

**Dear readers,**

*Before you is the newest issue of Sport Science, published by the Faculty of Education of the University of Travnik. Sport Science has been published regularly and for the past seven years fourteen issues have been published.*

*The first issue of Sport Science was published in June 2008 with the first scientific papers in the field of kinesiology. The journal was well accepted among Bosnian and Herzegovinian readers, as well as international readers. Sport Science has almost immediately become one of the most esteemed journals. What is significant is that every new issue published scientific papers of greater quality; it expanded scientific research in the field of kinesiology and has made a great contribution in the fields of sport theory, sports anthropology, sports management, sports systems, methodology of sport and so forth.*

*In retrospect, if the journal Sport Science hadn't been released kinesiological research at this University and in this region would not be possible. Hence, the release of this journal has, first of all, encouraged scientific research in the field of kinesiology and its multidisciplinary fields; brought together scientists and experts from Bosnia and Herzegovina and neighboring countries, Europe and the world; it has accelerated the flow of scientific information; placed research at a higher level; opened up new possibilities for references, scientific research, scientific questioning and confirmation of research results with a higher number of other scientific publications and journals.*

*Today, however, most of the goals which were set at the beginning have been accomplished. The journal Sport Science has become one of the most prestigious journals in Bosnia and Herzegovina. It has also made an affirmation in Europe and the world.*

*That is precisely why we know that it is our obligation to continue publishing Sport Science and to make it an even better and more recognized journal. Fourteen issues of Sport Science obligate us to do that.*

*The issue before you has been published after the first international conference in the field of sports, science, education and development - InSEED 2015 which took place in February this year and after which we have launched the third cycle of studies – doctoral studies at the Faculty of Education. In that regard, and tying together the conference, journal and doctoral studies, we have created the preconditions for scientific research and scientific work at the highest level. On the other hand, when speaking about the quality of scientific papers, we believe that the issue before you has created new standards when it comes to publishing scientific research results and results of scientific papers.*

*Dr. Nihad Selimović, MSc  
Editor in chief*

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# COGNITIVE AND CONATIVE FUNCTIONING OF JUDOKAS, SHOOTERS AND VOLLEYBALL PLAYERS

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## Abstract

The aim of this research is to show whether the uniformity of the cognitive and conative functioning in the heterogenic and complex sport space can also be noticed among different sports, not only within one. The study sample was indential for both studies and included 11 judokas, 21 shooters, 12 volleyball player and 22 students. The constructs measured in this research rely on the cybernetic model of the cognitive and conative functioning. Those characteristics are assessed by applying the battery of tests of the cognitive efficiency and the conative functioning. The difference appeared for the variables AL-4, S-1 and ETA on the level of significance  $p < 0.01$ , while for the variable DELTA the level of significance was  $p < 0.05$ . The difference among the groups occurred for the variables NoEr4-11 on the level of significance  $p < 0.01$ , while for the variables MinT2-41 and TB4-11 the difference is on the level of significance  $p < 0.05$ . The serial and parallel processors do not favourize the athletes in comparison to the control group, which implies that the intellectual factor has a modelling effect on the success in sport, rather than the direct. It was confirmed that a dimension of emotional stability correlates to the sports competence in the strongest way. The athletes belonging to all three groups have a better coordination than non-athletes (even though it is not statistically significant for volleyball).

**Keywords:** Cognitive abilities, conative characteristics, characteristics of attention, operational thinking.

## Introduction

The way an athlete notices, analyzes and integrates, as well as reacts to the stimuli from sports surroundings (cognitive functioning) and the way in which their personality and behavioural tendencies model their response to the given situation (conative functioning) represent a part of the intrapersonal factor which an athlete integrates in the developing process as a „means“ of transforming sensory-motor skills in sports achievement<sup>1</sup>. Many authors have dealt with the association between cognitive and conative functioning and sports achievement. In the area of cognitive functioning, the cybernetic model of information processing has been the basis for many researches. The most often examined differences in a sports setting were between the participants and non-participants, and later, with the expansion of the research paradigm „beginners-experts“, between athletes on an elite level, those on a sub-elite level and beginners<sup>2</sup>. Even though it was established that there are no significant differences in visual abilities (such as range of visual input, visual sharpness and depth of perception) between participants and non-participants, or elite and sub-elite athletes<sup>3</sup>, surveys have shown that top athletes have better strategies for exploring the visual field<sup>4,5</sup>. Also, reaction time in a task relying on central sight is shorter than reaction time intasks relying on periphery visual exploration<sup>6</sup>. Despite the differences in capacity of information reception, top athletes differ from less successful ones in efficiency of attention<sup>7</sup>. More successful athletes pay attention to informative signs in a game and ignore irrelevant ones. Taking into account that they have developed a more efficient system of sensory examination, top athletes access stored structures of knowledge a lot faster, which results in faster and more appropriate anticipatory reactions to a given situation<sup>8,9</sup>. Cortical processing of data is performed in the appropriate sensory and motor centres and consequentially

allows the performance of an action which, from the point of view of efficiency, should provide a synchronised, timely and adequate movement or series of movements. The ability of coordination adds, to a great extent, to the ability of coordination. Numerous researches have confirmed that there is a significant correlation between the intelligence and the cognitive functioning among the motor skills<sup>10,11</sup>. Many authors connect coordination with the notion of motor intelligence, which represents a foundation for the development of top talent in sport<sup>1,12,13</sup>. Taking into account that coordination represents the cross-section of mutual elements and cognitive and motor functioning, it can rightly be called a psycho-motor skill which often includes subfactors such as motor intelligence, the ability of motor education and reorganization of stereotyped motor movements. As far as the conative space is concerned, researchers usually confirm that athletes often have more expressed extraversion and a lower level of neuroticism than non-athletes, or that participants in individual sports have a lower level of neuroticism and extraversion than participants in team sports<sup>14,15</sup>. In entering the training process, each athlete brings their own „initial share“. At the beginner level the shares have high dispersion, but in reaching the highest level of competition, the characteristics of top athletes start separating until the level on which they achieve bigger or smaller uniformity. The aim of this research is to show whether the uniformity of cognitive and conative functioning in the heterogenic and complex sport space can also be noticed among different sports, as well as, between groups of sport participants and non-participants. Therefore, the aim is to show whether there are specific mental profiles for different groups of sport and if there are, how different they are in comparison to those who do not train any sport. Taking all this into account, the aim of this paper is to compare psychological functioning among participants in sports which have significantly

different structural-dynamic characteristics:

- judo, which is an individual, contact sport with great physical burden<sup>16</sup> and complex movement characteristics and which is played in dynamic surroundings with a quick exchange of stimuli which require fast data processing and adequate decision making<sup>17</sup>,
- volleyball which is a parallel no-contact team sport with explosive actions and a strong necessity to „coordinate the team“ and where the dynamics of the game are even more expressed than in judo and
- shooting which is done in static and standard sports surroundings and emphasizes attention, precision and patience as dominant characteristics of a shooter.

## Material and Methods

### The study sample

The study sample included 11 elite serbian judokas ( $21.82 \pm 3.97$  y), 21 elite serbian shooters (11 male and 10 female;  $22.43 \pm 7.49$  y), 12 elite serbian female volleyball players ( $20.42 \pm 2.84$  y) and 22 students (11 female and 11 male;  $23.41 \pm 2.42$  y). Prior to research, participants in the survey gave written consent about voluntary participation. All participants were healthy and without injuries and did not use any psychoactive substances or anything else that could affect alertness and behaviour.

### A sample of the measuring instruments

The constructs measured in this research rely on the cybernetic model of cognitive and conative functioning. Those characteristics are assessed by applying the battery of tests of cognitive efficiency<sup>18,19</sup> and conative functioning<sup>20,19</sup>.

Cognitive abilities were assessed by using three representative tests for determining cognitive processor efficiency:

- efficiency of the perceptive processor – IT<sub>1</sub> (designed to measure perceptive ability which represents a synthesis of the ability of perceptive analysis, perceptive structuring and perceptive identification. Test tasks are of a multiple choice type; the subject has to identify which of four images is identical to a given image. The test consists of 39 tasks that have to be solved in 4 minutes, thus meeting the criteria of a speed test);
- efficiency of the serial processor – AL4 (designed for the assessment of verbal comprehension and contains 40 tasks consisting of pairs of words; measuring the ability to process information in a sequential way, i.e. one after another, the subject is asked to determine whether the pair of words have an identical or opposite meaning. The time allowed for the test is 2 minutes, therefore the test meets the criteria of a speed test); and
- efficiency of the parallel processor – S1 (designed for assessment of visual spatialization; measuring the ability to process information at the same time, the test consists of 30 tasks, each of which represent a three-dimensional image of a pile of bricks; the subject has to choose one of the four transverse projections of the brick pile which corresponds to the given image when observed from a particular angle; the time allowed for the test is 8 minutes).

Conative characteristics were assessed by using scales from KON-6 designed on the basis of the cybernetic model of conative regulatory functions. These scales estimate six conative regulatory mechanisms:

- activity regulator –  $\epsilon$  (one of the elementary and lowest subsystems in the hierarchy, which is responsible for the activity and energy level at which subsystems are functioning, including cognitive and motor processors);
- organ function regulator –  $\chi$  (formed by the correlated action of subcortical centers for the regulation of organ functions, mostly located in the hypothalamic region, and superior cortical systems responsible for regulation and control);
- regulator of defense responses –  $\alpha$  (located in the hypothetical center for the regulation of defense responses, in the limbic system; it modulates tonic excitation, probably on the basis of appropriate programmes transmitted by genetic code or formed during ontogenic development, as a rule due to conditioning);
- regulator of attack responses –  $\sigma$  (located in the hypothetical center for the regulation of attack responses, in the limbic system; likewise the center for the regulation of defense responses, however, it also modulates primary tonic excitation, based on the program of destructive response, formed during phylogenic or ontogenic development);
- system for coordination of regulatory functions –  $\delta$  (coordinates functions of subsystems that are functionally or hierarchically different, including functions of cognitive processors; therefore, this system is functionally superior to the regulators of organ functions, regulators of attack responses and defense responses, and to a certain extent to the activity regulator); and
- system for integration of regulatory functions –  $\eta$  (it is superior to all conative regulatory systems, integrates conative processes within the psychological area structure, the social area structure and its changes in particular, thus the level of socialization directly depends on this system).

