIH TRANSFORMACIJSKIH PROCESA U KINEZILOGIJI I EDUKACIJI

### Sažetak

Cilj ovog članka bilo je predstavljati uvodnih postavki novog modela i submodela matematičke definicije kontrole oscilatornih procesa u kineziologiji (edukaciji, ekonomiji, medicini,...). Iz navedenih primjera, očito je da transformacijski proces možemo dekomponirati na njegove sastavne sub-procese. Članak je ponudio jednu drugačiju dekompoziciju, a ona se odnosi na poseban način upravljanja i kontrole oscilatornih procesa, tj. na način da se prepoznaju kumulativni subproces, ali i kratkoročni efekti i konačno brzi odziv. Očito je da je ponuđeni model u ovom članku potencijalno snažan alat za identifikaciju procesa bilo kojih vrsta, a posebno kinezioloških.

**Ključne riječi:** procesi, oscilacije, nadzor, parametrizacija, matematika

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## DIFFERENCES IN PHYSIOLOGICAL LOAD ON HANDBALL PLAYERS DURING THE STRAIGHT LINE RUNNING AND SPECIFIC HANDBALL POLYGON

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Original scientific paper

### Abstract

The aim of this study was to determine the differences in the physiological load of the straight line running test (400 meters) and the specific handball task. The samples of entities were 10 healthy amateur handball players. The subjects (mean aged: 22.50 ± 1.35 years; body weight 87.9 ± 4.31 kg and body height 184.00 ± 5.29 cm) ran 400 meters on athletic track as well as handball ground path in three attempts. Maximum heart rate and perception of exertion (Borg scale) were measured after every repetition, while the blood lactate concentrations were measured after the last repetition. The results showed no statistically significant difference in maximum heart rate ( $p = 0.06$ ), subjective perception of exertion ( $p = 0.90$ ) and blood lactate concentration ( $p = 0.17$ ) between 400 meters running and specific handball task. The conclusion is that there are no major differences in the physiological load of 400 meters running and specific handball task. Both activities can be used in glycolytic anaerobic endurance training of handball players, but specific task with its greater relation to the specific conditions is more appropriate.

**Key words:** anaerobic capacity, handball task, blood lactate, Borg scale

### Introduction

Handball as a team sport is a complex activity with lots of different movements (sprints, jumps, changes of directions, throws, shots, etc.). Several studies have examined the physiological characteristics of both elite and nonelite adult teamhandball players (Rannou et al., 2001; Sibila et al., 2004; Gorostiaga et al., 2005; Gorostiaga et al., 2006), but according to authors knowledge only one offers data on heart rates (HRs), blood lactate concentrations, and other physiological parameters during typical games (Souhail et al., 2010). Top level players possess a wide range of physical skills that include jumping and throwing with power, diving, blocking, sprinting, ball control, and agility (Wallace et al., 2007). Although playing handball itself can improve many of these skills, elite players must be involved in additional handball-specific conditioning (Hermassi et al., 2011). A combination of speed and explosive strength training are needed to improve peak running speed and jump height (Christou et al., 2006; Chelly et al., 2009) and bouts of high intensity running are needed to develop maximal anaerobic power and explosive capacity (McMillan et al., 2005; Buchheit et al., 2008; Buchheit et al., 2009).

Complexity is the reason that one handball player needs to be on high level in physical condition. Dominant places take aerobic and anaerobic capacity, explosive power, speed and accuracy (Cervar et al., 2004). Anaerobic energy is essential to performance in sprints, high-intensity runs, jumps, shots, duel plays, all of which may contribute to the final outcome of the game. Development of glycolytic anaerobic endurance is based on using the energy gained by anaerobic degradation of glycogen (Guyton et al., 2003).

That kind of training in handball is usually used in preparation and pre-competition period, while in competition period training of anaerobic capacity is used for sustaining the achieved level. The most common activity which is used for developing the glycolytic anaerobic endurance is straight line running distances between 200 and 600 meters (Sporis et al., 2010). For that purpose are also used tasks with specific and situational activities that lasts between 60 and 120 seconds. Intensity is maximal with maximal physiologic reactions of organism. Glycolytic anaerobic trainings are very stressful for the athletes in physical and psychological demands. Also, motivation for those trainings needs to be on high level which is not easy to accomplish for team sports athletes if activity is straight line intensive running. Therefore the aim of this study was to examine the difference in physiological load between straight line running and specific handball task.

### Methods

Physiological load was examined with heart rate, perception of exertion and blood lactate concentration. There has been considerable research on exertional perception during exercise, and the findings are reviewed elsewhere (Mihevic et al., 1981; Roberts et al., 1982; Carton et al., 1985). Although the previous studies have proven the effects of high-intensity runs on anaerobic capacities (Laursen et al., 2002; Psotta et al., 2005), there is a need for scientific studies examining effects of specific handball task on anaerobic capacities and their implementation in glycolytic training. Previous study showed that there were no statistically significant differences

between the players' positions when measuring blood lactate and maximal heart rate (Sporis et al., 2010), which means that the same activity can be useful for every player regardless his position in the game. It can be hypothesized that there is no significant difference in physiological load between straight line running and specific handball task of similar duration time.

#### Subjects

The subjects in this study were 10 healthy amateur handball players from Croatian first and second league, aged  $22.50 \pm 1.35$  years, with  $10.80 \pm 2.53$  years of active training who volunteered the experiment. Average weight was  $87.9 \pm 4.31$  kg and height  $184.00 \pm 5.29$  cm. All subjects were informed about procedures. The measurement procedures and potential risks were fully explained to each subject prior to obtaining a written informed consent according to the Helsinki Declaration. The study was approved by the Ethics Committee of the Faculty of Kinesiology, University of Zagreb. None of the subjects were injured 6 months before the testing. Players did not use any nutrition supplements. In addition, subjects were not taking exogenous anabolic-androgenic steroids and other drugs that might be expected to affect physical performance or hormonal balance during this study.

#### Procedures

The data collecting was done by fifth year Kinesiology students and experienced medicine doctor for blood lactate concentration measurement. Each subject got the instructions 3 days before testing. Subjects were instructed to abstain from alcohol drinks and anaerobic training 2 days before the experiment with considering the regular eating and sleeping. Before the experiment each subject had the exact warming up protocol which consisted of 10 min of warm up running, 10 min of stretching, and 5 x 30m of running exercises. Experiment was done in 2 days at 10am with 72 hours of rest between days in which subjects were instructed to abstain from any training activity and alcohol drinks. In that period subjects were instructed to eat regular mixed food with at least one carbohydrate meal per day and to have regular sleep. In first day of experiment subjects were running 400 m straight distance on the track and field stadium "Mladost" in Zagreb, with outside temperature of 21°C. Collection of data (400m distance running time, Heart Rate and Borg Scale) were immediately after running, while blood lactate concentration (LAC) was measured 1 minute after the running from fingertip of the left hand. In the second experimental day subjects were tested in specific handball polygon on the handball court in the gym of Faculty of Kinesiology in Zagreb (Figure 1). The Lactate Scout analyzer (LS, SensLab GmbH, Germany) was used for lactate analysis.

#### The sample of variables

Sample consists of three variables: *heart rate (HR)*, *Borg scale (BS)* and *blood lactate concentration*

(LAC). Heart rate (HR) data were collected with heart rate monitors *Polar RS400*, (Polar- Electro, Kempele, Finland) and results are expressed in beats per minute (b/min). Variable Borg scale (BS) is subjective stress level estimation by subjects after the activity, expressed in 1 to 13 degrees. Degree 1 means *very, very low intensity*, while 13 means *maximum intensity without no energy to continue activity* (2). Blood lactate concentration (LAC) was measured by experienced medicine doctor via a fingertip blood drop with Lactate Scout analyzer (LS, SensLab GmbH, Germany).

#### Polygon description:

1. *Lateral agility* – subject moves laterally between 4 m distanced lines with maximum speed. Start is on mark "go", moving is laterally without crossing the legs. Outside leg must cross or touch the line and distance between lines must be six times crossed.
2. *Sprint 20 meters* – after the lateral agility subject sprints 20 meters to the basketball backboard
3. *10 two-legged vertical jumps* – when reaching basketball backboard subject does 10 two-legged vertical jumps with touching the backboard with both hands
4. *Jump shot* – after task 3, subject takes the ball from the marked place on the floor and shoots with jump on the goal from 9 m line. After the jump shot subject moves to the mark on the 7 m line
5. *Sprint* – the task is to sprint on the other side of the court to the 6 m line
6. *"Eights"* – the task consists of running around 4 marks which makes rectangle of dimensions 4 m length and 3 m wide located with longer side on the 6 m line. Subject runs two rounds and one more diagonal before running to the next task
7. *Dribble with changes of direction plus jump shot* – after task 6, subject takes the ball from marked place and starts dribbling around 6 marks "zig-zag" positioned 5 m from each other and 3 m wide.
8. *Jump shot* - when dribbling is done, subject shoots on the goal from the 9 m line with jump shot
9. *Sprint with turn in the middle of the court* – after jump shot subject sprints to the other side of the court with turn in the middle and continuing backwards running to the 6 m mark on the other side of the court and starts over again from task 1 if there is time left considering subjects 400 m running

#### Statistical analysis

The collected data was analyzed by standard statistics software (Statistica for Windows 7.0). Descriptive statistics were calculated for all experimental data. Kolmogorov-Smirnov test was calculated for all variables before analysis to prove the normality of distribution. A t-test for dependent variables was used in order to determine statistically significant differences between the tested variables. The statistical significance was set at  $p < 0.05$ .

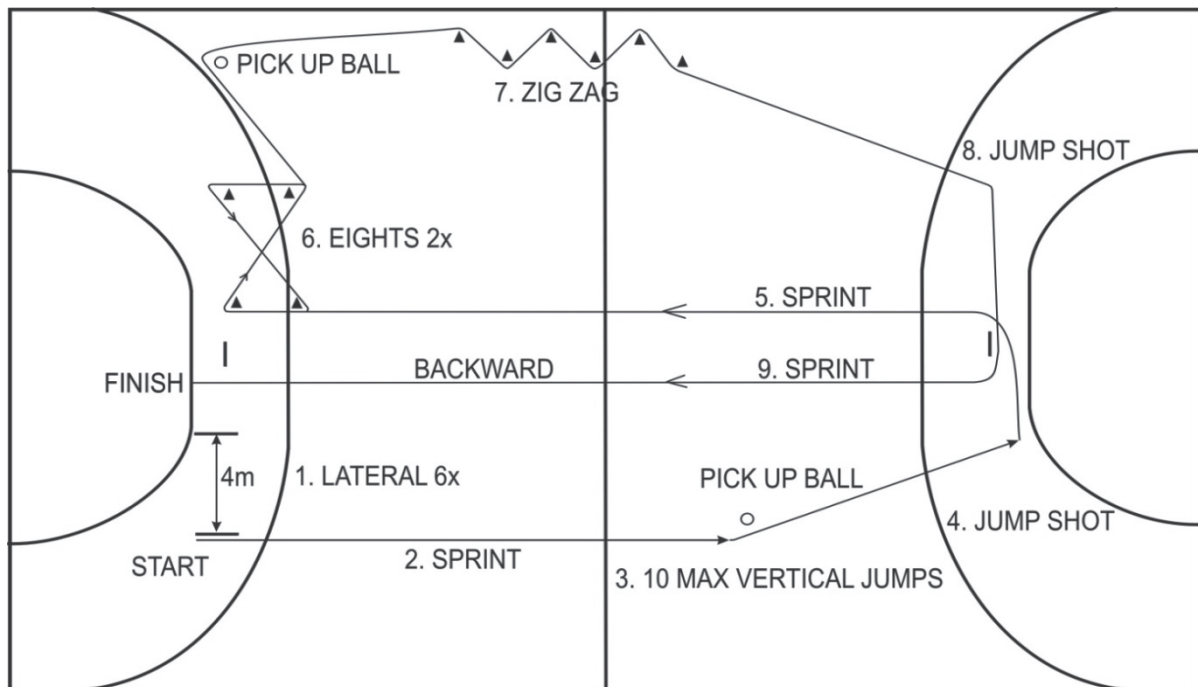


Figure 1. Scheme of the specific handball polygon

## Results and discussion

The Kolmogorov-Smirnov test has shown that data was normally distributed. Mean heart rate for 400m straight running was similar as specific handball polygon  $187.60 \pm 7.40$  and  $185.80 \pm 7.85$ , respectively. These values show that subjects did the testing with high level of motivation and proper intensity of running. There was no statistically significant difference ( $p=0.06$ ) in heart rate between straight line running and specific handball polygon (Table 1). Also, there were no significant differences ( $p > 0.05$ ) between 400m straight running and specific handball polygon in blood lactate concentration ( $14.60 \pm 0.98 \text{ mmol} \cdot \text{L}^{-1}$  vs.  $15.09 \pm 0.96 \text{ mmol} \cdot \text{L}^{-1}$ , respectively) and Borg scale ( $11.82 \pm 1.47$  vs.  $12.23 \pm 1.39$ , respectively).

Table 1. Differences between straight running and specific handball polygon

	Straight running	Handball polygon	p
Heart rate (beats/min)	$187.60 \pm 7.40$	$185.83 \pm 7.85$	0.06
Borg scale	$11.82 \pm 1.47$	$12.23 \pm 1.39$	0.90
Blood lactate (mmol/L)	$14.60 \pm 0.98$	$15.09 \pm 0.96$	0.17

Based on the results of the experiment and according to the T-test for dependent samples, there were no statistically significant difference between straight running values and specific handball polygon for amateur Handball players.

Comparisons between handball and other team sports are limited by differences in rules, field of play, and duration of the game, but some useful comparisons can be made with other team sports that demand intermittent types of activity (Rebello et al., 1988). In earlier study (Sporis et al., 2008) authors concluded that more improvement in anaerobic capacity in football players can be accomplished with specific training than with straight line running intervals. They measured heart rate and lactate blood concentration after 300 yard test in two years after different training periods. In first year sprinting intervals were used to improve anaerobic capacity, while in second four minutes situational practice was used. Borg scale is a common physiological tool used to assess perception of effort (Purvis et al., 1981; Baechle and Earle, 2000). In this study according to results in Borg scale, subjects experienced testing as stressful and hard. The estimated levels of stress after 400 m running were between 7 and 13, while after polygon between 5 and 13. Comparing average levels, subjects experienced polygon more stressful and hard than 400 m running. In Table 1 t-test show that there is no statistically significant difference between those two variables ( $p = 0.82$ ), so it can be confirmed that intensity of anaerobic glycolytic running can also be replaced with specific polygon if goal is improving anaerobic endurance. Differences between lactate blood concentration after 400 m running and polygon were not statistically significant ( $p = 0.17$ ). Comparing research results with other researchers there is relatively high lactate concentration ( $14.60$  and  $15.09 \text{ mmol} \cdot \text{L}^{-1}$ ). Anaerobic endurance was tested among rugby league players with triple-120 meter shuttle test and average blood lactate



concentration was  $13.2 \text{ mmol L}^{-1}$  (15). Lower concentration was probably due to the longer time (3 minutes) of resting before measurement protocol than in this research. Average lactate concentration among football players of first Croatian football league was measured after 300 yard test (16). Value  $15.00 \text{ mmol} \cdot \text{L}^{-1}$  is similar to the value after specific handball polygon used in this study ( $15.09 \text{ mmol} \cdot \text{L}^{-1}$ ) which means that intensity in polygon can be similar to the straight line running intensity in 300 yard test which is proven anaerobic endurance test. The HR in handball match remains above 85% of maximum for an average 83% of playing time and the player is engaged in very vigorous physical activity for >80% of a game. In addition and compared with other sports such as basketball, soccer, and rugby, the HR rarely falls below  $150 \text{ b} \cdot \text{min}^{-1}$  (Chelly et al., 2011). The high blood lactate concentrations confirm a great use of anaerobic energy (McInnes et al., 1995), which substantiates the fact that team handball is physically very demanding, with an anaerobic demand greater than that in many team sports. Physiological demands during handball match contributes to finding the right tests for elite and subelite players.

The purpose of this study was to determine is there statistically significant difference in physiological load between straight line running and specific handball polygon. In every variable used in research statistically significant difference was not found. Average blood lactate concentration and average Borg scale stress level was higher after polygon while average heart rate was higher after 400 m running. But, gained differences were too small to be statistically significant.

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Activities during Handball game alternate between high intensity sprints and low level aerobic activity coupled with jumping, throwing, and blocking. These physical demands translate into considerable metabolic stress, both aerobic and anaerobic, as exemplified by the elevated lactate and heart rate responses during a match (Cuesta, 1991). Developing anaerobic capacity and its related performance component of strength, power, and speed is integral to success in team handball. Specific handball test is more related to the situational demands than straight line running and it gives more information about specific anaerobic endurance. Use of that kind of activity is better than straight running, especially for top level players.

## Conclusion

It can be concluded that both activities can be used in order to improve anaerobic glycolytic endurance in Handball players. Coaches need to decide what is better for their teams or individuals considering the period and fitness condition of their players. Preparation period is more appropriate to use straight line running more than polygon because player's body is not prepared for specific movements at that time. In competition period polygon is more acceptable because it simulates activities during the Handball game. Properly done situational and specific Handball elements in maximum intensity during polygon tasks means that player needs to be concentrated to dribble, shoot, jump and run even the fatigue is getting bigger and conditions are stressful and hard. This kind of training should result with more efficiency in the real conditions of the handball game.

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## RAZLIKE U FIZIOLOŠKOM OPTEREĆENJU KOD RUKOMETAŠA ZA VRIJEME PRAVOCRTNOG TRČANJA I KOD SPECIFIČNOG RUKOMETNOG POLIGONA

### Sažetak

Cilj ovog istraživanja bio je utvrditi razlike u fiziološkim opterećenjima kod testa trčanja na pravcu (400 metara) i kod posebne rukometne zadaće. Uzorci su bili 10 zdravih osoba amaterskih rukometaša. Ispitanici (uzrasta  $22,50 \pm 1,35$  godina, tjelesne težine  $87,9 \pm 4,31$  kg, a visina tijela  $184,00 \pm 5,29$  cm) trčali su 400 metara na atletskoj stazi kao i na rukometnom terenu u tri pokušaja. Maksimalni broj otkucaja srca i percepcija napora (Borg skala) su mjereni nakon svakog ponavljanja, dok su koncentracije laktata izmjerene nakon zadnjeg ponavljanja. Rezultati su pokazali statistički značajnu razliku maksimalnog broja otkucaja srca ( $p = 0,06$ ), subjektivne percepcije napora ( $p = 0,90$ ) i laktata ( $p = 0,17$ ) između 400 metara i izvođenja posebne rukometne zadaće. Zaključak je da ne postoje velike razlike u fiziološkim opterećenjem od 400 metara i specifičnih rukometnih zadaća. Obje aktivnosti mogu se koristiti u analizi anaerobni treninga izdržljivosti kod rukometaša, ali specifičan zadatak je prikladniji obzirom na situacijske uvjete..

**Ključne riječi:** anaerobni kapacitet, rukometne zadaće, laktati u krvi, Borgova skala

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## DIFFERENCES IN INDEXES AND VARIABLES DIRECTLY ARISING FROM THE RESULTS OF A TABLE TENNIS COMPETITION IN TWO DIFFERENT SEASONS

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Original scientific paper

### Abstract

The basic aim of this research is to question to what extent the indexes and variables derived directly from the results of individual table tennis games are different in two different seasons of table tennis championships. We have examined a sample of table tennis players competing in various recreational table tennis leagues in SOKAZ (N=914 during 2006 and N=956 during 2007). We found statistically significant differences between individual variables, between the indexes of the table tennis competitor's efficiency and between the "pure statistical" variables, in two different competition seasons. Comparing the differences in variables and indexes that are the indicators for uncertainty of the competition, directions for changing competitive system can be suggested, differently on certain league levels.

**Keywords:** table tennis, differences, competition

### Introduction

Comparing the results in different championship seasons can have at least two meanings: analysing the quality of performance of the certain players or teams in two different competitor's environments (1) and analysing the uncertainty of the competitions in certain leagues (2). In fact, both types of data could provide us information important for considering changing of the competition system (defining number of teams promoted and relegated, number of teams in one league, etc.), with a purpose of increasing uncertainty of the competition (Del Corral, 2007). The ultimate concern in high-performance sport is the final performance, whether it is at the training or on the competition. The final output that is observed is dependent on a complexity of factors. Each of them may contribute a variable amount to the performance.

Table tennis is one of the fastest ball games in the world and therefore it is difficult for the coach to notice and remember all the key elements occurring within a game or training session (Hughes & Franks, 1997; Baca et al, 2004; Leser, & Baca, 2009). Other important issue is approach with uncertainty coefficient as a method for optimisation of the competition. Coefficient of uncertainty at the competition, is an attempt to define the uncertainty of the matches in certain competition (Del Corral, 2007, 2009; Forrest & Simmons, 2002). From sports aspect, the basic and most utilitarian indicator of game quality is exactly the achieved result on a particular sports competition. Amongst different manners of quality analysis of the table tennis players' game, the basic idea of research was to seek to detect those indicators (data) for collection of which only the final result in particular competitions in larger number of events, in one table tennis game, certain sets in one table tennis game could be sufficient.

How to assess the game quality is the basic question which is set by the professionals aiming to improve result effect of table tennis player. In the world of table tennis, some studies on game analysis can be found, but in general there is a lack of literature for this discipline (Baca et al, 2004; Leser, & Baca, 2009). Sindik & Vidak (2009) tried to find out uncertainty coefficient as a method for optimization of the competition system in table-tennis leagues. Sindik (1999) performed that by implementation of variables which could directly be derived from the results of competitions, however, those variables one could reduce to a smaller number of indexes. Sindik and Juričević (2007) derived 16 indexes as the indicators of game quality, exactly based on the achieved result in a particular table tennis competition, but for former system of points in table tennis (game with two sets, played till reaching 21 points). As we can see from this short literature review, indicators of game quality can be different and more or less numerous, and the analysis using indexes and variables directly derived from the results of individual table tennis games was applied only on former system of points in table tennis (with a smaller ball, additionally).

Researching which indexes and variables directly derived from the results of individual table tennis games are different in different seasons of table tennis championships, could provide us few types of information: about indirect efficiency indicators (for example, games won), indirect indicators of the success (such as matches won in five sets) and "neutral" variables, named "pure statistical" variables (for example, number of matches played). For analysing uncertainty, we can analyse the differences between two seasons in certain direct and indirect efficacy indicators, as well as certain "pure statistical" variables.



The uncertainty can be estimated in comparison between key indicators of uncertainty (game played in five sets, turnover index, game played in five sets index, with belonging variables) and "pure statistical" variables (turnover games, games played in five sets, sets played on point difference) that are indicators of uncertainty, but always in combination with number of games played. In this research, we'll simplify our approach, assuming that absence of the differences between number of matches played in two seasons, means reliable comparing other variables and indexes. The *basic aim* of the research is to question to which extent the indexes and variables directly derived from the results of individual table tennis games are different in two different seasons of table tennis championships (in 2006 and 2007). *The goals* of the research are to determine the differences between two different competition seasons in: individual variables of the table tennis competitor's efficiency in two different competition seasons (1); indexes of efficiency, derived by summarization of several particular variables (2); "pure statistical" variables in the table tennis (3). We assumed that there are no differences between two different competition seasons toward: individual variables of the table tennis competitor's efficiency, derived indexes of efficiency. as well as in "pure statistical" variables.

## Methods

*Data collection* has been performed by inspecting all the results of individuals (players-examinees) from official web page of the Table Tennis Organization of Clubs and Activities of Zagreb (SOKAZ) [www.sokaz.hr](http://www.sokaz.hr). The total result of an individual in larger number of individual tennis table games, sets, games has been registered. All results were collected from two championships in the period during 2006 in 2007, from the different competition ranks in which the named team has competed. The role of judges and audience was reduced to a minimum, while games were played in three sets won.

## Sample

The final sample comprised of 914 table tennis players competing in various recreational table tennis leagues in SOKAZ, during 2006, who played in leagues ranged from 1 to 20, with minimum of 36 to maximum of 59 players in each league and the final sample of 956 table tennis players competing in various recreational table tennis leagues in SOKAZ, during 2007 that played in leagues ranged from 1 to 20, with minimum of 33 to maximum of 63 players in each league. In total, in both championships, data from 1870 players are collected. In fact, we have collected the data about the same players, but partially differently distributed in various leagues. Each individual whose result was collected played at least 8 individual games in period observed, while the maximum number of individual games which the individual could play during one competition was 66.

All the players were male. The data were collected directly from the Internet players' database (website: [www.sokaz.hr](http://www.sokaz.hr)).

## Variables

The main independent variable in this research was the year of the competition. We have analyzed two championships in different levels of leagues in SOKAZ in 2006, and two championships in different levels of leagues in SOKAZ in 2007. I.e. this variable was dichotomous (players that played in 2006 and in 2007). The other independent variable, used only for the additional interpretation of the results obtained, was the league level (1=1<sup>st</sup> to 5<sup>th</sup> league; 2=6<sup>th</sup> to 10<sup>th</sup> league; 3=11<sup>th</sup> to 15<sup>th</sup> league; 4=16<sup>th</sup> to 20<sup>th</sup> league). Indicators (direct and indirect) in the table tennis competition have been defined, which can be derived directly from the competition results.

*Direct efficacy variables* have been determined:

1. games won: total games won, for an individual
  2. sets won: total number of sets won, for an individual, from the total number of games played
- Other variables* were also directly derived from the results, and they are divided in two groups:
- A. indirect efficacy variables (indicators of success);*
3. games lost: total games lost (individual);
  4. sets lost: total number of sets played in which an individual lost the set;
  5. sets won with points difference: total numbers of sets won that were played on difference (won 11-9, 12-10 etc.);
  6. sets lost with points difference: total number of sets won that were played on point difference (lost 9-11, 10-12, etc.);
  7. games won played in five sets: total number of games won that were played in five sets (result 3-2 for an individual);
  8. games lost played in five sets: total number of games lost, that were played in five sets (result 2-3 for an opponent);
  9. games won after 0-2 in sets for opponent: number of games won in which an individual won after losing the first two sets (0-2 advantage of the opponent);
  10. games lost after leading 2-0 in sets: number of games lost in which an individual lost after winning the first two sets (2-0 advantage);
- B. 'pure statistical' (neutral) variables*
11. number of games played: total number of games played by an individual;
  12. number of sets played: total number of sets played by an individual;
  13. turnover games (lost after leading 2-0 and won after 0-2): total number of games won in which an individual won after losing the first two sets (0-2 advantage of the opponent) and the number of games lost in which an individual lost after winning the first two sets (0-2 advantage of the opponent);
  14. games played in five sets: total number of games played in five sets (result 3-2 for an individual or 2-3 for the opponent);
  15. sets played on point difference: total number of sets played on point difference (won 11-9, 12-10 etc. or lost 9-11, 10-12, etc.).

### Indexes

Indexes in table tennis competition have been defined, which can be derived directly from the competition results (variables). These indexes are theoretically organized as a 'composition' of two particular variables - , basic 'logic' is the calculation of ratio between effectively accomplished number of cases and the maximum possible number of cases, in relation to the hypothetic indicators of efficiency in competition situations.

*Direct efficacy indexes* (indicators):

1. game index: ratio between the number of games won and lost in all an individual's games: total number of games won is divided by the total number of games played;

2. set index: ratio between the number of sets won and lost, in all sets in games played by an individual: total number of sets won is divided by the total number of sets played;

*Indirect efficacy indexes* (indicators):

3. set played on point difference index: ratio between the numbers of sets won and lost, in sets played on point difference (11:9, 12:10 etc.): the number of sets won on point difference is divided by the total number of sets played on point difference;

4. game played in five sets index: ratio between the number of games played in 5 sets, in relation to the total number of games played; the number of games played in 5 sets is divided by the total number of games played;

5. turnover index: ratio between the number of games won and lost, in which an individual won after losing the first two sets (0-2 advantage of the opponent), and in games when an individual had an advantage to the opponent leading 2-0 (and finally lost the game).

Finally, total efficacy index is the sum of three indexes (set play on difference, game played in five sets, turnover index), as a hypothetic measure of total player's efficacy.

### Data Analysis

All data analysis was performed using the SPSS 15.0 package. Descriptive statistics for all variables and indexes are calculated. In order to determine differences in the achievement of table tennis players in two different competition years (2006 and 2007), by using variables and indexes of competitive efficacy in table tennis, we carried out t-tests. Then, by applying the discrimination analyses, we also established factors of differences for indexes and variables of competitive efficacy in table tennis, in relation to the two competition years in SOKAZ and to the competition level. Then we tested the correlation between the league in which a player plays and all indexes and variables of competitive efficacy, directly deduced from the results.

### Results

In Table 1 are presented the results of discrimination analysis, in relation to the dependent variable year of competition (2006 or 2007), we notice that the group centroids are quite distant

.457 (the year of 2006) and -.327 (the year of 2007). Based on the discrimination function, 66.7 % of initially grouped cases could be correctly classified. The discrimination function statistically significantly differentiates indexes of efficiency at table tennis players in 2006 and 2007. ANOVA results showed statistically significant differences between two seasons in total efficacy index, but also in game played in five sets index. That is to say, it was demonstrated that table tennis players in the competitions of the SOKAZ leagues in 2006 (in relation to 2007) were statistically significantly more successful in matches played in five sets indexes.

In Table 2 it is noticeable that the values of 'pure statistical' variables, in comparison with 2006 and 2007, in two cases differentiate statistically significantly. That is to say, it was demonstrated that among 'pure statistical' variables, there is a statistically significant difference in the number of turnover games (higher number in 2007) as well as in games played in five sets (higher number in 2007). In Table 3 having examined the results of discrimination analysis, in relation to the dependent variable year of competition (2006 or 2007), we notice that the group centroids are quite distant -.267 (the year of 2006) and .256 (the year of 2007). Based on the discrimination function, 61.3 % of initially grouped cases could be correctly classified. The discrimination function statistically significantly differentiates variables of efficiency in table tennis players in 2006 and 2007. ANOVA results showed statistically significant differences between two seasons in the following variables: won games after 0-2 in sets for opponent (higher results in 2007), lost games after leading 2-0 in sets (higher results in 2007), lost sets with difference (higher results in 2007), won games played in five sets (higher results in 2007), lost games played in five sets (higher results in 2007). In Table 4 is showed that the most of indexes and variables (directly deduced from the competition results), but also 'pure statistical' variables, are negatively and very low, but statistically significantly correlated with the league level in which table tennis players compete. In other words, in the more qualitative competitive leagues, there are more equalised games, games played in five sets or even turnover games, as well as sets played on difference.

In Table 5, the discrimination analysis is performed in relation to the dependent variable SOKAZ league categories (for 2006 and 2007 together). Based on the discrimination function, 31 % of initially grouped cases could be correctly classified. The first discrimination function statistically significantly differentiates indexes of efficiency in table tennis players in 2006 and 2007, as per the leagues' competitive 'strength'. ANOVA results statistically significantly differentiate the following variables: games played in five sets index (higher results in 'stronger' leagues), turnover games index (also higher results in 'stronger' leagues, however the highest in the SOKAZ leagues 11-15).