Each of the six conative tests contains 30 statements, and a subject has to mark one of five answers on the Likert scale. Time given to solve the test is not limited (about 30 minutes for the whole test battery), and each test score can range from 30 to 150 points. In this research a computerised set of psychological tests was used – CRD-series (Complex Reactionmeter Drenovac)<sup>21</sup> which consists of 38 standardized tests arranged in 4 working boards and aimed at examining perceptive and cognitive functions, as well as different psycho-motor reactions. The following two series of CRD tests were used:

- CRD 2-41 – a test for the identification of accidentally arranged three-figure numbers in rising order, where the subjects of measurement can be abilities of the visual apparatus (central and periphery sight), skills of visual exploration and characteristics of attention.
- CRD 4-11 – a test of complex psycho-motor reaction where the task of the participants is to react to one to three (out of four) light stimuli by using one or a combination of limbs. In the



test CRD 4-11 the signal system has a uniquely defined order: a flashing signal lamp signifies the limb which is used to react (two upper lamps represent arms and two lower ones legs). The subject of measurement of this test can be operational thinking, coordination of movements and associative memorizing.

By applying a specific methodology of fractioning of latent periods<sup>22</sup> of solving tasks and specific procedures of shaping indicators of the functional significance they show, for the purpose of describing results of CRD tests in this research, specific indicators of the fluctuation of partial effects during the test and manifested functional disturbances were measured:

- Total time of doing the test (TT),
- The shortest time of the exact action (MinT),
- The total number of errors in the test (NoEr), and
- The total ballast (TB) – or the lost time, the variability in the time of solving individual tasks represented by the total of differences between

the time of solving individual tasks in the test and the shortest time of solving any task in the test.

#### Data analysis

Multivariate and univariate differences between four groups of participants were calculated and tested by MANOVA and ANOVA (LSD post-hoc test). Arithmetic means (AM) and standard deviations (SD) of every variable in each group are reported with the tests of significance of differences ( $p < 0.05$  was considered as statistically significant).

#### Results

The analysis showed that there was a statistically significant difference among the tested groups for most variables (Table 1). The differences were found regarding cognitive efficiency measured by subscales AL-4, S-1 and within the conative space regarding constructs measured by ETA ( $p < 0.01$ ) and by DELTA ( $p < 0.05$ ).

Table 1. Differences in cognitive and conative functioning among different groups of athletes

Variables	Judokas X(SD)	Shooters X(SD)	Volleyball players X(SD)	Control group X(SD)
<b>Perceptive processor efficiency (IT1)</b>	20.81 (3.91)	22.57 (4.33)	23.83 (5.42)	23.04 (3.88)
<b>Serial processor efficiency (AL4) **</b>	30.54 (4.63)	30.09 (7.77)	33.08 (3.89)	36.40 (2.97) <sup>jj ss</sup>
<b>Parallel processor efficiency (S-1) **</b>	23.90 (6.68)	25.85 (3.24) <sup>vv</sup>	19.25 (7.14)	24.04 (3.16) <sup>v</sup>
<b>Activity regulator (ε)</b>	118.45 (16.37)	114.09 (16.32)	118.91 (11.57)	117.72 (11.11)
<b>Organ function regulator (χ)</b>	42.63 (14.17)	50.23 (12.65)	50.91 (12.50)	47.36 (14.70)
<b>Defense response regulator (α)</b>	62.27 (18.38)	72.28 (20.43)	80.50 (22.22) <sup>y</sup>	67.00 (19.10)
<b>Attack response regulator (σ)</b>	93.00 (14.90)	94.95 (13.57)	96.41 (11.60)	86.81 (13.60)
<b>Coordination of regulatory functions (δ) *</b>	43.81 (8.58)	45.47 (10.13) <sup>x</sup>	44.75 (10.89) <sup>x</sup>	38.36 (5.62)
<b>Integration of regulatory functions (η) **</b>	46.00 (12.63)	58.28 (11.98) <sup>x</sup>	59.16 (13.79) <sup>jx</sup>	48.13 (11.19)

Judokas,  $j$   $p < 0.05$ ;  $jj$   $p < 0.01$ ; shooters,  $s$   $p < 0.05$ ;  $ss$   $p < 0.01$ ; volleyball players,  $v$   $p < 0.05$ ;  $vv$   $p < 0.01$ ; students  $x$   $p < 0.05$ ;  $xx$   $p < 0.01$ ; ANOVA \*  $p < 0.05$ , \*\*  $p < 0.01$

Post-hoc testing demonstrated (LSD test) differences among some groups. The group of students has significantly higher results for the variable AL-4 than judoists and shooters on the level of significance  $p < 0.01$ . The shooters are significantly different from the volleyball players for the variable S-1 on the level of significance  $p < 0.01$ , while the students are better than the volleyball players for the same variable, but on a somewhat lower level of significance ( $p < 0.05$ ). The volleyball players have a

significantly higher result ( $p < 0.05$ ) for the variable ALPHA than the judoists. For the variables DELTA and ETA significantly higher results ( $p < 0.05$ ) are obtained by the shooters and volleyball players than the students, while the volleyball players on the same level of significance have higher results than the judokas for the variable ETA. Testing differences in the level of coordination, attention and visual exploration of analyzed groups was performed by applying multivariate analysis of variance (Table



2). The difference among groups of participants occurred for the variables NoEr4-11 on the level of significance  $p < 0.01$ , while for the variables MinT2-

41 and TB4-11 the difference was on the level of significance  $p < 0.05$ .

Table 2. Differences in level of coordination, attention and visual exploration among different groups of athletes and non-athletes

Variable	Judokas	Shooters	Volleyball players	Control group
	X(SD)	X(SD)	X(SD)	X(SD)
<b>TT 2-41</b>	187.54 (27.15)	193.06 (54.57)	199.64 (57.43)	183.22 (49.10)
<b>MinT 2-41*</b>	0.44 (0.12)	0.62 (0.19) <sup>j,v,x</sup>	0.46 (0.30)	0.46 (0.19)
<b>NoER 2-41</b>	0.40 (0.51)	0.39 (0.98)	0.41 (0.90)	0.14 (0.53)
<b>TB 2-41</b>	170.06 (29.13)	168.12 (0.49)	181.37 (0.56)	164.79 (0.51)
<b>TT 4-11</b>	27.93 (0.44)	32.27 (0.68)	32.43 (0.69)	36.67 (1.07) <sup>jj</sup>
<b>MinT 4-11</b>	0.42 (0.07)	0.46 (0.06)	0.45 (0.06)	0.45 (0.08)
<b>NoEr 4-11**</b>	5.70 (2.49)	8.77 (4.12)	11.00 (7.16)	14.35 (2.97) <sup>jj,ss</sup>
<b>TB 4-11*</b>	13.13 (3.77)	15.99 (5.62)	16.51 (6.61)	20.75 (9.23) <sup>jj,s</sup>

Judokas, *j*  $p < 0.05$ ; *jj*  $p < 0.01$ ; shooters, *s*  $p < 0.05$ ; *ss*  $p < 0.01$ ; volleyball players, *v*  $p < 0.05$ ; *vv*  $p < 0.01$ ; students *x*  $p < 0.05$ ; *xx*  $p < 0.01$ ; ANOVA \*  $p < 0.05$ , \*\*  $p < 0.01$

Post-hoc testing revealed some differences among groups. The group of shooters have significantly higher results of the variables MinT2-41 than all other groups of examinees on the level of significance  $p < 0.05$ . The students have significantly higher results than judokas for the variables TT4-11, NoEr4-11 and TB4-11 on the level of significance  $p < 0.01$ , while their results are higher than those of the shooters for the variables NoEr4-11 on the level of significance  $p < 0.01$ , while the level of significance for the variable TB4-11 is somewhat lower,  $p < 0.05$ .

## Discussion

Considering cognitive characteristics, the results show that there is no difference in the perceptive skills among groups of volleyball players, shooters, judokas and the control non-athlete group. This result is congruent with previous findings of Bala and Franceško<sup>23</sup> according to which the perceptive processor is unable to explain differences on the level of sensory-perceptive apparatus between athletes and non-athletes, as well as differences among athletes who take part in different levels of competition. The differences seem to occur at the higher level during the processing of the verbal material and mental visualization. As was expected, students earned the best scores on the test AL-4. This is explained by the fact that this group is frequently exposed to a verbal type of material as part of their formal education curriculum. Statistically significant difference is also found in comparison to the groups of shooters and judokas, but not in comparison to the volleyball players (who belong to a lower level of competition). This can be an indicator of a negative correlation between the level of sports competence and the speed of verbal data processing, which, on the other hand, has a positive correlation with the level of education. Namely, the participation of an athlete in activities which are not associated to sports (e.g., studying at faculty) decreases as their involvement in athletic activities increases,

especially if that involvement is followed by higher sport accomplishments. The scores on the test S-1 show some statistically significant differences in favor of the shooters (on the level 0.01) and the students (on the level 0.05) in comparison to the volleyball players. If we recall Cattell's classification of fluid and crystallized intelligence, we can assume that manipulation with verbal material will be in a positive correlation with the level of crystallized intelligence, which is obtained during the process of acquiring both formal and informal education, while fluid intelligence, which is genetically determined, will be predicted mostly by the test of spatial abilities. This paper proves no dominant influence of either the parallel processor<sup>23</sup>, or the serial one<sup>19</sup> in the cognitive functioning of athletes. If the parallel processor was the best at describing the latent space of a general motor factor, we would expect the national team players to have better results on the test S-1 in comparison to the volleyball players. In the domain of conative characteristics, there are three variables which indicate the differences among the examined groups of athletes. The alpha test, which measures defense reactions (close to the Eysenck's neuroticism dimension), shows that the volleyball players have the highest score among all tested groups. This finding is supported by Dobersek and Bartling<sup>24</sup> who discovered that the volleyball players have a higher level of neuroticism than other athletes, including golfers and tennis players. This is in accordance with previous findings that a higher level of neuroticism and anxiety is a feature of team sport players, especially in a parallel type of sport without any contact with the opponents. If we take into account the fact that the volleyball players have the highest score in tests of defense and attack reactions (even though the latter is not statistically significant), it can be concluded that they have the weakest emotional regulation or the lowest ability to express emotional response with the appropriate intensity and length. On the other hand, judokas have the lowest scores of defense and attack reactions,

which implies that they are emotionally very stable. Even though some researchers have confirmed that among personal features emotional stability is the best indicator of sport achievements<sup>25</sup>, the question might be whether emotional stability is a better predictor of top results in the case of individual and contact types of sport or also in the case of team parallel sports. In the domain of psycho-motor abilities the results on the test CRD 2-41 show that the shooters' minimal reaction time is the shortest. This can be explained by the specific nature of this sport. Shooting belongs to a group of sports where the tenacity of attention, or focusing on one point, with the simultaneous elimination of other stimuli, is a precondition of successful shooting. In other words, shooters rely on the benefits of central sight and static visual sharpness trying to maximize the resolution of the target. The analysis of other indicators show that, in spite of such minimal reaction time, shooters have a lower ballast in comparison to the other two groups of athletes (even though it is not statistically significant), which implicitly indicates their stability, which is also a characteristic of this sport. Unlike judo and volleyball, which are played in very dynamic surroundings with quick and frequent changes of stimuli requiring great vigility of attention, anticipatory reactions and quick and adequate decision making, shooting is a closed-type skill sport performed in a stable and predictable setting<sup>26</sup>. The established sequence of movements and the length of time needed to shoot develops a general stability in shooters demonstrated on test CRD 2-41. The prolonged reaction time and significantly higher number of errors that students non-athletes made on the test CRD 4-11 comparing to judokas and shooters probably is the consequence of a weaker eye-arm-leg coordination. Considering previous findings that athletes show faster motor reactions than non-athletes<sup>27</sup>. The reason for that lies in the fact that the elements of a concrete problematic situation are more similar to the elements which occur during the process of motor learning during training, than the everyday situations the students experience. That is why it is possible that there is a transfer of certain structural characteristics of a motor task for athletes<sup>28</sup>. It can be assumed that a motor program with certain similarities probably exists in the motor-kinesthetic memory which is now actualized and applied in the new laboratory conditions. Since test CRD 4-11 also examines the efficiency of associative memory (the connection of a certain lamp with the appropriate limb), there is a greater possibility that an association like that (or a stereotype) lies in the memory of athletes because they could find its sense more easily through a combination of movements. In this case, by reorganizing the existing stereotype athletes can rely on their procedural knowledge (how to do something practically, performative knowledge) more easily than students who rely on their capacities of declarative knowledge (how to do something in theory, factual knowledge). A closer connection between motor skills and practical intelligence

instead of with verbal intelligence explains the worst coordination result performed by the students and their best verbal intelligence result. Also, there might be a questionable validity of the KOG3 battery when used to measure „sports intelligence“ which, even though it has good psychometric characteristics, is deprived of a contemporary contextualized frame. As far as the conative variables are considered, this research confirmed the results of some other studies about the non-existence of differences between athletes and non-athletes. The difference between these two groups was not found in the dimension of introversion-extraversion (epsilon in KON-6), also reported by Auweele et al.<sup>29</sup>, and Morris<sup>30</sup>, including the domain of aggression<sup>31</sup>. Still, the functioning of the system for the coordination of regulatory functions (delta in KON-6), which is above average, brings into question the conclusion made by Momirović about the influence of the system of coordination of regulatory functions on the organization/disorganization of cognitive, conative and motor functions<sup>18,20</sup>. The functioning of this conative system, which is above average for some students, can be the consequence of the appropriate sample which gathered people with unnoticeable deviation tendencies, so it is perhaps only justified to talk about the influence of the system on the conative characteristics. Finally, the results revealed that the system which regulates defense reactions proves to play a significant role in emotional stability in sport<sup>32</sup>. The recommendations for future researches would be to compare these results with other indicators of an emotional response which can be detected by the battery of tests CRD.

## Conclusion

By analyzing the differences in the cognitive and conative functioning among the judokas, volleyball players, shooters and non-athletes, the following conclusions were made:

1. The serial and parallel processors do not favor the athletes in comparison to the control group, which implies that the intellectual factor has rather an indirect than a direct effect on the success in sport.
2. It was confirmed that a dimension of emotional stability strongly correlates to sports achievements.
3. The athletes belonging to all three groups have a better coordination than non-athletes (with the exception of significant difference for the volleyball players).
4. There is no difference in visual skills and attention between the athletes and non-athletes.
5. There are some indicators which show that the characteristics of athletes can be modeled according to the requirements of a certain sport, which is why shooters show a specific method of visual exploration, while volleyball players have the highest level of emotional instability.

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## KOGNITIVNO I KONATIVNO FUNKCIONISANJE DŽUDISTA, STRIJELACA I ODBOJKAŠA

### Sažetak

*Cilj ovog istraživanja je da pokaže da li se uniformnost kognitivnog i konativnog funkcionisanja u heterogenom i kompleksanom sportskom prostoru može uočiti među različitim sportovima, ne samo u okviru jednog. Studijski uzorak je identičan za obje studije i uključivao je 11 džudista, 21 strijelaca, 12 odbojkaša i 22 studenta. Konstrukcije izmjerene u ovom istraživanju oslanjaju se na kibernetički model kognitivnog i konativnog funkcionisanja. Te karakteristike se ocjenjuju primjenom baterije testova kognitivne efikasnosti i konativnog funkcionisanja. Razlika se pojavila za varijable AL-4, S-1 i ETA na stepenu važnosti  $p < 0,01$ , dok je za varijablu DELTA stepen važnosti  $p < 0,05$ . Razlika između grupa pojavila se za varijablu NoEr4-11 na stepenu važnosti  $p < 0,01$ , dok je za varijable MinT2-41 i TB4-11 razlika na stepenu važnosti  $p < 0,05$ . Serijski i paralelni procesori ne favorizuju sportaste u odnosu na kontrolnu grupu, što znači da intelektualni faktor ima učinak modeliranja na uspjeh u sportu, više nego direktan. Potvrđeno je da je dimenzija emocionalne stabilnosti u korelaciji sa sportskom kompetencijom na najjači način. Sportisti koji pripadaju u sve tri grupe imaju bolju koordinaciju od ne-sportaša (iako to nije statistički važno za odbojku).*

**Ključne riječi:** Kognitivne sposobnosti, konativne karakteristike, karakteristika pažnje, operativno razmišljanja

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## DIFFERENCES IN THE MORPHOLOGICAL CHARACTERISTICS WITH ATHLETES AND NON ATHLETES AT THE AGE OF 16-18 YEARS

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### Abstract

The main objective of the study was to determine and compare the indicators for assessment of the anthropometric dimensions and body composition, with respondents dealing with karate and non athletes at the age of 16-18 years. The sample of respondents was defined with 85 respondents from the population athletes and non athletes males divided into three subsamples of which: the first included 25 respondents karate athletes who have trained at least 1 (one) year, the second subsample covered 30 respondents non athletes from rural environment and the third subsample covered 30 respondents from urban environment - or entities who are not engaged even in recreational sports activities. Total of 28 variables were applied, from which 20 variables to assess the anthropometric characteristics, 8 variables to assess the body composition - TANITA. To determine and compare the indicators for assessment of the anthropometric dimensions and body composition among respondents dealing with karate and non athletes were used multi variant and uni variant analysis of variance. Based on the statistical analysis of the data it can be concluded that there is statistically significant differences in the morphological characteristics between the applied variables and groups.

**Keywords:** anthropometric dimensions, body composition, karate athletes, non athletes, ANOVA, MANOVA.

### Introduction

The morphological development of the human, with all of his basic and special characteristics, has a significant role in the physical culture, mainly from two aspects: firstly, directing and prediction of the development of the morphological features and particularities and secondly, prediction and determination (selecting) of athletes for different sport disciplines, based on the morphological features, particularities and traits. However, this issue in theoretical settings, as in practical implementation, consists of contentious moments, without defined argumentation and without empirical efficiency. The previous research from this field, however bear some clear commitments which can be relatively successfully implemented in practice, but in coordination and correlation with other scientific components, contained in the sport disciplines and predictions for relative successfulness on unsuccessfulness. Karate is among the sports that have a significant impact on the transformation of the human person as a whole. With its regular practice through a long period of time influences on the optimal development of the athlete, on improving the structure of the psychosomatic status, influences on the anthropometric and motor dimensions of the athletes, allowing direct control of inborn reflex movements or have a significant impact on all spaces (conative, cognitive, social, psychological, etc.) (Soklevska, E. 2010). Anthropological characteristics are an important factor for success in karate sport, where the most important role in achieving top performance is the high-speed (Scepanović, I., Vlahović, A. 2013). Anthropometric characteristics have been proposed to contribute to improved performance in many sports (Carter, JEL, & Heath, BH 1990).

### Methods

The survey was conducted on a sample of respondents which is drawn from the population of students dealing with sports and non athletes males at the age of 16-18 years ( $\pm 6$  months). The total sample includes 85 respondents and it is divided into three subsamples of which: the first subsample included 25 respondents karate athletes who have trained at least a year, the second subsample covered 30 respondents non athletes from rural environment and the third subsample included 30 respondents from urban environment who are not engaged even in recreational sports activities. The main objective of the study was to determine and compare the indicators for assessment of the anthropometric dimensions and body composition, with respondents dealing with karate and non athletes at the age of 16-18 years. For the purposes of this research total of 28 variables were applied, from which 20 variables to assess the anthropometric characteristics, 8 variables to assess the body composition - TANITA. The sample of variables to assess the anthropometric space consists of: Variables for evaluation of the longitudinal dimensionality of the skeleton: Body height (ATVI), Leg length (ADNO), Arm length (ADRA). Transversal dimensionality of the skeleton: Ankle diameter (DSZG), Diameter of the knee (DKOL), Diameter of the pelvis (DKAR), Shoulders diameter (DRAM). Body voluminosity: Body weight (ATTE), Chest volume (inhalation) (OGKE), Chest volume (exhale) (OGKI), Volume of the humerus (ONLK), Volume of the forearm (OPLK), Volume of the femur (ONKOL), Volume of the tibia (OPKOL). Subcutaneous adipose tissue: Abdomen skin fold (AKNS), Triceps skin fold (AKNT), Biceps skin fold (AKNB), Subscapularis skin fold (AKNSS), Suprailiac skin fold (AKNSI), Skin fold of the lateral head (AKNLI). Sample of variables to assess the body composition TANITA: Age of respondent (chronological) (AGE), Fat free mass (FFM - Fat)%, Total mass of body water (TBW)%, Muscle mass (MMAS) kg, Physical Assessment (FRAT) 1-9,