Table 1. Factors of differences in indexes of efficiency at table tennis players (between 2006 and 2007)

Discrimination function		Eigen value	Wilk's $\lambda$	Canonical correlation	$\chi^2$ (degrees of freedom)			p
Discrimination function		.149	.870	.361	227.423 (6)			<.01
Variables	Wilk's $\lambda$	Correlation with a discrimination factor	F-test (1.1636)	p	M 2006	$\sigma$ 2006	M 2007	$\sigma$ 2007
game index	.998	.117	3.355	>.05	.4621	.2385	.4391	.2583
set index	.998	.118	3.415	>.05	.4625	.1940	.4434	.2146
set play on difference index	.999	.090	2.000	>.20	.4498	.1817	.4336	.2564
game played in five sets index	.991	.244	14.564	<.01	.3804	.2535	.3299	.2717
turnover games (lost after leading 2-0 and won after 0-2)	.998	.113	3.129	>.10	.1173	.2193	.0994	.1904
total efficacy index	.885	.931	211.718	<.01	1.8146	.8313	1.2590	.7083

Table 2. Differences in variables of efficiency at table tennis players and in 'pure statistical' variables (between 2006 and 2007)

Variable	Year	Mean	Std. Deviation	t-test
<i>turnover games (lost after leading 2-0 and won after 0-2)</i>	2006	1.7287	1.5291	-7.897**
	2007	2.2922	1.3367	
<i>number of games played</i>	2006	48.6050	19.2216	-.254
	2007	48.8335	19.6422	
<i>sets played on difference</i>	2006	25.7057	12.9246	.987
	2007	25.1141	12.9941	
<i>games played in five sets</i>	2006	10.5602	6.0788	-6.216**
	2007	50.3791	197.8613	
<i>number of sets played</i>	2006	186.0022	74.3351	1.120
	2007	182.1183	75.5400	
won sets	2006	95.5449	51.7219	.696
	2007	93.8723	52.1783	
lost sets	2006	90.3184	40.1856	1.080
	2007	88.3037	40.4112	
won games	2006	25.0864	15.8935	-.367
	2007	25.3602	16.3367	
lost games	2006	23.9376	13.0267	.787
	2007	23.4733	12.4579	

\*\*t-test significant at  $p < .01$  \*t-test significant at  $p < .05$  (Shaded: pure statistical variables)

Table 3. Factors of differences in indexes of efficiency at table tennis players (between 2006 and 2007)

Discrimination function		Eigen value	Wilk's $\lambda$	Canonical correlation	$\chi^2$ (degrees of freedom)			p
Discrimination function		.068	.936	.253	123.486 (6)			<.01
Variables	Wilk's $\lambda$	Correlation with a discrimination factor	F-test (1.1867)	p	M 2006	$\sigma$ 2006	M 2007	$\sigma$ 2007
won games after 0-2 in sets for opponent	.979	.555	39.386	<.01	.8643	1.0451	1.1475	.9031
lost games after leading 2-0 in sets	.978	.570	41.489	<.01	.8643	1.0175	1.1467	.8752
won sets with difference	1.000	.006	.004	>.20	12.8643	7.3851	12.8890	8.9429
lost sets with difference	.997	.203	5.291	<.05	12.8282	6.8554	19.9120	92.8649
won games played in five sets	.980	.545	37.939	<.01	5.2867	3.7435	25.6607	99.9336
lost games played in five sets	.980	.544	37.836	<.01	5.3151	3.4656	25.6974	100.1199

Table 4. Correlation between indexes and variables in our research with the league rank in SOKAZ (2006 and 2007 together)

VARIABLES OF EFFICIENCY									
won games	lost games	won sets	lost sets	won games played in five sets	lost games played in five sets	won turnover games	lost turnover games	won sets with difference	lost sets with difference
-.169**	-.100**	-.242**	-.200**	-.234**	-.231**	-.090**	-.084**	-.236**	-.231**
'PURE STATISTICAL' VARIABLES									
number of games played		number of sets played		games played in five sets		turnover games (lost after leading 2-0. won after 0-2)		sets played on difference	
-.224**		-.298**		-.282**		-.176**		-.259**	
INDEXES OF EFFICIENCY									
game index	set index	set play on difference index		game played in five sets index		turnover games (lost after leading 2-0 and won after 0-2)		total efficacy index	
-.035	-.046*	.046*		-.113**		-.061*		-.049	

\*\*correlation significant at  $p < .01$  \* correlation significant at  $p < .05$

Table 5. Factors of differences in indexes of efficiency at table tennis players in 2006 and 2007 (between four levels of SOKAZ leagues)

Discrimination function		Eigen value	Wilk's $\lambda$	Canonical correlation	$\chi^2$ (degrees of freedom)			p
Discrimination function 1		.017	.977	.129	37.258 (12)			<.01
Discrimination function 2		.006	.993	.080	10.427 (6)			>.10
Variables	Wilk's $\lambda$	Correlation with a discrimination factor	F-test (3.1593)	p	M 1-5	M 6-10	M 11-15	M 16-20
set play on difference index	.996	.244	2.069	>.10	.4406	.4666	.2417	.4289
game played in five sets index	.988	.803	6.404	<.01	.3841	.3802	.2620	.3141
turnover games (lost after leading 2-0 and won after 0-2)	.989	.696	5.637	<.01	.1451	.1009	.1868	.0917
total efficacy index	.997	.393	1.591	>.10	1.5411	1.5437	.8027	1.4404

League levels: 1-5 league, 6-10 league, 11-15 league, 16-20 league,

## Discussion and Conclusions

The main research findings comprise a conclusion that there are differences in characteristics of table tennis matches in the SOKAZ leagues, on both levels of indexes and variables, which can be directly deduced from the results of table tennis matches. The total efficacy of table tennis players in 2006 was statistically significantly higher than in 2007, which can be a consequence of statistically insignificantly higher results for turnover index and game played in five sets index, which are however additive components for total efficacy index. So, this result could be consequence of the low or moderate high but statistically significant and positive correlations between all efficacy indexes (except turnover games) in both championship seasons. (These results are not presented here, because of prolixity). The reason for it could be the fact that competitions in various championships can be equalised to a different extent, even when a relative competitive efficacy is almost practically identical, which is shown by the game index and set index values. It can probably be justly assumed that most of differences in variables of table tennis player efficacy are conditioned directly by the fact

that in the 2007 championships there were a lot more turnover games and games played in five sets, which could have been the consequence of equalised competition in some or most of the league competitions in SOKAZ. In the more qualitative competitive leagues, there are more equalised games. Upon examination of the results of our research, we can assume that more present equalisation of competitions in certain competition seasons is the consequence of the equalisation's fluctuation in certain leagues, where a 'concentration' of higher or lower number of qualitative teams occasionally occurs. It is possible that the aforementioned characteristics of the achievement of table tennis players in the large-scale recreational table tennis competition, such as the one in SOKAZ, significantly differ, depending on a competition season, or on the level of more seasons. The competition in individual leagues or in more leagues becomes less or more equalised. Relevant fault of all efficiency indicators (indexes and variables) directly derived from the competition results is the fact that the total result does not need to necessarily be the real 'measure' of players' competition efficiency. In practical situations in competition, it might come to players

being 'laid-back' in situations of more significant result advantage or 'fall back' in relation to the opponent, 'predictions' of convincing victory or defeat, 'playing' with anticipatory inferior or 'superior' opponent during the entire event (Sindik & Vidak, 2009). We should not forget that we are not talking about top-quality table tennis, but recreational table tennis; therefore we should be additionally careful in generalizing these results. However, in average and in 'result-wise more equalized' competitions, suggested efficiency indicators could be useful hypothetically. One of the main limitations of this study was the structure of the samples: we compared the same people, distributed in different (or same) leagues. However, important aim of this study was to analyse how redistribution of the players can have an influence on different uncertainty of the individual and team games (Sindik & Juričević, 2007). Using of t-test and discrimination analysis (for independent samples) in fact contribute to the possibility of making Type 2 error: in two different seasons half of total number of teams (as well as team members) remain in the same league level, while three teams became relegated and three teams promoted. So, we have a situation of mixed independent/dependent sample, when we are comparing the same league in two seasons. Second important limitation was the missing data about the age of the players. These data were not available from our sources (Internet database), but we can assume that the age average and range remain approximately the same, inside certain league).

It could be very interesting to compare the players, according to their age, in the interaction with league level where they play, in future studies. Also, it could be interesting to analyze female players, comparing with male ones (in case of SOKAZ leagues we could have only very small sample of female players, because they play only in two leagues). Other demographic information also misses in our study, as well as the influence of family, but these data could be collected in future research.

However, it is desirable to in any case inspect the proposed variables and indexes (direct and indirect indicators) of player's efficacy in future researches, on the sample of examinees of elite table tennis players', maybe not only male, and from different age groups. We can also use more indirect indicators of player's efficacy, as did Sindik & Juričević (2007), on the two sets won and 21 points won point-system. Significant differences in two different competition seasons between individual variables of the table tennis competitor's efficiency, between indexes of efficiency and between 'pure statistical' variables in the table tennis. So, we reject all three hypothesis. It was proved, that we can estimate the level of uncertainty in competition, simply comparing players' efficiency during too championship seasons. On the base of such indicators, competition system can be adjusted, especially in league levels with less uncertainty competition in current championship, comparing with previous season.

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## RAZLIKE U INDEKSIMA I VARIJABLAMA IZRAVNO PROIZLAZEĆIM IZ REZULTATA STOLNOTENISKOG NATJECANJA U DVIJE RAZLIČITE SEZONE

### Sažetak

Osnovni cilj ovog istraživanja je pitanje u kojoj se mjeri indeksi i varijable izvedene izravno iz rezultata pojedinačnih stolnoteniskih mečeva razlikuju u dvije različite stolnoteniske sezone. Ispitan je uzorak stolnotenisača koji se natječu u raznim rekreativnim stolnoteniskim ligama SOKAZ-a (N=914 u 2006. godini i N=956 u 2007. godini). Pronađene su statistički značajne razlike između pojedinih varijabli, indeksa stolnotenisačeve učinkovitosti i za "čiste statističke" varijable, u dvije različite sezone natjecanja. Uspoređujući razlike varijabli i indeksa koji su pokazatelji neizvjesnosti natjecanja, mogu se predložiti upute za promjenu sustava natjecanja.

**Ključne riječi:** stolni tenis, razlike, natjecanje

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## DETERMINATION OF QUANTITATIVE CHANGES OF PROGRAMMED WORK AT ATTENDEES IN BASKETBALL SCHOOL

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### Abstract

The main purpose of this paper is to provide a modest contribution to the knowledge of the changes that occur at the primary school student (12-14 years), under the influence of training in the school of basketball, which are nevertheless included in regular classes, and physical and health education. This study is an attempt to determine kvantativnih changes in the space of some morphological characteristics, basic - motor and situational - motor skills under the influence of the quarterly program of basketball.

**Key words:** transformations, morphology, motor skills, quantitative changes

### Introduction

If we want to make significant progress and a step forward in creating future generations of boys and girls basketball, which will be much better compared to the currently selected with, you have to start with quality-selection and systematic work (transformation process) from earliest youth. It is believed that a high level of motor and functional abilities as a functional morphological prerequisite for effective teaching and learning of new movement structures in all age categories. The influence of a program depends on the degree of complexity of the training unit, the connection between the volume of the transformation process, the energy and information orientation program and the circumstances in which the procedure takes place. It is believed that a high level of motor skills is a precondition for effective learning new motor structures, training and successful use of basketball.

### Methods

#### Research subject

The subject of this research is the effects of the quarterly scheduled work on the transformation of the analyzed morphological characteristics, basic-motor and situational-motor skills in the school basketball, ages 12-14 years, which are in addition covered and regular teaching physical and health education.

#### Research problem

The problem in this study is whether under the influence of training programs in basketball, ie three-month program to reach kvantativnih changes in morphological characteristics, basic-motor and situational-motor abilities.

#### Research aim

The main objective of this study was to determine the quantitative changes in the morphological characteristics and the basic-motor and situational-

motor skills, students school basketball, under the influence of programmed work. ie the transformation process.

#### Hypothesis

Based on the wording of the case and the research problem, research objectives, and the results of previous studies, the general hypothesis of this paper could be formulated as follows: H - is expected to be a training program for a period of three months, a positive impact on the quantitative improvement of these morphological characteristics, basic motor skills and situational - motor abilities of participants in school basketball.

Compared to the general hypothesis can be set and the following specific hypotheses: H - 1st It is expected that under the influence of basketball training result in significant positive changes kvantativnih defined morphological characteristics .H - 2nd It is expected that under the influence of basketball training result in significant positive changes kvantativnih defined basic - motor skills.H - 3rd It is expected that under the influence of basketball training result in significant positive changes kvantativnih defined situational - motor skills.

#### Examinees sample

The study was conducted on a sample of 108 girls, boys aged 12 -14 years, the sports star is a selection of pioneering age.

#### Sample of variables

When selecting variables that are supposed to shed light on the problem set, the subject and aim of the study, we took into account that they meet basic psychometric properties (validity, objectivity, sensitivity, ...). With this choice of variables is appropriate age women, and with this objective and appropriate material and spatial conditions.

### Morphological area

To assess morphological dimension subjects applied the following variables: body height, body mass, leg length, arm length, shoulder width, the width of the pelvis, arm span, hand length, hand width and length of the foot.

### Motor area

For the assessment of basic motor skills were applied variables that students know because they were tested in a regular classroom. The sample of variables for assessing basic motor skills: Sprint from a standing start to 20 yards, two foot jump from place to place, two foot jump from a running start, foot tapping, envelope test, side steps, hand tapping, deep forward bend on the bench, jump with both feet long jump from place to place, sit-lying, hand grip and run at 20 m, back and forth with progressive acceleration.

### Specific abilities

For the assessment of situational-motor abilities, players will apply the following test battery: Turning the ball around the hull 24 seconds, turning the ball around the entire body 24 seconds, throwing basketballs out of the breast with both hands, throwing a basketball above his head with two hands in step, moving into position odbranbenom sideways, forward and back for 24 seconds, moving the reversing face the basket, slalom dribbling, change of direction in dribbling, shooting a five external position for 24 seconds and dribble the racket with rubble under the basket.

### Measurement methods and training programme

Research in the area of motor skills are executed in the sports hall. The temperature during the measurements was in the range of 18 to 22°C. All measurements carried out by the same group of timekeepers and they consist of professors and teachers of physical education and basketball coaches who were previously trained for it. Tests are planned in a way that is completely off greater impact fatigue resulting preceding tests.

Programmed physical training activity that is carried out in this study is multidimensional. Used the analytical and synthetic methods of work, the essence of the realization of the experimental program applied in this research is the application of situational methods. The structural part of the training is conducted according to the available theory and practice that treats methods of working age categories with players aged 12-14 years. The program of work was carried out for three months, which is 4 classes a week of training with a total of 50 units.

### Data analysis

Data obtained by measuring and testing will be processed using the software system for multivariate data analysis. To identify significant quantitative changes of these morphological characteristics, basic motor skills and situational-motor abilities of participants in school basketball. Will apply: SSDIF model (Bonacin, 2010).

## Results and discussion

Table 1. Obliquely rotated factors of difference between measurement and correlation of factors

	PX1	PX2	PX3	PX4	PX5
AVIT	-0.01	<b>0.85</b>	0.16	0.05	-0.03
AMAS	0.00	0.27	-0.41	<b>0.79</b>	-0.25
ADUN	0.04	<b>0.81</b>	0.10	0.07	0.06
ADUR	-0.02	<b>0.79</b>	-0.06	-0.02	0.16
ABAK	-0.01	0.07	0.14	<b>0.81</b>	0.00
ABIK	0.06	-0.14	0.25	<b>0.74</b>	0.03
ARRU	-0.02	<b>0.82</b>	0.20	0.01	-0.22
ADSA	0.01	0.20	<b>0.62</b>	0.26	0.27
ASSA	0.12	0.21	<b>0.79</b>	-0.13	0.02
ADST	-0.24	0.06	<b>0.62</b>	0.14	-0.32
M20V	<b>0.95</b>	0.03	-0.03	-0.03	0.17
MSVM	<b>-0.95</b>	-0.11	0.09	0.02	-0.11
MSVZ	<b>-0.95</b>	-0.12	0.10	0.08	-0.12
MTAN	<b>-0.58</b>	-0.10	-0.08	0.08	0.44
MTUP	<b>0.55</b>	-0.03	0.07	-0.12	-0.47
MKUS	<b>0.57</b>	-0.02	-0.09	0.01	-0.37
MTAR	<b>-0.64</b>	-0.12	0.02	0.25	0.26
MPRK	<b>-0.89</b>	-0.03	0.09	-0.03	0.04
MSDM	<b>-0.84</b>	-0.04	0.10	0.01	0.10
MPTL	<b>-0.95</b>	0.02	0.06	-0.08	-0.15
MDIN	<b>-0.64</b>	-0.04	0.20	0.04	0.26
MSAT	<b>-0.95</b>	0.01	-0.04	0.05	-0.08
OLT2	<b>-0.91</b>	0.03	-0.02	-0.07	-0.02
OLTC	<b>-0.90</b>	0.01	-0.04	-0.06	0.03
BKLF	-0.20	-0.01	0.03	-0.13	<b>0.70</b>
BKLG	<b>-0.72</b>	0.14	-0.14	-0.01	0.22
KOS2	<b>-0.85</b>	0.01	-0.01	-0.06	0.04
KPS2	<b>-0.63</b>	0.31	-0.05	-0.24	0.06
SDFF	<b>0.66</b>	-0.08	0.05	0.03	-0.28
PSDF	<b>0.64</b>	-0.03	0.02	0.02	-0.38
SPSS	<b>-0.63</b>	0.06	-0.16	0.00	0.41
SIK2	<b>-0.68</b>	0.06	-0.16	0.00	0.37
	PX1	PX2	PX3	PX4	PX5
PX1	1.00	-0.15	-0.03	-0.14	-0.37
PX2		1.00	0.19	0.28	0.28
PX3			1.00	0.27	-0.09
PX4				1.00	0.15
PX5					1.00

There were made correlations from the selected variables, basically just condensation on a smaller number of factors, so we now can further discuss the factors differences. Factor solution in fact tell us in which direction changes took place for the whole group of the whole treatment and we talk about what are the effects achieved even in latent space. Promax factors (Bonacin, 2010) talk about partial effects that can be achieved. It is evident that obtained five Promax factors, which means that the total treatment caused five different types of effects. First by far the most important that can be noted is that which can be seen along the motor shaft and the motor situational shaft, with exception of throwing the ball with a chest that has a special story. Thus, the first and most important effect is achieved and that is the latent sense visible integration of complete motor - general and situational, and it is the primary effect, and that was the aim of treatment. Another direction in which things have turned out is such that the distinction in relation to longitudinal morphologic dimensions, defined by the body height, leg length, arm length and arm span, all of which very accurately describes longitude dimensions. The third partial effect is described in the third Promax factor is extremely interesting because it contains information on three variables which are: length fist, hand width and length of the foot.



The real question to be asked why these three variables are allocated, perhaps the answer can be found in the fact that all three represent the growth of micro segments of bone, and it is precisely in the distal parts of the locomotor system (hands and feet). It does not fall under the longitudinal dimension, nor the transversal dimensions, especially at this age, and especially with the girls.

Table 2. Rezultati SSDIF analize kvantitativnih promjena

	A	D	S	R	P(an)
AVIT	1.27	4.32	2.30	<b>0.62</b>	0.00
AMAS	0.44	-1.08	0.57	0.15	0.00
ADUN	0.53	-3.39	1.75	<b>0.47</b>	0.00
ADUR	0.34	1.86	1.60	<b>0.43</b>	0.00
ABAK	0.23	3.34	1.71	<b>0.46</b>	0.00
ABIK	0.21	17.42	1.92	<b>0.52</b>	0.00
ARRU	1.26	1.01	2.25	<b>0.61</b>	0.00
ADSA	0.12	-0.90	1.86	<b>0.50</b>	0.00
ASSA	0.08	-10.33	1.58	<b>0.43</b>	0.00
ADST	0.17	17.50	1.98	<b>0.53</b>	0.00
M20V	-0.26	-0.38	-1.25	<b>-0.34</b>	0.00
MSVM	3.79	0.49	1.06	<b>0.29</b>	0.00
MSVZ	4.08	-0.49	1.03	<b>0.28</b>	0.00
MTAN	1.95	1.28	1.12	<b>0.30</b>	0.00
MTUP	-1.09	1.38	-0.92	<b>-0.25</b>	0.00
MKUS	-0.59	0.20	-0.86	-0.23	0.00
MTAR	1.66	-0.48	0.82	0.22	0.00
MPRK	1.95	0.65	1.22	<b>0.33</b>	0.00
MSDM	7.17	0.02	0.96	<b>0.26</b>	0.00
MPTL	2.50	0.21	1.15	<b>0.31</b>	0.00
MDIN	3.01	-0.24	1.04	<b>0.28</b>	0.00
MSAT	8.50	-0.20	1.01	<b>0.27</b>	0.00
OLT2	3.50	0.33	1.16	<b>0.31</b>	0.00
OLTC	3.45	-0.04	1.06	<b>0.28</b>	0.00
BKLF	0.67	-0.25	0.56	0.15	0.00
BKLG	10.79	-0.10	0.89	<b>0.24</b>	0.00
KOS2	1.34	0.12	1.15	<b>0.31</b>	0.00
KPS2	0.42	2.08	1.09	<b>0.29</b>	0.00
SDFE	-1.19	0.75	-1.02	<b>-0.27</b>	0.00
PSDF	-1.11	-0.12	-0.91	<b>-0.25</b>	0.00
SPSS	1.10	1.08	1.09	<b>0.29</b>	0.00
SIK2	1.02	1.26	1.00	<b>0.27</b>	0.00
M2	13.79				
Ht	1489.45				
F	33.06				
DF1	32				
DF2	76				
P	0.0000				

(A = differences of means, D = discr. coefficients, S = standardized projections, R = structure function, P (an) = probabilities analysis of variance, M2 = Mahalanobis distance, Ht = Hotelling T test, F = f-test, DF1, 2 = degrees of freedom, P = probability)

What needs to be further explained in relation to the size of the ball is the scope of basketball for all official competitions of women 724-735 mm, because that obviously plays a tremendous role and is actually favored treatment and as a special dimension. Fourth Promax is pure transversal dimension as described with biacromial and bicristal range, that is shoulders and pelvis width associated with a measure of mass. Fifth Promax factor is a that fifth way to locate the effects of this treatment, represents a single factor (been described by a single variable) – described with throwing the ball from the chest. The answer of this effect is probably in the fact that it is if not the most, then certainly the optimal motion in basketball, which is in ball communication between

players by passing a ball on a middle or at a bigger distance. It is the structure of simplest, most logical action and provides enough power for throwing the ball, and also sufficient accuracy and is certainly good enough reason why this effect is achieved in this way. So the recapitulation in the area of quantitative effects can be summarized as follows: Treatment caused such effects that can be treated in five different directions. We are talking about the directions in which of these five lines of the development going on. There are integrated and affect genetic base and normal biological growth and development characteristics of children and were going in 5 of these routes. Results based on the indicators in Table 2 shows that under the influence of treatment in a sample student there have been many quantitative changes. The structure of discriminative function noticeable shows two sets of variables affected. First set all belong to morphological area and are of the order of magnitude of 0.50 - 0.60 and are in fact critical to the description of the overall changes. So morphological variables or rather a more or less natural growth and development may be supported with exercise in essence growth and development. All other variables are the motor and belong to another block and with order app. Of 0.20 - 0.30, and such of their projections on the discriminant function actually moderate magnitude, it does not mean they are not important, therefore, contribute significantly to the overall change but individually less for the entire an order of magnitude less than morphology. In all this, most important are the two variables in the morphological space. First one is mass, which naturally increases when the body height increases. Second – longitudinal dimension where it is quite certain that the rapid growth and development is very likely to produce a relative mass loss and the relative weight in this context. Motor variable throwing the ball from a chest, whose position has caused a marked specificity, is very likely situational in terms of specific motor or situational tests, such as basketball, which means it possesses a particular specificity that can look for genetic reasons, for reasons of history, human development, and who knows how all the girls might like these, and certainly belong to the closest specifics of basketball as a game and not be ruled out that it is so important motion in basketball that it just all students had to learn. Translation coefficient, i.e., displacement of individual variables, shows that the most obvious are the situational variables and the same situation is with the coefficients of expansion (dispersion). In the example variables results shows the shift of about 125%, which means that the whole group was more accurate. However, not all pupils are equally advanced and therefore dilation increased significantly (2.66) compared to the first measurement. Therefore, those students who were initially better, are more advanced, and the difference between them and those poorer increased. This means that within the overall sample there is a distinct ability to adapt to the applied specific basketball assignments and hence different final levels of achievement.

Table 3. Analysis of translation and dilation

	MEAN-1	MEAN-2	DELTA	TL	VAR-1	VAR-2	DT
AVIT	159.90	161.18	1.27	1.01	39.27	37.78	0.98
AMAS	48.73	49.17	0.44	1.01	110.94	109.03	0.99
ADUN	91.94	92.47	0.53	1.01	18.78	18.58	0.99
ADUR	69.86	70.20	0.34	1.00	11.64	11.54	1.00
ABAK	34.56	34.79	0.23	1.01	3.58	3.64	1.01
ABIK	26.37	26.58	0.21	1.01	4.92	4.92	1.00
ARRU	160.33	161.58	1.26	1.01	51.61	50.63	0.99
ADSA	18.39	18.51	0.12	1.01	1.37	1.37	1.00
ASSA	7.84	7.91	0.08	1.01	0.19	0.20	1.02
ADST	24.12	24.29	0.17	1.01	1.46	1.47	1.00
M20V	4.34	4.08	-0.26	0.94	0.07	0.11	1.24
MSVM	25.23	29.02	3.79	1.15	18.55	33.69	1.35
MSVZ	26.25	30.32	4.08	1.16	23.51	42.00	1.34
MTAN	39.40	41.35	1.95	1.05	11.76	14.65	1.12
MTUP	27.72	26.63	-1.09	0.96	5.61	7.46	1.15
MKUS	11.13	10.55	-0.59	0.95	0.89	1.31	1.21
MTAR	35.85	37.51	1.66	1.05	12.72	20.41	1.27
MPRK	39.86	41.81	1.95	1.05	52.42	57.43	1.05
MSDM	158.96	166.13	7.17	1.05	274.34	425.05	1.24
MPTL	16.31	18.81	2.50	1.15	11.81	16.02	1.16
MDIN	22.22	25.22	3.01	1.14	21.07	30.33	1.20
MSAT	33.69	42.19	8.50	1.25	90.96	224.00	1.57
OLT2	20.81	24.31	3.50	1.17	10.69	16.17	1.23
OLTC	21.20	24.65	3.45	1.16	9.59	16.37	1.31
BKLF	7.09	7.76	0.67	1.10	0.95	1.38	1.20
BKLG	83.96	94.76	10.79	1.13	128.16	296.38	1.52
KOS2	14.45	15.80	1.34	1.09	1.76	3.33	1.37
KPS2	4.00	4.43	0.42	1.11	0.08	0.23	1.70
SDFP	19.78	18.59	-1.19	0.94	4.61	7.00	1.23
PSDF	20.21	19.11	-1.11	0.95	1.73	3.62	1.45
SPSS	0.88	1.98	1.10	2.25	0.20	1.40	2.66
SIK2	1.12	2.15	1.02	1.91	0.22	1.31	2.43

(MEAN-1, 2 = means, DELTA = difference TL = coefficient of translation, VAR1, 2 = variance, DT = coefficient of expansion, marked changes greater than 10%)

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In general, and translation and dilation achieved mainly in the specific motor skills, which is the aim of the treatment was rudimentary. The significance of this research is the modeling and structuring of different programs working with younger age categories in basketball, especially with the age of 12-14 years in modern basketball require the most serious, the most thorough and most professional approach. Results of this study will serve coaches in dealing with this same age selection of basketball in solving important problems that impose daily. The results obtained in this study can be used, except for such purposes as other similar comparisons of researching.

## Conclusion

In the area of quantitative changes in the morphological characteristics, basic motor-skills and situational-motor abilities were obtained five factors difference, which means that the treatment caused changes in up to 5 lines, which can be identified in quantitative terms. Obliquely rotated factors show that the total treatment caused five different effects. Quarterly basketball program led to a positive transformation in almost all the morphological characteristics and the basic - motor skills and situational- motor abilities - accordingly accepted hypothesis H , H-1 , H-2 , H-3.

## ODREĐIVANJE KVANTITATIVNIH PROMJENA PROGRAMIRANOG RADA S POLAZNICAMA ŠKOLE KOŠARKE

### **Sažetak**

Osnovna svrha ovog rada jeste da pruži skroman doprinos u spoznaji promjena koje se dešavaju kod učenica osnovne škole (12 - 14 godina), pod utjecajem treninga u školi košarke, a koje su pored toga obuhvaćene i redovnom nastavom tjelesnog i zdravstvenog odgoja. Ovo istraživanje predstavlja pokušaj utvrđivanja kvantitativnih promjena u prostoru nekih morfoloških karakteristika, bazično - motoričkih i situaciono - motoričkih sposobnosti pod utjecajem tromjesečnog programa košarke.

**Ključne riječi:** transformacije, morfologija, motorika, kvantitativne promjene

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## THE ANALYSIS OF THE RESULT DIFFERENCES IN THE TIME SEGMENTS OF A HANDBALL MATCH FOR YOUNG FEMALE HANDBALL PLAYERS

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### Abstract

The aim of the research has been to establish the differences between the results performed in particular time segments of a handball match (10 minute quarters) by comparing the winning and the losing teams at the 2012 National Championship for young female handball players (under 16). Situational parameters, defined as a partial result increase in particular periods of matches, and the result differences, recorded at the end of each quarter, have been included in the analysis, all being gathered at the final games of the Croatian Championship for young female handball players (under 16) in the 2011/2012 season. Analysis of variance and Mann-Whitney U-test have been applied to determine the differences, and the results of both showed that the winning and the losing team differ in all four observed segments of the handball match, in respect to the partial result increase, as well as regarding the result differences at the end of each quarter.

**Key words:** handball, female, situational efficiency, match periods, Croatian championship

### Introduction

Some objective indicators of the actual quality of the particular male or female players, as well as the handball teams in the whole, may be presented by monitoring and registering the realization of the specific elements of the technique or tactics performed in situational conditions that is, in a handball match. A handball match provides enough spatial and time conditions to show an individual's and a team's overall fitness within the frames of the handball game rules and regulations. The input-potential, with which opposing teams start their confrontation at a handball game, represents the resultant of the individual's/team's overall status within the field of anthropometric, motor, functional and other components of the anthropologic status. The upgrade is made up of the skills level within the field of the handball technique and tactics, which, connected with finding a solution in the particular segments of a handball game (attack or defence phase and transition from one phase to another) and other possible external factors, finally might be observed through quantitatively measurable indicator i.e. scoring a goal. According to the handball rules "the goal is scored when the entire ball has crossed the goal line completely, provided that no violation of the rules has been committed by the thrower, a teammate or a team official, before or during the throw." This event is caused by the numerous activities of the defending and the attacking players and a goalkeeper at the same time, it is the only event expressed by a numeric change of the result (Rogulj, 2009). A dynamics of the goal scoring at the time of interacting confrontation in a handball match differs from team to team, as it differs regarding the specific segments (periods) of the handball match. In numerous studies, a team situational efficiency is connected to establishing influence/ differences between the teams, in the context of analysing

registered standard situational efficiency parameters (success in shooting from different positions, assisting, technical mistakes, exclusions, blocks and other). The goal scoring, observed partially in specific segments of the handball matches, has, in some earlier research, referred to the dynamics of the goal scoring individually for each (winning/losing) team at the end of the divided time segments (quarters or sixths of the handball match), as well as to the research in question apply to the samples of the top senior male (Rogulj, Vuleta & Milanović, 2002; Vuleta et al., 2005; Gruić, Vuleta & Vrbik, 2007; Foretić, Rogulj & Burger, 2011) and female handball teams (Gruić, Vuleta & Ohnjec, 2006). Situational efficiency in younger age categories of male and female handball players has been significantly less studied in comparison to the senior teams of the different quality levels. The studies are mostly based on the statistic data gained at the top competitions (European and World Championships) for youths (Taborsky, 1999; Sevim, 2001; Krokhin, 2003; Grünanger & Köning, 2005; Hianik, 2007; Elias, 2009; Tuma et al., 2011) and for juniors (Taborsky, 1996; 1998; Taborsky et al., 2004, Neukum, 2009; Taskiran et al., 2007). An organised training programme includes as its constituent part a particular number of competitions, as a part of a general development of the young male and female handball players. Milanović, 2010 points out that it is not advisable to overstate with the numerous competitions for younger age groups, thus suggesting the referring value of 70 competitions for the young male and female handball players (18 year-olds). A currently valid competing system for female players under 16 in Croatia applies to the competitions at the national level, as well as to the competitions among counties.

According to the rules and regulations of the Croatian Handball Association in the First Croatian Handball League for girls under 16, the championship is played in two parts: the groups (3 regions: north, west and south) and the final competitions. The teams are classified in the competition finals according to their rank in the preliminary groups. The aim of this paper is to observe the situational effectiveness of the young female handball teams in regard to the goal scoring in particular segments of the match.