Bone mass (BMAS) kg, Visceral mass (VFR) 1-59, Body mass index (BMI). For assessment of the aforementioned variables were used the following instruments successfully: Antropometer - by Martin; Caliper PCE-DCP 150I; Tanita scale model (BODY COMPOSITION ANALYZER TANITA TBF-300 A);

## Results and discussion

### RESULTS AND DISCUSSION

The Table. 1 presents the basic descriptive indicators for the total sample of respondents. The sample includes 85 respondents divided into three subsamples: the first subsample included 25 respondents karate athletes, the second subsample covered 30 respondents non athletes from rural environment and the third subsample included 30 respondents from urban environment. From the table can be seen greater values in the anthropometric space with the variables for assessment of the mass volume and body mass in karate athletes compared with the other groups (non athletes from rural environment and non athletes from urban environment), in the variables ATTE (Body Weight), OGKE (Chest volume - inhale), OGKI (Chest volume - exhale), OPLK (Volume of the forearm). Also karate athletes showed higher values in the variables for assessment of the body composition in the variables: MMAS (Muscle mass), FRAT (Physical assessment) and BMAS (Bone mass). The obtained results from the studied respondents can be explained on the basis of genetic conditions in this age. In this age the pubertal stage is nearly completed, so the individual differences in this respect are minimal. These results are consistent with the results obtained from the research conducted by the authors Vuković, A., Obradović, M., Đurić, S., & Mudrić, M. (2013). The authors in their research found that there are no statistically significant differences between students and karate athletes in body weight and BMI. In the variable Body weight the t-test was  $p = 0.228$ , while the results of BMI indicate values of similar arithmetic

mean, which for the students were calculated 19.40 and for karate athletes 19.31. The BMI t-test is  $p = 0.474$ . These results are consistent with the results of similar research in other martial arts, conducted by the authors Ilić, V., Mudrić, M., Kasum, G., Cirković, M., Gavrilović, D, (2012). In Table. 2 the results of the uni variant analysis of the variance among the variables to assess the anthropometric characteristics and body composition in the studied subsamples are presented. Based on the uni variant analysis it can be noted that there are statistically significant differences in seven (seven) variables: AKNLI (Skin fold of the lateral head) and BMI (Body mass index), in favor of the non athletes from rural environment, DSZG (Ankle diameter) in favor of the non athletes from urban environment, DKOL (Knee diameter), MMAS (Muscle mass) and FRAT (Physical assessment) all of the variables are in favor of karate athletes. Our results suggested that most of the variables of body composition are in favor of karate athletes. In terms of BMI, respondents from rural environment have higher values but not better than the other results of the other groups, indicating the impact of the environment on some morphological characteristics. Results from several studies have shown that the environment affects on all kinds of physical activities, and so, on the morphological characteristics, according to Ilse De Bourdeaudhuij, Sallis and Saelens, (2003). The survey conducted by El Mugamer et al. (1995) shows that the inhabitants of rural environment in the United Arab Emirates have a higher value of BMI, ( $p = 0.002$ ) and where 27% of all inhabitants of the urban environment resulted with values of BMI = 30. Better results in the variable Body mass index BMI in our study showed the respondents non athletes from rural environment, but these results cannot be generalized because different environment have different characteristics. On the physical activity influence factors, such as economic factors, socio-cultural factors, infrastructure, geographical characteristics of the environment and others according to Ross et al., (2001).

Table 1. Basic statistic indicators

	Mean			Minimum			Maximum			Std.Dev.		
	I N=25	II N=30	III N=30	I N=25	II N=30	III N=30	I N=25	II N=30	III N=30	I N=25	II N=30	III N=30
ATV	174.84	174.26	174.48	164.00	163.00	161.00	186.00	189.00	185.00	± 6.03	± 5.86	± 6.33
ATTE	69.14	62.81	66.15	52.10	44.00	42.40	94.20	79.40	102.00	± 9.65	± 8.35	± 12.89
ADNO	102.28	103.64	105.19	93.00	95.00	94.50	110.00	113.00	119.00	± 4.83	± 4.16	± 5.34
ADRA	76.46	75.87	77.43	73.00	17.00	69.00	80.00	87.00	89.00	± 2.05	± 11.63	± 4.36
AKNS	10.03	10.22	9.69	4.00	4.50	4.20	22.80	22.00	18.80	± 4.52	± 4.10	± 4.24
AKNT	8.29	7.07	7.09	5.00	3.40	3.60	11.00	16.40	13.20	± 1.85	± 0.87	± 2.61
AKNB	3.85	3.47	3.44	2.10	2.20	2.20	5.50	6.00	6.20	± 0.83	± 1.11	± 1.02
AKNSS	9.38	8.79	9.21	5.20	4.90	5.40	15.40	19.00	17.40	± 2.45	± 2.71	± 3.60
AKNSI	8.61	7.79	9.00	3.80	3.30	4.00	18.80	15.80	30.00	± 3.79	± 3.35	± 5.95
AKNLI	12.10	9.83	12.80	6.20	5.20	4.20	18.80	24.00	23.00	± 3.81	± 4.32	± 5.13
OGKE	94.90	92.68	93.82	80.00	79.00	75.50	107.00	101.00	108.00	± 5.30	± 4.96	± 6.92
OGKI	86.72	84.88	85.51	70.00	71.00	68.50	101.00	93.00	100.00	± 6.02	± 5.10	± 7.51
ONLK	25.52	25.22	25.72	20.50	21.00	18.50	31.00	29.00	31.00	± 2.22	± 2.09	± 3.04
OPLK	23.83	23.55	23.71	20.00	20.00	18.00	27.00	27.50	27.50	± 1.99	± 1.98	± 2.01
ONKOI	50.04	49.13	50.75	43.00	40.00	40.50	59.00	59.00	59.00	± 4.54	± 4.15	± 4.89
OPKOL	34.47	34.43	35.33	24.50	29.00	28.00	41.00	40.00	40.00	± 3.68	± 2.62	± 2.80
DSZG	6.68	6.93	7.10	6.00	5.80	6.00	7.40	7.90	8.10	± 0.42	± 0.60	± 0.50
DKOL	9.76	9.33	9.51	8.30	8.20	8.10	11.00	10.20	10.70	± 0.69	± 0.57	± 0.61
DKAR	28.46	27.47	27.78	25.30	25.30	24.00	32.50	29.80	32.10	± 1.83	± 1.12	± 2.12
DRAM	37.24	38.75	38.66	31.50	31.80	31.60	42.30	43.00	44.00	± 2.94	± 2.40	± 2.62
AGE	16.48	17.03	16.40	15.50	16.00	16.00	18.50	18.00	18.00	± 0.93	± 1.00	± 0.81
FFEM	11.09	10.26	11.49	5.00	5.00	5.00	21.10	18.50	21.90	± 4.84	± 3.23	± 4.15
TBW	62.54	64.95	63.93	54.20	57.10	55.50	73.70	77.10	78.80	± 4.18	± 4.31	± 5.73
MMAS	58.34	53.44	54.81	42.10	39.60	38.10	75.40	66.20	65.20	± 8.70	± 5.99	± 7.14
FRAT	7.12	6.17	6.03	5.00	4.00	5.00	9.00	8.00	8.00	± 1.36	± 1.32	± 1.33
BMAS	3.02	2.86	2.88	2.20	2.20	2.10	3.90	3.40	3.40	± 0.42	± 0.27	± 0.37
VFR	1.08	1.13	1.30	1.00	1.00	1.00	3.00	3.00	5.00	± 0.40	± 0.43	± 0.84
BMI	22.62	20.64	21.39	17.20	16.60	14.20	28.75	27.00	28.10	± 2.66	± 2.29	± 2.74

Table 2. Variance analysis

	SS	Df	MS	SS	df	MS	F	P
ATV	4.57	2.00	2.28	3031.33	82.00	36.97	0.06	0.94
ATTE	551.22	2.00	275.61	9074.27	82.00	110.66	2.49	0.09
ADNO	116.45	2.00	58.22	1888.02	82.00	23.02	2.53	0.09
ADRA	37.45	2.00	18.73	4576.79	82.00	55.81	0.34	0.72
AKNS	4.37	2.00	2.18	1500.74	82.00	18.30	0.12	0.89
AKNT	26.00	2.00	13.00	518.39	82.00	6.32	2.06	0.13
AKNB	2.77	2.00	1.38	82.54	82.00	1.01	1.38	0.26
AKNSS	5.20	2.00	2.60	732.71	82.00	8.94	0.29	0.75
AKNSI	22.52	2.00	11.26	1697.33	82.00	20.70	0.54	0.58
AKNLI	142.99	2.00	71.49	1653.01	82.00	20.16	3.55	0.03
OGKE	67.31	2.00	33.66	2778.48	82.00	33.88	0.99	0.37
OGKI	46.84	2.00	23.42	3259.27	82.00	39.75	0.59	0.56
ONLK	3.80	2.00	1.90	513.42	82.00	6.26	0.30	0.74
OPLK	1.11	2.00	0.55	325.60	82.00	3.97	0.14	0.87
ONKOI	39.39	2.00	19.69	1689.00	82.00	20.60	0.96	0.39
OPKOL	15.19	2.00	7.60	751.75	82.00	9.17	0.83	0.44
DSZG	2.45	2.00	1.23	21.68	82.00	0.26	4.64	0.01
DKOL	2.44	2.00	1.22	31.81	82.00	0.39	3.15	0.05
DKAR	13.86	2.00	6.93	247.97	82.00	3.02	2.29	0.11
DRAM	38.20	2.00	19.10	573.38	82.00	6.99	2.73	0.07
AGE	7.01	2.00	3.50	68.91	82.00	0.84	4.17	0.02
FFEM	23.25	2.00	11.62	1366.95	82.00	16.67	0.70	0.50
TBW	79.59	2.00	39.80	1909.02	82.00	23.28	1.71	0.19
MMAS	341.79	2.00	170.89	4336.61	82.00	52.89	3.23	0.04
FRAT	18.63	2.00	9.31	145.77	82.00	1.78	5.24	0.01
BMAS	0.42	2.00	0.21	10.32	82.00	0.13	1.66	0.20
VFR	0.75	2.00	0.37	29.61	82.00	0.36	1.03	0.36
BMI	53.51	2.00	26.75	540.35	82.00	6.59	4.06	0.02

Table. 3 Multivariate analysis of the variance

	Test	Value	F	Effect	Error	P
Intercept	Wilks	0.000	25612.19	28	55	0.000
NewVar	Wilks	0.160	2.95	56	110	0.000

Table. 3 presents the results of multivariate analysis of variance, and from it may be noted that in multivariate level between the studied groups statistically significant intergroup differences were established, where Wilks'0 Lambda accounted for 0.160, and the value at Rao's approximation of Rao's F- 2.95, and degrees of freedom df1 = 56 and df2 = 110 is significant at level  $p = 0.00$ . The obtained results are consistent with studies of Simonović, Z. et al (2010).