## Methods

The entity sample has consisted of 74 opponents in 37 matches of the final games at the Croatian Championship for girls under 16 (girls born 1996 and younger) in Čakovec that took place from 29<sup>th</sup> March to 1<sup>st</sup> April 2012. There were 38 matches played at the championship, however, considering the win/loss criterion, a tied match has not been included in the further analyses. The tournament was played according to both: a league and a cup system, meaning that the preliminary part was played according to the league system, and then, the teams ranked first and second in every preliminary group crossed-over in the semi-finals, the winning teams going into the finals and the losing one's playing for the third or fourth position. The teams ranked below the top two in the preliminary round groups, played one against

another to define the 5<sup>th</sup> to the 12<sup>th</sup> ranking position. The variables sample is represent by: a) *partial result increase* at different periods of the match that is the goals scored in four time periods - four handball match 10-minute intervals and b) *result difference*, in other words, the result between the scored and received goals, recorded at the end of a particular period of the match. The opposing teams in a match have been classified in categories *winning or losing teams*, according to the success at the end of the game. Central and dispersive parameters of the observed variables have been analysed within the frames of the descriptive statistics. The distribution normality of the specific results in every variable has been assessed by Kolmogorov-Smirnov test (K-S max d). The analysis of variance and the Mann-Whitney U-test have been applied to determine the differences in the particular time segments of the match (quarters), comparing the winning and the losing teams. Statistica for Windows/7.0 program has been used to analyse the collected data.

## Results

The Table 1 results show the basic descriptive and distribution parameters of the partial increase variables and the result differences, whereas the Tables 2 and 3 show the results of the differences between the winning and the losing teams for the variables observed.

Table 1. Descriptive and distribution parameters

varijabla	N	MEAN	Min	Max	S.D.	a <sub>3</sub>	a <sub>4</sub>	KS-d	KS-p
PRIRE 1	74	4,07	0,00	8,00	1,76	0,23	-0,68	0,15	p < ,10
PRIRE 2	74	4,89	1,00	10,00	2,01	0,11	-0,49	0,12	p > .20
PRIRE 3	74	4,84	1,00	9,00	2,13	0,18	-0,91	0,15	p < ,10
PRIRE 4	74	5,20	2,00	9,00	1,91	0,13	-0,63	0,11	p > .20
RAZ 1	74	0,00	-6,00	6,00	2,47	0,00	-0,41	0,14	p < ,10
RAZ 2	74	0,00	-6,00	6,00	2,82	0,00	-0,43	0,08	p > .20
RAZ 3	74	0,00	-6,00	6,00	3,15	0,00	-0,93	0,09	p > .20
RAZ 4	74	0,00	-6,00	6,00	2,44	0,00	-0,12	0,12	p > .20
REZ/RAZ	74	0,00	-14,00	14,00	6,96	0,00	-0,44	0,06	p > .20
GOLOVI	74	19,00	10,00	30,00	4,95	0,46	-0,64	0,14	p < ,10

(N – number of cases; AS – arithmetic mean; Min – minimum; Max – maximum; S.D – standard deviation; a<sub>3</sub> – skewness; a<sub>4</sub> – kurtosis; KS-d – maximum distance between the theoretical cumulative relative frequency /normal/ and relative cumulative empirical frequency /obtained by measurement/.; KS-p – value of significance)

Table 2. Analysis of variance and the Mann-Whitney U test regarding the result increase

variable	mean winning	mean losing	F	p	Z	p
PRIRE 1	4.84	3.30	17.30	0.00	3.80	0.00
PRIRE 2	5.43	4.35	5.69	0.02	2.36	0.02
PRIRE 3	5.70	3.97	14.51	0.00	3.63	0.00
PRIRE 4	5.81	4.59	8.26	0.01	2.52	0.01

(AS – arithmetic mean, F- F- value of F-test, p- value of significance threshold of F-test, Z – z value, p – value of significance threshold for z value)

The analysis of variance and Mann-Whitney U test results point at the statistically significant differences between the winning and the losing teams considering the result increase in all four time periods of the match.

Table 3 Univariate variable analysis and the Mann-Whitney U test regarding the result differences

Variable	Mean winning	Mean losing	F	p	Z	p
RAZ 1	1.54	-1.54	37.16	0.00	4.97	0.00
RAZ 2	1.08	-1.08	12.62	0.00	3.29	0.00
RAZ 3	1.73	-1.73	31.72	0.00	4.73	0.00
RAZ 4	1.22	-1.22	24.28	0.01	4.26	0.00

(AS – arithmetic mean, F- F- value of F-test, p- value of significance threshold of F-test, Z – z value, p – value of significance threshold for z value)

The analysis of variance and Mann-Whitney U test results point at the statistically significant differences between the winning and the losing teams considering the result differences in all four time periods of the match.



## Discussion

At the Croatian Championship for young female handball players aged 14-16, which took place in Čakovec in 2012, there were on the average 38 goals scored per match in total, and there were approximately 8 (8,14) goals scored in the first quarter and about 10 in the second (9,78), third (9,68) and in the last quarter of the match (10,41). From the total number of the goals scored in the complete match, the least were scored in the first, whereas the most in the last ten minutes of the matches. Almost equal realisation efficiency has been recorded at end of the first and at the beginning of the second half of the match.

There were the most goals scored in the last quarters of the matches, probably due to the weakening of the confronting opponents' influence in the later phases of the match (Rogulj, 2009), while there were the least goals scored in the first quarter, because of the possible stress conditions of the competition (opening of the game) as well as the consequence of the strongest confronting opponent in the initial phases of the match. There was almost an equal number of goals scored in the second and third quarter, which might be explained with the adaptation of the organism and the tactics plan to the opponents.

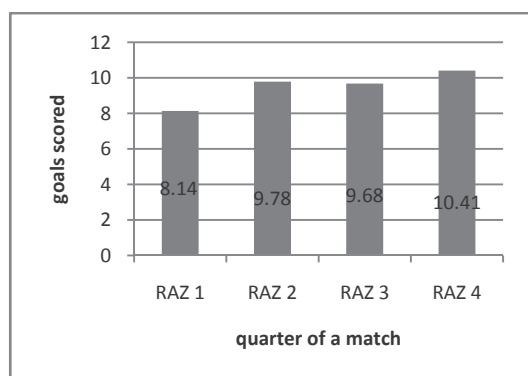


Figure 1 The goals scored in each quarter of the matches

The finals contestants of the young female handball players U16 competition sometimes ended the first quarters without scoring any goals, while there was a minimum of 1 or 2 (Table 1) goals scored in other parts of the match. The inexperience in taking part in the most important competition at the developmental stages of their sport careers, in connection to which there are some other psychological elements (nervousness, insecurity, level of confidence, etc.) of the girls under 16, may be the factors of handball elements performance inefficiency, and thereby of the poor attacking effectiveness. The winning teams of the young female handball players U 16 score on average about 22 goals in the finals of the national championship, whereas the number of goals scored by the losing teams amounts approximately 16 per match. The winning teams score on average approximately 6 goals more than the losing ones.

An interesting fact has been occurring at the younger age category Croatian handball events: the girls leaving the younger age categories (the girls of 17 and 18), who compete in the next season as seniors, have been scoring the same number of goals in their category in the finals of the national championship. The above said suggests the conclusion that the similar realisation efficiency of the girls U16 and U18 is defined by directing the training process, in the younger age categories, from the technically-tactical operation, towards the trends set by the senior teams. In this connection, it is necessary to point out the respect for the total working load, that is, energetic and informational component of the working load, which differs at the younger and senior age. The other possible factor of the high total result efficiency achieved by the younger categories, might as well be, the approach to, and the idea of the game in the defence phase. Namely, there is the assumption that, in younger age categories, there is no motivation factor and no attention focus factor, that is, there is no concentration on the execution of that specific phase of the handball game, required to improve the execution of the specific defensive elements (individual, collective and group), due to an inadequately developed conscience of the importance of the phase in question. The goal scoring, in other words, being focused on the finalising the attack by a shot at a goal is, nevertheless, an actually materialized, indisputable performance indicator to the players as it is to the other participants of the matches (parents and others). Very often are the team manager's instructions directed exactly on the attacking efficacy, which only supports the hypothesis made earlier.

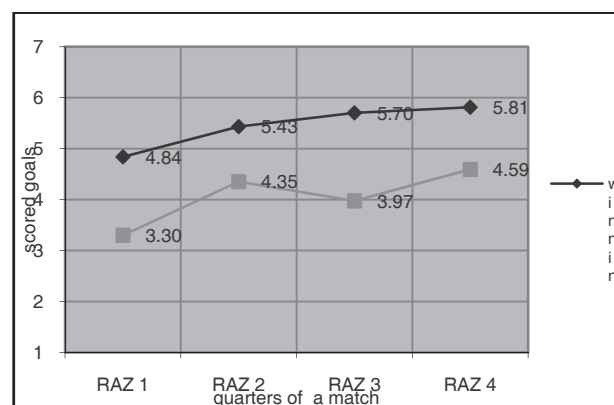


Figure 2 Goal scoring progression in the quarters of the match by winning and losing teams

The winning teams on average score more goals in every period, where from the partial increase of the result differences in each time segment becomes evident (1,54; 1,08; 1,73; 1,22), and they both represent the final result efficiency factors. There have been noticed the greatest differences between the goals scored in the third quarter, that is, in the first ten minutes of the second half of the game, which probably mostly influenced forming of the final result in favour of the winning teams.

The final result of the handball matches in the finals of the Croatian National Championship for young female handball players U16 that took place in Čakovec in 2012 is defined by the goal scoring dynamics in every period of the match. Although the majority of the goals were scored in the third time interval of the match, the results of the winning and losing team difference analysis show that the final success was being built up from the beginning, to the end of the game (Gruić, Vuleta and Ohnjec, 2006). In the first period of the match, the winning teams scored more goals than the losing ones. It is possible that in the opening of the match, the greater experience of the winning teams, based on participating in more important contests as well as taking part in senior training and competing process, is reflected on the efficacy itself. At the same time, the positively selected players of the winning teams, evaluated in their clubs as the promising ones and in consistence to the above stated, enter the match with a less competition stress condition effect and complete more effectively the attacking phases of the game. The mentioned conditions are present throughout the match, and they are the most intense at the beginning, but however, diminish as the match progresses. It is possible that the presumed, in combination with the conditioning preparation enable the result control, in other words, the higher/lower level of preparedness, along with greater/smaller adaptation to stress conditions at the competition, generate the result difference between the opposed teams. The winning teams lay the foundations at the beginning of the halftime, which then they follow throughout it till the end; the losing teams follow the same approach, however, the result superiority achieved in the first ten minutes suffices for the final positive results, in favour of the winning teams.

The technically-tactical operation principle of the both teams shows no stronger oscillations, but it continuously follows what was set at the beginning of the match. There have been recorded the greatest differences in the number of the scored goals, between the winning and the losing teams in the resumption of the match (the third period) after a halftime break. On one hand, the break between the halftimes is sufficient for the players of the winning teams to regenerate and recuperate, so they continue their positive goal scoring trend. On the other, the lower level of condition training of the girls under 16 in the losing teams is manifested in the situational effectiveness field. It is necessary to point out that the winning teams have at least 3-4 players in their line-ups who carry the game play, and who can continuously successfully execute the technically-tactical aims set before them, whereas in the losing teams there is only one such player. The strain put on one player only, as a bearer of the team, has not caused any relevant oscillations in the game throughout the first half, but, due to the weariness and the tactic formation of the opposing winning teams, concentrated on stopping that very player, it has eventually led to the more prominent negative realisation.

Till the end of the match (the last ten minutes), both winning and losing teams score the most goals, because of the weakened activity of the opposed team, however, the winning teams only have to keep the advantage they made previously, which proves to be unattainable for the losing teams. The total realisation efficacy has also been defined by a possibly lower level of the goalkeeper's competence. It might be that they, when compared to the field players, stabilise their effectiveness later in their sport careers, and in some clubs, there is lacking an adequate continuous work directed toward specific goalkeeping trainings.

## Conclusion

The aim of this paper is to establish the differences between the results of the winning and the losing team in each time segment of a handball match (quarters lasting 10 minutes). Situational parameters defined as a partial result increase in particular periods of matches and the result differences recorded at the end of each period of the match, collected on the games played in the finals of the Croatian Female U16 Championship in 2011/0212 season. The analysis of variant and Mann-Whitney U test results imply the statistically significant differences between the winning and the losing teams in each for time intervals of the game.

The winning teams on average score more goals in every period, where from the partial increase of the result differences in each time segment becomes evident (1,54; 1,08; 1,73; 1,22), and they both represent the final result efficiency factors. The final result of the handball matches in the finals of the Croatian National Championship for girls U16 that took place in Čakovec in 2012 is defined by the goal scoring dynamics in every period of the match. Although the majority of the goals were scored in the third time interval of the match, the results of the winning and losing team difference analysis show that the final success was being built up from the beginning, to the end of the game (Gruić, Vuleta and Ohnjec, 2006). The young male and female handball players, detected and selected timely in the younger age categories, if included in an adequate training processes, might expect the top results in senior categories as well.

The results obtained in this research, with the emphasis on the total goals scored by the both winning and losing teams, and the final results of the individual matches, indicate that the basic working guidelines of the particular clubs follow the modern handball trends in the field of the general realisation efficacy, since the gained values do not differ significantly from the results of the senior female handball players. Simultaneously, the coaches of the younger age categories could use the obtained results as the orientation values, and especially the result values gained for every quarter individually might form the guidelines for the situational- tactic activities, when creating strategy for certain competitions.

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## ANALIZA RAZLIKA REZULTATA U VREMENSKIM SEGMENTIMA RUKOMETNE UTAKMICE ZA MLADE RUKOMETAIŠICE

### Sažetak

Cilj ovog istraživanja bio je utvrditi razlike između rezultata u pojedinim vremenskim segmentima rukometne utakmice (četvrtine trajanja 10 minuta) u odnosu na pobjedničke i poražene ekipe mlađih kadetkinja na rukometnom Prvenstvu Hrvatske 2012. godine. U analizu su uvršteni situacijski parametri definirani kao parcijalni prirast rezultata u pojedinim razdobljima utakmica te rezultatske razlike zabilježene na kraju pojedinih četvrtina, koji su prikupljeni na utakmicama završnice prvenstva Hrvatske za mlađe kadetkinje u natjecateljskoj 2011./2012. godini. Za utvrđivanje razlika primijenjena je analiza varijance i Mann-Whitnijev U-test čiji rezultati su pokazali da se pobjedničke i poražene ekipe razlikuju u sva četiri promatrana segmenta rukometne utakmice i u parcijalnim prirastima rezultata kao i u rezultatskim razlikama na kraju pojedinih četvrtina.

**Ključne riječi:** rukomet, djevojke, situacijska učinkovitost, periodi utakmice, prvenstvo Hrvatske

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## THE INFLUENCE OF MOTOR ABILITIES ON RESULTS OF SPORT GAMES POLYGON AT PHYSICAL EDUCATION CLASSES

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Original scientific paper

### Abstract

The aim was to determine the influence of motor abilities on results of sport games polygon performing, which consisted of basketball and football technical elements. 30 male fourth grade students of chronological age 10 years  $\pm$  6 months, involved in regular physical education classes participated in testing for this research. 10 motor tests were measured: Speed - 20 meters low start running, hand circling, foot circling, foot tapping and hand tapping; Coordination - figure "8" with bending, envelope test, side steps, jumping over the rope, coordination with the bat. Sport games polygon has been made of basketball and football technical elements, which were related to ball manipulation and situational-motor precision. Regression analysis was used in data processing, which showed a statistically significant influence of both motor dimensions (speed and coordination) that were tested in this study, on results of the sport games polygon. At the individual level, except for foot tapping, all speed tests showed a statistically significant influence on results of sport games polygon. In the case of coordination, only coordination with the bat had not statistically significant influence on results of sport games polygon.

**Key words:** sport games polygon, motor abilities, physical education classes

### Introduction

Polygon is one of the oldest forms of work organization in physical education, whose name was formed from two Greek words - poly (many) and agon (task). From the name itself it can be estimated the basic characteristics of this type of exercise, as a unique exercise with many tasks to be executed. This form of work organization is used for exercise implementation in complex conditions for training coordination skills of students, as well as a type of fitness exercise, for testing physical abilities, for competition, in recreational purposes, and also for training and evaluation of sport and technical knowledge (Zdanski, 1986; Višnjić et al., 2004). Application of this form of work provides great opportunities for physical education teacher in organization of classes in creative aspect. Very interesting and dynamic exercise/tasks can be designed that will be an integral part of the polygon, but at the same time very useful for development of physical fitness and improving of sport-technical education. The good side of the polygon is the fact that efficiently organized exercise may be conducted in a small space for a large number of children, and also a teacher of physical education is not limited by need for standardized objects and accessories, age and gender of students, season and type of playground that is available. Of course, it should be mentioned the weaknesses of such an organization, related to a reduced ability to control and keep the students during tasks performing, so it can result with injury. On the other hand, the desire of each student to complete his tasks as soon as possible frequently leads to an irregular performance of polygon elements and thus to losing of exercise meaning.

Tasks are performed without a break, because the student is constantly moving from obstacle to obstacle, overcoming them with higher or lower speed. The formation of the obstacles in polygon primarily depends on the primary goal of using this work form. A polygon with obstacles can be consisted of a larger or smaller number of obstacles, in other words exercises, which primarily depends on age and number of students involved in exercising process, but also on available space, equipment and accessories. The task schedule in a polygon can be in the form of a semi-circle, circle, square, rectangle, ellipse, eights, straight or dashed zig-zag lines, etc. On the occasion of forming the polygon it should take into account the choice of place, defining the term, the number of obstacles, device layout, the order of tasks, their distance, etc. Distance between each obstacle and their order are primarily determined by the specific material and spatial conditions. This form of work, at easier form, can also be used in the introductory phase of the class, except in the main one (Branković & Dragić, 2007). There are different types of polygons in the practice of teaching. The divisions can be made (Višnjić et al., 2004):

- according to made method: natural, artificial and combined;
- according to purpose: for movement improving, physical fitness improving, physical fitness testing, competitive, recreational and humorous
- according to the type of physical exercise that dominates: gymnastic polygon, athletic polygon, sport games polygon and mixed polygon;
- according to the number of tracks: one-track polygon and multi-track polygon (spaghetti).



For the purposes of this study sport games polygon was selected, which consisted of two sport games (basketball and football) in which ball manipulation and situational-motor precision were analyzed. With pre-testing of some basic motor skills (speed and coordination), the interest was directed to the fact which abilities of students are the most affected to the results achieved on sport games polygon.

## Methods

30 male fourth grade students of chronological age 10 years  $\pm$  6 months, involved in regular physical education classes participated in testing for this research. The aim was to determine the influence of motor abilities on results of sport games polygon performing, which consisted of basketball and football technical elements.

10 motorical tests were measured:

### Speed

- 20 meters low start running (TR20),
- Hand circling (KRUZR)
- Foot circling (KRUZN),
- Foot tapping (TAPN)
- Hand tapping (TAPR).

### Coordination

- Figure "8" with bending (OSMSS)
- Envelope test (KOVER)
- Side steps (KORUS),
- Jumping over the rope (VIJAC)
- Coordination with the bat (PALIC)

Regression analysis was used in data processing.

Sport games polygon (figure 1) - was made up of basketball and football technical elements, which were related to ball manipulation and situational-motor precision: curved (slalom) and straight line dribble of football, vertical target precision of football, curved (slalom) and straight line dribble of basketball, horizontal target precision of basketball.

### Description of exercise at sport games polygon:

From point A, which represents the starting position, a 10 meters curved line movement (slalom) around the cones with football is performing. After that, straight line movement is continuing to the next cone at 10 meters distance, going around it and returning the same route and type of movement to the point A, shooting from it to a small football goal of 1.5x0.5 meters dimensions. Movement without the ball is performing to point B, first basketball is being taken from the hoop and shooting at the basket at 5 meters distance.

After that, the second basketball is being taken from the hoop and curved line movement around the cones is performing, as well as straight line movement to point C shooting from it to a basket score. Basketball is being taken again, and it is returning the same route and type of movement to the point B which represents finish. For every failure or incorrect assignment was made, the total time is subtracted by one second.

## Results

Table 1 Regression analysis of speed and sport games polygon

	Ro	Ro <sup>2</sup>	F-test	Q
	.46	.21	9.09	.000
Speed tests	R	Part-R	t	Q
TR20	.68	.46	5.11	.000
KRUŽR	.34	.30	3.08	.003
KRUŽN	.33	.31	3.15	.002
TAPN	.15	.16	1.63	.107
TAPR	.33	.41	4.41	.000

Influence of speed as predictor system on criterion variable of sport games polygon is shown in table 1 as influence of the whole predictor system, but also the influence of its individual variables. The value of the multiple correlation coefficient is  $R_o = .46$ , indicating that there is a strong connection between predictor variables and the criterion. The statistical significance of this connection is  $Q = .000$ , and 21% is common variance, as evidenced by the determination coefficient  $R_o^2 = .21$ . The remaining 79% is attributed to other anthropological characteristics and abilities. Individual variables through their correlation coefficients (R) and partial correlations (Part-R) are showing the level of connection with the criterion variable, and thus a statistically significant connection is at: 20 meters low start running (TR20 -  $R = .68$ ,  $R = \text{Part-.46}$ ), hand circling (KRUZR -  $R = .34$ ,  $\text{Part } R = .30$ ), foot circling (KRUZN -  $R = .33$ ,  $\text{Part } R = .31$ ) and hand tapping (TAPR -  $R = .33$ ,  $\text{Part-R} = .41$ ). Significance of partial regression coefficients (Q) confirms the current connection: 20 meters low start running (TR20 .000), hand circling (KRUZR .003), foot circling (KRUZN .002) and hand tapping (TAPR .000). Test foot tapping (TAPN) showed no statistically significant influence on results of the sport games polygon.

Table 2 Regression analysis of coordination and sport games polygon

	Ro	Ro <sup>2</sup>	F-test	Q
	.82	.67	21.24	.000
Coordination tests	R	Part-R	t	Q
OSMSS	-.21	-.26	-2.62	.010
KOVER	.94	.86	16.79	.000
KORUS	-.54	-.36	-3.78	.000
VIJAC	-.28	-.27	-2.78	.007
PALIC	.16	.18	1.79	.076

In the case of influence of coordination on results of the sport games polygon (table 2), coefficient of multiple correlation is  $R_o = .82$ , which indicates a very strong connection between predictor variables and the criterion. The statistical significance of this connection is  $Q = .000$ .

On the bases of the value of determination coefficient  $R^2 = .67$ , it can be said that the common variance is 67%. The correlation coefficient (R) and partial correlations (R-Part) at the individual level suggest that a statistically significant connection is at following tests: figure "8" with bending (OSMSS -  $R = -.21$ , Part-R =  $-.26$ ), envelope test (KOVER -  $R = .94$ , Part R =  $.86$ ), side steps (KORUS -  $R = -.54$ , Part-R =  $-.36$ ) and jumping over the rope (VIJAC -  $R = -.28$ ,  $R = \text{Part-} -.27$ ). Significance of partial regression coefficients (Q): figure "8" with bending (OSMSS  $.010$ ), envelope test (KOVER  $.000$ ), side steps (KORUS  $.000$ ) and jumping over the rope (VIJAC  $.007$ ). Coordination with the bat (PALIC) showed no statistically significant influence on results of the sport games polygon.

### Discussion and conclusion

Sport-technical education is one of the subject areas of physical education besides development of physical skills and linking physical education with life and work. Sport technique consists of large number of motor programs that are necessary for performance of the movement structure. It takes a long process of learning motor structures to achieve a certain level of technique acquisition. Only at that point, based on highly developed motor skills, technical preparedness allows the student to purposefully manage his own body movements during the performance of dynamic stereotypes in some particular sport. Learned stereotypes of movement allows repetition of motion in the same or changeable conditions. Essentially, technique is the result of large number of repetitions to the occurrence of reflex activity

level in specific activity (Branković & Dragić, 2007). There are large number of sport techniques: basic sports (gymnastics, athletics, swimming) sport games (volleyball, basketball, soccer and volleyball) at physical education classes. In adopting a specific movement structures it is necessary to perform large number of repetitions to form a habit. The main task teachers are facing with is how to create the conditions for performing as many repetitions as it could in time limit of 45 minutes. This can be done by increasing the number of equipment, number of classes for particular subject matter, and using an appropriate organizational form of work that will largely help the adoption of sport techniques and to show which motor skills they are in greatest relation with. The organizational form of work - polygon is used in teaching practice, as already mentioned, for different purposes and with different contents. There are studies in which the polygons determined the level of physical ability in preschool children (Veselinović, Milenković & Jorgić, 2009), younger school children (Milanović, 2007; Žuvela, Božanić & Miletić, 2011), then sport games polygon were the contents of researches with high school age (Dzajic & Kuna, 2012), as well as comprehensive polygons in faculty teaching with students of physical education (Obradović, Korovljević & Pantović, 2009; Obradović, Pantović & Korovljević, 2009). In this study, polygon was consisted of technical elements of basketball and football, involving ball manipulation and situational-motor precision. The connection of these elements with different dimensions of motor abilities, namely, speed and coordination was searched. Therefore, it can be concluded that both dimensions have statistically significant effects on technical elements of sport games, at multivariate level as well as at individual level of most individual tests.

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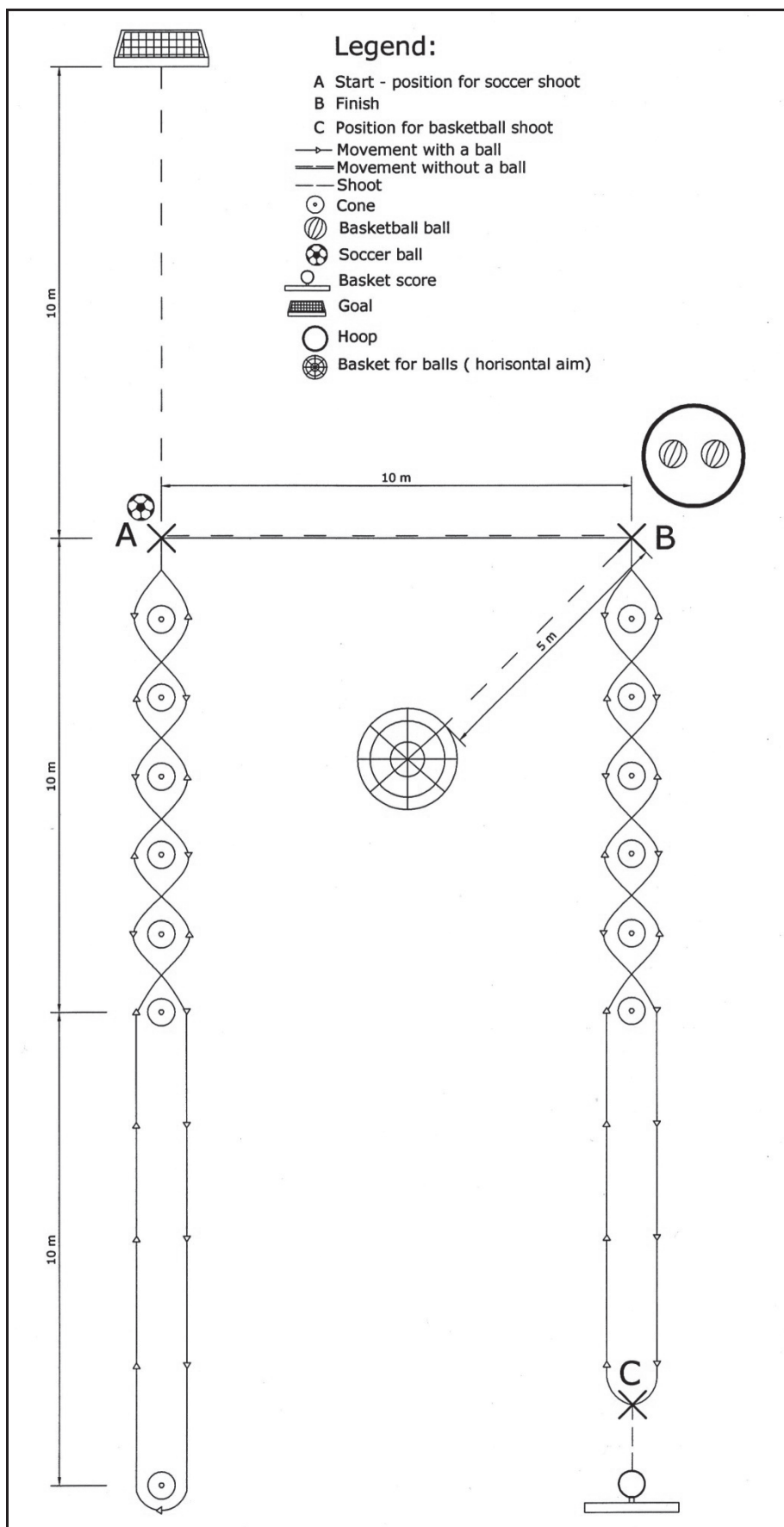


Figure 1 Sport games polygon

## UTJECAJ MOTORIČKIH SPOSOBNOSTI NA REZULTATE POLIGONA SPORTSKIH IGARA NA NASTAVI TJELESNOG I ZDRAVSTVENOG ODGOJA

### Sažetak

*Cilj istraživanja bio je utvrđivanje utjecaja motoričkih sposobnosti na rezultate poligona sportskih igara. U testiranju je sudjelovalo 30 učenika četvrtog razreda osnovne škole, kronološke starosti 10 godina  $\pm$ 6 mjeseci, muškog spola, obuhvaćenih redovnom nastavom tjelesnog vježbanja u školi. Izmjereno je 10 testova za procjenu motoričkih sposobnosti: Brzina – trčanje na 20 metara iz niskog starta, kruženje rukom, kruženje nogom, taping nogom i taping rukom; Koordinacija – osmica sa sagibanjem, koverta test, koraci u stranu, preskakanje horizontalne vijače, koordinacija s palicom. Poligon sportskih igara bio je sastavljen od tehničkih elemenata iz košarke i nogometa koji su se odnosili na manipulaciju loptom i situacijsko-motoričku preciznost. U obradi podataka korištena je regresijska analiza koja je pokazala postojanje statistički značajnog utjecaja obje motoričke dimenzije (brzina i koordinacija) koje su testirane u ovom istraživanju na rezultate poligona sportskih igara. Na pojedinačnoj razini, osim testa taping nogom, svi testovi brzine pokazali su statistički značajan utjecaj na rezultate poligona sportskih igara. U slučaju prostora koordinacije, jedino test koordinacije sa palicom nema statistički značajan utjecaj na rezultate poligona sportskih igara.*

**Ključne riječi:** *poligon sportskih igara, motoričke sposobnosti, nastava tjelesnog i zdravstvenog odgoja*

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## RELATIONS BETWEEN COMPETITIVE ANXIETY AND SELF-CONFIDENCE STATES AND SITUATIONAL ACHIEVEMENT OF ELITE EUROPEAN JUNIOR FEMALE VOLLEYBALL PLAYERS

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Original scientific paper

### Abstract

Four volleyball teams (N=48) filled the Revised Competitive State Anxiety Inventory – 2 (CSAI-2R) by Cox, Martens and Russel (2003), used in measuring somatic and cognitive anxiety and self-confidence. The questionnaire was filled immediately before the teams played their first match at the European junior championship, with the aim of determining does the pre-competitive anxiety influence the situational success in elite junior female volleyball players. Application of one-way ANOVA and Scheffe post-hoc test revealed the existence of significant differences in the state anxiety components in elite junior teams with different group placement at the European volleyball championship. The players of more successful teams showed lower levels of somatic and cognitive anxiety than the players of less successful teams. The findings of this research partially support the findings present in the literature, but nevertheless, further research on anxiety and competitive success is recommended.

**Key words:** anxiety, self-confidence, situational efficacy, CSAI-2R

### Introduction

The study of emotions in sport is important because emotions influence the performance and give important information about the relation of an athlete and its surroundings. This information can help in better understanding of an athlete and in creating a program of certain athletes' performance improvement. Anxiety is a complex emotion with numerous intellectual, physiological and "behavioural" symptoms, often related to stress or excitement. Stress is an untypical reaction of a body to a demand set before it (Selye, 1983, according to Cox, 2005). The quality of an athlete's performance often depends on his excitement (Cox, 2005). Anxiety is related to increase of excitement. A moderate level of anxiety results in nervousness, worry and tension, while high level of anxiety results in intensive notion of fear, catastrophic thoughts and strong physiological excitement. Trait anxiety differs from state anxiety.