Table.4 Results from BMI and Fat % with karate athletes compared with other authors

Study	BMI	% Fat
This Study	22.6 ± (2.6)	11,9±(4,4)
Amusa & Onyewadume (2001) (elite)	22,0±(2,5)	12,2±(4,6)
Giampietro Pujia & Bertini (2003) (elite)	22,3±(1,7)	8,2±(2,4)
Rossi & Tirapegui (2007)	-	10,5±(7,7)
Silva et al (2012)	22,7±(3,6)	12,3±(8,6)

The results of the variables Body mass index BMI obtained in this study are similar with the results obtained in (Silva et al, 2012), (Giampietro Pujia & Bertin, I, 2003) and (Amusa, LO, & Onyewadume, IU 2001). While the results of the variable Fat free mass are higher than the results obtained from (Giampietro Pujia & Bertin, I, 2003), (Rossi & Tirapegui, 2007) and lower than the results from (Amusa, LO, & Onyewadume, IU 2001) (Silva et al, 2012).

## Conclusions

The training process in any form more or less influences on the adaptive changes in the human body. By applying various methods and tools in the training process can lead to increased levels of physical ability. All this is accompanied by changes in the morphological status and morphological structure of the athlete. The genetic, innate athlete's potential represents a factor that largely depends on changes in the morphological characteristics and motor abilities of athletes. From this research based on the obtained results can be determined that statistically significant differences exists in the morphological characteristics between karate athletes and non athletes from rural and urban environment.



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## RAZLIKE U MORFOLOŠKIM KARAKTERISTIKAMA KOD SPORTISTA I NESPORTISTA U DOBI OD 16-18 GODINA

### Sažetak

*Glavni cilj istraživanja bio je utvrditi i usporediti pokazatelje za procjenu antropometrijskih dimenzija i tjelesne kompozicije, s ispitanicima koji se bave karateom i ne sportaša u dobi od 16-18 godina. Uzorak ispitanika je definisan sa 85 ispitanika iz muške populacije sportista i ne sportaša podijeljen u tri poduzorka od kojih: prvi uključuje 25 ispitanika karatista koji su obučeni najmanje 1 (jednu) godinu, drugi poduzorak obuhvata 30 ispitanika ne sportista iz ruralne sredine i treći poduzorak obuhvata 30 ispitanika iz urbane sredine - ili subjekte koji se ne bave ni u rekreativnim sportskim aktivnostima. Ukupno 28 varijabli je primijenjeno, od kojih je 20 varijabli za procjenu antropometrijskih karakteristika, 8 varijabli za procjenu tjelesne kompozicije - TANITA. Da bi se utvrdili i usporedili pokazatelji za procjenu antropometrijskih dimenzija i tjelesne kompozicije među ispitanicima koji se bave karateom i ne sportistima koristile su se multi varijanta i Uni varijanta analize varijacije. Na temelju statističke analize podataka može se zaključiti da postoji statistički značajna razlika u morfološkim karakteristikama između primijenjenih varijabli i grupa.*

**Ključne riječi:** Antropometrijske dimenzije, tjelesna kompozicija, karatista, nesportisti, ANOVA, MANOVA.

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## IS THE TECHNICAL EFFICACY ASSOCIATED WITH PROMINENCE LEVEL IN FOOTBALL?

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### Abstract

The aim of this study it was analyse the association between technical efficacy and the prominence level of football players in different competitive levels. For that reason, the Team Sport Assessment Procedure and the Social Network Analysis it were used to analyse the technical actions and tactical prominence. Thirty-one male soccer players (U16 –  $15.67 \pm 0.7$  years old; Semi-professional –  $23.45 \pm 4.2$  years old) were observed during four official matches. Results showed that OutDegree had a moderate positive correlation with volume of play ( $r = .0425$ ;  $p = .001$ ), Efficiency Index ( $r = .327$ ;  $p = .002$ ), and performance score ( $r = .484$ ;  $p = .001$ ). The InDegree showed large positive correlation with volume of play ( $r = .587$ ;  $p = .001$ ), moderate positive correlation with performance score ( $r = .404$ ;  $p = .001$ ) and small negative correlation with efficiency index ( $r = -.097$ ;  $p = .369$ ). It was possible to analyze that tactical prominence can be associated with volume of play and performance score, although cannot be associated with the efficiency of football players.

**Keywords:** Graph Theory; Adjacency Matrices; Network Analysis; Performance; Team Sports.

### Introduction

The individual performance in football it is a crucial indicator that may determine the overall result of a team (Gréhaigne, Godbout, & Bouthier, 1997). Such performance in technical and tactical levels can be constrained by strength and conditioning levels, environment, psychological levels or even the inter-relationships status inside a team (Filipe M Clemente, Couceiro, Martins, Mendes, & Figueiredo, 2013). All these factors may deal with contextual variables that may determine the final results obtained from the match (Carling, Reilly, & Williams, 2009).

If in the case of physiological and physical levels the investigation have been well documented, in the case of technical and tactical analysis the studies are not so well reported (Coutts, 2014). For that reason, it is necessary to ensure the continuation of match analysis to identify how players behave and how they cooperate to increase the possibilities to achieve the ultimate goal in team sports: the victory. The technical analysis have been made based on observational systems (Machado, Barreira, & Garganta, 2014). The systems are not standardized and for that reason there are few studies per each system. Despite of that, some procedures have been growing to ensure some comparisons between different studies. One of this procedures it is the Team Sports Assessment Procedure (TSAP) (Gréhaigne et al., 1997) that have been used to measure the technical level in the context of young players and physical education students. Despite of this, a recent study in Amateur players with more than 20 years old used the TSAP to analyse the technical levels achieved in different small-sided games (Filipe Manuel Clemente, Wong, Martins, & Mendes, 2014). Besides the technical analysis, another important measure it is the tactical level. In the case of this important content, many approaches have been used to classify the players. The majority depends from the observational processes (Costa, Garganta, Greco, Mesquita, & Seabra, 2010; Sarmento et al., 2014). The result that comes from is based on the specific moves that support the

overall organization of the team. Another alternative analysis is the network approach that may imply the knowledge how teammates' cooperates to achieve the collective organization (Lusher, Robins, & Kremer, 2010). The regular approach is based on Social Network Analysis (SNA) using different metrics to identify the general properties of the team and the centrality levels of the players inside the cooperation process of the team (Filipe Manuel Clemente, Couceiro, Martins, & Mendes, 2014). As possible to observe there are different approaches for each performance indicator. Nevertheless, the association of different performance indicators are not regularly conducted in team sports. In fact, no study analysed the association between the technical levels and the tactical prominence in the match. There is any relation between great technical efficacies with great values of centralization in the cooperation process during attacking moments? Following this research question, this study aimed to analyse the relationship between technical variables and network centralities in football players from U16 and Semi-Professional levels.

### Methods

#### Participants

Thirty-one male soccer players (U16 –  $15.67 \pm 0.7$  years old and  $5.32 \pm 1.3$  years of practice; Semi-professional –  $23.45 \pm 4.2$  years old and  $11.12 \pm 2.7$  years of practice) were observed during four official matches. All participants signed the Free and Clarified Consent Form according to the Declaration of Helsinki for the study in humans. The players had been previously trained for a five-month period with four soccer-specific training sessions per week, each lasting for 80 min to 100 min, and one weekly competition.

#### Sample

A total of eight matches (four matches per competitive level) from the Portuguese League were analysed

and codified in this study. A total of 1.867 passes between teammates were recorded and processed. Eight adjacency matrices were generated and then treated for social network analysis.

#### Data collecting

The codification of the players during the match it was made based on the tactical lineup of the teams. A techno-tactical assignment was adopted to positional roles (Di Salvo et al., 2007). The following codes were attributed to the tactical position: 1) goalkeeper (GK); 2) external defender (ED); 3) central defender (CD); 4) midfielder (CMF); 5) external midfielder (EMF); and 5) forward (FW). To process the network analysis, it was only considered the attacking units that resulted in more than two consecutive passes linking two players. The linkage indicator it was the pass made between teammates. Per each unit of attack (passing sequences without opponent's interception or losing the ball) it was generated an adjacency matrix that numerically indicated the direction and weight of relationships. This study followed similar protocols for social network analysis in football (Filipe Manuel Clemente, Martins, Kalamaras, Wong, & Mendes, 2015). The observation it was made by the same researcher. To ensure the reliability of the data collection, it was executed a test-retest process with 10% of the full data with 20-day interval. The Cohen's Kappa test showed a value of 0.91 that it is considered an appropriate margin for this procedures (Robinson & O'Donoghue, 2007).

#### Technical Analysis

Following the procedures of TSAP (Gréhaigne, Richard, & Griffin, 2005), five main indicators per players it were collected: i) conquered balls (CB) – balls recovered from the opponent; ii) received balls (RB) – passes received from teammates; iii) neutral balls (NB) – routine pass without progress in the field; iv) pass (P) – pass to a teammate that contributes to moving forward in the field; and v) shots on goal (SS) – shot to the opponent's goal. Using these five technical indicators, three levels it were computed:

i) volume of play

$$Volume\ of\ Play(VP) = CB + RB$$

ii) efficiency index

$$Efficiency\ Index(EI) = \frac{P + SS}{10 + LB}$$

iii) performance score

$$Performance\ Score(PS) = \left( \frac{VP}{2} \right) + (EI \times 10)$$

#### Network Analysis

Two centrality metrics were used in this study to analyse the prominent levels of players. Both metrics were computed in the software SocNetV (version 1.8.). The SocNetV it is a specific software that it is used to process the network data based on Social Network Analysis (Kalamaras, 2014). The both metrics will be following introduced.

#### Out-degree Centrality

The centrality level that determines how a player it is important to the passing sequence it is the OutDegree. The algorithm used to measure the %OdC it is (Opsahl, Agneessens, & Skvoretz, 2010):

$$C^{w}_{(D-out)}(n_i) = \frac{k_i^{w^{out}}}{\sum_{i=1}^n \sum_{j=1, j \neq i}^n a_{ij}},$$

that is the proportion of weights of nodes that are adjacent to  $n_i$ .

#### In-degree Centrality

The in-degree centrality (IDC) measure the in-degree of each node, which can be denoted by  $k_i^{in}$  or  $k_i^{w^{in}}$  (Wasserman & Faust, 1994). For the case of standardize the group size  $n$ , the %IdC may be computed as follows (Opsahl et al., 2010):

$$P^{w}_D(n_i) = \frac{k_i^{w^{in}}}{\sum_{i=1}^n \sum_{j=1, j \neq i}^n a_{ij}}$$

that is the proportion of weights of nodes that are adjacent to  $n_i$ .

#### Statistical Procedures

The relationship between network metrics (%InDegree and %OutDegree) and technical variables (volume of play, efficiency index and performance score) was investigated using Pearson product moment correlation coefficient. Preliminary analysis was performed to ensure no violation of the assumptions of normality, linearity, and homoscedasticity, as suggested by Pallant (Pallant, 2011). The following scales were used to classify the correlation strength (Hopkins et al., 1996): very small, 0–0.1; small, 0.1–0.3; moderate, 0.3–0.5; large, 0.5–0.7; very large, 0.7–0.9; 0.9–1, nearly perfect; 1, perfect. All statistical analyses were performed using IBM SPSS Statistics (version 22) at a significance level of  $p < .05$ .

#### Results

This study analyzed the network centralities and the technical efficacy of U16 and amateurs (more than 20 years old) in four official football matches. The descriptive statistics can be verified in the following Table 1.

Table 1. Descriptive statistics (mean and standard deviation) of network performance and technical efficacy per tactical position and competitive level.

	%InDegree		%OuDegree		Volume of Play		Efficiency Index		Performance Score	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
<i>U16</i>										
GK	2.32	1.92	6.57	2.64	5.50	6.03	0.95	0.62	12.25	9.15
ED	5.95	2.70	10.42	3.05	14.00	8.11	0.79	0.47	14.92	7.96
CD	6.26	2.14	9.95	3.57	15.00	5.66	0.99	0.46	17.37	7.07
CMF	12.16	4.89	11.02	3.03	23.67	8.11	0.73	0.31	19.16	5.75
EMF	11.50	3.22	7.98	4.49	18.63	6.00	0.79	0.46	17.19	7.24
FW	13.75	1.55	3.66	1.21	25.00	7.35	0.56	0.19	18.12	4.90
<i>Amateurs</i>										
GK	1.76	0.54	5.02	1.20	6.50	2.52	1.65	0.54	19.74	6.53
ED	9.17	2.88	10.20	2.26	48.75	12.60	1.70	0.64	41.38	10.34
CD	6.12	1.58	8.02	1.63	33.38	12.07	1.27	0.44	29.42	10.33
CMF	12.82	3.72	12.52	1.92	57.92	15.90	1.19	0.34	40.87	7.71
EMF	10.00	1.87	7.54	0.64	39.63	6.89	0.22	0.10	22.01	3.99
FW	9.21	2.16	5.92	0.69	35.00	5.48	0.06	0.05	18.07	2.68

The relationship between network centralities (%InDegree and %OutDegree) and the characteristics of the technical efficacy (volume of play, technical efficiency and performance score)

was investigated using Pearson product-moment correlation coefficient. The values of the coefficients are shown in Table 2.

Table 2. Correlation values between the network centralities and the technical efficacy – overall.

	%OdC	%IdC	VP	EI	PS
<b>Network Centralities</b>					
(1) %OdC: OutDegree	1	.389**	.425**	.327**	.484**
(2) %IdC: InDegree		1	.587**	-.097	.404**
<b>Network Performance</b>					
(3) VP: Volume of Play			1	.239*	.883**
(4) EI: Efficiency Index				1	.667**
(5) PS: Performance Score					1

\* Correlation is significant at  $p \leq 0.050$ .

\*\* Correlation is significant at  $p = 0.001$ .

The %OdC showed a moderate positive correlation with VP ( $r = .0425$ ;  $p = .001$ ), EI ( $r = .327$ ;  $p = .002$ ), and PS ( $r = .484$ ;  $p = .001$ ). The %IdC showed large positive correlation with VP ( $r = .587$ ;  $p = .001$ ), moderate positive correlation with PS ( $r$

$= .404$ ;  $p = .001$ ) and small negative correlation with EI ( $r = -.097$ ;  $p = .369$ ). Based on the analysis per tactical position, it was carried out r-Pearson test organized per position. The results can be found in table 3.

Table 3. Correlation values between the network centralities and the technical efficacy – tactical position.

	%OdC	%IdC	VP	EI	PS
GK	<b>Network Centralities</b>				
	(1) %OdC: OutDegree	1	.866**	.700	.294
	(2) %IdC: InDegree		1	.862**	.551
	<b>Network Performance</b>				
	(3) VP: Volume of Play		1	.799*	.882*
	(4) EI: Efficiency Index			1	.988**
ED	(5) PS: Performance Score				1
	<b>Network Centralities</b>				
	(1) %OdC: OutDegree	1	.606*	.314	.280
	(2) %IdC: InDegree		1	.766**	.544*
	<b>Network Performance</b>				
	(3) VP: Volume of Play		1	.734**	.955**
CD	(4) EI: Efficiency Index			1	.903**
	(5) PS: Performance Score				1
	<b>Network Centralities</b>				
	(1) %OdC: OutDegree	1	.848**	.145	.341
	(2) %IdC: InDegree		1	.510*	.617*
	<b>Network Performance</b>				
CMF	(3) VP: Volume of Play		1	.788**	.964**
	(4) EI: Efficiency Index			1	.924**
	(5) PS: Performance Score				1
	<b>Network Centralities</b>				
	(1) %OdC: OutDegree	1	.249	.412*	.188
	(2) %IdC: InDegree		1	.458*	-.153
EMF	<b>Network Performance</b>				
	(3) VP: Volume of Play		1	.442*	.962**
	(4) EI: Efficiency Index			1	.670**
	(5) PS: Performance Score				1
	<b>Network Centralities</b>				
	(1) %OdC: OutDegree	1	.479	.067	.488
FW	(2) %IdC: InDegree		1	-.044	.438
	<b>Network Performance</b>				
	(3) VP: Volume of Play		1	-.366	.757**
	(4) EI: Efficiency Index			1	.330
	(5) PS: Performance Score				1
	<b>Network Centralities</b>				
	(1) %OdC: OutDegree	1	-.694	.650	-.813*
FW	(2) %IdC: InDegree		1	-.501	.807*
	<b>Network Performance</b>				
	(3) VP: Volume of Play		1	-.488	.701
	(4) EI: Efficiency Index			1	.281
	(5) PS: Performance Score				1

\* Correlation is significant at  $p \leq 0.050$ .\*\* Correlation is significant at  $p = 0.001$ .

In the correlation of %IdC of goalkeepers it was found statistical large positive correlation with VP ( $r = .862$ ;  $p = .006$ ). The %IdC of external defenders revealed large positive correlations with VP ( $r = .766$ ;  $p = .001$ ), EI ( $r = .544$ ;  $p = .030$ ) and PS ( $r = .723$ ;  $p = .002$ ).

The %IdC of central midfielders revealed moderate positive correlation with VP ( $r = .412$ ;  $p = .046$ ). Finally, the %IdC of forwards revealed large negative correlations with EI ( $r = -.813$ ;  $p = .014$ ).



Table 4. Correlation values between the network centralities and the technical efficacy – competitive level.

		%OdC	%IdC	VP	EI	PS
U16	<b>Network Centralities</b>					
	(1) %OdC: OutDegree	1	.129	.246	.425**	.415**
	(2) %IdC: InDegree		1	.767**	.013	.499**
	<b>Network Performance</b>					
	(3) VP: Volume of Play			1	.290	.816**
	(4) EI: Efficiency Index				1	.790**
	(5) PS: Performance Score					1
Amateurs (> 20 years old)	<b>Network Centralities</b>					
	(1) %OdC: OutDegree	1	.783**	.846**	.310*	.827**
	(2) %IdC: InDegree		1	.877**	-.188	.560**
	<b>Network Performance</b>					
	(3) VP: Volume of Play			1	.087	.814**
	(4) EI: Efficiency Index				1	.649**
	(5) PS: Performance Score					1

In the correlation of %OdC of U16 it was found statistical moderate positive correlation with EI ( $r = .425$ ;  $p = .004$ ) and PS ( $r = .415$ ;  $p = .005$ ). In the same competitive level, %IdC revealed large positive correlation with VP ( $r = .767$ ;  $p = .001$ ) and moderate positive correlation with PS ( $r = .499$ ;  $p = .001$ ). In the analysis carried out in Amateurs it was found statistical large positive correlations of %OdC with VP ( $r = .846$ ;  $p = .001$ ), PS ( $r = .827$ ;  $p = .001$ ) and moderate positive correlation with EI ( $r = .310$ ;  $p = .041$ ). In the case of %IdC it was found statistical large positive correlation with VP ( $r = .877$ ;  $p = .001$ ) and PS ( $r = .560$ ;  $p = .001$ ).

## Discussion

This study aimed to analyse how technical performance maybe associated with tactical prominence in football. For such analysis it were used two procedures based on observational processes. In one case (TSAP) the analysis it was purely based on the human observation. In the other case (SNA) the analysis had the use of specific algorithms to determine the tactical prominence of players during the attacking process of their team. Using the overall data, it were observed large correlations of indegree centrality with volume of play and performance score. The specific performance indicators used by both metrics to compute the performance levels can explain these results. In the case of indegree it is used the received balls from teammates. In the volume of play, the same indicator it is crossed with conquered balls. For that reason, it is explained the large correlation of indegree with volume of play. Nevertheless, the correlation with performance score it is not only due by the specific performance indicator. In fact, the high efficiency index of a player may explain the confidence of their teammates to pass and to increase the prominence of this player. The correlation values it were also analysed per tactical position. In this case it was observed the bigger correlations of indegree centrality with volume of play in goalkeepers. These results can be justified by the fact that goalkeeper perform a small number o conquered balls, thus the performance indicator of

balls received justified the large correlation among metrics. By other hand, the moderate values of correlation between defensive positions with volume of play may indicate that these players increases the volume of conquered balls, thus not only depends from balls received to have a great volume of play. It was also observed small or moderate values of correlation between indegree centrality and efficiency index in the majority of tactical positions, thus suggesting that despite a player receive a great number of passes may not be by their efficacy to keep the ball. The variability and dynamic of the game may constrained the players to pass to the closer players even if this player do not have the best conditions to be successful during the passing sequence (McGarry, 2005). Generally, outdegree centrality had smaller correlation values than indegree centrality. This may suggest that the prominence maybe be better explained by the fact to be more requested for the teammates than by the fact to be the most prominent in to pass the ball for the teammates. In a practical example, the central defender may pass more times than playmaker, nevertheless the playmaker is more recruited by teammates to pass based on their capacity to define the play and make the difference in attacking process. This study had some limitations based on the small sample used to process the data and the limitation to process only two observational processes of analysis. In the future will be interesting to add more observational processes and compare in order to identify how they work to justify the tactical prominence of a player and the association with their technical efficacy. In other way, will be also interesting to process an interview with players in order to understand if they perceive the tendencies to pass for the players with better efficacy and how they do that.