State anxiety or competitive anxiety is a characteristic that has drawn the most scientists' and experts' attention in the psychology of sport. The multidimensional anxiety theory resulted in numerous measuring questionnaires, and CSAI-2 by Martens, Vealey, Burton, Bump and Smith (1990) is a very well known and often used questionnaire. It measures the cognitive anxiety, as a mental component caused by fear of negative social evaluation, and fear of failure and loss of self-esteem. The somatic anxiety is a physical anxiety component, causing physiological reactions (rapid heartbeat, accelerated breathing and muscle tension). The authors introduced the third factor, called "individual self-confidence difference factor". Self-confidence is defined as a belief of an individual that he can cope with the challenges set before him.

Regarding the time of anxiety measuring, the authors determined the highest relation between anxiety and sport performance was half an hour before the competition (shorter and longer time distance resulted in relation decreases). Craft et al. (2004), using the sample of 29 research (meta analysis) that studied the relation between the cognitive and somatic anxiety and self-confidence on one side and sport performance on the other side, did not found the significant relation of cognitive anxiety and sport performance, while the relation between somatic anxiety and sport performance was low, negative and was not statistically significant. Woodman and Hardy (2003), performing the meta-analysis of 48 research, analysed the relation of anxiety and self-confidence cognitive component with sport performance. Cognitive anxiety had significantly higher negative influence onto the sport performance in male athletes in relation to female athletes, and also a negative influence of the component was significantly higher in higher quality and important competitions. Self-confidence had significantly higher positive influence onto the sports performance in male athletes and in higher quality level competitions. Volleyball is characterised by actions performed at high speeds. In jump serve the time of ball flight is 0.7-0.9 sec (Janković, 1995). The reaction possibilities are very low, and the fear of errors due to expectations is increasing. Kais (2005) researched the relation between certain anxiety components and their direction and the situational success of sand volleyball. The groups of more and less successful sand volleyball players did not differ in the levels of somatic anxiety. Variance analysis revealed that sand volleyball players of higher quality had significantly lower level of cognitive anxiety and



significantly more self-confidence. Besides, elite volleyball players took anxiety as something stimulating, and less successful as a hindering factor of their play. The aim of this research was to ascertain does the pre-competitive state of anxiety influence the situational success in elite junior volleyball players.

## Methods

The subject sample consisted of 48 volleyball junior female players from four European representations (Croatia, Poland, Serbia and France), participating at the 2008 European Junior Volleyball Championship. The measuring of the psychological characteristics of the examinees (states of anxiety and self-confidence) was conducted by applying the *Revised Competitive State Anxiety Inventory - 2* (CSAI-2R) by Cox, Martens and Russel (2003), consisting of 17 items, measuring: *somatic anxiety*; *cognitive anxiety* and *confidence*. From 17 questionnaire items in total, 7 items measured the somatic anxiety component and 5 items measured cognitive anxiety component and self-confidence. For this research, the questionnaire was first translated into Croatian, Serbian, and the existing French (Martinent, Ferrand i Guillet, 2007; Martinent, Ferrand, Guillet i Gauthier, 2010) and Polish (Borek-Chudek, 2007) questionnaire versions were applied. The anxiety and self-confidence were measured 60 minutes before the first championship match. The situational success of a certain team is estimated by their placement in the group after all the matches played. All the measured teams played in the same group, and it is important to remark that a team played with all the remaining teams in the group. The descriptive indicators of variables were calculated in order to process the collected data. The correlation analysis determined the levels of relation between the certain anxiety and self-confidence components, and the univariate variance analysis determined the difference significance in the anxiety components, regarding the situational success – team group placement.

## Results and discussion

The calculation of the basic descriptive parameters, as well as the indicators of measuring instruments sensitivity, was achieved by application of the questionnaire onto the four junior female teams. The conclusion, based on the data shown in table 1, was that all of the variables of CSAI-2R questionnaire had high sensitivity, because their result distribution did not significantly differ from the normal distribution. Elite young volleyball players had equal average level of cognitive and somatic pre-competitive anxiety state (1.95), calculated by dividing the average value of a certain scale by the number of particles of the same scale. This finding was in concordance with the one by Martens et al. (1990), conducted approximately one hour before the match. Self-confidence of the examinees was medium high, since the average value was 3.12, and the max. possible range of results was from 1.00 to 4.00.

Table 1 Descriptive characteristics of the CSAI-2R scales

VARIABLE	Somatic	Cognitive	Self
M	13.67	9.77	15.58
SD	4.66	3.10	2.36
of items	1.95	1.95	3.12
(K-S test)	0.15	0.11	0.13
MIN	7	5	8
MAX	25	16	20
SKEW	0.55	0.17	-0.58
KURT	-0.61	-0.99	1.15

Legend: M – mean; SD – standard deviation; D (K-S test) – coefficient of the Kolmogorov-Smirnov test; MIN – minimum result; MAX – maximum result; SKEW – measure of distribution asymmetry; KURT – measure of distribution shape

However, all of these findings were determined using the total sample of the examinees, and it was necessary to additionally ascertain did the players differ by the expressiveness of their psychological characteristics regarding their situational effectiveness at this championship.

Table 2 Correlations of the CSAI-2R scales

VARIABLE	Somatic anxiety	Cognitive anxiety	Self confidence
Somatic anxiety	1.00	* 0.71	* -0.39
Cognitive anxiety	* 0.71	1.00	* -0.53
Self confidence	* -0.39	* -0.53	1.00

Legend: \* - statistically significant coefficient of correlation

The table 2 shows the relation between the measured variables. A high positive correlation was determined between the two anxiety components (0.71), while the level of negative relation of cognitive anxiety and self-confidence was medium high (-0.53). The ascertained negative correlation between the self-confidence and cognitive anxiety was expected and understandable. Namely, self-confidence is all about the belief of the player in the achievement of sport success (Vealey, 2001), and it was expected that an individual, if his level of self-confidence prior to the match was low, would develop a higher degree of cognitive anxiety, directly related to the uncertainty of realising the successful sport result at the match. Further on, a high positive correlation between the cognitive and somatic anxiety indicated the possibility of a mutual latent base in this research, and it is recommended to ascertain the factor structure of the CSAI-2R questionnaire in the following research. Based on the results of the conducted variance analysis for determining the difference between the groups of female players in different situational success, the success of the placement of their teams inside a group at the junior Europe championship, express of the anxiety and self-confidence states, it is possible to conclude that the groups of players significantly differed in all the measured variables, regarding the final group placement.

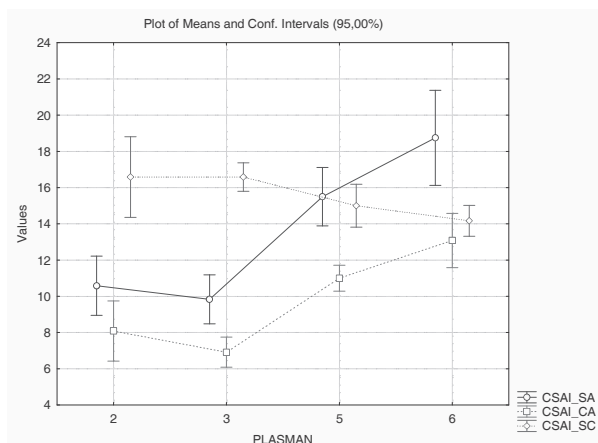
Table 3 Differences of the CSAI-2R results according to the situational team efficacy

VARIABLE	Results of Anova	
	F	p
Somatic anxiety	24.62	0
Cognitive anxiety	24.49	0
Self confidence	3.65	0.02

Legend: F – coefficient of one-way analysis of variance; p – level of statistical significance of the coefficients.

The most pronounced differences were in the two anxiety components (coefficient of statistic difference significance of both measures was  $p=0.000$  in both groups), and it was found somewhat lower for the self-confidence variable ( $p=0.02$ ). The ascertained differences between the teams of different placement are graphically represented in figure 1.

Figure 1 Display of the average results of groups of players (teams) with different situational success



Legend: CSAI\_SA – somatic anxiety; CSAI\_CA – cognitive anxiety; CSAI\_SC – self-confidence.

The graphic display clearly shows the previously determined differences between the groups of representative female volleyball players (teams), second-ranked and third-ranked, in relation to those groups of players (teams) who were next-to-last and last team of the group. The players of two successful teams had very similar results on the psychological characteristics scale, while there were certain less significant differences in the players of the two less successful teams. The fact ascertained in detail in this graphic representation, referring to the previously determined findings regarding the identical expression of the somatic and cognitive component of players` anxiety (shown in table 1) in the complete sample is the fact that the identical values of somatic and cognitive anxiety in the total sample are a product of significantly different expressions of different teams players` anxiety components, the average value of the lower degree anxiety of the more successful teams and higher degree of anxiety in the less successful teams. To ascertain in detail the differences in individual groups of players with different situational success, a *post-hoc* analysis was conducted, using the Scheffe test.

The determined differences of the difference coefficient statistical significance are shown in tables 4 to 6.

Table 4 Statistical significance levels of somatic anxiety difference coefficients

Team placement	2	3	5	6
2		0.94	0.00	0.00
3	0.94		0.00	0.00
5	0.00	0.00		0.08
6	0.00	0.00	0.08	

Table 4 shows the significant difference between the two successful teams and the less successful ones in the degree of somatic anxiety. The players of the successful teams showed significantly lower level of somatic anxiety than the players of less successful teams, and the ascertained differences were very notable (all the statistic significance difference coefficients were  $p=0.00$ ). The somatic anxiety result difference between the two least successful groups was very close to reaching the level of statistical significance ( $p=0.08$ ).

Table 5 Statistical significance levels of cognitive anxiety difference coefficients

Team placement	2	3	5	6
2		0.55	0.01	0.00
3	0.55		0.00	0.00
5	0.01	0.00		0.09
6	0.00	0.00	0.09	

Table 5 shows the significant difference between the two successful teams and the less successful ones in the degree of cognitive anxiety. The players of the successful teams showed significantly lower degree of cognitive anxiety than the players of the less successful teams, and the ascertained differences were very high (statistic difference significance coefficients were  $p=0.01$  or higher).

Similar as with the differences of the somatic anxiety, the difference of the cognitive anxiety results between the two least successful teams were very close to reaching the statistical significance ( $p=0.09$ ). Players of the more successful teams differed from those of less successful teams by the somatic and the cognitive pre-competitive anxiety.

Table 6 Self-confidence difference coefficient levels of statistical significance

Team placement	2	3	5	6
2		0.99	0.38	0.08
3	0.99		0.37	0.08
5	0.38	0.37		0.83
6	0.08	0.08	0.83	

Although the One-way ANOVA show significant differences between the groups of players of different situational success, Schaffe *post-hoc* test did not show significant differences between the individual groups (teams) of players.

It is noticeable that the players from the least successful team had the lowest self-confidence, and the two difference significance coefficients were very close to the criterion of determining a statistical significance (both were  $p=0.07$ ). This research had several limits which should be considered while interpreting the results: the questionnaire was filled only once, before the first championship match, and it was possible that after the match there were some changes in the competitive state anxiety and self-confidence components, due to the different achievement of the players in a game.

The teams group placement was only one of the possible criteria of the team, the situational success at the European junior championship; only small portion of the teams participating at the championship agreed to fill in the CSAI-2R questionnaire. It is recommended to repeat the research, while "solving" these limitations, and it is also recommended to explore the states of anxiety component relations with the game role of a player, relations of the anxiety state with the measures of team cohesion and to follow the possible changes of anxiety degree during the competition.

### Conclusion

Based on the results of this research it can be concluded that there were significant differences in certain anxiety components in elite junior teams with different group placement at the European volleyball championship. It was ascertained that better team placement meant lower degree of somatic and cognitive anxiety, and a higher degree of players' self-confidence. It can be assumed that the members of the less successful teams due to their high state anxiety and lower self-confidence at the important competitions did not manage to play volleyball at the level of their actual possibilities. This is why it is important that their trainers, parents and everybody participating in the training process and life of young athletes, by their behaviour and action contribute the decrease of the anxiety level, and rise of the self-confidence. While doing this, it is crucial that the atmosphere at the training and competition is such in which the accent would be at the intrinsic, instead the extrinsic motivation. The fellowship of the team and the feeling that the co players are ready to mend the possible errors of the game can also contribute greatly to the decrease of the anxiety level of the young players.

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## RELACIJE NATJECATELJSKE ANKSIOZNOSTI I STANJA SAMOPOUZDANJA I SITUACIJSKOG POSTIGNUĆA KOD ELITNIH EUROPSKIH JUNIORSKIH ODBOJKAŠICA

### Sažetak

S ciljem utvrđivanja utječe li prednatjecateljsko stanje anksioznosti na situacijsku uspješnost kod vrhunskih juniorskih igračica odbojke, 4 odbojkaške ekipe (N=48) su neposredno prije odigravanja svoje prve utakmice na europskom juniorskom prvenstvu popunile revidirani upitnik stanja natjecateljske anksioznosti (eng. Revised Competitive State Anxiety Inventory – 2, CSAI-2R), autora Cox, Martens i Russell (2003) kojim se mjere somatska i kognitivna anksioznost, te samopouzdanje. Primjenom jednosmjerne ANOVE i post-hoc analize razlika utvrđeno je postojanje značajnih razlika u komponentama stanja anksioznosti kod vrhunskih juniorskih ekipa različito plasiranih u grupi na europskom prvenstvu u odbojci. Igračice uspješnijih ekipa pokazuju niže razine somatske i kognitivne anksioznosti od igračica manje uspješnih ekipa. Nalazi ovog istraživanja djelomično podupiru nalaze u literaturi, te se preporučaju daljnja istraživanja relacija stanja anksioznosti i natjecateljske uspješnosti.

**Ključne riječi:** anksioznost, samopouzdanje, situacijska uspješnost, CSAI-2R.

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## REGRESSION ANALYSIS OF CONNECTION BETWEEN MORPHOLOGICAL, MOTOR AND FUNCTIONAL ABILITIES WITH THE SUCCESS OF PERFORMANCE OF TECHNICAL ELEMENTS IN DANCE

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*Original scientific paper*

### **Abstract**

*This research was conducted on 84 dancers (78 females and 6 males) with the age range from 11 to 16 year old; the sample is the population taken from different dancing clubs in Bosnia and Herzegovina: Gemma (Banja Luka), City Jazz (Banja Luka), Bolero (Banja Luka) and Orion (Pale). The participants were divided in two groups randomly. The experimental group (N = 44, 40 females and 4 males) was formed of 'Gemma' dancing club members and they were used for a three-month experimental program. The control group members (N=40, 38 females and 2 males) were trained by the standard dance program. The primary aim of the research was to investigate significance and relative impact of morphological characteristics, motoric and functional abilities (marked as predictor variables) on the competence shown in a composite dance test which serves to indicate mastery of dance movement structures in dance (marked as a criterion). A regression analysis was used to determine a possible influence of morphological characteristics, motoric and functional abilities on success of technical performance of dance movements. On the basis of the regression analysis results after initial and final measurements, it can be concluded that the proprioceptive training with a jumping rope resulted in positive changes, that is, it was positively correlated to predictors and changes of structures. The conclusion based on the influence of predictors is that the success in dance needs joint participation of all applied variables (morphological characteristics, motoric and functional abilities).*

**Key words:** regression analysis, dance structures, anthropological dimensions

### **Introduction**

Dance belongs to a group of polistructural conventional sports. There are numerous researches that confirm the influence of anthropological dimensions on dance in general and sports dance (Oreb, 1989; Zagorc, Karpljuk & Friedl, 1999; Kostić, Zagorc & Uzunović, 2004; Lukić & Bijelić, 2006; Uzunović, 2008; Uzunović, Kostić & Miletić, 2009; Vlašić, Oreb, Prlenda & Zagorc, 2011). Proprioception is a complex activity of neuromuscular system which includes transmission of information from peripheral receptors through afferent and efferent neural pathways; this enables body to maintain stability and orientation during static and dynamic activities (Laskowski, Newcomer-Aney & Smith, 1997). Proprioceptive training incites activation of proprioceptors which ensure optimal reaction of organism in urgent situations which could result in an injury (Jukić, 2003). Proprioception was rarely utilized as an experimental program in dance, even though it is of essential importance for dancers considering that it helps them in injury prevention and improvement of dance technique and performance. Batson (2009) emphasizes the need to verify proprioceptive programs which are specifically designed for dance, while Green-Gilbert & Smith noticed the effects of targeted exercises on dancers' technique, excluding children. In certain researches it was found that the proprioceptive training has influence on: the ability of muscle power (Heitkamp, Horstmann, Mayer, Weller &

Dickhuth, 2001), flexibility (Malliou et al., 2004; Yaggie & Campbell, 2006) and jumping ability (Ziegler, Gibson & McBride, 2002; Kovacs, Birmingham, Forwell & Litchfield, 2004). Wolf-Cvitak, Grčić-Zubčević and Dolančić (2002) note that learning of certain movements in polistructural conventional sports can be accelerated by reliance on kinesthetic feeling. Šebić-Zuhrić, Rađo and Bonacin (2007) conclude that proprioceptive training accelerated formation of global controlling structures and enabled local differentiation which resulted in higher range and improved quality of movement. Further, it is concluded that the exercising program in rhythmic gymnastics should include elements of proprioceptive training, as well as a precise definition of different kinds of tasks, number of repetitions depending on the phase of transformation and exercising goals; total amount and content should be programmed in accordance with the characteristics of a particular sport. It is also necessary to work on verification of proprioceptive programs that are specially designed for dance (Batson, 2009). Lukić (2010) found that the implementation of proprioceptive program resulted in positive changes in all analyzed balance tests, in one test of coordination (MAGOSS) and in quality of dance techniques performance. The conclusion proceeding from this is that the content of training programs in sport dance should include elements of proprioceptive training. Srdić (2012) found that proprioceptive training and training with



a jumping rope produced statistically significant differences and quantitative changes (effects) of the treated anthropological places (in the participants of the experimental group as compared to the control group). A jumping rope is used at the beginning of training as a tool for warming up, but also for development of different motoric skills such as speed, coordination, reaction time, explosive power, flexibility, balance, rhythm and kinesthetic and proprioceptive sensibility. Lee (2003) indicates that the use of a jumping rope improves dynamic balance. Concerning motoric and functional abilities Bašić, M. and Bašić D. (2005) emphasize that the jumping rope training influences development of the following: aerobic endurance, anaerobic endurance, speed and reaction time, flexibility, rhythm and balance, explosive power, coordination and kinesthetic and proprioceptive sensibility. Procedural effects of kinesiological treatments could be determined if there is a group of value parameters for evaluation of effects, if the transformational procedure is known and if an appropriate set of analytical procedures to evaluate effects is applied (Bonacin, Bilić & Bonacin, Da., 2008).

**Methods**

*Sample*

The research was conducted on the sample of 84 participants – young dancers of both sexes, age between 11 and 16 from the following dance clubs: 'Gemma' from Banja Luka, 'City Jazz' from Banja Luka, 'Bolero' from Banja Luka and 'Orion' from Pale. The participants were divided into two groups randomly: an experimental group (N=44) which underwent an experimental three-month program and a control group which trained by the standard dance program. The participants are competitors registered in the state dance association who also compete on state competitions of Bosnia and Herzegovina or who competed at least 3 months prior to the experimental treatment. The level of competitors is I (international) and A (highest national). A special precaution was taken to include only participants that are from 11 to 16 years old, medically examined, attending regularly the experimental program, registered in the current year as competitors in the state dance association of Bosnia and Herzegovina.

*Variables*

Variables used to assess morphological characteristics were: variable for assessment of longitudinal dimensions of skeleton (body height – AVISTJ, length of arms- ADUŽRU, length of legs - ADUŽNO, length of feet - ADUŽST), variables for assessment of circular dimensions of skeleton and body mass (circumference of belly - AOBTRB, circumference of upper arm - AOBNAD, circumference of a forearm - AOBPOD, circumference of a thigh - AOBNAT, circumference of a lower leg - AOBPOT, body weight - ATEŽTJ, body mass index - ABMIDX) and variables for assessment of body fat (a skin fold of the upper arm - AKNNAD, a skin fold on the back - AKNLEĐ, a

skin fold on the belly - AKNTRB, a skin fold on the lower leg - AKNPOT). Variables used to assess motoric abilities were: variables for assessment of balance (Flamingo balance test - MFLAMI), variables for assessment of segment speed – frequency of movements (hand tapping - MTAPRU, leg tapping - MTAPNO), variables for assessment of explosive power of legs (standing long jump - MFESDM, Sergeant jump test- MFEVIS), variables for assessment of coordination – performance of rhythmical structures (drumming with hands and legs -MBUBRN), variables for assessment of flexibility (lateral change of movement speed to the left side - MLATBL, lateral change of movement speed to the right side - MLATBD). The variable for assessment of success rate of dance technique performance was represented by a composite test - SMKOMT. The variables for assessment of functional abilities were: variables for assessment of respiratory functions (forced expiratory volume - FFEV75, maximum expiratory volume in the first second - FMFEV1, forced vital capacity - FFVCAP, peak expiratory flow - FMAPEF, maximum voluntary ventilation - FMVVNT, time needed to exhale lung capacity - FFETME) and variables for assessment of heart function (frequency of heart in stationary condition - FSRFRM).

*Composite test and assessment scale*

The measurement of success rate of dance technique performance needed a special composite test to be created; the test was executed with music of different tempo and it contained the following elements: salsa basic walk, chasse to the right side, chasse to the left side, relevé, passe, padebure, right side 360-degree turn with jumping, kick ball change, slide to the right side, slide to the left side and contraction-release action. Success of the execution of dance technique elements (composite test) was evaluated during the regular sports training.

Table 1 *Scale and criteria for evaluation of successfulness of dance technique performance in a composite test*

Grade	Criteria
0	No element was performed correctly or majority of the elements weren't performed correctly, a participant performs elements outside of the required rhythm
1	Several elements weren't performed or they were performed incorrectly, a participant performs elements outside of the required rhythm
2	Elements were performed following the required sequence but with mistakes, a participant didn't follow all requirements of a rhythmical structure
3	Elements were performed correctly and followed the required sequence with smaller mistakes, a participant performed elements with a required rhythm with smaller mistakes
4	Elements were performed correctly and followed the required sequence with only one mistake, a participant performed all elements with a required rhythm, presentation was flawed
5	All elements were performed correctly and followed the required sequence, a participant performed all elements with a required rhythm and dancer's presentation was good

It was performed in sports halls where participants usually train by three independent evaluators who had gotten either referee or trainer license from the dance association. The evaluation grades were derived from a specially created scale and criteria for evaluation of successfulness of dance technique performance. The participants warmed up for 15 minutes before testing. One dance coach was hired for the test demonstration; he showed the participants sequential elements of the test with music. The participants had been allowed to repeat the given elements maximum 3 times before they were tested. The scale and criteria for evaluation of successfulness of dance technique performance in a composite test were shown in Table 1.

#### *The experimental program*

The experimental program was implemented in the period between the 1<sup>st</sup> of September and the 30<sup>th</sup> of November 2012 (three months), and it consisted of the proprioceptive program (exercises on a balance board and on a trampoline) and the program with a jumping rope. A total of 40 training units were executed. At the beginning of each dance training session, there was a warm-up session lasting 10-15 minutes followed by the experimental program with duration of 15 to 20 minutes.

Duration of specific tasks from the experimental program was ranging from 30 seconds to 2 minutes. The experimental program included 13 training sessions on a balance board, 13 training sessions with a jumping rope, 12 training sessions on a trampoline and 2 training sessions with a balance board and a trampoline combined.

#### *Data analysis*

Data analysis in this research will be done with statistical and mathematical procedures and the usage of the program SPSS 14 or STATISTIKA 6. In order to determine the degree of the influence of morphological characteristics, motoric and functional abilities, which were defined as a group of predictor variables, on the success of performance of dance technique elements, regression analysis was used in initial and final measuring.

### **Results and discussion**

The results of the initial measurements of regression analysis of criterion variables SMKOMT, which served to assess the successfulness of performance of dance technique elements, are shown in Table 2. The Table 2 shows that the whole system of predictor is significant in prediction of the criterion ( $p=0.032$ ), which means that the analysis of relative influence can be undertaken for each predictor on the criterion.

Multiple correlation is very high at the  $RO = 0.76$ , which explains correlation of 30 variables from three groups as predictors and the success rate of performance of dance technique elements as a criterion.

The system of predictors explains 57% of common variance of the criterion system (DLT 0.57). The analysis of influence of individual predictor variables on the successfulness in the composite test shows that a very few predictor variables explains the criterion. From the total system of predictor variables, a relative contribution of each predictors in the explanation of influence on the criterion is following: in the morphological group, a skin fold on the lower leg (AKNPOT 7.5%) – variable for assessment of body fat and circumference of a lower leg (AOBPOT 6.5%) – variable for assessment of volume. In the motoric group, Sergeant jump test (MFESVM 12%) – variable for assessment of explosive power, lateral change of movement speed to the left side (MLATBL 9%) – variable for assessment of flexibility and from the functional abilities group, maximum voluntary ventilation (FMVVNT 33%) and forced expiratory volume with the negative result (FFEVT75 -0.24), which essentially represents an obstacle in the training procedure. When the results of the initial measurements of the criterion variable SMKOMT regression analysis are examined, it can be concluded that the influence of predictor variables (morphological characteristics, motoric and functional abilities) on the success of performance of dance technique elements is statistically significant at the level of  $p = 0.032$  (Table 3) and that multiple correlation is  $RO = 0.76$ , which means that the system of applied predictor variables can explain the criterion variable SMKOMT with 57%. The analysis of individual variables influence on the success rate of performance of dance technique elements showed an insignificant number of predictor variables that proved to have some influence. According to this, a total impact of predictors is such that only their total sum is producing an effect which significantly impacts the test results (SMKOMT) of participants. This piece of information tells us that the joint implementation of all the applied variables (morphological, motoric and functional) is necessary for the success in dance.

The results of the regression analysis of the criterion variables SMKOMT, which evaluate success rate of performance of dance technique elements with its final measurements, is shown in the Table 4. The aforementioned table shows that the whole set of predictor variables is significant in prediction of the criterion variable at the level of  $p = 0.032$  (Table 5), which means that the analysis of the relative influence of each individual predictor on the criterion can be done. A quotient of multiple correlation is equally high as in the initial measuring at  $R = 0.76$ , which explains correlation of 30 variables from three groups as predictors and the composite test as the criterion. The total sum of predictors explains 57% of common variance of the criterion system (DTL 0.57). From the analysis of individual variables influence in the predictor system on the success of the composite test can be concluded that there are certain positive changes when the results are compared to the initial measuring.

Table 2 Regression analysis of criterion variables SMKOMT – initial measurements

	R	Q(R)	P-R	B	P	S-B	Q(B)	F(B)
AVISTJ	0.11	0.31	0.13	0.56	6.27	0.56	0.67	0.15
ATEŽTJ	0.02	0.85	-0.13	-0.95	-1.94	1.00	0.65	0.03
ABMIDX	-0.01	0.89	0.12	0.85	-1.21	0.97	0.61	-0.02
ADUŽRU	0.12	0.28	0.07	0.10	1.16	0.20	0.64	0.16
ADUŽNO	0.04	0.72	-0.08	-0.15	-0.59	0.27	0.59	0.05
ADUŽST	0.03	0.76	-0.25	-0.30	-0.98	0.16	0.06	0.04
AOBTRB	0.04	0.71	-0.02	-0.05	-0.19	0.27	0.86	0.05
AOBNAD	0.03	0.80	-0.04	-0.10	-0.28	0.40	0.79	0.04
AOBPOD	0.06	0.62	-0.15	-0.39	-2.21	0.35	0.27	0.07
AOBNAT	0.18	0.10	0.19	0.36	6.51	0.26	0.16	0.24
AOBPOT	0.07	0.54	0.13	0.34	2.35	0.35	0.66	0.09
AKNNAD	-0.10	0.64	0.14	0.21	-2.17	0.21	0.31	-0.13
AKNLEĐ	-0.11	0.31	0.11	0.20	-2.32	0.26	0.56	-0.15
AKNTRB	-0.11	0.66	-0.12	-0.25	2.60	0.27	0.63	-0.14
AKNPOT	-0.27	0.01	-0.17	-0.28	7.47	0.22	0.21	-0.35
FFE75	0.24	0.03	-0.13	-0.98	-23.80	0.11	0.64	0.32
FMFEV1	0.20	0.07	-0.06	-0.30	-5.93	0.67	0.66	0.26
FFVCAP	0.05	0.66	-0.18	-0.35	-1.71	0.26	0.18	0.06
FMAPEF	0.31	0.00	0.08	0.15	4.60	0.25	0.56	0.41
FMVVNT	0.24	0.03	0.15	0.14	33.40	0.12	0.26	0.31
FFETME	-0.06	0.61	0.01	0.01	-0.03	0.13	0.97	-0.08
FSRFRM	-0.04	0.72	0.09	0.07	-0.29	0.12	0.54	-0.05
MFLAMI	-0.15	0.17	-0.09	-0.08	1.13	0.12	0.53	-0.20
MTAPRU	0.21	0.05	-0.19	-0.17	-3.59	0.12	0.17	0.28
MTAPNO	0.35	0.00	0.18	0.17	6.03	0.12	0.17	0.47
MBUBRN	0.27	0.02	0.19	0.17	4.59	0.12	0.16	0.35
MFESDM	0.47	0.00	0.06	0.08	3.84	0.18	0.66	0.63
MFEVIS	0.57	0.00	0.19	0.21	11.87	0.15	0.16	0.76
MLATBL	-0.43	0.00	-0.12	-0.21	8.86	0.23	0.62	-0.56
MLATBD	-0.48	0.00	-0.05	-0.08	3.83	0.24	0.74	-0.63
	DLT	S-DLT	RO	F	DF1	DF2	p	
	0.57	0.65	0.76	2.37	30	53	0.0032	

Table 3 Variance analysis – initial state

	Sum of squares	df	Mean squares	f	p
Regression	48.42	30	1.61	2.37	0.003
Residual	36.12	53	0.68		
Total	84.54				

These are the variables which stand out in the explanation of the criterion: form the morphological group, body weight (ATEŽTJ 9.3%) – a variable for assessment of the body mass, circumference of a thigh (AOBNAT 13.0%) – a variable for assessment of the circumference of the body; from the motoric group, drumming with hands and legs (MBUBRN 19.2%), - a variable for assessment of coordination, standing long jump (MFESDM 11.6%) and Sergeant jump test (MFEVIS 7.8%) – a variable for assessment of explosive power of legs, lateral change of the movement speed to the left side (MLATBL -13%) and lateral change of the movement speed to the right (MLATBD 26%); from the group of functional ability, forced expiratory volume (FFE75 28%) and maximum voluntary ventilation with a negative result (FMVVNT - 31.3%). After examination of the regression analysis results in the final measuring, it can be concluded that there is a significant statistical influence of the total predictor system on the

criterion (successfulness of the performance of dance technique elements) and that all applied predictor variables participate in the equation of specification. When compared to initial measuring, in the final measuring the circumference of a thigh (AOBNAT) from the morphological group, drumming of hand and legs (MBUBRN) and lateral change of movement speed to the right (MLATBD) from the motoric group, appear as significant predictors in the explanation of the criterion.

Considering the fact, that the final measuring showed the variable of lateral change of movement speed to the right negative (MLATBL -13%), it can be concluded that the proprioceptive training and training with a jumping rope disrupted the existing symmetry and caused a negative effect. It is probable that the participants from the experimental group were pressured and for them it caused a certain stress.

Table 4 Regression analysis of the criterion variable SMKOMT - final measurement

	R	Q(R)	P-R	B	P	S-B	Q(B)	F(B)
AVISTJ	0.18	0.10	-0.02	-0.07	-11.98	0.46	0.88	0.24
ATEŽTJ	0.13	0.25	0.10	0.74	9.31	0.96	0.55	0.17
ABMIDX	0.08	0.52	-0.06	-0.25	-2.01	0.61	0.69	0.11
ADUŽRU	0.18	0.09	-0.02	-0.03	-0.63	0.22	0.87	0.24
ADUŽNO	0.13	0.25	-0.10	-0.20	-2.57	0.29	0.51	0.17
ADUŽST	0.15	0.16	-0.06	-0.08	-1.17	0.18	0.67	0.20
AOBTRB	0.11	0.32	0.05	0.12	1.30	0.35	0.73	0.15
AOBNAD	0.15	0.16	0.18	0.29	4.40	0.21	0.17	0.20
AOBPOD	0.18	0.09	-0.12	-0.24	-4.45	0.28	0.61	0.24
AOBNAT	0.21	0.05	0.28	0.60	12.56	0.29	0.04	0.28
AOBPOT	0.06	0.60	-0.22	-0.50	-2.93	0.30	0.10	0.08
AKNNAD	-0.05	0.63	0.01	0.01	-0.06	0.24	0.96	-0.07
AKNLEĐ	-0.06	0.62	-0.11	-0.19	10.83	0.25	0.56	-0.07
AKNTRB	-0.06	0.58	-0.05	-0.08	0.48	0.23	0.74	-0.08
AKNPOT	-0.15	0.16	0.01	0.01	-0.12	0.17	0.96	-0.20
FFE75	0.15	0.18	0.22	0.19	27.70	0.12	0.11	0.19
FMFEV1	0.15	0.18	0.00	0.10	1.52	0.12	0.99	0.20
FFVCAP	0.12	0.27	0.01	0.03	0.32	0.35	0.94	0.16
FMAPEF	0.18	0.11	-0.10	-0.17	-3.01	0.23	0.54	0.23
FMVVNT	0.15	0.18	-0.02	-0.21	-31.37	0.12	0.85	0.20
FFETME	-0.11	0.31	0.02	0.02	-0.22	0.16	0.90	-0.15
FSRFRM	0.08	0.54	-0.02	-0.02	-0.13	0.12	0.89	0.11
MFLAMI	-0.22	0.05	-0.05	-0.04	0.81	0.11	0.74	-0.29
MTAPRU	0.38	0.00	-0.18	-0.20	-7.48	0.15	0.19	0.50
MTAPNO	0.30	0.01	0.09	0.08	2.42	0.13	0.54	0.39
MBUBRN	0.41	0.00	0.47	0.47	19.25	0.12	0.00	0.54
MFESDM	0.51	0.00	0.17	0.23	11.56	0.18	0.20	0.67
MFEVIS	0.46	0.00	0.17	0.17	7.86	0.14	0.22	0.61
MLATBL	-0.38	0.00	0.20	0.33	-12.36	0.22	0.14	-0.50
MLATBD	-0.45	0.00	-0.30	-0.58	26.48	0.26	0.03	-0.60
	DLT	S-DLT	RO	F	DF1	DF2	p	
	0.57	0.65	0.76	2.37	30	53	0.0032	

Table 5 Variance analysis – final state

	Sum of Squares	df	Mean squares	f	p
Regression	56.50	30	1.88	2.37	0.0032
Residual	42.09	53	0.79		
Total	98.59				

The variable, forced expiratory volume (FFE75), now explains positive criterion and contributes to explanation with 28%. This change can certainly be attributed to a positive influence of proprioceptive training and training with a jumping rope, because the participants have now learned how to breathe properly. Therefore, a conclusion can be drawn that the continuous dance training, proprioceptive training and training with a jumping rope have made a positive effect on normal breathing. The variable, maximum voluntary ventilation (FMVVNT) now stands as an obstacle because from the positive influence in the initial measuring, it turned negative in the final measuring. That means that one cannot breathe in any fashion, but in a manner that a certain activity requires.

### Conclusion

The primary goal of this research was to determine significance and influence of morphological characteristics, motoric and functional abilities as predictor variables on the success rate of performance of dance technique elements as the criterion. A regression analysis was used to calculate a possible influence of morphological characteristics, motoric and functional abilities on the assessment of success of realization of dance structures. Judging from the results of the regression analysis in the initial and final measuring, it can be concluded that the influence of proprioceptive training and training with a rope was

positive, that is, positive change of predictors and of structure happened. The changes are small, and the greatest influence in the explanation of the criterion in the final state had the following predictors: body mass (body weight ATEŽTJ, 9.3%), body circumferences (circumference of a thigh - AOBNAT, 13.0%), coordination (drumming with hands and legs - MBUBRN, 19.2%), explosive power (standing long jump - MFESDM, 11.6% and Sergeant jump test- MFEVIS, 7.8%), flexibility (lateral change of movement speed to the left - MLATBL, -13.0%) and lateral change of movement speed to the right side - MLATBD, 26.0%) and respiratory functions (forced expiratory volume-FFE75, 28%) and maximum voluntary ventilation with a negative result - FMVVNT, -31.3%). The aforementioned changes indicate that the experiment with the group of motoric abilities and morphological characteristics disrupted the existing symmetry and that the participants learned how to breathe properly and that breathing is conditioned by dance movement structures.

On the basis of regression analysis results in the initial and final measuring, it can be concluded that proprioceptive training and training with a rope has a significant synergic effect with regular dance trainings and other forms of dance exercising and that all the applied variables (morphological characteristics, motoric and functional abilities) are needed for success in dance.

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## REGRESIJSKA ANALIZA POVEZANOSTI IZMEĐU MORFOLOŠKIH, MOTORIČKIH I FUNKCIONALNIH SPOSOBNOSTI S USPJEHOM U IZVOĐENJU TEHNIČKIH ELEMENATA PLESA

### Sažetak

Istraživanje je provedeno na 84 plesača (78 žena i 6 muškaraca) uzrasta 11 do 16 godina, na uzorku stanovnika uzeti iz različitih plesnih klubova u Bosni i Hercegovini: Gemma (Banja Luka), Grad Jazz (Banja Luka), Bolero (Banja Luka) i Orion (Pale). Sudionici su bili podijeljeni po quasi-slučajnom ključu u dvije skupine. Eksperimentalna skupina (N = 44, 40 žena i 4 muškarca) je formirana od 'Gemma' članovi plesnih klubova i s njima je proveden tromjesečni eksperimentalni program. Kontrolna skupina (N = 40, 38 djevojaka i dva muškarca) bili obučavani u standardnom plesnom programu. Primarni cilj istraživanja bio je ispitati značenje i relativni utjecaj morfoloških, motoričkih i funkcionalnih sposobnosti (označene kao prediktorske varijable) na uspješnost izvođenju složenog plesnog testa koji služi za označavanje majstorstva plesnih pokreta i struktura u plesu (kriterij). Regresija je imala za cilj odrediti mogući utjecaj morfoloških, motoričkih i funkcionalnih sposobnosti na uspjeh tehničke izvedbe plesnih pokreta. Na temelju rezultata analize regresije nakon inicijalnog i finalnog mjerenja može se zaključiti da je proprioceptivni trening rezultirao pozitivnim promjenama, koje pozitivno koreliraju s prediktorima i promjene strukture. Zaključak može biti donesen da je za uspjeh u plesu potrebno zajedničko sudjelovanje svih analiziranih svojstava (morfoloških značajki, motoričkih i funkcionalnih sposobnosti).

**Ključne riječi:** regresijska analiza, plesne strukture, antropološke dimenzije

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## ANALYSIS OF THE BEST WOMEN'S HIGH JUMP RESULTS IN THE OLYMPIC GAMES HISTORY

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Original scientific paper

### Abstract

The aim of the investigation was to analyse women's high jump performances in the Olympic Games' history. Analysis covers results of the gold, silver and bronze women medallists in Olympic high jumping. The possibilities of forecasting performances on the polynomial linear regression basis were commented. The dynamics of results progression was explained. Analysis was based on the results of 60 women athletes, winners of the gold, silver or bronze medal at the Olympic Games since 1928 in Amsterdam until 2012 in London.

**Key words:** high jump, history of Olympic Games, regression analysis, best results

### Introduction

Monitoring the results achieved at the Olympic Games or at other main sports competitions can offer numerous answers to the issues of the structure and effects of sport training process, efficiency of learning technical and tactical elements in certain sporting discipline, new technologies influence, quality of new diagnostic procedures application and development of sports results themselves through history. Historically, the development of sports results is important for tracking progression in and determination of developmental characteristics of athletes pertaining to certain sports through observing great sport competitions like the Olympic Games, World and European Championships and other main competitions. Analysis of result development is especially suitable in athletics' disciplines since sport achievements have been measured exactly. Competitions in athletics are held worldwide under standardized conditions, determined by the IAAF rules (IAAF, 2011). The results/achievements are obtained highly objective, with no impact from referees. Therefore, ranking of competitors in athletics' disciplines is based on highly precise measurements. Numerous recent research studies give coaches and athletes valuable feedback on the previously mentioned issues. Scientifically based analyses and forecasting in certain sporting disciplines is founded on the already existing insights into stable regularities of the sport in question (Harasin, 2002; Lepers, 2008; Milinović, Milanović and Harasin, 2008; Chiu and Salem, 2010). By analysing sports results it is possible to determine general principles of achievement development of individuals. These general principles enable sport practitioners to determine probable achievements of individual athletes and also of sport discipline in general (Wazny, 1978). Also, development of the results and records in sport is a reliable way to get an insight into potentials of human body (modified to Lippi et al., 2008).

Women's high jump competition is a part of the official Olympic program since the 1928 Olympic Games in Amsterdam, Holland. Number of competitors on these Games was 3014 from 46 countries of the world, and only 290 of them were women (Platonov and Guskov, 1997). The first woman gold medallist in this discipline was a Canadian athlete Ethel Catherwood. Her winning result was 159 centimetres (Wallechinsky, 2000). Since then till the London Olympic Games in 2012 this athletics' discipline has become very popular, as can be seen in the Games and other great sport competitions. The main goal of this investigation was to establish trend of result development in women's high jump at the Olympic Games tournament. Also, the authors wanted to discuss possibilities of predicting results for the competitions to come.

### Methods

In this investigation sample of participants is comprised of the winners in woman's high jump competitions at Olympic Games since 1928 in Amsterdam, Holland until 2012 in London, United Kingdom. In 20 Games that were held until today, there were 60 gold, silver and bronze medallists. Consequently, the sample of participants is 60 athletes' winners of Olympic medal in woman's high jump competitions at the Olympics. The data used in this investigation were collected from "The Complete Book of the Olympics" (Wallechinsky, 2000). Since all the results from the Olympic Games were not contained in this book, the rest of the data was collected from the official web site of the Olympic Movement, [www.olympic.org](http://www.olympic.org). The collected data was analysed and processed using statistical program STATISTICA 9.0 at the Faculty of Kinesiology, University of Zagreb. The trend of result development was analysed to determine whether a successive change of the results had a linear or curvilinear flow.

The linear and polynomial regression analysis was used to process trends of the development of the best results in women's high jump at the Olympics.

**Results**

Table 1 contains original results of the gold, silver and bronze medallists at the Olympic Games since 1928 in Amsterdam until 2012 in London. Also, in the Table are mean values for every year based on the result of medallists for each year. The results are expressed in centimetres.

Table 1. Original results of women's high jump medallists at the Olympic Games

City and year	Gold	Silver	Bronze	Average
Amsterdam 1928	159	156	156	157
Los Angeles 1932	166	166	160	164
Berlin 1936	160	160	160	160
London 1948	168	168	161	165.66
Helsinki 1952	167	165	163	165
Melbourne 1956	176	167	167	170
Rome 1960	185	171	171	175.66
Tokyo 1964	190	180	178	182.66
Mexico City 1968	182	180	180	180.66
Munich 1972	192	188	188	189.33
Montreal 1976	193	191	191	191.66
Moscow 1980	197	194	194	195
Los Angeles 1984	202	200	197	199.66
Seoul 1988	203	201	199	201
Barcelona 1992	202	200	197	199.66
Atlanta 1996	205	203	201	203
Sydney 2000	201	201	199	200.33
Athens 2004	206	202	202	203.33
Beijing 2008	205	205	203	204.33
London 2012	205	203	203	203.66

Based on the results shown in Table 1 we can depict an image about the progression of results in women's high jump at the modern Olympics. The best result values progressed by 47 centimetres. First time when women's high jump became a part of the official Olympic program in 1928, the winning result was 159 centimetres. This result developed and grew up to 206 centimetres in Athens 2004 and 205 centimetres in Beijing 2008 and London 2012. Accordingly, average of the three best results at the Olympics also progressed from 157 centimetres in 1928 to 203.66 centimetres in 2012. These results are graphically presented in Figure 1.

**Development of women's high jump gold medal winner's results**

Progression of women's high jump gold medallists' performances is shown in Figure 2. Table 2 contains results of the linear regression analysis computed according to the results of the gold medallists in women's high jump at the Olympic Games since 1928 till 2012. Original results and predicted values based on the computed linear regression are shown in Table 3. Based on the obtained results it can be concluded that the linear regression analysis is not a good tool for assessing performance in the women's high jump at the Olympic Games.

Namely, large differences in the values of the original and the estimated results, or residuals were obtained.

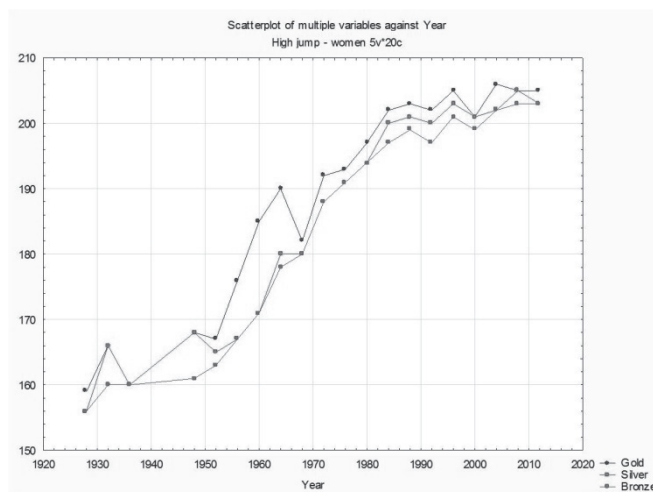


Figure 1. Development of the gold, silver and bronze medallists' results at the women's high jump competitions of the modern Olympic Games since 1928 till 2012.

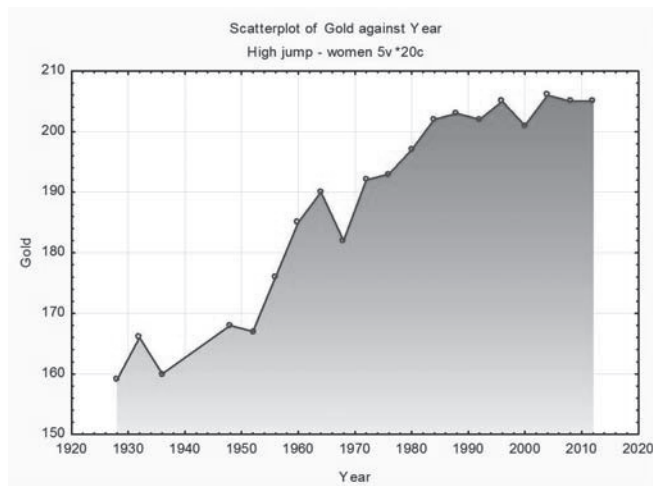


Figure 2. Development of the best result at women's high jump competitions of the modern Olympic Games since 1928 till 2012.

Table 2. Results of linear regression analysis for the best results at women's high jump competitions at the Olympics

Model is: $v_2 = b_0 + b_1 * v_1$ (High jump - women) Dep. Var.: Gold Level of confidence: 95.0% ( $\alpha = 0.050$ )						
	Estimate	Standard error	t-value df = 18	p-value	Lo. Conf Limit	Up. Conf Limit
b0	-1036.04	887.04	-116.80	0.0000	-1222.40	-849.68
b1	0.62	0.04	138.03	0.0000	0.53	0.72

Figures 3, 4 and 5 show dispersion of the results in a coordinate system using the linear, quadratic and cubic regression equations based on the best performances in women's high jump at the Olympic Games since 1928 till 2012. Also, the results of the original and estimated performance values, along with the residuals, are shown in Tables 4 and 5. The best way to describe progression of the results is to use the quadratic regression equation as shown in Figure 4 and Table 4.

Table 3. Original results, estimated results and residual values for the best results at women's high jump competitions on the Olympics based on the linear regression analysis

Model is: $v_2=b_0+b_1*v_1$ (high jump - women)			
Olympic Games	Original results	Estimated results	Residuals
Amsterdam 1928	159	160.40	-1.40
Los Angeles 1932	166	162.88	3.12
Berlin 1936	160	165.36	-5.36
London 1948	168	172.81	-4.81
Helsinki 1952	167	175.29	-8.29
Melbourne 1956	176	177.77	-1.77
Rome 1960	185	180.26	4.74
Tokyo 1964	190	182.74	7.26
Mexico City 1968	182	185.22	-3.22
Munich 1972	192	187.70	4.30
Montreal 1976	193	190.19	2.81
Moscow 1980	197	192.67	4.33
Los Angeles 1984	202	195.15	6.85
Seoul 1988	203	197.63	5.37
Barcelona 1992	202	200.11	1.89
Atlanta 1996	205	202.60	2.40
Sydney 2000	201	205.08	-4.08
Athens 2004	206	207.56	-1.56
Beijing 2008	205	210.04	-5.04
London 2012	205	212.53	-7.53

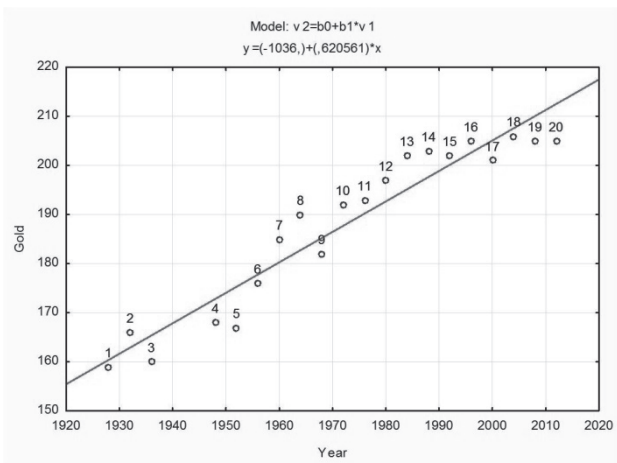


Figure 3. The best results and linear function in a coordinate system computed by the linear regression equation.

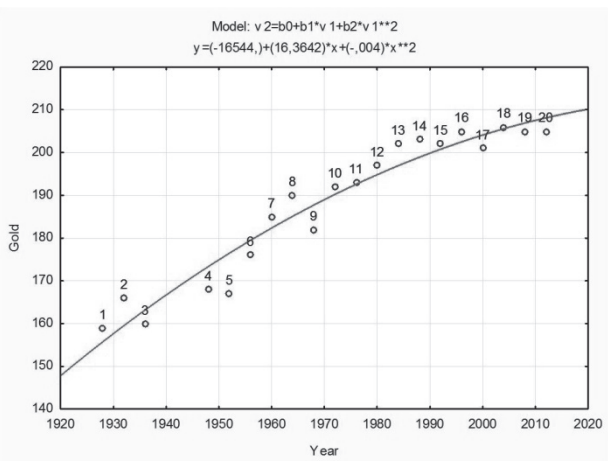


Figure 4. The best results and linear function in a coordinate system computed by the square regression equation.

Just minimal deviations of the estimated results in high jump for women at the Olympic Games from the actual competition results were obtained in calculations using quadratic regression analysis. This is the reason why it is feasible to conclude that the quadratic linear equation is the best way to describe and estimate performance of female high jumpers at the Olympics. This is the way to get best indicators in trend analysis of performances.

Table 4. The original results, estimated results and residual values for the best results in women's high jump competitions of the Olympics based on the quadratic regression analysis

Model is: $v_2=b_0+b_1*v_1+b_2*v_1**2$ (high jump - women)			
Olympic Games	Original results	Estimated results	Residuals
Amsterdam 1928	159	155.73	3.27
Los Angeles 1932	166	159.51	6.49
Berlin 1936	160	163.15	-3.15
London 1948	168	173.32	-5.32
Helsinki 1952	167	176.45	-9.45
Melbourne 1956	176	179.46	-3.46
Rome 1960	185	182.33	2.67
Tokyo 1964	190	185.08	4.92
Mexico city 1968	182	187.71	-5.71
Munich 1972	192	190.20	1.80
Montreal 1976	193	192.57	0.43
Moscow 1980	197	194.81	2.19
Los Angeles 1984	202	196.92	5.08
Seoul 1988	203	198.90	4.10
Barcelona 1992	202	200.75	1.25
Atlanta 1996	205	202.48	2.52
Sydney 2000	201	204.08	-3.08
Athens 2004	206	205.55	0.45
Beijing 2008	205	206.90	-1.90
London 2012	205	208.11	-3.11

**Conclusion**

In this paper we brought up a few possible ways to analyse the performance trend in women's high jump top-level competitions. This investigation is based on the best results of 60 female high jumpers at the Olympic Games since 1928 in Amsterdam, Holland, till 2012 in London, United Kingdom.

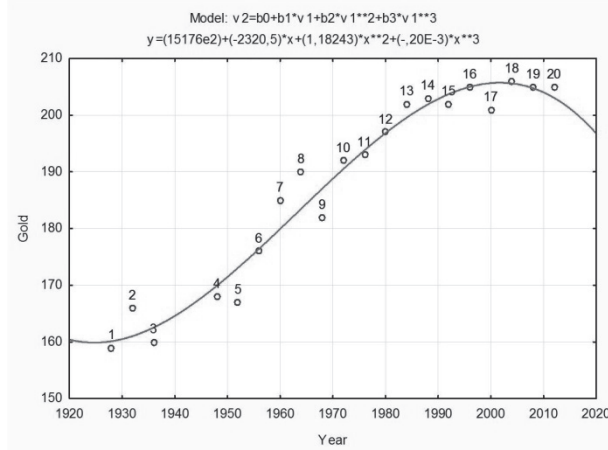


Figure 5. The best results and linear function in a coordinate system computed by the cubic regression equation.

From the plots, which were presented in the study, it can be concluded that the result development of women high jumpers through the Olympic Games' history has a form of progressive regression function. It would be best to use the quadratic regression analysis to describe the performance trend in this discipline. It is important to emphasize that along with the statistical analysis of the results it is crucial to consider other parameters as well. These parameters should include level of athletes' preparedness, their health status, psychological state and level of the development of training technologies in historical contexts of sport results achieved in a certain sport discipline. Namely, estimation and forecasting of the future results based just on the information about performance and computations is not appropriate. To support the afore-mentioned, we wish to highlight that total deviations of the estimated from the original results equalled zero. This shows that forecasting and estimation based just on regression models is meaningless. Of course, all useful information from this system of monitoring sports performance trends must be recognised. That is why it is important to continue with investigations using this or similar models in order to improve sport and sports science.

Table 5. The original results, estimated results and residual values for the best results at women's high jump competitions of the Olympics based on the cubic regression analysis

Model is: $v_2 = b_0 + b_1 \cdot v_1 + b_2 \cdot v_1^2 + b_3 \cdot v_1^3$ (high jump -			
Olympic Games	Original	Estimated	Residuals
Amsterdam 1928	159	160.11	-1.11
Los Angeles 1932	166	161.02	4.98
Berlin 1936	160	162.54	-2.54
London 1948	168	169.91	-1.91
Helsinki 1952	167	173.06	-6.06
Melbourne 1956	176	176.43	-0.43
Rome 1960	185	179.93	5.07
Tokyo 1964	190	183.50	6.50
Mexico city 1968	182	187.05	-5.05
Munich 1972	192	190.51	1.49
Montreal 1976	193	193.80	-0.80
Moscow 1980	197	196.84	0.16
Los Angeles 1984	202	199.56	2.44
Seoul 1988	203	201.88	1.12
Barcelona 1992	202	203.72	-1.72
Atlanta 1996	205	205.01	-0.01
Sydney 2000	201	205.67	-4.67
Athens 2004	206	205.61	0.39
Beijing 2008	205	204.77	0.23
London 2012	205	203.07	1.93

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## ANALIZA NAJBOLJIH REZULTATA ŽENSKOG SKOKA U VIS U OLIMPIJSKOJ POVIJESTI

### **Sažetak**

*Cilj ovog rada jest utvrđivanje trenda razvoja nizova rezultata u ženskom skoku u vis na Olimpijskim igrama kroz povijest. Analiza obuhvaća rezultate osvajačica pojedinih odličja na Olimpijskim igrama od 1928. do 2012. godine te osvrt na prognoziranje rezultata temeljem linearnoga, kvadratnoga i kubnoga regresijskog modela. Na temelju prikupljenih i obrađenih rezultata izražena je dinamika razvoja sportskih rezultata u skoku uvis u navedenom razdoblju. Analiza je provedena na temelju rezultata 60 ispitanica koje su na Olimpijskim igrama od 1928. do 2016. godine bile osvajačice jednoga od odličja.*

**Ključne riječi:** *skok uvis, povijest Olimpijskih igara, regresijska analiza, najbolji rezultati*

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## ORGANISATIONAL STRUCTURE IN RELATION TO PERFORMANCE OF THE PROFESSIONAL FOOTBALL CLUBS IN THE CROATIAN FIRST LEAGUE

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Original scientific paper

### Abstract

Nowadays football is not just a sport, but it has become involved in the market sphere, and therefore its quality depends on the performance of club's organization and management. Question of organization and management of football clubs are top issue today at different societal levels. The aim of this research is to explore characteristics of the organizational structure of professional football clubs in the Croatian First League in relation to performance measures. The research was conducted on 19 football clubs in the Croatian First League through a five year period from 2007/8 to 2011/12 championship season. Throughout this period 11 out of 19 football clubs were continuously present in the First League. Results revealed that the football clubs in the Croatian First League are not uniform in terms of organizational structure, but there are interclub differences in the number and type of organizational units. According to organizational type, eight clubs began the process of transformation from the Sport association to sports joint-stock company, and four clubs finished the reforming process, and now they are sports joint-stock company. As for specific organizational units, certain services have all clubs (administrative, financial, sports), but often lacks the marketing service. Organizational size in terms of units was not significantly correlated to financial measures, but ranking and income are significantly correlated. Significant positive correlation was found between Club placement on ranking list for nearby seasons with exception for 2011/12 season.

**Key words:** football club, organizational structure, ranking

### Introduction

Nowadays professional sport presents an important sport and business activity. Great interest in sports worldwide affected events that made sports a market of great business interest (Beech & Chadwick, 2010). Today, according to estimates, over two hundred million people are involved in the football. Football has become "the second most important thing in the world," so it is not irrelevant how it will be organized. In many countries, football has become part of the national culture and many aspects of life revolve around the game. Today, football is not just a sport, but it has become involved in the market sphere, and therefore its quality depends on the quality of its organization and management (Širić, 2012). Question of organization and management of teams in football is a top issue today at different levels - from recreational football to professionals (Bartoluci & Škorić, 2009; Beech & Chadwick, 2010). However we cannot forget all the people who "consume" football and all of its follow-up activities - football spectators in the stands and those in front of TV, because they are an important target group for various marketing activities (Bartoluci, 2003).

### Aim

A study has been conducted about the organizational structure and the performance of the professional football clubs in the Republic of Croatia through the five-year period from 2007/8 to 2011/12 championship season. The aim is to explore is there differences in characteristics of the organizational structure of professional football

clubs in the Croatian First League, and relate this to clubs' performance (ranking and financial status).

### Methods

The research was conducted on 19 football clubs in the Croatian First League through a five year period from 2007/8 to 2011/12 championship season: Cibaliya, Croatia-Sesvete, Dinamo 1961, Hajduk, Hrvatski dragovoljac, Inter, Istra 1961, Karlovac, Lokomotiva, Lučko, Međimurje, Osijek, Rijeka, Slaven Belupo, Split, Šibenik, Varteks, Zadar, Zagreb. Since all clubs present in the First League were included, research covers the entire target population so the sampling method was not used.

Data were collected using questionnaire (questions on organizational structure, and measures of performance) that was delivered to clubs by mail, and from available official statistics (ranking, organizational type).

### Results and discussion

#### Organizational Structure

The concept of organizational structure indicates the composition, and structure of the organization. It is the most important part of any organization and integrates the use of all the resources of the organization. Organizational structure in general is a systematic form of differentiation and integration of organized activities (Wehrich & Koontz, 1998). The basic organizational structure of professional football clubs is vertical - hierarchical.

*Organizational form of football clubs in Croatian First League*

Up to 2006 and adoption of the new Sports Act the only organizational form of clubs was sports club-association, whereas now it is possible, and for some clubs, which have gained mandatory legal conditions, also obligatory, to reform into a completely new organizational form of the society of capital – joint stock sports company(Law on Associations, 2001). According to Croatian legislation there are two possible forms of sport clubs organization:

1. Sports club/association for competition
2. Joint stock sports company

Sports club/association for competition is the sports association founded to perform sporting activities of participating in sporting competitions must include in its name the words "sports club" or the word "club" must be preceded by the name of the sport in which the activity is performed (Sports Act, 2006; Pravilnik o Registru profesionalnih športskih klubova, 2007). According to Sports Act, Article 28, a sport club/sport joint-stock company is a sports club which is founded, operates and is terminated according to the Company Act and other regulations applied to joint-stock companies. The name of a sport joint-stock company must include the words "sport joint-stock company", while the shortened name must include the mark "s.d.d." (SJSC). An SJSC performs the sporting activity of participating in sporting competitions, but it can also perform other sporting activities and other activities in accordance with the provisions of the Act. One of the survey questions was about planned future organization structure of the club. Ten clubs indicated that the planned future organization is a sports joint-stock company, and nine stated that the future organization is Sports association for competition (Figure 1).

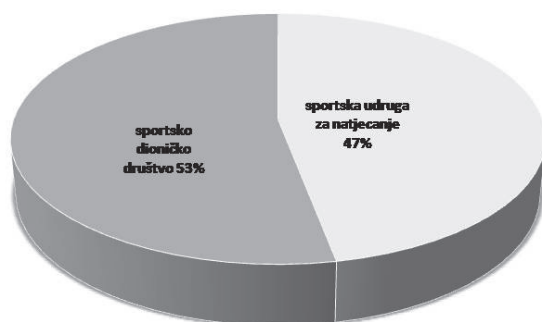


Figure 1. Self-reported planned organizational structure of the Croatian First League Football Clubs

To compare planned and achieved organizational type, data on current organizational structure of the clubs were collected in April 2013. The majority of the clubs currently are Sports association of citizens (14 clubs). Seven of those began the process of transformation from the Association to Sports joint-stock company (Međimurje, Varteks, Zadar, Šibenik, Split and Hrvatski dragovoljac). To this day five clubs finished the reforming process, and now they are sports joint-stock company (Hajduk, Istra 1961, Cibaliija, Rijeka, and Osijek).

The first club that completed the transformation was FC Hajduk in 2009. If we compare the planned structure and the current situation, we see a number of clubs joined the reshaping process in relation to the expressed intent. Initially, 53% of clubs have stated that they plan to reform to sports joint-stock company and now it is a total of 63% of clubs that began or finished the reforming. More than it was planned. Figure 2 shows the distribution of the Croatian First League Clubs by current organizational form. The majority of clubs is currently in the reforming process.

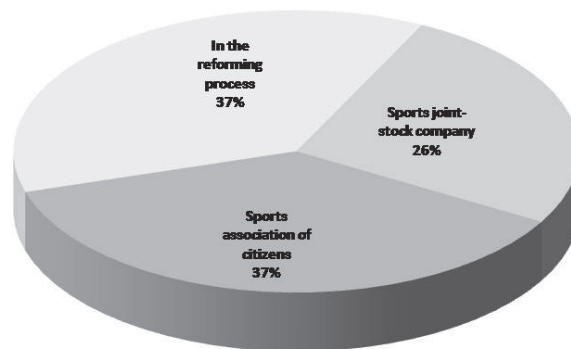


Figure 2. Current organizational structure of the Croatian First League Football Clubs

*Organizational units of the football clubs in Croatian First League*

Data were collected on the number and type of organizational units of the clubs. The results showed that there were differences in the number and type of established organizational units.