## Conclusion

The aim of this study it was compare the technical efficacy and the tactical prominence of football players in different competitive levels. Results showed that outdegree centrality had large correlation values with volume of play in goalkeepers and forwards.

By other hand, indegree centrality had large values of correlation with volume of play in the majority of tactical positions, thus revealing that the capacity to be participative are more associated with the prominence to received the ball. Moreover, indegree

centrality had also large values of correlation with efficiency index in the majority of tactical positions, thus suggesting that the efficacy of individual actions may lead with the capacity to be more requested from teammates during attacking moments.

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## DA LI JE TEHNIČKA EFIKASNOST POVEZANA SA NIVOOM UČINKOVITOSTI U NOGOMETU?

### Sažetak

*Cilj ovog istraživanja je bio analizirati povezanost između tehničke učinkovitosti i razine učinkovitosti nogometaša u različitim razinama natjecanja. Iz tog razloga, korišteni su postupak procjene u timskim sportovima i analiza društvenih mreža, za analizu tehničke i taktičke učinkovitosti. Trideset jedan muški nogometaš (U16 - 15.67 ± 0,7 godina, polu-profesionalni - 23.45 ± 4,2 godine) posmatrani su tijekom četiri službene utakmice. Rezultati su pokazali da je izlazni stupanj imao umjerenu pozitivnu korelaciju s volumenom igre ( $r = .0425$ ;  $p = .001$ ), Indeks učinkovitost ( $r = 0,327$ ;  $p = 0,002$ ), a ocjena nastupa ( $r = 0,484$ ;  $p = .001$ ). Ulazni stepen pokazao je veliku pozitivnu korelaciju s volumenom igre ( $r = 0,587$ ;  $p = .001$ ), umjerene pozitivnoj korelaciji s učinkom rezultatom ( $r = 0,404$ ;  $p = .001$ ) i mala negativna korelacija s indeksom učinkovitosti ( $r = -0,097$ ;  $p = 0,369$ ). To je moguće analizirati kako taktička istaknutost može biti povezana s volumenom igre i rezultatom performansi, ali se ne može povezati s učinkovitosti nogometaša.*

**Ključne riječi:** Teorija grafova, matrice susjedstva, analiza mreže, izvođenje, timski sportovi.

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## EFFECTS OF RECREATIONAL SOCCER ON HEALTH STATUS IMPROVEMENT

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*Original scientific paper*

### Abstract

**Background:** Physical inactivity and sedentary lifestyle lead to the emergence of modern diseases such as hypertension, diabetes, obesity and cardiovascular insufficiency such as heart failure, arterial complications and sudden cardiac death. Recreational soccer can be fun and useful form of exercise which can improve health status.

**Methods:** Classification and selection of relevant work was carried out by searching the relevant databases: MEDLINE, Pub Med, SPORTDiscus, Web of Science and Google Scholar using combinations of keywords: recreational soccer, soccer, health, oxygen uptake, effects of soccer. By filtering processes, from 514 available articles, 27 RCTs articles were detected, according to the set criteria which was used as relevant.

**Results:** A statistically significant increase in VO<sub>2</sub>max when playing recreational soccer for 12 – 16 weeks, ranges from 8 – 13 % for men of all ages with no previous playing experience. For women, the maximum oxygen receive during the same period, was increased for 14 – 16 %.

Total amount of body fat was reduced from 3 % to even 13 % among males and females. There was also a slight increase within total muscle mass segmentary on lower extremities.

Mean arterial pressure (MAP) significantly lowers by playing recreational soccer, especially for men with mild to moderate hypertension. Systolic blood pressure (SBP) decreases from 8 to 12 mm/Hg, while diastolic blood pressure (DBP) lowers for 5 – 8 mm/HG.

Under the influence of the recreational soccer programs, lipid changes are reflected in the reduction of LDL cholesterol and triglycerides up to 6 %, with a slight increase of HDL.

**Conclusion:** Playing recreational soccer 2 – 3 times a week promotes an active lifestyle and improves health status by raising general physical abilities, improving cardiac function, regulating body weight by lowering blood pressure and blood fat. Regularly playing soccer is recommended as an additional drugless therapy and as a prevention of modern diseases.

**Keywords:** Health benefits, SSG, football, exercise, body fitness.

### Introduction

During this millennium, soccer stands as most popular sports game. Soccer as a form of recreation is an activity that is fun, dynamic, purposeful and helps with maintain an active lifestyle (Krustrup, Dvorak, Junge, & Bangsbo, 2010), and according to the latest data, soccer game is played by a little less than a half a billion of the total human population. Complex soccer motion structures include large number of changing directions, sprints, jumps, duels and kicks (Krustrup, Dvorak, et al., 2010), which requires a high energy consumption (Krustrup et al., 2014). The psychological domain of playing soccer and competitive character provide a high level of motivation and self – confidence (Seabra et al., 2014), which produces a relatively high level of intensity load of more than 80 % of maximum heart rate (HR<sub>max</sub>). Activities with optimal physical effort and intensity, such as playing soccer, can improve health status and general physical condition (T. Andersen, J. F. Schmidt, M. Thomassen, et al., 2014; Schmidt et al., 2014). Hyperkinesia, or a decreased physical activity combined with stress factors, poor quality and uneven diet lead to the emergence of modern diseases: high blood pressure, neurological disorders, obesity, diabetes and diseases of the cardio vascular system (Blair, 2009). Physical

inactivity not only reduces the functionality, but can also cause a sudden death (Collaboration, 2002). Special attention is dedicated to preventing causes of the previously mentioned most spreaded noncommunicable diseases. Is playing a recreational soccer the right solution for preventing and treating these diseases? First high – quality researches about the effects of recreational soccer on prevention and preservation of health status were conducted in 2006. by a group of Danish scientists. A special attention to a positive health transformation by soccer game, was dedicated in 2010. by FIFA in order to prevent the risks of occurrence of diseases through playing soccer (Blatter & Dvorak, 2014). Based on the 13 researches until then, it was concluded that soccer as a form of recreation has a positive motivational and sociological effects, which was later confirmed (Krustrup, Dvorak, et al., 2010; Seabra et al., 2014), as though that practicing soccer two to three times a week affects the adaptability of the cardiovascular and muscular system, strength and muscle growth, regardless of age, the age and skill level (Blatter & Dvorak, 2014). According to the two leading experts in the field of health and recreational soccer, today there are 60 different studies on this subject (Krustrup & Bangsbo, 2015). Playing soccer organized as small sided games – SSG, has obvious health benefits. Football

and jogging are the best forms of movement for developing and strengthening of cardio respiratory function (Oja et al., 2015). Expansion of recreational soccer in the last decade, as a tool for prevention and treatment of various conditions and diseases is not accidental. Scientifically based facts indicate that recreational soccer even in the elderly who have never played soccer, improves cardiac function and physical capacity (T. Andersen, J. F. Schmidt, J. J. Nielsen, et al., 2014; Schmidt et al., 2014). Additionally, leads to lowering of hypertension in men and women in a relatively short period of 12-16 weeks (Bangsbo, Junge, Dvorák, & Krstrup, 2014), while a period of 24 weeks of playing football hypertension grows into normal blood pressure in 3 of 4 recreationists (Krstrup et al., 2013). Mentioned studies reflect on a better effects in relation to hormonal treatment. Furthermore, a risk of hear diseases was reduced by decreasing body fat for over 13 %, waist circumference, total weight and reduction of the LDL (low density lipoprotein) cholesterol and triglycerides (Bangsbo et al., 2014; Krstrup & Bangsbo, 2015). Soccer Games (SG) also improve bone strength (Helge, Andersen, et al., 2014) in elderly, homeless and women and enhance strength, growth of muscle mass and physical capacity in patients suffering from prostate cancer, who are treated with androgen therapy (Bangsbo et al., 2014; Uth et al., 2014). Also, a reduced insulin resistance in diabetics (type 2 diabetes mellitus (T2DM)) was recorded (T. Andersen, J. F. Schmidt, M. Thomassen, et al., 2014). Research issues of this study are the effects of recreational playing football on health in physically inactive population with or without previous experience in sports. Recreational soccer in the study implies on a group organized competition sporadic activity of soccer practice in groups of different calendar age, sociological and health condition. Timeframe of research should show a global picture. Also, the effects of recreational soccer probably have a similar impact on women and men, which will be clearly identified. The aim of the research was to perform a traditional systematic review which should determine health benefits of the recreational soccer in relation to the various populations of subjects. This study should provide information regarding the effect of recreational soccer on the prevention of modern diseases.

## Methods

### Selection and qualification of studies

The selection of qualified researches regarding this review article was done by searching databases: MEDLINE, Pub Med, SPORTDiscus, Web of Science, and Google Scholar. Database search was done manually using a combination of keywords: recreational soccer, soccer, health, oxygen uptake, effects of soccer. In addition, a reference list of selected articles were examined. Aspects of the health status of population samples provided for the study, were primarily: 1.) functional lung capacity (VO<sub>2</sub>max); 2.) Changes in body fat and lean tissue mass; 3rd) systolic (SBP) and diastolic blood pressure (DBP); 4.) Blood lipids. Total search identified 514 articles where, after removing duplicates by reading titles and abstracts, were selected RCTs 48 articles, of which 27 have investigated the specific areas covered by this systematic review.