Table 1. Number and type of organizational units by five-year period from 2007 to 2012 championship season

Season	2007/08	2008/09	2009/10	2010/11	2011/12
No. of Clubs in the Croatian First League	12	12	16	16	16
Organis. units	No. of clubs with specific organizational unit				
Administrative	12	12	16	16	16
Financial	12	12	15	15	16
Technical	11	11	15	15	15
Medical	11	11	15	15	15
Sport	12	12	16	16	16
Marketing	8	8	9	11	12
No. of Clubs → total N of Units	8 → all 6 3 → 5 1 → 4	7 → all 6 4 → 5 1 → 4	7 → all 6 7 → 5 2 → 4	10 → all 6 4 → 5 2 → 4	11 → all 6 4 → 5 1 → 4

Of the above six organizational units, more than 50% have all units trough this five-year period. In each season, about one third of the clubs lack one unit and it is usually marketing unit while 1-2 clubs have formed only four units. And most of them lack the marketing department too, in some clubs also lacks medical or technical services. One of the possible explanations for that was a possibility for medical or technical services can be covered by an external collaboration contract and similar forms of contracting to provide Clubs certain services at certain times.

Results from 5-year period show increase in number of clubs that have marketing service. In the last season (2011/12) marketing service is organized as a separate department in 75% of clubs, while 25% still have not established the marketing department/unit. Possible reasons for this situation may be related to:

- limited budget of the clubs
- obsolescence of business and a lack of vision on the marketing importance, failure and absence to recognize the need for a separate marketing department and continuous marketing activities.

However, in modern business organizations, including professional football clubs, marketing plays an important role in the revenue of the club. Applying the marketing concept is dependent on the final clubs budget, while the budget of the club depends on the success of club's marketing (Medić & Pancić, 2009). Marketing role is significant in terms of sponsorships, donations and membership fees and other things (souvenirs, props, sweepstakes) (Medić et al. 2012). Sponsorship is increasingly recognized as an important issue in the development of Croatian football. The role of marketing in the annual budget is also important (Bartoluci, 1992). Therefore, in the context of lower budget, marketing is an important aspect of the business, which can significantly improve Clubs' future financial performance.

#### *Measures of performance*

As each organization, sports organizations measure and evaluate its performance and success. Financial indicators were typical measures. But in sport, placement on the ranking list (by championships season, annually, etc.) was very important success indicator and can be used as a performance measure in combination with finances performance.

#### *Placement/ranking*

Number of clubs in the Croatian First League changed throughout 5-year period. In 2007/8 and 2008/9 season there were 12 clubs and 16 clubs in last 3 seasons (from 2009/10 to 2011/12). From total of 19 clubs covered by this research, 11 have been continuously in the Croatian First League. From remaining clubs, two were only in one championship season which they achieve low ranking. To explore is there significant change in rankings through 5-year period, Spearman's rho correlation coefficient was used to calculate relationships between Clubs rankings by seasons. Results revealed positive statistically significant correlation between Club's placement on ranking list for nearby seasons from 2007 till 2010. Somewhat different situation was found for 2011/12 ranking which was not significantly correlated to nearby season but was significantly correlated to 2007/08 and 2008/09 season.

#### *Clubs' finances/income*

There were five annual income categories and each club reported income category for each season. Results revealed high positive correlation between income categories through five-year period.

That indicates no change in clubs income status. Those in high income category in 2007/08 stay in high categories through five-year period till 2011/12. And same for those with low income.

Table 2. Correlations between season rankings

	Ranking 07/08	Ranking 08/09	Ranking 09/10	Ranking 10/11
Ranking 08/09	** .71			
Ranking 09/10	.56	* .66		
Ranking 10/11	.44	.57	** .68	
Ranking 11/12	* .61	* .63	.34	.50

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

\* Correlation is significant at the 0.05 level (2-tailed)

Table 3. Correlation between club income categories by seasons

	Income 07/08	Income 08/09	Income 09/10	Income 10/11
Income 08/09	** .90			
Income 09/10	** .86	** .88		
Income 10/11	** .65	** .75	** .80	
Income 11/12	* .56	** .70	** .76	** .88

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

\* Correlation is significant at the 0.05 level (2-tailed)

Furthermore, average ranking and average income for stated five-year period were calculated. There was high negative correlation between average ranking and average income ( $r = -.721$ ;  $p < .01$ ) in this 5-year period. Clubs with higher placement almost by the rule have higher annual income. Organizational size in terms of units was not significantly correlated to financial measure for either season. However, causality conclusions should not be made based on correlation coefficients (Mejovšek, 2008).

## **Conclusion**

Throughout five-year period there was little change of clubs in the Croatian First League. Eleven out of 19 football clubs continuously remain in the First League. Based on the obtained results it can be concluded that the football clubs in the Croatian First League are not uniform in terms of organizational structure, and there are interclub differences in the number and type of organizational units. As for specific organizational units, certain services are continuously in the organizational structure of the club (administrative, financial, sports). Often lacks the marketing department, which even now a lot of the clubs do not have, although there is an apparent increase in the number of clubs that have formed the marketing service. Explored performance measures (ranking and financial status) are significantly correlated. According to financial performance measures, most of the clubs remain in the similar income category throughout five-year period what looks like little hope for clubs with low income nowadays. Improving organizational performance of the professional football clubs can be made through modern management that can assure functioning of the club as a cost effective sport organizations.

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## ORGANIZACIJSKA STRUKTURA U ODNOSU NA USPJEŠNOST NOGOMETNIH KLUBOVA PRVE HRVATSKE NOGOMETNE LIGE (1. HNL)

### Sažetak

Danas nogomet nije samo sport, već je ušao i u tržišnu sferu, a samim tim njegova je kvaliteta ovisna o uspješnosti menadžmenta i organizacije kluba. Pitanje organizacije nogometnih klubova i menadžmenta u nogometu danas je aktualna tema na različitim društvenim razinama. Cilj ovog istraživanja je ispitati obilježja organizacijske strukture profesionalnih nogometnih klubova 1. Hrvatske nogometne lige (1.HNL) u odnosu na mjere uspješnosti tih klubova. U istraživanje je uključeno 19 nogometnih klubova, svih koji su bili u 1.HNL u razdoblju od 2007./8. do 2011./12. natjecateljske sezone. U navedenom razdoblju 11 klubova je kontinuirano bilo u 1.HNL. Rezultati su pokazali da klubovi 1.HNL nisu uniformni po pitanju organizacijske strukture već da postoje međuklupske razlike u tipu organizacije, te broju i vrsti organizacijskih jedinica. Po pitanju ustrojbenog oblika, 4 kluba su postala sportsko dioničko društvo (s.d.d.), dok je 8 klubova trenutno u procesu preoblikovanja u s.d.d. Po pitanju organizacijske strukture, određene organizacijske jedinice (službe) su prisutne u svim klubovima (administrativna, financijska, sportska) dok najčešće nedostaje marketinška služba. Pokazalo se da organizacijska struktura u smislu broja i vrsti jedinica nije povezana s financijskom uspješnosti klubova, međutim utvrđena je značajna povezanost plasmana i financijskog statusa kluba. Nadalje, utvrđena je značajna korelacija plasmana kluba za susjedne sezone ali ne i za udaljene, s izuzetkom 2011/12 sezone.

**Ključne riječi:** nogometni klub, organizacijska struktura, plasman

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## COMPARATIVE ANALYSIS OF ATTITUDES ABOUT FITNESS AND ELEMENTS OF ITS PROMOTION AS A STRATEGY OF 4P

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### Abstract

*Fitness as a form of recreation represents one of the ways we can affect the health of individuals. For the information of the existence and importance of fitness we use marketing. In the modern world marketing exists in all spheres of life and we need to use marketing in a positive way through the 4P concept of strategy with special focus on promotion as one of the categories 4P. The aim of this paper is to present comparative analysis of attitudes about the importance of fitness in people's lives and to see the awareness of respondents about the need of doing fitness as a form of recreation. The aim of this work is also to show which the attitudes of respondents are when it comes to ways to promote fitness but within the 4P strategy. In this way, we can form the guidelines which can show us what form of promotion we should pay more attention to. The assumption of this paper is that comparative analysis will show increased parameters when it comes to awareness of respondents about fitness as one of the best ways for female population to recreate. The assumption in this paper is also that on advertising as an element of promotion should be given more attention to. The survey was conducted on a sample of 31 respondents in the target population who are female trainees as a recreational form of fitness activities. The survey was conducted during the year 2009/2010 and was repeated in the year 2013. The results showed through comparative analysis that for variable: "I think that fitness is one of the best ways to exercise", respondents showed greater awareness and greater interest in the research that is conducted in the year 2013 than in the previous research. According to the results of new research 96.773% of the respondents agree and completely agree with this statement observed in the year 2013 which is in compare to previous analysis of the attitudes measured during 2009/2010.godinu higher result in a difference of 26, 77%. Research has shown that the greatest attention should be paid to advertising as an element of a promotion and that place of sale took the first place as an element of promotion in the strategy 4P. The research has also shown that according to general rang and when it comes to the total value of answers, respondents put communication from mouth to mouth on the fourth place and public relations on the first place.*

**Key words:** fitness, promotion, 4P, strategy

### Introduction

Fitness as a form of recreation represents one of the ways of how we can affect an individual health. Marketing serves us for informing people about the existence and importance of fitness. In a modern world there is marketing in all spheres of a life and it is necessary to use it in a positive way so that are used the concepts of strategy 4P with the special review to the promotion as one of the 4P categories. Comparative analysis of fitness attitudes will show the span of the values and attitudes of the respondents when their awareness about fitness and a need for recreation of female population is in a question. Promotion elements of the strategy 4P are very important because they are directing us to the conclusions towards which we will act in the range of marketing strategy.

A term „fitness“ in a more narrow sense represents well-developed physical abilities, in English in the original title says *physical fitness or just fitness*. In a wider sense fitness represents physical preparation, regarding the whole idea of recreative exercising with the aim of improving physical ability levels. Fitness is connected to lives of people as a healthy component and it should be observed that way.

Namely, today recreation is very important as a form of exercising so that people feel better and live more healthy. To achieve that, they can do fitness. This is just one of the ways of improving life and health quality. For fitness people need to have information, as for all other things. For new and present products or services people should be informed in a right and positive way. Promotive activities and different elements of the promotion serve us for a placement of information and meeting consumers, regarding the ultimate users. Promotive activities are a part of marketing as a special scientific discipline. In all life spheres, business and private, on every step we find marketing and some of the promotion forms. Marketing can serve us in positive purposes and this way we can use it. Marketing is one complex scientific discipline which can be determined in different ways. We can say it connects market and consumers. Market is important because everything happens in the market and it must be explored who needs something in the market, why they need it and with the needs of market, marketers can create a certain marketing strategy. For marketing consumers are very important, actually users of some services.



As a basic aim of marketing on the first place stands out satisfying the needs of consumers then on the second place a profit, regarding realizing aims of an organization, ie. company. Marketing is an activity that goods are moving from producers to consumers. Marketing is a process of management which is used for identification and prediction and satisfaction of the needs and wishes of consumers in a profitable way. Consumers are those who buy products and use services. Marketing-mix means(4P) :

- Price
- Product
- Place
- Promotion

Beside these basic elements, some theorists quote that there should be following elements: People, Process and Physical environment. Promotion is perhaps the most important component because the most depends on representing itself and product description or service to consumers with the minimal exception of the real condition of things because consumers can recognize everything in certain moments. It is necessary to follow the needs of consumers and to work on their interest to achieve satisfaction of consumers, users of a product and service users. Promotion uses four elements in that purpose:

- advertising (communication which is paid - commercials on TV and radio, Internet ad, advertising and ads in print media - newspapers, magazines and billboards);
- public relations ( communication which is not directly paid, newspapers reports, trade fair, exhibitions, shows, seminars and so on);
- communication from mouth to mouth (informal communication about product among individuals. Those individuals can be satisfied consumers, and can be engaged persons to encourage communication from mouth to mouth);
- Place of sale (place where a sale product communicates with a consumer. Kindness of staff, their uniforms, decoration of sale space, inventory, pleasant atmosphere, surroundings etc).

In our case consumers are exercisers and all those who are interested in fitness. As any kind of service or product fitness also can be promoted to affect the awareness of people about their health and a better condition of the organism in psycho-physical sense.

## Methods

### *Sample of respondents*

The research was done on the sample of 31 respondents, out of which 3 questionnaires are incomplete so they were eliminated and 31 questionnaires are valid. Previous research meant 30 respondents which for the needs of comparative analysis in the total number is 61 respondents. Targeted respondent group represents female population, fitness exercisers through three forms of fitness, aerobic training, corrective gymnastics and mix aerobics.

### *Variables and measurement*

The research was performed with the questionnaire in which are consisted attitudes as variables:

- I consider fitness as a modern sports-recreative activity and
- I consider fitness one of the best ways to rcreate myself.

In the questionnaire also is set a chart with granting the expected values according to numbers to determine the position of some elements of the promotion. Offered variables: Advertising, public relations, communication from mouth to mouth, place of sale. The research was done on the basis of the questionnaire. Respondents answered to the first two statements on the basis of the offered answers in the form of Liker's scale: agree completely, agree, partly agree, do not agree and disagree completely. In the range of frequency of the answers of the respondents to the promotion elements are shown individual and group rang lists of promotion elements so as values of the answer frequency for specific promotion elements expressed in values of the absolute and relative frequencies of the answers. During the result analysis comparative analysis was done. With comparative method were compared the results of the first two statements from the questionnaire done during 2009/2010 and results of the questionnaire done during 2013. The first assumption of the work is that comparative analysis will show increased parameters when the awareness of respondents about fitness as one of the best ways for female population to recreate is in question. The second assumption in the work is that to the advertising as an element of promotion, bigger attention should be given.

## Results and discussion

### *Comparative analysis of attitudes about fitness and importance of fitness*

During the research the comparative analysis of the attitudes of exercisers was done about the importance of fitness. Comparative analysis means comparing the results of the reseach which was done during 2009/2010. and the reseach done in 2013. The reseach was done on the sample of 31 respondents. Previous reseach considered 30 respondents which for the needs of the comparative analysis in the total number is 61 respondents. The targeted group represents female popoulation, of fitness exercisers through 3 fitness forms, aerobic fitness, corrective gymnastics and mix aerobics.

### *Analysis of fitness attitudes*

In the chart 1 are seen comparative results connected to the attitudes of the respondents: I consider fitness as a modern sports-recreative activity. For variable: I consider fitness as a modern sports-recreative activity, comparative analysis showed that during 2009/2010. 91 % respondents answered that they agree and completely agree with this statement, while for 2013. that percent was 96.77%.

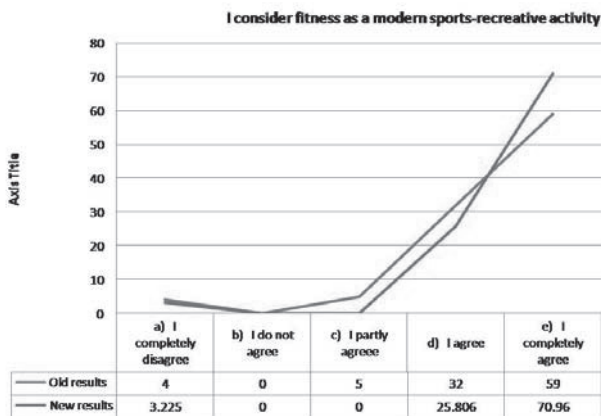


Chart 1 Comparison to the first attitude

In the chart 2 are seen the comparative results connected to the attitude of the respondents. I consider fitness one of the best ways to recreate myself.

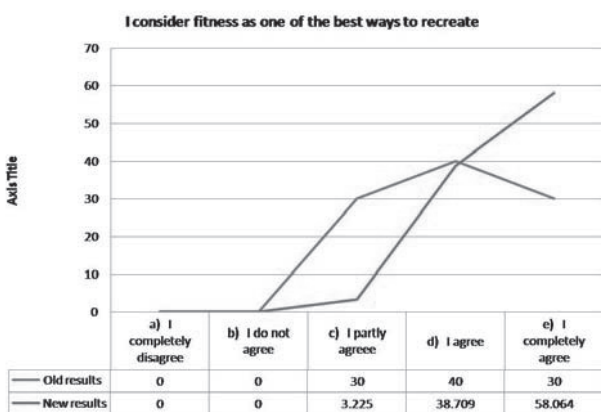


Chart 2 Comparison to the second attitude

For variable: I consider fitness one of the best ways to recreate, the comparative analysis showed that during 2009/2010, the total of 70 % respondents answered that they agree and completely agree with this statement, while for 2013. That percent was 96.773 %. With the analysis we showed that the number of respondents who agree with the listed statement was increased through the observing period. That showed that the female awareness has been changing and that they are more interested in fitness as a recreation, with which was proved the first assumption listed in the paper.

*Analysis of elements 4P*

In the chart can be seen the frequency of the answers expressed in the numeric values. The answers are connected for assigning places to specific elements of promotion according to the importance.

In the table 2 can be seen the frequency of the answers expressed in percents. The answers are connected for assigning places to specific elements according to the importance.

Table 1. Results of questionnaire expressed in absolute frequencies of answers

Promotion elements	Frequency of answers for the place 1	Frequency of answers for the place 2	Frequency of answers for the place 3	Frequency of answers for the place 4
a) Advertising	9	4	6	12
c) Public relations	2	4	19	6
c) Communication from mouth to mouth	9	16	2	4
d) sale place	11	7	4	9

Table 2. Results of questionnaire expressed in relative frequencies of answers

Promotion elements	Frequency of answers for the place 1, %	Frequency of answers for the place 2, %	Frequency of answers for the place 3, %	Frequency of answers for the place 4, %
a) Advertising	29.032	12.903	19.354	38.709
b) Public relations	6.451	12.903	61.29	19.354
c) Communication from mouth to mouth	29.032	51.612	6.451	12.903
d) sale place	35.483	22.58	12.903	29.032

According to the attitudes and opinions of the respondents, on the first place is the place of sale, because 35.483 % of the respondents out of the total number set this promotion element on the first place featuring it as the most important and to the place of sale enough attention was given. According to the attitudes of the respondents on the last place was the advertising as the promotion element because 38.709 % of the respondents set this element on the last place, regarding the position number 4. With the analysis we showed that to the advertising it is necessary to bring bigger attention as a promotion element and that it is not used enough as a promotion element in a positive way. With this attitude of the respondents the second assumption is confirmed. This assumption is partly confirmed because the results of complete rank list presented in the chart 4 gave different display of the results. The analysis of the individual attitudes arranged according to the given order is shown in the table 3. Individual rank list is showing how many times every respondent put a single element on the first, respecting the fourth place. In the table 4 is listed the collective rank of promotion, according to the involvement of the answers for the first and second place which were assigned for specific promotion elements. This rank shows the total level of participation for specific promotion elements which are assigned the position according to the attitudes of the respondents.

Table 3. Individual rank list

Promotion elements	Place
d) Sale place	1
c) Communication from mouth to mouth	2
b) Public relations	3
a) Advertising	4

According to the collective rank, results are somehow changed regarding the table 3 in which the individual rank is shown.

Table 4. Collective rank of promotion forms

Promotion elements	Place
a) Communication from mouth to mouth	1
d) Sale place	2
a) Advertising	3
b) Public relations	4

According to the collective rank the respondents are observing the total values of the answers, on the first and second place put communication from mouth to mouth and on the fourth place are public relations.

With this is partly affirmed the assumption that to the advertising element should have bigger attention.

## Conclusion

The research results showed that through the comparative analysis they are for the variable: Considering fitness one of the best ways to recreate, the respondents showed greater awareness and bigger interest in research which was done during 2013 than in the previous one. According to these new results 96, 773 % of the respondents agree and completely agree with this attitude during the period 2013. What is in a comparison with the previous analysis of the attitudes measured during 2009/2010 a bigger result with a difference of 26, 77 % . With this, the assumption of the work is confirmed. With the analysis we showed that to the advertising as an element of promotion should be given bigger attention and it is not used enough as an promotion element in a positive way. With this attitude partly is confirmed the second assumption. This assumption is partly confirmed because the results of complete rank list shown in the table 4 provided completely different display of the results. According to the collective rank the respondents observing the total values of the answers, on the first and second place put the communication from mouth to mouth and on the fourth one, there are public relations. According to individual rank the advertising was on the last place while the place of sale took the first place.

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## KOMPARATIVNA ANALIZA STAVOVA O FITNESSU I ELEMENTI NJEGOVE PROMOCIJE KAO STRATEGIJE 4P

### Sažetak

Fitnes kao oblik rekreacije predstavlja jedan od načina kako možemo utjecati na zdravlje pojedinaca. Za informiranost ljudi o postojanju i važnosti fitnesa služi nam marketing. U suvremenom svijetu marketing se nalazi u svim sferama života i potrebno ga je iskoristiti na pozitivan način tako što se služimo konceptima strategije 4P sa posebnim osvrtom na promociju kao jednu od kategorija 4P. Cilj ovog rada je prikazati analizu komparativnih stavova o važnosti fitnesa u životu ljudi i sagledati svjesnost ispitanika o potrebi bavljenja fitnessom kao jednim oblikom rekreacije. Cilj ovog rada je takođe prikazati koji su stavovi ispitanika kada su u pitanju načini promocije fitnesa ali kroz strategije unutar strategije 4P. Na taj način dolazimo do smjernice koja pokazuje kojem obliku promocije treba posvetiti veću pažnju. Pretpostavka rada je da će komparativna analiza pokazati povećane vrijednosti kada je u pitanju svijest ispitanika o fitnessu kao jednom od najboljih načina da se ženska populacija rekreira. Pretpostavka u radu je takođe da oglašavanju kao elementu promocije treba posvetiti veću pozornost. Istraživanje je provedeno na uzorku od 31 ispitanika u sklopu ciljne grupe ženske populacije vježbačica fitnesa kao rekreativnog oblika aktivnosti. Istraživanje je provedeno tijekom 2009/2010 godine i ponovljeno je u 2013. godini. Rezultati istraživanja pokazali su kroz komparativnu analizu da su ispitanici za varijablu: Smatranje fitnes jednim od najboljih načina da se rekreiramo, pokazali veću zainteresiranost u istraživanju koje je urađeno u toku 2013. godine nego u prethodnom. Prema novim rezultatima 96,77 % ispitanica se slaže i u potpunosti slaže sa ovim stavom promatrano za 2013. godinu što je u usporedbi s prethodnom analizom stavova prikupljenih tijekom 2009/2010. godine bolji rezultat za 26,77 %. Istraživanje je pokazalo da najveću pozornost treba posvetiti oglašavanju kao elementu promocije a da je vodeću ulogu zauzelo mjesto prodaje kao elemenat promocije u okviru strategije 4P. Istraživanje je pokazalo da su prema zbirnom rangu ispitanici (gledano prema ukupnim vrijednostima odgovora), na prvo i drugo mjesto stavili komunikaciju od usta do usta a na četvrtom mjestu su se našli odnosi sa javnošću.

**Ključne riječi:** fitnes, promocija, 4P, strategija

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## INFLUENCE OF MOTOR ABILITIES ON THE EXECUTION SPEED OF COMPLEX KARATE COMBINATION IN RELATION TO TERRITORIAL FACTOR

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Original scientific paper

### Abstract

The aim of this study is to determine the possible existence of territorial depending influence of basic motor abilities on the execution speed of complex karate combination. Sample of subjects included 115 Montenegrin male karate practitioners, aged 15 years  $\pm$  6 months, divided into three subsamples according to the corresponding territorial regions (north  $n=37$ , central  $n=39$  and south  $n=39$ ). For the purposes of this study a system of 19 variables, which are hypothesized to cover areas of basic motor abilities (18 variables) and specific motor abilities (1 variable), was used. All results have been subjected to statistical analysis, which involves regression analysis as the primary statistical operation. Insight into results relieved that in two out of three subsamples (north and south region) predictor system of basic motor abilities has a statistically significant influence on the criterion, while significant influence in central region was not found. With this it is possible to conclude that the existence of territorial factor resulted with the differences in motor abilities influence on the execution of karate techniques in three regions.

**Key words:** motor abilities, karate technique, karate combination, territorial factor

### Introduction

Karate takes an important place in today's sport, not just because it is widespread, but because the organization of the competitions is at a high level. With this in mind, sport karate has become one of the most popular forms of martial arts competition (Gibson & Wallace, 2004). It allows the practitioners a safe and controlled environment in which it is possible to test their skills against various opponents, using a light contact with the appropriate points system. Karate belongs to the family of acyclic polystructural sports, in which participants aim to achieve symbolic victory over the opponent with simulated or strictly controlled techniques, either by punches or kicks, while trying to avoid penalty by striking opponent too hard. This is most crucial difference between karate and other martial arts. Because of the aforementioned system of regulations and restrictions, in today's karate kumite competitions, fight between two karatekas takes the general form of demonstrating athlete's speed, agility, strength and technical repertoire.

To achieve top results in today's karate sport it is very important to have a clearly controllable training process. Anthropological characteristics are an important factor for success in karate, where the most important role for achieving top results has speed. Taking this into account, Sertić (2004) gave a hypothetical equation of success specification in karate, which reads as follows: JSK = 25% speed + 20% coordination + 18% strength + 15% flexibility + 12 % accuracy + 10% balance. It is apparent that the largest share at the specification of performance in karate has speed with coordination and strength in all its forms. Martínez de Quel Pérez (2003) states that the most important factor in meeting today's karate competition demands are reaction speed with visual reaction speed.

In addition, Thouburn (2002) says that success in sport karate depends on explosive strength, speed and anaerobic endurance while there remains a need for aerobic endurance to maintain a high energy level throughout the competition. Special treatments that are conducted in the training karate process always strive for the establishment of such anthropological dimensions that are adequate for the implementation of strictly specific sport activities that lead to successful and high-quality sport results. Given this, only athletes who possess a high enough level of basic motor abilities will be able to perform all necessary activities for participation in top level karate. Doder et al. (2011) suggest that with greater development of karate as a sport, modern approaches, concepts, forms, activities and procedures in training technologies with young karate athletes are required. This especially concerns the structure of anthropological characteristics and specific impacts on athletic performance. In kumite fight, there are a large number of techniques that are being used in competition, most often like a combination of techniques, while some combinations are so complicated that even some top trained karate athletes are not able to respond to all requests imposed to them by this sport. For these reasons, there is a constant search for ways to apply the laws of science to improve the movement of the body, where the effectiveness of karate technique itself is a derivative of these scientific recognitions. Relations of motor abilities and specific motor abilities and karate technique effectiveness are determined in many studies (Blažević et al., 2006; Doder, et al., 2009; 2011; Mikić, et al., 2009; Roschel et al., 2009; Katić et al., 2010). However, it is not recorded that geographical features were involved into the equation.



With this in mind, it was meant to check does territorial factor represent an important characteristic while assessing influence of basic motor abilities on karate techniques, in small country like Montenegro.

**Problem and aim**

The main problem of this study is to identify influences of territorial factor on the influence level of basic motor abilities on the effectiveness of techniques in karate practitioners aged 15 years ± 6 months. The aim of this study is to determine the possible existence of territorial depending influence of basic motor abilities on the execution speed of complex karate combination. With this information it was meant to find out about the impact rate of the basic motor abilities on the correct performance of multiple hand and foot karate techniques.

**Methods**

Sample of subjects included 115 Montenegrin male karate practitioners, aged 15 years ± 6 months, divided into three subsamples according to the corresponding territorial regions (north n=37, central n=39 and south n=39). Subsample north region subjects (body height - 171.78±5.16 cm; body mass - 63.83±6.69kg) came from karate clubs "Jedinstvo" - Bijelo Polje, "Ris" - Pljevlja and "Gorštak" - Kolašin. Subsample central region subjects (body height - 172.51±6.33cm; body mass - 61.71±8.04kg) came from karate clubs "Budućnost" - Podgorica, "Onogošt" - Nikšić, "Omladinac" - Podgorica and "Nord Iskra" - Podgorica. Subsample south region subjects (body height - 170.32±4.93cm; body mass - 63.41±7.26kg) came from karate clubs "Jadran" - Herceg Novi, "Risan" - Risan, "Albulena" - Ulcinj and "Bar" - Bar. With this type of research in mind, only brown or black belt competitors in kumite fights, participated in this study. All subjects were in the systematic training process for a minimum time period of 3 years.

For the purpose of this study a system of 19 variables, which are hypothesized to cover areas of motor abilities (18 variables) and specific motor abilities (1 variable), was used. For assessment of basic motor abilities, variables: flamingo (MRFLM), Stork test with closed eyes (MRSTK), hand tapping (MBTAR), foot tapping (MBTAN), 20m running start (MBT20M), 20m shuttle run (MI20SR), standing long jump (MESDM), throwing a medicine ball from lying position (MEBML), 30s crunches (MSLS), pushups on parallel bars (MSSR), endurance on high bar (MSIV), endurance in a half squat with weight (MSIPT), side steps (MKKUS), agility in air (MKOZ), precision with long rod (MPCDS), throwing at horizontal aim (MPGHR), over-arm flip (MFIP) side-lying leg raising (MFOLB) were used. For assessing specific motor abilities, the execution speed of complex karate combination (SBIKK) variable, was used.

In assessing of this criterion, subjects were tasked to, in the shortest time possible, do 5 different

"kumite" punches and kicks, while moving forward and crossing the line of 2m. A complex karate combination consists of the following techniques: kizami-zuki, djako-zuki, ashi-mawashi-geri, mae-geri, and ushiro-mawashi-geri. The results in this study were subjected to statistical analysis, which in this case includes regression analysis. With regression analysis, predictor value of selected indicators of motor abilities on established criterion, were determined. To determine the relations of predictor variables and the criterion variable, multiple correlation coefficient (R), coefficient of determination (R<sup>2</sup>), statistical significance level of the coefficient of multiple correlation (Q), the partial regression coefficient (β) and the statistical significance level of partial regression coefficient (Q(β)), were calculated. All results were analyzed using SPSS 17.0 statistical PC software.

**Results**

In this part, given below are tables showing results of regression analysis of the basic motor abilities impact on execution speed of complex karate combination, as well as detailed analysis of the obtained data.

Table 1. Regression analysis of SBIKK criterion in subsample north region

Variable \ Parameter	B	Se(β)	β	Q-β
MRFLM	8.16	.02	.05	.75
MRSTK	-2.88	.01	-.07	.60
MBTAR	-3.38	.03	-.21	.31
MBTAN	-6.67	.03	-.03	.86
MBT20M	-.43	.18	-.41	.02
MI20SR	1.68	.04	.07	.70
MESDM	-1.14	.01	-.05	.83
MEBML	6.10	.01	.24	.45
MSLS	1.14	.02	.07	.69
MSSR	-2.68	.02	-.30	.25
MSIV	-3.67	.01	-.12	.57
MSIPT	3.69	.01	.19	.54
MKKUS	.26	.09	.44	.02
MKOZ	.42	.16	.61	.02
MPCDS	2.42	.02	.20	.30
MPGHR	-2.74	.01	-.33	.08
MFIP	5.40	.01	.10	.68
MFOLB	-1.21	.01	-.19	.48

R=.92, R<sup>2</sup>=.85, Q=.00

Inspection of the values of the parameters contained in table 1, the calculated values of the multiple correlation coefficient (R=.92), in accordance with expectations, suggest that there is a statistically significant linear relationship between the predictor variable system of basic-motor abilities and criterion SBIKK, in a percentage of 92% at Q=.00 level of statistical significance. In addition to examining the determination coefficient R<sup>2</sup>, shows that there is 85% of common variability between predictor system and criterion, for this subsample of subjects. Having demonstrated a statistically significant effect of the independent variables of the system that represents basic motor abilities to perform complex karate combination as dependent variable, it can be moved to further

analysis of the individual  $\beta$  coefficients. The second part of table 1 shows which of the individual variables, and on what extent, has a significant impact on dependent variable SBIKK. There are three variables that showed a statistically significant impact on criterion at  $Q \leq .05$  level. The first variable is MKKUS, where the partial regression coefficient is  $\beta = .44$  ( $Q(\beta) = .02$ ). Another dependent variable that has a statistically significant impact on criterion is MKOZ, where  $\beta = .61$  at  $Q = .02$  level of statistical significance. These variables are assessing coordination, which could lead to a conclusion that successful execution of karate combination requires an optimally developed level of coordination in karate athletes. Noticeable, a negative impact of variable for assessment of running speed (MBT20M), where the level of statistical significance is  $Q(\beta) = .02$ , while the partial regression coefficient is  $\beta = -.41$ . This negative effect can be interpreted as subjects that scored numerically lower results on test 20m flying start running, at a test execution speed of complex karate combination, scored numerically higher results. At last, it can be reported that only these three variables showed statistically significant influence of basic motor abilities on criterion in the subsample north region.

Table 2. Regression analysis of SBIKK criterion in subsample central region

Variable \ Parameter	B	Se( $\beta$ )	$\beta$	Q( $\beta$ )
MRFLM	1.90	.05	.10	.71
MRSTK	3.93	.01	.08	.71
MBTAR	2.33	.03	.14	.54
MBTAN	-3.27	.05	-.12	.57
MBT20M	-.13	.46	-.07	.77
MI20SR	-4.91	.06	-.01	.99
MESDM	-4.20	.01	-.19	.54
MEBML	-1.08	.01	-.04	.82
MSLS	-6.12	.03	-.36	.11
MSSR	-2.01	.03	-.16	.54
MSIV	-2.97	.01	-.06	.82
MSIPT	-4.10	.01	-.01	.94
MKKUS	-5.52	.12	-.10	.67
MKOZ	-4.76	.21	-.05	.82
MPCDS	-6.77	.04	-.38	.14
MPGHR	2.66	.02	.27	.30
MFIP	-1.11	.01	-.20	.52
MFOLB	-1.49	.02	-.20	.55

$R = .76, R^2 = .58, Q = .15$

A review of some previous studies (D. Doder & R. Doder., 2006; Doder et al., 2009) which deal with similar problem, has not shown that in some instances a coordination test showed a statistically significant effect on the performance of karate technique, while none of these cases assessed the combination of five techniques but a single or combination of two techniques. Analysis of table 2, which carries the regression analysis information of basic motor abilities predictors on criterion SBIKK, shows that with  $Q = .15$  level of statistical significance, there is no significant effect of the predictor system on criterion. As no statistical significance of the predictor system on criterion is found, analyzing of partial regression coefficients

won't be done. Influence values of basic motor abilities predictor system on specific motor abilities criterion SBIKK in the subsample south region, are shown in table 3. Insight into the value of the multiple correlation coefficient ( $R = .90$ ), shows the existence of regression relations between aforementioned variables on  $Q = .00$  statistical significance level.

Table 3. Regression analysis of SBIKK criterion in subsample south region

Variable \ Parameter	B	Se( $\beta$ )	$\beta$	Q( $\beta$ )
MRFLM	-5.92	.04	-.30	.17
MRSTK	-3.70	.01	-.08	.70
MBTAR	3.59	.04	.25	.44
MBTAN	-.13	.06	-.64	.06
MBT20M	.51	.31	.52	.11
MI20SR	-1.57	.05	-.00	.99
MESDM	-3.06	.01	-.13	.65
MEBML	1.54	.01	.52	.02
MSLS	1.26	.03	.08	.65
MSSR	2.36	.03	.18	.50
MSIV	-9.05	.01	-.25	.33
MSIPT	1.09	.01	.05	.78
MKKUS	6.82	.10	.15	.00
MKOZ	-1.78	.12	-.01	.98
MPCDS	-2.70	.02	-.21	.21
MPGHR	-1.02	.01	-.10	.54
MFIP	-6.10	.01	-.01	.96
MFOLB	-5.21	.01	-.07	.67

$R = .90, R^2 = .82, Q = .00$

Coefficient of multiple correlation explains existence of 90% relation with the independent variable. With other parameter, determination coefficient, it can be concluded that there are about 82% of mutual variability between dependent and independent variable, that shows the level of predictor system influence on criterion. Insight into individual variables and their influence on the dependent variable, it can be noticed that two variables have statistically significant on criterion. Variable MKKUS has a statistically significant influence ( $Q(\beta) = .00$ ), where the partial regression coefficient is  $\beta = .15$ . Besides this, variable MEBML, also shows statistically significant influence ( $Q(\beta) = .02$ ) with  $\beta = .52$ . In both cases coefficient  $\beta$  is positive, but it is evident that subsample south region subjects which scored better results in coordination test also scored better scores in executing complex karate combination. With these results in mind, here it could be concluded, that for quality execution of complex karate combination in the subsample south region, biggest prediction value has coordination, which in this case is expressed through test - side steps. In other hand, also, important predictive impact was shown through throwing a medicine ball from lying position assessing hand power.

**Discussion and conclusion**

It could be concluded that testing results of the subsample central region determined final results in differences of motor abilities influence on the execution speed of complex karate combination.

In this case subsamples north and south region are characterized by statistically significant predictor system influence on criterion at  $Q=.00$  level. Different from these, regression analysis showed that the subsample central region did not possess statistically significant influence ( $Q=.15$ ) of the predictor system on criterion, while the same subsample shows lowest values of multiple correlation and determination coefficients. The subsample north region possesses highest value of the multiple correlation coefficient ( $R=.92$ ), while the value of this parameter in the subsample south region is  $R=.90$ . Determination coefficient is highest in the subsample north region ( $R^2=.85$ ), while in the subsample south region this parameter has value of  $R^2=.82$ . From this it could be concluded that system differences between north and south regions are very small and could be ignored. Inspecting values of partial regression coefficient, statistically significant influence in the subsample north region was seen in variables MBT20M ( $\beta=-.41$ ;  $Q-\beta=.02$ ), MKOZ ( $\beta=.61$ ;  $Q-\beta=.02$ ) and MKKUS ( $\beta=.44$ ;  $Q-\beta=.02$ ), while in the subsample south region these variables are MKKUS ( $\beta=.15$ ;  $Q(\beta)=.00$ ) and MEBML ( $\beta=.52$ ;  $Q(\beta)=.02$ ). In the earlier studies (Blažević et al., 2006; Katić et al., 2010) it is stated that to achieve good results when performing specific karate tests, one must have high level of explosive strength, which is accompanied with the factors of speed and coordination. In this case, primary in the subsamples north and south region, important test for predicting results in execution speed of complex karate combination is side steps, while it could be concluded that high level of agility was necessary for faster execution of techniques. Running speed and coordination were shown as significant in the subsample north region, while explosive strength of upper body was found significant in south region.

In earlier studies (Mikić et al., 2009; Doder et al., 2009; Doder et al., 2011), it is noted that technical and competition karate success depends of explosive strength of lower body, while influence of upper body explosive strength was not found. With this information, it could be seen that there are differences in motor abilities influence on execution of complex karate combination between subsamples. The differences are smaller between subsamples north and south region, but the results in the subsample central region expand the gap. It could lead to a general conclusion that the existence of territorial factor resulted with the differences in motor abilities influence on the execution of karate techniques in three regions.

To achieve high sport results in competitions, a highly programmed and controlled training process, or procedure to maintain and develop many characteristics, abilities and skills in athletes, is needed. Results gained in this study, undoubtedly point to some differences in a few segments of long-term development and selection of athletes, as well as in period of starting early sport specialization. It is evident that training processes differentiate between karate clubs in three regions. Different approaches in training procedures lead to differences in karate technique learning and mastering, which, most likely, caused the occurrence of these different motor abilities influence on execution speed of complex karate combination in three geographically specific subsamples. Therefore, this study can serve as a starting point to optimize the training process in Montenegrin karateka. In order to confirm the results obtained in this study, further research with older sample of subjects is needed, while leaving room to test the impact of morphological characteristics on this criterion.

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## UTJECAJ MOTORIČKIH SPOSOBNOSTI NA BRZINU IZVOĐENJA KOMPLEKSNE KARATE KOMBINACIJE U RELACIJI SA TERITORIJALNIM FAKTOROM

### **Sažetak**

*Cilj ovog istraživanja je određivanje mogućeg postojanja teritorijalno zavisnog utjecaja bazičnih motoričkih sposobnosti na brzinu izvođenja kompleksne karate kombinacije. Uzorak ispitanika podrazumijeva 115 crnogorskih karatista muškog spola, uzrasta 15 godina  $\pm$  6 mjeseci, podijeljenih u tri subuzorka prema odgovarajućim teritorijalnim obilježjima (sjeverna regija  $n=37$ , središnja regija  $n=39$  i južna regija  $n=39$ ). Za potrebe ovog istraživanja korišćen je sistem od 19 varijabli, koje hipotetski pokrivaju prostor bazičnih motoričkih sposobnosti (18 varijabli) i jedna za procjenu specifičnih motoričkih sposobnosti (1 varijabla). Svi rezultati su podvrgnuti statističkoj analizi (regresijska analizu) kao primarnoj statističkoj operaciji. Uvidom u rezultate otkriva se da kod dva od tri subuzorka (sjeverna i južna regija) prediktorski sistem bazičnih motoričkih sposobnosti ima statistički značajan utjecaj na kriterij, dok se nije otkrio statistički značajan utjecaj kod subuzorka središnja regija. Sa ovim, moguće je zaključiti da je postojanje teritorijalnog faktora uvjetovalo razlike u utjecaju motoričkih sposobnosti na izvođenje karate tehnika kod tri regije.*

**Ključne riječi:** motoričke sposobnosti, karate tehnika, karate kombinacija, teritorijalni faktor

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## CORRELATION BETWEEN MOTOR SKILLS AND PERFORMANCE EVALUATION OF BALL ROUTINE ELEMENTS IN RHYTHMIC GYMNASTICS

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*Original scientific paper*

### **Abstract**

*The primary aim of this research was to establish if there exists any correlation between motor skills and success in performing technical elements of the ball routine in rhythmic gymnastics. The research was conducted on 52 female sophomore students of the Faculty of Kinesiology at the University of Zagreb. The students were put through a series of 12 tests establishing their basic motor skills: coordination, flexibility, explosive strength and static strength. Their success in performing technical ball routine elements (6), which are defined and prescribed in the course plan and program, was assessed by five competent judges. Through regression analysis it was established that a cogent statistical significance between the observed motor skills and success in performing technical elements from the ball routine does not exist. From the set of predictor variables, only the test for assessing coordination MBKS3L (slalom with three balls) showed statistical significance in the prediction of success in performing the selected criterion element.*

**Key words:** *students, coordination, flexibility, strength, regression*

### **Introduction**

Rhythmic gymnastics is a conventional sport, which is characterized by the unity of the movement of the whole body complimented with the manipulation of apparatus in harmony with music that represents an integral part of all movements. (Wolf-Cvitak, 2004). The successful execution of individual competition compositions depends on the current Code of Points prescribed by the sport's governing body, the *Fédération Internationale de Gymnastique* (susceptible to changes in each Olympic cycle), judicial discretion, the gymnasts degree of preparedness and contemporary trends in the sport (Jastremskaia, N., Titov, Y., 1999). The gymnasts performance is evaluated by judges based on thoroughly established criteria, however, as there does not exist a precise measuring instrument, the final score depends on the judges subjective assessment, and therefore errors are possible. The execution of elements that are an integral part of the choreography depends on a number of different factors: the level of motor skills, which according to Wolf-Cvitak (1984) affects the performance of rhythmic gymnasts by up to 60%. As a precondition to virtuosity in handling the apparatus, with the simultaneous coordinated execution of physical elements. (Kolarec, 2012). Well developed motor skills allow for the adoption of the basic elements of rhythmic gymnastics, creating a broad base for learning technical skills: elements with and without apparatus (rope, ball, hoop, clubs and ribbon), which the quality of the performance of competitive compositions depends on (Jastrjemskaia, Titov, 1999). Besides motor skills the success of rhythmic gymnasts is affected by: cognitive abilities, conative characteristics and morphological characteristics, important for the execution of elements and choreography, and artistic impression (Vandorpe et al, 2011; Zuniga et al, 2011; Siatras et al, 2009).

Full-time female students of the Faculty of Kinesiology at the University of Zagreb take the rhythmic gymnastics course in their second year of study. The course syllabus includes the acquisition of general motor skills by adopting the basic physical elements of rhythmic gymnastics and manipulation techniques for each of the apparatus (rope, hoop, ball, clubs, AND ribbon). Given that each student, when enrolling into the university, must meet a certain level of motor abilities and motor skills, the assumption is that they will become proficient at initial level technical elements for each sport relatively quickly, and that the adoption of more complex movement structures will require of them greater commitment and more training, and that at this level their performance will differ more significantly. The objective of this study was to determine the relationship between the motor skills of students at the Faculty of Kinesiology and the successful execution of technical elements from the ball routine in rhythmic gymnastics.

### **Methods**

The sample unit consists of 52 sophomore students of the Faculty of Kinesiology at the University of Zagreb, aged between 20-22 years, who attended the rhythmic gymnastics course for 2 semesters. The sample of predictor variables consisted of the results obtained by measuring motor abilities through 12 tests for assessment: *coordination* – MAGKUS (lateral steps), MAKTOZ (in air agility) and MBKS3L (slalom with three balls); *flexibility* – MFLPRK (sit and reach), MFLISK (overhead raise with stick) and MFLMOST (bridge); *explosive strength* – MFEBSL (medicine ball throw from supine position), MFESDM (standing long-jump) and MFESVM (stationary standing vertical jump)



and *repetitive strength* – MSCUC1 (squats in 1 minute), MRCDIZ (back contractions) and MRCSJD1 (sit-ups in 1 minute) (Metikoš et al, 1989).

The criteria variables consisted of the average value of all ratings (5 experts) with which the success of their execution of technical elements with the ball were evaluated: toss, turn 360° and catching with one hand (LBH), forward somersault with throwing and catching the ball (LKOL); hip rotations with hands extended to both sides (LKOT); rhythmic striking with a waltz step (LUV); horizontal figure eights with feet shoulder width apart and wave (LV8), 2 jumps with throwing and catching (L2S). (Furjan-Mandic, 2000). The assessment of the mastery of each element with the ball is defined by clear protocols and pointing criteria that are unambiguously defined and aligned with the rules of judging in rhythmic gymnastics (*Code of points 2010*) for the purpose of objectivity, and were assigned on a scale of 1 (lowest) to 5 (highest rating), using exclusively whole numbers. Data was collected throughout the semester during lectures and classes, and the results were analyzed by the Statistics package program for Windows version 7, at the Faculty of Kinesiology at the University of Zagreb.

For all variables in the predictor group basic statistical parameters were defined, normality of distribution was determined, and the correlations of predictor variables were calculated. While determining the objectivity of the judge’s marks descriptive parameters were calculated and the objectivity of the judges assessments were reviewed by a reliability analysis using the *Reliability analysis-scale Alpha*, and correlations in the judge’s marks for each individual element was established. Relations between the predictor and each individual criterion variables were determined through the application of *forward stepwise regression analysis*.

**Results and discussion**

Table 1. Matrix of descriptive parameters for predictor variables

	N	MV	SD	MIN	MAX	Skew	Kurt
MAGKUS	52	9,47	0,53	8,24	10,33	-0,41	-0,36
MAKTOZ	52	4,26	0,45	3,28	5,15	-0,08	-0,32
MBKS3L	52	25,70	3,35	19,29	33,37	-0,14	-0,49
MFLPRK	52	54,28	6,43	38,33	66,00	-0,53	-0,14
MFLISK	52	69,12	13,06	23,67	93,33	-0,64	1,57
MFLMOST	52	85,20	15,75	29,00	127,67	-0,55	2,72
MFEBML	52	7,97	1,25	5,37	11,27	0,37	-0,01
MFESDM	52	191,24	18,11	151,67	241,00	-0,17	0,20
MFESVM	52	47,07	5,70	37,33	58,33	0,36	-0,71
MSCUC1	52	52,31	6,12	38,00	68,00	0,02	0,28
DINZAKL-I	52	23,65	8,15	10,00	49,00	1,08	1,84
MRCSJD 1	52	35,81	4,98	23,00	46,00	-0,29	0,01

N – number of test subjects, MV – mean value, SD – standard deviation, MIN – minimum value, MAX – maximum value, Skew - asymmetry coefficient, Kurt - coefficient of curvature

The negative asymmetric distribution of the observed results indicates better results in most of the variables, which is most likely conditional to: positive selection, engagement and commitments to other practical subjects at university, and the fact that most of them were involved in a systematic training process. Positive asymmetry was observed in the back contractions test (DINZAKL), as a result of lower repetitive strength in the back, and in the medicine ball throw from supine position test (MFEBML), weaker explosive strength of the arms and shoulders, stationary standing vertical jump (MFESVM), weaker plyometric explosive strength and squats in 1 minute (MSCUC1), weaker repetitive leg strength.

From the correlation matrix it is clear that the majority of the correlations between variables to assess motor abilities are low, but statistically significant. A significant parallel between motor variables with a correlation of -0.47 and common variability of 22.09% is visible between assessment tests: explosive power MFESVM (stationary standing vertical jump) and coordination MBKS3L (slalom with three balls). Significant correlations were obtained between the variables to assess the same latent dimensions, the same mechanisms for the regulation of movement, between tests to assess vertical jump explosive power: stationary standing vertical jump (MFESVM) and standing long jump (MFESDM) = 0.52, and 27.04% common variance, and between tests to assess flexibility: bridge (MFLMOST) and overhead raise with stick (MFLISK) = 0.49 and 24.01% of common variance. Although the judges determined and elaborated evaluation criteria in advance, and were selected on the basis of knowledge and experience, objectivity is checked through reliability coefficients, and the correlation coefficient. (Miletić et al, 2004). Assessing or scoring the technical elements with the ball covered six elements from the group of: throwing and catching, deflecting, rolling (on the body or the ground) and the various movements with the apparatus such as: swinging, balancing, circling, figure eights and lobbing, in connection with physical elements. The average values of the judges scores ranged from 1.50 to 5.00, with mutual correlation coefficients ranging from 0.86 to 0.96, and an average correlation between the units of 0.92 (AVR). The resulting high value Cronbach reliability coefficient ( $\alpha = 0.98$ ), indicated consistency in judicial assessment. This high level of objectivity, is the result of the competence (knowledge) and training (experience) of the judges (Dizdar, 2006), as well as of the clearly defined evaluation criteria. The results of the *Forward stepwise regression analysis* between the group of predictor variables (motor skills) and success criteria (total score) in the performance of elements with the ball did not establish a statistically significant association ( $p < 0.27$ ), except in the predictor sit-ups in 1 min (MRCSJD1) with an error factor of 0.05 ( $p < 0.03$ ). This association was unexpected because the assessed technical elements with the ball predominantly require agility in manipulating the apparatus.

Table 2. Correlation matrix of predictor variables; p=0,05

	MAGKUS	MAKTOZ	MBKS3L	MFLPRK	MFLISK	MFLMOST	MFEBML	MFESDM	MFESVM	MSCUC1	DINZAKL-I	MRCSD1
MAGKUS	1,00	0,24	0,26	0,01	-0,20	-0,26	-0,10	<b>-0,34</b>	-0,24	-0,23	0,05	-0,10
MAKTOZ	0,24	1,00	<b>0,40</b>	0,03	-0,05	-0,03	-0,05	<b>-0,20</b>	<b>-0,32</b>	-0,11	0,14	-0,27
MBKS3L	0,26	<b>0,40</b>	1,00	-0,16	-0,02	0,02	0,04	-0,23	<b>-0,47</b>	-0,22	0,04	-0,06
MFLPRK	0,01	0,03	-0,16	1,00	<b>-0,35</b>	<b>-0,40</b>	0,21	0,11	0,22	0,04	-0,11	0,10
MFLISK	-0,20	-0,05	-0,02	<b>-0,35</b>	1,00	<b>0,49</b>	-0,22	0,12	-0,05	-0,18	-0,15	-0,03
MFLMOST	-0,26	-0,03	0,02	<b>-0,40</b>	<b>0,49</b>	1,00	-0,15	0,05	-0,11	0,02	0,15	-0,22
MFEBML	-0,10	-0,05	0,04	0,21	-0,22	-0,15	1,00	<b>0,29</b>	<b>0,33</b>	0,02	-0,27	-0,06
MFESDM	<b>-0,34</b>	-0,20	-0,23	0,11	0,12	0,05	<b>0,29</b>	1,00	<b>0,52</b>	0,03	-0,05	0,26
MFESVM	-0,24	<b>-0,32</b>	<b>-0,47</b>	0,22	-0,05	-0,11	<b>0,33</b>	<b>0,52</b>	1,00	-0,01	-0,07	0,07
MSCUC1	-0,23	-0,11	-0,22	0,04	-0,18	0,02	0,02	0,03	-0,01	1,00	0,19	0,09

Table 3. Descriptive parameters and reliability analysis of judges scores for the elements with the ball

	N	MV	Min	Max	SD	Skew	Kurt	Itm-Totl	Alpha if
ASL 1	52	3,43	2,17	4,83	0,67	0,21	-0,80	0,96	0,97
ASL 2	52	3,36	2,17	4,83	0,63	0,28	-0,44	0,94	0,98
ASL 3	52	3,64	2,50	5,00	0,65	0,07	-0,67	0,98	0,97
ASL 4	52	2,92	2,00	4,17	0,59	0,36	-0,77	0,92	0,98
ASL 5	52	2,59	1,50	4,00	0,59	0,40	-0,31	0,93	0,98
AVR	0,92								

N – number of test subjects, MV – mean value, MIN – minimum value, MAX – maximum value, SD – standard deviation, Skewness – asymmetry coefficient, Kurtosis – coefficient of curvature, Itm-Totl – correlation of individual units with a simple linear combination of all the other units, Alpha if – test reliability coefficient, ASL 1 – ASL 5 – average value of score for technical elements with ball first - fifth judge, AVR – average correlation between judges scores.

Table 4. Regression analysis of predictor variables and the criterion variable of the total score for elements with the ball

R= 0,53 R <sup>2</sup> = 0,28 F(12,39)= 1,28 p<0,27 SEP: 0,58						
	b	SEP	Beta	SEP	t(39)	p
Intercept			4,26	3,30	1,29	0,20
MAGKUS	-0,19	0,16	-0,22	0,18	-1,20	0,24
MAKTOZ	0,00	0,16	0,00	0,22	0,02	0,98
MBKS3L	0,27	0,17	0,05	0,03	1,53	0,13
MFLPRK	0,23	0,16	0,02	0,01	1,48	0,15
MFLISK	-0,06	0,18	0,00	0,01	-0,32	0,75
MFLMOST	-0,16	0,18	-0,01	0,01	-0,89	0,38
MFEBML	-0,11	0,16	-0,05	0,08	-0,66	0,51
MFESDM	0,20	0,18	0,01	0,01	1,15	0,26
MFESVM	-0,18	0,19	-0,02	0,02	-0,95	0,35
MSCUC1	0,10	0,15	0,01	0,01	0,64	0,52
DINZAKL-I	0,20	0,16	0,01	0,01	1,23	0,23
MRCSD1	-0,36	0,16	-0,04	0,02	-2,24	0,03

R – multiple correlation coefficient, R<sup>2</sup> – determination coefficient of multiple correlation, F – coefficient of multiple correlation with the degrees of freedom, p – level of significance of multiple correlation coefficients, SEP. – standard error of prediction, b – regression coefficient, Beta – standardized (partial) regression coefficient, t – degrees of freedom when testing the significance of regression coefficients, p – level of significance of the regression coefficient

Through the Forward stepwise regression analysis, it was established that a statistically significant correlation (R=0.46) exists between the predictor variables and the criterion variables in the successful execution of elements with the ball, with a 21% mutual variance in error levels 0.05 (p<0.04).

Table 5. Forward stepwise method of regression analysis between the predictor and criterion variable for elements with the ball

R= 0,46 R <sup>2</sup> = 0,21 F(5,46)= 2,52 p<0,04 SEP: 0,56						
	b	SEP	Beta	SEP	t(46)	p
Intercept			3,11	1,73	1,80	0,08
MBKS3L	0,29	0,14	0,05	0,02	2,10	0,04
MFLPRK	0,28	0,13	0,03	0,01	2,09	0,04
MRCSD1	-0,28	0,13	-0,03	0,02	-2,05	0,05
DINZAKL-I	0,22	0,13	0,02	0,01	1,66	0,10
MAGKUS	-0,17	0,14	-0,20	0,16	-1,28	0,21

A significant partial contribution was established for predictor variables: slalom with three balls (MBKS3L) (p<0.04), sit and reach (MFLPRK) (p<0.04), and sit-ups in 1 minute (MRCSD1) (p<0.05). The ball is the first apparatus that students taking the rhythmic gymnastics course are introduced to, for this reason a selection of more demanding elements was made because they spent more time in contact with this apparatus.

Therefore, the adoption of technical elements with the ball, manipulating the apparatus and control over its movement in space in coordination with the body, does not represent a limiting factor for the students. On the contrary, the knowledge acquired in the program of study prior to the rhythmic gymnastics course, represents a clear benefit for their successful mastery.

### Conclusion

The main objective of this study was to investigate the relationship between motor skills and successful performance in rhythmic gymnastics. The sample consisted of 52 female test subjects between the ages of 20-22, full-time students enrolled in their sophomore year at the Faculty of Kinesiology at the University of Zagreb. The group of predictor variables consisted of a total of 12 tests of 3 each to assess basic motor skills: coordination, flexibility, explosive and static strength. The criterion set of variables consisted of ratings by 5 competent judges that evaluated the subjects success in mastering the 6 elements with the ball. The relationship between the predictor variables (motor skills) and criteria (score in elements with

the ball) were determined by applying the Forward stepwise regression analysis. The results showed that out of a set of predictor variables, only the slalom with three balls test (MBKS3L), designed to assess coordination, stands apart as statistically significant with regard to the successful execution of elements with the ball. The execution of this test requires of the test subjects a simultaneous coordinated performance, manipulating their hands and feet, while executing a slalom with 3 balls around pylons, which is most similar to the performance of the technical elements with the ball. The acquired results point to the inadequacy of the selected tests, considering the complexity of rhythmic gymnastics as a sport. It is therefore necessary, for scientific purposes, to engage in further research that would encompass motor areas through the application of specific tests to assess balance, rhythm, precision, static strength. Thereby empirically and scientifically established motor skills that contribute to the successful execution of the technical elements of rhythmic gymnastics. This form of higher content assessment would certainly contribute to a better selection of content and methodological procedures in the implementation of teaching the subject of rhythmic gymnastics.

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## KORELACIJE IZMEĐU MOTORIČKIH VJEŠTINA I USPJEŠNOSTI IZVOĐENJA ELEMENATA S LOPTOM U RITMIČKOJ GIMNASTICI

### Sažetak

Osnovni cilj ovog istraživanja bio je utvrditi postoje li relacije između motoričkih sposobnosti i uspješnosti u izvođenju tehničkih elemenata s loptom u ritmičkoj gimnastici. Istraživanje je provedeno na uzorku od 52 studentice druge godine studija Kineziološkog fakulteta Sveučilišta u Zagrebu. Studentice su izmjerene s ukupno 12 testova za procjenu bazičnih motoričkih sposobnosti: koordinacije, fleksibilnosti, eksplozivne snage i statičke snage. Uspješnost u izvođenju tehničkih elemenata s loptom (6), koji su definirani i predviđeni planom i programom kolegija, procjenjivalo je pet kompetentnih sutkinja. Regresijskom analizom se utvrdilo da ne postoji veća statistička značajnost između promatranih motoričkih sposobnosti i uspjeha pri izvođenju tehničkih elemenata s loptom. Iz skupa prediktorskih varijabli, samo je test za procjenu koordinacije MBKS3L (slalom s tri lopte) pokazao statističku značajnost u predikciji uspjeha u izvođenju odabranog kriterijskog elementa.

**Ključne riječi:** studentice, koordinacija, fleksibilnost, snaga, regresija

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## THE IMPACT OF HYPEROXYGENATION ON PERFORMANCE AND RECOVERY DURING REPEATED 200m RUNNING LOAD OF SUBMAXIMAL INTENSITY

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### Abstract

The possibility of using inhalation of concentrated oxygen in repeated 200m run of submaximal intensity has been a part of our research within VEGA 1/1175/12 project. The aim of the presented paper was to verify the impact of short term hyperoxygenation on repeated short term load of submaximal intensity with short-distance runners. We conduct the research by testing athletes during endurance training aiming at developing anaerobic lactate capacity. The athletes were observed during two mode trainings (6x200m runs) and they inhaled concentrated oxygen in experimental and placebo measurements/exposures. We evaluated the efficiency according to performance and speed of recovery. Based on the data gathered we found that inhalation of concentrated oxygen had a positive effect on repeated short term submaximal performance in the model described. It also had a positive effect on the process of recovery.

**Key words:** short-distance running, speed endurance, hyperoxygenation, anaerobic performance, lactate

### Introduction

The problem of inhalation of concentrated oxygen has been researched by many authors (Bannister and Cunningham, 1954; Welch, 1982, 1987; Snell et al., 1986; Plet et al., 1992; Knight, 1996; Takafumi and Yasukouchi, 1997; Morris et al., 2000; Harms, 2000; Peltonen, 2001; Wilber, 2003, 2004; Kay et al., 2008; Suchý et al., 2008, 2010 a, b; Pupiš et al., 2009, 2010 a, b). Most authors confirmed positive effects of hyperoxygenation on athlete's organism. However, some researches did not prove positive effect of oxygen inhalation on performance. Murphy (1986) did not record positive effect of oxygen inhalation especially in medium term and long term loads. Robbins et al. (1992) and Yamyji and Shepard (1985) came to a similar conclusion in case of short term submaximal or maximal loads. Máček and Radvanský et al. (2011) questioned previous researchers and found that inhalation of oxygen mixtures can increase the amount of oxygen in blood by 1 ml in 100 ml of blood. However, if one takes into consideration that 100 ml of blood contains approximately 20 ml of oxygen, the increase makes 5 %. At the same time, the authors admit that it takes up to 12 hours after the load relief to redress the balance between O<sub>2</sub> and CO<sub>2</sub> and it takes several hours for the organism to get rid of the redundant lactate. In general we can say that lack of oxygen has a negative effect on performance and it prolongs the process of recovery. A question rises, whether this is also truth vice versa. It could work due to increased saturation of blood and tissues by oxygen and decreased anaerobic activity of working muscles which accelerates recovery and the return to original values (Haseler et al., 1999, Nummela et al., 2002). One-time or repeated short term applications of concentrated oxygen or hyperoxic

mixtures can temporarily increase the saturation of tissues by oxygen. This effect can be used for acceleration of the regeneration in interrupted loads (Nummela et al., 2002, Suchý et al., 2008, 2010 a, b). Positive effect of hyperoxygenation decreases with prolonged load because the organism is not able to create supplies of oxygen due to limited capacity of tissues to tie up nonphysiologically increased amount of oxygen (Robbins et al., 1992). Yamaji and Shepard (1985) speak of persisting effect of inhalation of concentrated oxygen for several tens of seconds up to several minutes. Kato et al. (2004) confirmed that the load in the conditions of hypoxigenation disturbs the pH level and thus creates an assumption that hyperoxygenation could lead to more effective utilization of lactate. Heigenhauser et al. (2006) confirmed significant relation between accumulation of lactate and concentration of oxygen in the inhaled air. Nummela et al. (2002) confirmed significant dependency of saturation of blood by oxygen during the load and the concentration of inhaled oxygen in the inhaled air. The possibility of the usage of inhalation of hyperoxygenated mixture in repeated 200 m running load of submaximal intensity has been a part of our research within our grant project VEGA 1/1175/12. In 200 m running two anaerobic metabolisms coexist – non-lactate and lactate metabolism. According to Semiginovský and Vránová (2001) anaerobic non-lactate metabolism is related to a load lasting 10-15 seconds (with the potential energy of 21-33 kJ) and the lactate metabolism to a load lasting 45-90 seconds (with the potential energy of 125-420 kJ). According to Havlíčková et al. (2008), pre-start heart frequency of a 200 m runner reaches 130 bpm (SD 21) and 190 bpm (SD 9) after running.



Several authors speak of the increase of lactate concentration after 200 m running, however, the range of lactate level varies. Laczo and Nedelický (2004) state that in 200 m running the lactate concentration reaches 15-18 mmol.l<sup>-1</sup>. According to Hautier et al. (1994) the level of lactate reaches 10,3 (SD 0,8) mmol.l<sup>-1</sup> 3 minutes after finishing 200 m run. During intensive muscle load lactic acid (C<sub>3</sub>H<sub>6</sub>O<sub>3</sub>) is produced. It immediately dissociates to lactate (C<sub>3</sub>H<sub>5</sub>O<sub>3</sub>), i.e. lactate anion (La<sup>-</sup>) and hydrogen cation (H<sup>+</sup>) which is the primary cause of the disturbance of acidosis during the load. Human body can resynthesize the lactate into glycogen. Havlíčková et al. (2008) confirms that sufficient supply of oxygen must be provided after anaerobic activity to resynthesize energy sources and to liquidate acidosis. In sport training it is very important to synchronize quality and quantity. In the process of achieving the quality, the effect of quantity can be seen in energy exhaustion connected with muscle weakness. The causes of muscle weakness are probably complex. During a short term intensive load the level of phosphocreatine is a very important factor. After exceeding one's physical limits, the level of phosphocreatine decreased dramatically. At the same time, the concentration of inorganic phosphate increases (Jones, 2008). Inorganic phosphate significantly influences muscle contraction by entering the sarcoplasmic reticulum and by ejecting the calcium cation (Allen et al., 2008). In case of aerobic environment creatine is rephosphorized into high-energy phosphocreatine (Haseler et al., 1999). At the same time, inorganic phosphate is being decreased. In this way hyperoxygenation can contribute to acceleration of regeneration. Different means of speed endurance development are being used in the preparation phase of short-distance running training. They are all used for the development of anaerobic lactate capacity. During the submaximal intensity load the running distance is 60 -300 m, the rest interval is 2-6 minutes and it depends on the workload volume. The load lasts 7-40 seconds and the intensity presents 90-95% of the maximum intensity. Total volume in 6-8 running distances can be up to 2 kilometers. The stronger intensity and longer distances, the longer rest intervals are needed. As the racing period gets closer, the intensity must be increased, the rest interval must be prolonged, the volume must be decreased and the training gradually changes into anaerobic lactate performance training. In sprint training the speed endurance is the most flexible feature thus it provides the biggest space for performance increase – especially after using all natural speed reserves. Both submaximal aerobic exercise and interval training can improve the body's ability to buffer and tolerate lactate. However, only intense interval training can increase various important components of anaerobic power and capacity. Submaximal aerobic exercise does not and may even decrease anaerobic enzyme activity not good for speed development!) (Astrand, Rodahl, 1986; Abernethy et al., 1990; Plisk, 1991; Viru, 1993; Viru, 1995; Brooks, 1996). The aim of this paper is

to verify the impact of short term hyperoxygenation on repeated short term submaximal intensity load with short-distance runners on the basis of endurance speed training, which develops anaerobic lactate capacity. We assumed that short term oxygen inhalation will have a positive effect on repeated anaerobic performance and it will result in increased performance and faster recovery after load. The research was executed in compliance with Medical Association Declaration of Helsinki – Ethical Principles for Medical Research Involving Human Subjects that was amended in October 2008 in Seoul ([www.wma.net](http://www.wma.net)). In order to verify our hypothesis we decided to conduct a double experiment – inhalation of concentrated oxygen from an oxygen concentrator EverFlow between repeated 200m runs. The probands inhaled either concentrated oxygen or placebo (controlling measurement) from the same device using a special inhalation mask following the instructions provided on the cover. The oxygen concentrator contained 90-95% oxygen and a placebo of 20-21% of oxygen. The probands did not know whether they had inhaled oxygen concentrator or a placebo. Before they took the tests they had been given instructions about inhaling.

## Methods

### Research process

The research was conducted in a training hall of Sport Grammar School in Banská Bystrica; the training hall is equipped with tartar track surface on 170 m round, December 7 and December 14, 2010. Device Lactate Plus (Nova Biomedical) was used for measuring the lactate level.

### Procedure

- 1) 4-1 minutes before the first run the probands inhaled oxygen/placebo for 3 minutes.
- 2) 6 x 200 m run with rest interval 7 minutes, 6 minutes, 5 minutes, 4 minutes, 3 minutes; during the rest intervals the probands inhaled oxygen/placebo for a minute.
- 3) 3 minutes after the final run the level of lactate was measured from blood sample obtained by fingerstick.
- 4) 5 minute long inhalation of oxygen/placebo.
- 5) 15 minutes after the last run the level of lactate was measured from fingerstick sample.

### Information about probands

- Š.M. (male), 19 years old, junior, height: 181 cm, weight: 77 kg, specialization: 200m running, length of training: 6 years
- R.O.(male), 16 years old, juvenile athlete, height: 183 cm, weight: 70,5 kg, specialization: 110m and 400m hurdle-run, length of training: 3 years
- M.I. (female), 19 years old, junior, height: 176 cm, weight: 56 kg, specialization: 400m running, length of training: 4 years
- T.M. (female), 16 years old, juvenile athlete, height: 157 cm, weight: 46 kg, specialization: 100m running, length of training: 2 years.

During our research all athletes were healthy; as for their all-year training cycle, they were in their preparation stage at the beginning of their special sport preparation. We used the following characteristic features in order to evaluate the effect in pair comparisons: average change, relative change, and Cohen's kappa coefficient. Blahuš (2000) measures the average change in the units of the constant observed and defines the average change as the difference between the average constant before and after the activity of the factor observed, i.e.  $d = x_1 - x_2$ , where  $x_1, x_2$  = average of the constant observed before or after the activity of the factor observed. Relative change is defined as the percentage of the average change within the overall average of the constant observed, i.e.  $d_r = d/x$  where  $x$  = overall average of the constant before and after the activity of the factor observed. Figures of relative change are expressed in percents. Cohen's kappa coefficient  $d_x$  or  $d_d$  is for the purposes of pair comparison defined in two versions (Hendl, 2004). In our paper we used the following version of Cohen's coefficient:  $d_x = d/s_x$ , where  $s_x$  = deviation of values of the constant before and after the activity of the factor observed. Hendl (2004) proposes the following interpretation of the data gathered:  $d > 0,8$  expresses major effect; value  $d$  in interval 0,5 to 0,8 expresses medium effect; value  $d$  in interval 0,2 to 0,5 expresses minor effect;  $d < 0,2$  expresses almost no effect.

## Results and discussion

Table 1. Time and lactate levels of the athletes

Name	Average (s)	Max. (s)	Min. (s)	LA 3' (mmol.l <sup>-1</sup> )	LA 15' (mmol.l <sup>-1</sup> )
Š.M. placebo	25,5	26,2	25	12,2	12,8
R.O. placebo	26,8	28,3	26	14,0	14,3
M.I. placebo	30,1	32,2	28,7	12,0	13,7
T.M. placebo	34,2	35	33,4	14,6	15,6
Š.M. oxygen	26,05	28,8	24	15,3	13,1
R.O. oxygen	26,2	27,5	25,1	12,2	8,8
M.I. oxygen	29,1	31,5	28	13,7	10,3
T.M. oxygen	33,6	35,4	32,6	13,4	10,4
Average P	29,2	30,4	28,3	13,2	14,1
Average O	28,7	30,8	27,4	13,7	10,7
% diff. P-O	-1,4%	1,2%	-3,1%	3,3%	-32,4%

Due to small number of team members we will proceed by individual evaluation of the athletes. Athlete Š.M. achieved worse results in runs where his performance was enhanced by inhalation of concentrated oxygen compared to those runs in which he was given placebo (the oxygen-enhanced result was worse by 0,5 seconds – see table 1). His result time was affected by ineffective stamina management in individual runs while the difference between his best and worst result in oxygen-enhanced runs was as big as 4,8 seconds in comparison with placebo-enhanced runs where the difference was only 1,2 seconds.

Due to this fact it is impossible to evaluate the impact of inhaled oxygen on the performance of Š.M. However, the inhalation had a positive effect on the body's reaction after the workload. In experimental measurements the lactate level reached 15,3 mmol.l<sup>-1</sup>, after the controlling measurement it was 12,2 mmol.l<sup>-1</sup>. The recovery after experimental measurement was faster, the lactate level decreased 15 minutes after the load decreased by 3,1 mmol.l<sup>-1</sup> in comparison with the placebo measurement where we recorded increase by 0,6 mmol.l<sup>-1</sup>. Athlete R.O. is a proof of a positive effect of inhalation of oxygen concentrator on one's performance and recovery (table 1).

In comparison with the preceding athlete, the difference between the best and worst time achieved in R.O.'s case was minimal in both measurements: 2,3 seconds in placebo measurement and 2,4 seconds in experimental measurement. He reached better performance in placebo measurement by 0,6 seconds as well as better maximal and minimal time. The inhalation of oxygen concentrator also had positive effect on the body's response to the load. The lactate level reached 12,2 mmol.l<sup>-1</sup> after three minutes in experimental measurement and 14,0 mmol.l<sup>-1</sup> in controlling measurement. As for the recovery assessment, experimental measurement after 15 minutes reflected a 3,4 mmol.l<sup>-1</sup> decrease in comparison with controlling measurement which showed a 0,3 mmol.l<sup>-1</sup> increase in lactate levels. The biggest impact of inhalation of concentrated oxygen on one's performance was seen in case of the athlete M.I. (table 1). The differences in times achieved during the tests were the same: in both cases the difference between the best and the worst time was the same – 3,5 seconds. In experimental measurement M.I. achieved a result better by 1,0 seconds than in the controlling measurement. Lactate level in experimental measurement taken after three minutes after final run was higher (13,7 mmol.l<sup>-1</sup>) than in controlling measurement (12,0 mmol.l<sup>-1</sup>). As for the recovery assessment, experimental measurement after 15 minutes reflected a 3,4 mmol.l<sup>-1</sup> decrease in comparison with controlling measurement which showed a 1,7 mmol.l<sup>-1</sup> increase.

Juvenile athlete T.M. reached better performance and recovery indicators in experimental measurement (table 1). The difference in times was bigger in experimental measurement (2,8 seconds) than in controlling measurement (1,6 seconds). In experimental measurement M.I. reached time by 0,6 seconds better than in controlling measurement. The positive effect of inhalation of oxygen concentrator was also seen in the body's response to the load. The lactate level reached 13,4 mmol.l<sup>-1</sup> after three minutes in experimental measurement and 14,6 mmol.l<sup>-1</sup> in controlling measurement. As for the recovery assessment, experimental measurement after 15 minutes reflected a 3,0 mmol.l<sup>-1</sup> decrease in comparison with controlling measurement which showed a 1,0 mmol.l<sup>-1</sup> increase in lactate levels.

Table 2. Statistics about athletes' performances

	Š.M	R.O.	M.I.	T.M.
Average placebo	25,55	26,88	30,08	34,22
Average oxyfit	26,05	26,17	29,1	33,66
D	-0,5	0,71	0,98	0,56
d <sub>r</sub> difference (%)	2,1	-3,6	-3,3	-1,6
d <sub>x</sub>	0,39	1,18	0,73	0,64

Based on the evaluation according to Cohen's kappa coefficient, the change in the parameters observed was significant in case of three athletes (table 2). Figures of athletes M.I. and T.M. reflect medium effect of oxygen and figures of athlete R.O. reflect major effect of oxygen. Relative change in their results is not large/significant (1,6-3,6%), however, from the perspective of expert evaluation even these changes are considerably important in their effect on short term performance. Based on the data gathered we assume, that inhalation of concentrated oxygen has a positive impact on repeated short term submaximal performance in the case study that we described. The results also show that inhalation of concentrated oxygen has a positive effect on the process of regeneration. Fast regeneration has a positive effect on lactate levels. Different results documented during the experiment are a convincing proof of the fact that inhalation of

95-99% oxygen positively effects final performance. A research conducted with greater amount of athletes could lead to the confirmation of this statement. We have found several studies documenting similar research, e.g. those that recorded maximal anaerobic capacity increase due to inhalation of concentrated oxygen by 3-6% (Smatlan., Gabrys and Gabrys, 2000; Suchý, 2010).

### Conclusion

Based on the data gathered here we can make the following conclusions: 1) The results of three out of four athletes document medium up to strong positive effect of inhalation of concentrated oxygen during 6x200m run. In the case of one athlete the positive effect of concentrated oxygen was not confirmed due to his inappropriate stamina management, 2) Inhalation of concentrated oxygen did not have an impact on correct speed estimation, 3) Inhalation of concentrated oxygen did not have an effect on lactate level 3 minutes after repeated submaximal intensity load, 4) The positive effect of concentrated oxygen was definitely confirmed 15 minutes after the run in the recovery phase. This was seen in the decrease of lactate level by ¼ in experimental measuring in contrast to the increase of lactate in placebo measurements.

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## UTJECAJ HIPEROKSIGENACIJE NA IZVEDBU I OPORAVAK TIJEKOM PONAVLJANIH TRČANJA NA 200M S OPTEREĆENJEM SUBMAKSIMALNOG INTENZITETA

### Sažetak

Mogućnost korištenja udisanja koncentriranog kisika u ponovljenom trčanju na 200m bio je dio našeg istraživanja u sklopu projekta VEGA 1/1175/12. Cilj ovog rada bio je provjeriti utjecaj kratkoročne hiperoksigenacije na ponovljenim kratkotrajnim opterećenjima submaksimalnog intenziteta u kraćem sprintu. Provedeno je istraživanje testiranja sportaša tijekom treninga izdržljivosti u cilju razvijanja tolerancije na anaerobne laktatne kapacitete. Rezultati sportaša su bilježeni kroz dva moda treninga (6x200m staze) i uz udisanje koncentriranog kisika u eksperimentalnom i placebo mjerenju / izloženosti. Procijenjena je učinkovitost prema performansama i brzini oporavka. Na temelju prikupljenih podataka utvrđeno je da je udisanje koncentriranog kisika imalo pozitivan učinak na ponavljanje kratkoročne submaksimalne izvedbe u opisanom modelu. Ona je također imala pozitivan utjecaj na proces oporavka.

**Ključne riječi:** kratki sprint, brzinska izdržljivost, hiperoksigenacija, anaerobne sposobnosti, laktati

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## RELIABILITY OF THE SELF-REPORT QUESTIONNAIRE FOR THE ASSESSMENT OF THE LEVEL OF LEISURE-TIME PHYSICAL ACTIVITY IN PRIMARY SCHOOL PUPILS

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### Abstract

Questionnaire for the assessment of the level of physical activity and leisure-time activities of pupils of the final four years of primary school. *Methods:* The survey was carried out on a sample of 847 grade 5 – 8 primary school pupils (413 girls and 434 boys) aged 11 – 15. The questionnaire collecting information on how pupils spent their free time in the previous 7 days was administered to pupils during the homeroom period. The pupils were instructed on how to fill out the questionnaire upon which they filled the questionnaire. In order to determine the reliability of the questionnaire, the test-retest method was used on 69 randomly selected subjects (32 boys and 37 girls). The test was conducted by administering the questionnaire to the selected subjects twice within a 15-day period. *Results:* The results obtained using the test-retest method showed a stable reliability of the questionnaire, ranging from  $r = 0.71$  to  $r = 0.81$  of the Spearman's rank correlation coefficient. The Cronbach's alpha values were relatively satisfactory for this type of questionnaire at  $\alpha = 0.70$ , while the 95% confidence interval ranged from 0.67 to 0.73. The interclass correlation coefficient was also relatively high at 0.7. Spearman's rank correlation coefficient was used to determine the criterion-related reliability between the weekly frequency of the activities and the estimated time spent on particular activities over the seven-day period. In the first measurement the correlation for kinesiological activities was  $r = 0.82$ , and for non-kinesiological activities the measured correlation was  $r = 0.75$ . The correlation was slightly lower in the second measurement, but it was still statistically significant. For kinesiological activities it was  $r = 0.71$  and the correlation coefficient for non-kinesiological activities was  $r = 0.63$ . *Conclusion:* Reliability of the designed questionnaire is very high and it can be used to collect reliable information on how pupils in the final four years of primary school spend their leisure time. This type of questionnaire should be further developed before it can be used in epidemiological studies aimed at obtaining relevant leisure-time indicators for school children.

**Key words:** children, reliability, questionnaire, physical activity, free time

### Introduction

There are references to physical activity as a concept closely related to motor activity in almost all relevant scientific and professional publications. The World Health Organisation defines physical activity as any bodily movement produced by skeletal muscles that requires energy expenditure (WHO, 2010). Physical inactivity is a major risk factor in the development of most common chronic conditions, including heart diseases, strokes, cancer, type 2 diabetes and various mental conditions (Bull, 2008). Furthermore, an active lifestyle can reduce the risk of depression, prevent fractures caused by fall in the elderly, improve cognitive functions and improve learning abilities in children (Katzmarzyk and Janssen, 2004). Regular physical activity of an adequate type, intensity, duration and frequency improves one's physical abilities primarily by improving functional abilities of the oxygen and energy transportation systems and the regulatory mechanisms of the nervous system (Mišigoj-Duraković et al., 1999). Physical activity is an indispensable biological impulse for the maintenance of the bodily structures and functions. Most, if not all, adaptive transformations caused by physical activity of moderate frequency and intensity positively affect person's health by

improving the structure and/or functional ability of respective organs (Vuori, 2004). Regular physical activity is in close correlation with short-term and long-term health benefits for children and adolescents in the areas of physical, cognitive, emotional and social life. (Sallis et al., 2000; Yang et al., 2006). Positive effects of physical activity on health in childhood and adolescence have been widely recognized (Strong et al., 2005). Health benefits can be identified both as immediate positive effects on health improvement in childhood or as predictors of the health status later in life (Barnett et al., 2009). According to the recommendations of the U.S. Department of Health and Human Services (DHHS, 2008), children and adolescents aged 6 to 17 need 60 minutes of physical activity every day, including moderate and high intensity activities as well as aerobic and body and bone building activities (Cavill et al., 2001; Klasson-Heggebo et al., 2003; Strong et al., 2005; Oja et al., 2010). This recommendation of one hour of physical activity for children and adolescents is in line with several other recent recommendations issued in the USA and Australia. However, in Canada, 90 minutes of every-day physical activity is recommended for youth (Janssen, 2007).

Also, some authors suggest 90 minutes of physical activity every day to reduce the risk of cardiovascular diseases in children and youth (Andersen et al., 2006). Health benefits of physical activity in adults have been recorded in much more detail than those in children (Oja et al., 2010), but there are some indications that this might change. Therefore, planned schedule of physical activity for children is extremely important considering the assumption that a high level of physical activity in childhood might be a key factor in adopting an active life style later in life (Rowland, 2003).

Regular physical activity at a young age is a factor closely correlating with a positive health status in adulthood. Survey methods based on self-reporting on the physical activity levels are the quickest and most acceptable instrument for obtaining information on physical activity. To obtain information on physical activity levels, global questionnaires, short recollection questionnaires and detailed physical activity questionnaires are used (Jurakić, 2009, Biddle et al., 2011). Self-report questionnaires are still the most widely used instrument in assessing physical activity levels. It is therefore essential to identify their advantages and disadvantages and to continually improve their quality (Sallis and Saelens 2000). Since TV viewing accounts for a big part of youths' leisure time (Currie, 2004), self-report instruments focus on the activities of viewing TV and using computer in the assessment of the time spent in sedentary activities. Although some instruments have been developed to encompass other sedentary activities of the youth, a targeted self-report instrument for the youth have not been designed yet (Hardy, Booth, Okely, 2007).

Questionnaires, interviews and journals are subjective methods for the assessment of physical activity levels, which are usually used in epidemiological studies. These instruments provide a wealth of information on physical activity and its energy expenditure and time spent on it and they are therefore the most popular instruments for the assessment of physical activity levels in epidemiological studies (Ainsworth, Montoye and Leon 1994, Barbosa et al., 2007, Janz et al., 2008). The advantages of self-report questionnaires concern their low cost and simple administration and a relatively low burden on the subjects (Troost, 2007., Sallis et al., 1993). The purpose of the study was to determine test-retest reliability of the self-report questionnaire for the assessment of the physical activity level and leisure-time activities in the pupils of the final four years of primary school.

## Methods

### Sample

The survey was carried out on a sample of 5-8 grade primary school pupils. The age of the pupils ranged from 11 to 15. The total number of the surveyed pupils was 847 (413 girls and 434 boys). All of the pupils were healthy at the time of the research.

The research was carried out in accordance with the Ethical Codex for Research with Children, a document compiled by the Council for Children, an advisory body of the government of the Republic of Croatia. A signed parental consent for the participation in the research was obtained for each subject. The principals of the schools covered by the research gave an approval for the participation of their respective schools in the research. The research was carried out by administering a self-report questionnaire to pupils during the homeroom period and instructing them how to fill it out. The time frame for filling out the questionnaire was 30 minutes. Test-retest reliability of the questionnaire was determined on 69 randomly selected subjects (32 boys and 37 girls). The average age of the subjects was  $13.31 \pm 1.41$ . Testing involved administration of the questionnaire to the selected pupils twice in a 15-day period. The assumption was that this period between two surveys was long enough for the subjects not to rely on their memory in reporting, and yet short enough for the assessed behaviour not to have changed.

### Measuring instrument

To assess pupils' leisure-time activity levels a questionnaire construed for the purposes of this research was used. It assessed the activity levels in the previous 7 days. It consisted of three parts. The first part of the questionnaire collected general information on the subject: name of the subject, name of the school, sex, age and grade. The second part of the questionnaire focused on kinesiological activities, whereas the third part referred to non-kinesiological leisure time activities.

### Assessed leisure-time kinesiological activity levels

The part of the questionnaire assessing kinesiological activity comprised 18 variables involving various kinesiological activities (track and field, swimming, gymnastics, karate, taekwondo, wrestling, tennis, table tennis, badminton, handball, basketball, football, dance – acrobatic rock and roll, rowing and/or kayaking, jogging or running, walking for exercise, cycling, rollerblading). In addition to the specified kinesiological activities, the pupils could add an activity which was not listed in the questionnaire. For each of the listed activities, the subjects were asked to report whether they had or had not engaged in it in the previous seven days.

If the answer was "yes", they had to specify the total amount of time spent on a particular kinesiological activity in the seven-day period. The time was specified in hours. Based on the answers to the questions in this part of the questionnaire, the subjects were divided into two categories, as follows:

- *physically inactive subjects* (spending less than 60 minutes of their leisure time a day in a kinesiological activity), and
- *physically active subject* (spending more than 60 minutes of their leisure time a day in a kinesiological activity).

*Assessed leisure-time non-kinesiological activity levels*

This part of the questionnaire offered 14 non-kinesiological activities (TV, DVD and video viewing, reading a book, reading newspaper and magazines, playing computer games, surfing the Internet, playing Playstation and similar games, listening to music, talking on the phone, texting, shopping with the parents, going to the movies, helping with the house chores, attending courses (languages, computer, painting, etc.)). In addition to the specified activities, the pupils could add an activity which was not listed in the questionnaire. As in the second part of the questionnaire, the subjects were asked to report whether they had or had not engaged in the listed activities in the previous seven days. If they had, they were asked to specify the total amount of time spent performing a particular activity in the seven-day period. The time was specified in hours.

*Data processing methods*

The reliability characteristic was expressed as Spearman's correlation range coefficient. Other reliability coefficients used included Cronbach's reliability coefficient, interclass correlation coefficient and standardized reliability coefficient (standardized alpha). Data were processed using STATISTICA for Windows version 5.0. and 7.1. and the data processing programme Statistical Package for the Social Sciences 11.5.

**Results**

The questionnaire collected information on the physical activity levels among pupils and the level of other non-kinesiological leisure-time activities. The subjects have provided information on which activities they engaged in and how many days they engaged in a particular activity over a seven-day period. They also had to assess the total time spent doing the activity in the previous seven days.

Table 1. Test-retest reliability coefficient of the questionnaire on the level of pupils' kinesiological and non-kinesiological leisure-time activities

	<i>Spearman coefficient</i>
<i>Weekly kinesiological activities</i>	0.72*
<i>Kinesiological activities - time</i>	0.79*
<i>Weekly non-kinesiological activities</i>	0.71*
<i>Non-kinesiological activities - time</i>	0.81*

\*  $p < 0.05$

Table 1 shows correlation coefficients in two measurements. The correlation values for the two measurements range from  $r = 0.71$  to  $r = 0.81$ . This correlation coefficient values fall into the significance level of  $p < 0.05$ , indicating reliable stability of the questionnaire and relative reliability of the information on leisure-time activities of 5-8 grade pupils collected using this questionnaire. Table 2 shows reliability parameters of the questionnaire. Cronbach's alpha values are satisfactory, and the 95% confidence interval values range between 0.67 and 0.73.

Table 2. Chronbach's alpha, interclass correlation and 95% confidence interval coefficients of the questionnaire on the level of pupils' kinesiological and non-kinesiological leisure-time activities

Chronbach's alpha $\alpha$	Standardized alpha	Interclass correlation coefficient	95% confidence interval
0.70	0.69	0.70	0.67 – 0.73

Table 3. Spearman's correlation range coefficient for the questionnaire on the level of pupils' kinesiological and non-kinesiological leisure-time activities

	1st MEASUREMENT		2nd MEASUREMENT	
	Kinesiological activities – frequency level	Non-kinesiological activities – frequency level	Kinesiological activities – frequency level	Non-kinesiological activities – frequency level
Kinesiological activities – time	0.82*		0.71*	
Non-kinesiological activities – time		0.75*		0.63*

\*  $p < 0.05$

In order to determine reliability with respect to the criterion (Table 3), responses concerning subjects' assessment of their own kinesiological and non-kinesiological activities were compared with the amount of time actually spent doing these activities in the seven-day period. The correlation coefficient value was statistically significant on the significance level  $p < 0.05$ , and it amounted to  $r = 0.82$  for kinesiological activities in the first measurement, while a slightly less statistically significant correlation ( $r = 0.75$ ) was determined for non-kinesiological activities. The second measurement was characterised by slightly lower, yet statistically significant, correlations for both kinesiological ( $r = 0.71$ ) and non-kinesiological activities ( $r = 0.63$ ).

**Discussion**

In order to collect information on the level of leisure-time physical activities and other leisure-time activities of pupils of the final four years of primary school, a questionnaire was developed. Reliability of the questionnaire was determined using the test-retest method on a sample of 69 pupils of the average age of  $13.31 \pm 1.41$ . The questionnaire was designed so as to allow children to self-report on their engagement in kinesiological and non-kinesiological activities in the previous seven days. Obtained information showed that the questionnaire has stable reliability ranging from  $r = 0.71$  to  $r = 0.81$  of Spearman's correlation coefficient. For questionnaires of a similar type, Crocker et al. (1997) determined test-retest correlation ranging from  $r = 0.75$  to  $r = 0.82$ . Other authors (Sallis et al., 1993, Godin and Shephard, 1984, Linder et al., 1983) have determined similar test-retest correlation coefficients in their studies (ranging from  $r = 0.70$  to  $r = 0.84$ ).

These values were thus to be expected considering that 15 days elapsed between the two measurements and that school children in grades 5 to 8 do not have fixed habits. Furthermore, the determined Chronbach's alphas were on the level  $\alpha = 0.70$ , which is slightly below the level determined in the study by Moore et al. (2007) for the population of American children of European origin ( $\alpha = 0.75$ ) and higher than the values for American children of African origin ( $\alpha = 0.56$ ). The values of the interclass correlation coefficient were relatively high (0.70). Similar values were determined by Huang et al. (2009). Slightly lower results for the interclass correlation coefficient were obtained in some other studies (Hong et al., 2012., Barbosa et al., 2007., Strugnell et al., 2011) based on differently designed questionnaires administered to subjects of similar age groups. Studies show differences in reliability and validity of self-report questionnaires targeting younger population (Huang et al., 2009, Moore et al., 2007). Comparison of questionnaires is hindered by differences in the methods used in carrying out surveys (independent responses, assistance of the researcher, computer assistance), the recollection period (1-7 days, one month to one year) (Sallis and Saelens, 2000) and the wording in the questionnaire ("typical week", "regular week" and "last week"). In the assessment of reliability of an instrument, it can be determined that the instrument has satisfactory reliability if the reliability coefficient is 0.70 or higher (Milas, 2005, Mejovšek, 2008). Reliability of the questionnaire was also determined by comparing the responses regarding pupils' independent assessment of kinesiological and non-kinesiological activity levels and the amount of time they spend performing these activities in the previous seven-day period. Spearman's coefficient was statistically significant on the significance level  $p < 0.05$  at  $r = 0.82$  for kinesiological activities. A slightly lower, yet statistically significant, Spearman's coefficient was determined for non-kinesiological activities ( $r = 0.75$ ). The correlation coefficient was somewhat lower in the second measurement, but it remained statistically significant. These results confirm that the responses that the pupils provided in the first questionnaire significantly correlated with the actual time which the pupils spent in the given kinesiological and non-kinesiological activities over

the seven-day period and that the pupils generally provided truthful answers. It is in most cases not possible to draw immediate comparisons between reliability of our questionnaire and questionnaires used in other studies, but they can be used to provide context for the assessment of the reliability of our questionnaire. Even though the purpose is the same (to assess daily physical activity levels in children), questionnaires used are differently construed and researchers make slight adjustments taking into account specificities of the given population. Since questionnaires are the most commonly used instruments for the assessment of physical activity in epidemiological studies, it is important to standardize the content and the design of the instrument for the assessment of physical activity levels in the population and to define questions to be used to collect information on various forms of physical activity and to be applicable to all socioeconomic, ethnic, gender and age groups (Ainsworth et al., 1994).

There is a lot of room for the improvement of the quality of questionnaires as instruments for the assessment of physical activity in children, as well as the totality of leisure-time activities that children engage in. A very important advantage of this type of research is its cost-effectiveness. Questionnaires are the most acceptable way to obtain quick and reliable data since they do not involve the use of expensive equipment that measures time spent in a physical activity. Finally, this type of questionnaire can also be used to collect information on the amount of time that pupils spend in other, non-kinesiological leisure-time activities, such as TV viewing, using computer or talking on the phone.

## Conclusion

The presented evidence suggests that the questionnaire is a reliable instrument that can be used to obtain reliable information on leisure-time activities of the pupils of the final four grades of primary school. This type of questionnaire needs to be further improved and effort should be made to develop high-quality models through an interdisciplinary approach, allowing researchers in epidemiological studies to obtain relevant and quick information on leisure-time activities of children at a low cost.

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## POUZDANOST SAMOEVALUACIJSKOG UPITNIKA ZA PROCJENU RAZINE TJELESNE AKTIVNOSTI U SLOBODNOM VREMENU UČENIKA OSNOVNIH ŠKOLA

### Sažetak

Primjenjen je upitnik za procjenu razine tjelesne aktivnosti u slobodno vrijeme za učenike četiri završna razreda osnovne škole. Metode: Istraživanje je provedeno na uzorku od 847 učenika 5.-8. razreda osnovne škole (413 djevojčica i 434 dječaka) u dobi od 11-15 g. Upitnikom su prikupljane informacije o tome kako učenici provode svoje slobodno vrijeme u prethodnih sedam dana, a ispunjavali su tijekom sata razrednika. Učenici su dobili upute o tome kako popuniti upitnik. Kako bi se utvrdila pouzdanost upitnika, test-retest metodom na 69 slučajno odabranih ispitanika (32 dječaka i 37 djevojčica). Ispitivanje je provedeno s odabranim temama dva puta unutar 15 - dnevnog razdoblja. Rezultati: rezultati su dobiveni test-retest metodom i pokazali su stabilnu pouzdanost upitnika, u rasponu od  $r = 0,71$  do  $r = 0,81$  Spearmanovog koeficijenta korelacije ranga. Cronbach alfa vrijednosti bile su relativno povoljne za ovu vrstu upitnika na  $\alpha = 0,70$ , dok se 95 % interval pouzdanosti kretalo 0,67-0,73. Koeficijent korelacije je također relativno visok i iznosi 0,7. Spearmanov koeficijent korelacije se koristiti za određivanje kriterija povezanih pouzdanosti između tjedne učestalosti aktivnosti i predviđenog vremena provedenog u određenoj aktivnosti tijekom sedmodnevnog razdoblja. U prvom mjerenju korelacija za kineziološke aktivnosti bila je  $r = 0,82$ , a za ne - kineziološke aktivnosti  $r = 0,75$ . Korelacija je nešto niža u drugom mjerenju ali je još uvijek statistički značajna. Za kineziološke aktivnosti bilo je  $r = 0,71$ , a koeficijent korelacije za ne - kineziološke aktivnosti bio je  $r = 0,63$ . Zaključak: Pouzdanost projektiranog upitnika vrlo je visoka i upitnik se može koristiti za prikupljanje pouzdanih informacija o tome kako učenici u završnoj četiri godine osnovne škole provode svoje slobodno vrijeme. Ovu vrstu upitnika treba dalje razvijati prije nego što može biti korišten u epidemiološkim studijama čiji je cilj dobivanje relevantnih pokazatelja slobodnog vremena za školsku djecu.

**Ključne riječi:** djeca, pouzdanost, upitnik, tjelesna aktivnost, slobodno vrijeme

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