- The inclusive criteria for the selection of the articles:
- Studies published in English,
- Randomized and matched studies with a control group,
- The respondents who did not have the status of athletes, regardless of gender, age and health status.

The training program had to last for at least 2 weeks, regardless of intensity, frequency and volume load. The content of recreational soccer training was irrelevant for this systematic review.

## Results

### Program characteristics of the qualified studies

Conducted indoor soccer training programs were mainly consisted of organized SSG format. Common formats include games as 3 vs. 3, 4 vs. 4, 5 vs. 5, 6 vs. 6, 7 vs. 7 or 9 vs. 9 (Lars Juel Andersen et al., 2010; Bangsbo et al., 2010; Knoepfli-Lenzin et al., 2010). Programmed soccer training games mainly consisted of different SSG formats, lasting up to 2x20 min. (Brito, Krstrup, & Rebelo, 2012). Field dimensions ranged from 20x40 with artificial surfaces to 45x60m grass courts. Training lasted from 40 minutes to 60 minutes, 1 to 3 times a week. The intensity of the training ranged from 71% HR max to 90% HR max.

The impact of recreational soccer on changes in VO<sub>2</sub>max

The maximum oxygen consumption (VO<sub>2</sub>max) can drop for up to 10% in each decade of age (T. Andersen, J. F. Schmidt, J. J. Nielsen, et al., 2014; Milanović, Pantelić, Čović, Sporiš, & Krstrup, 2015). Decreased lung function leads to reduced physical activity and ultimately an inactive life. All the studies that examined the effects of recreational soccer, have either directly or indirectly determined the improvement of maximum oxidative lung capacity. Krstrup (2009) found, by exploring the effects of recreational soccer on untrained men, that playing soccer for 1 hour three times a week, after 12 weeks increased VO<sub>2</sub>max for 13%. Similar results of VO<sub>2</sub>max increase from 8 – 13 % among untrained men, also got (Knoepfli-Lenzin et al., 2010; Krstrup, Christensen, et al., 2010; Morten Bredsgaard Randers et al., 2010) among homeless (Morten B Randers et al., 2012). Persons who have played soccer for a long term in their third age, have had a much higher VO<sub>2</sub>max compared to people who haven't played soccer (Sundstrup et al., 2010). VO<sub>2</sub>max in elderly healthy men has improved by 15% - 18% after 12 to 16 weeks of playing soccer (T. Andersen, J. F. Schmidt, J. J. Nielsen, et al., 2014; Schmidt et al., 2014). The increase in VO<sub>2</sub>max by playing soccer was also recorded in men with prostate cancer (Uth et al., 2014). It has been found that for patients with diabetes type II, playing recreational soccer increases maximum lung capacity by 11% (T. Andersen, J. F. Schmidt, M. Thomassen, et al., 2014; Sousa et al., 2014). A small number of studies was carried out on a female population, but it also identified the positive effects in VO<sub>2</sub>max increase. So Bangsbo (2010), Krstrup (2010), Andersen (2010), Krstrup (2010) found in

premenopausal women an increase of 14% - 16% of VO<sub>2</sub>max, after 16 weeks of playing soccer twice a week. Slightly smaller effect with an increase of 5% had a program implemented for 2 - 3 times a week for 12 weeks among hospital female employees (S Barene, Krustup, Jackman, Brekke, & Holtermann, 2014). Authors mostly stated that recreational soccer organized as a small sided games (SSG) improves physical capacity, even better than the running in medium intensity by 5% (Bangsbo et al., 2010; Krustup, Hansen, Andersen, et al., 2010; Krustup et al., 2009) strength training (Krustup, Dvorak, et al., 2010) and Zumba training (S Barene et al., 2014).

Recreational soccer reduces the fat and increases lean body mass

Physical activity of moderate intensity increases the oxidative capacity of fat and therefore reduces the total amount of body fat. Health is associated with an optimal amount of muscle mass with reducing the volume of fat tissue. Playing soccer 3 hours a week for 12 weeks, reduces the total amount of fatty tissue by 3% (1.8 kg), and also there is an increase of lean body mass in untrained man (Krustup et al., 2009). Period from 12 to 16 weeks of soccer training in untrained persons reduces 1.7 - to 3.2 kg of body fat (Lars Juel Andersen et al., 2010; Knoepfli-Lenzin et al., 2010; Morten Bredsgaard Randers et al., 2010), while in homeless (Helge, Randers, et al., 2014) for the same period soccer reduced the amount of the fatty tissue for 13 %. Prostate cancer patients, for 12 weeks of playing soccer, have reduced the amount of fat tissue by 2.8% (Uth et al., 2014). In persons who played soccer for a long term, it was observed that they have a greater amount of lean body mass even in a third life age, compared to those who haven't played, and that the diameters of muscle fibers were significantly higher among former players, especially those of oxidative type (Ia) (Sundstrup et al., 2010). Randers et al (2010) found that in healthy men who played soccer on average once a week for a period of all year round, reduced 3.2 kg of fat tissue. Recreational soccer has a similar effect in women. Krustup et al (2010) when determining the effects of recreational soccer on health of premenopausal women, found that soccer practice applied as SSG, implemented twice a week for a period of 16 weeks, reduced body fat mass by 1.4 kg, while increasing lean body mass in same quantity. Almost identical percentage decrease of body fat in female hospital employees found Barene (2013), but for a period of 12 weeks. Middle-aged women with hypertension, who played soccer for 15 weeks, gained 2.8 % of muscle mass while at the same time reduced the amount of body fat by 2.3 kg (Mohr et al., 2014). Obese boys aged 8 - 12 years can reduced muscle mass for nearly 5 % (Seabra et al., 2014) which ultimately reduced the overall weight. People with diabetes (T2DM) aged above 48 years, after playing SSG 3 vs. 3, three times a week for 12 weeks, were able to reduce the total amount of body fat for 3.4 kg (Sousa et al., 2014). This is very important given the high correlation of obesity and the occurrence of diabetes mellitus (Hu, 2011). Playing football is more effective exercise for reducing body fat and increasing lean body mass compared to running (Krustup, Christensen, et al., 2010), and can also be a great and fun way to exercise.

## Recreational soccer and blood pressure

High blood pressure is a leading cause of heart failure, sudden heart strokes, coronary and artery heart diseases (Lars Juel Andersen et al., 2010). Physical activity in the form of aerobic activity lowers blood pressure in people with moderately elevated arterial blood pressure (Lars Juel Andersen et al., 2010). Most authors found that playing soccer has a positive effect on lowering blood pressure. Recreational soccer lowers systolic (SBP) and diastolic (DBP) pressure for 5 - 8 mm/Hg in untrained healthy men (Lars Juel Andersen et al., 2010; Morten Bredsgaard Randers et al., 2010). Other authors mentioned decrease in blood pressure ranging from 10 to 12 mm/Hg of mean arterial pressure (MAP) (Knoepfli-Lenzin et al., 2010; Krustup et al., 2013). Playing football only once or twice a week for six months in untrained men with high blood pressure positively affected and lowered SBP by 12 mm/Hg and DBP by 8 mm/Hg (L. J. Andersen et al., 2014). Changes in the form of lowering blood pressure in women who played soccer for 16 weeks, on the average 1.8 to 2.4 times a week, were observed as well (Lars Juul Andersen et al., 2010; Krustup, Hansen, Randers, et al., 2010; Mohr et al., 2014). Soccer is a nonpharmaceutical drug for hypertension in men with mild to moderate hypertension (Lars Juel Andersen et al., 2010) and judging by the results in female as well.

## Blood lipids and recreational soccer

Recreational soccer affects the changes of blood lipids LDL (low density lipoprotein), HDL (high density lipoprotein) and triglycerides. Playing football reduces the level of LDL in blood (Krustup et al., 2009). A survey conducted by Randers (2012), which determined the effects of short - term playing street soccer in homeless people, found that in 12 weeks of playing intervention, change occurs in increase of HDL in relation to LDL by 0.6, while reducing LDL - by 6%. Improvements and lowering of total cholesterol for 0.4 mmol /L and triglycerides for 0.2 - 0.4 mmol/L were also observed in premenopausal women with moderate hypertension (Mohr et al., 2014; Sousa et al., 2014). The average age of women was 35 to 50 years, and the total program lasted 15 weeks with a frequency of three times a week. A significant reduction of blood fats after playing recreational soccer 3 times a week for 40 minutes, was observed in patients with type II diabetes (Sousa et al., 2014). Football reduces total cholesterol by 5.2% in men with hypertension (Knoepfli-Lenzin et al., 2010) after the period of 12 weeks.

## Discussion

The positive effects of recreational soccer were more expressed compared to the standard treatment of counseling and recommendations for behavior (Lars Juel Andersen et al., 2010). This primarily refers to the reduction of adipose tissue and increase of cardio vascular capacity. There was also decreased waist circumference in subjects (Knoepfli-Lenzin et al., 2010) which directly improved physical profile. Additionally, through a systematic review positive effects were noticed on reducing the level of glucose in T2DM patients, insulin resistance, improvement

in general blood counts, greater bone - muscle density, and improvement of physical capacity and motor task abilities. Also, playing recreational soccer can motivate and raise self - confidence of the respondents. Recreational soccer proved as a superior type of training for improvement of VO<sub>2</sub>max compared to running, zumba and strength training (Milanović et al., 2015). The increase of maximal oxygen consumption is based on increased working power of the heart. Recreational soccer improves cardiac function by increasing cardiac dimensions induced by the intensity of the game. Some authors claimed that there is no significant correlation connection between cardiac beat output and VO<sub>2</sub>max (Lars Juul Andersen et al., 2010). Mechanisms of increase are probably based on a different physiological model than usual. Earlier observations suggested that an increase in VO<sub>2</sub>max can be small or high and it depends on the initial, baseline level of VO<sub>2</sub>max in subjects, and that a greater progression achieved subjects with lower initial levels of VO<sub>2</sub>max (Knoepfli-Lenzin et al., 2010). By determining changes incurred on VO<sub>2</sub>max in inactive women, Krusturp (2010) noted the progress of 15% for 16 weeks, while Barane (2014) for a period of 40 weeks of playing soccer with similar content, found magnification of VO<sub>2</sub>max for about 4%. Such results raise doubts in the previous arguments, especially because the initial VO<sub>2</sub>max was significantly higher in the study with a larger percentual progress. Analyzing implemented programs of mentioned studies, author of this paper believes that the only difference is actually in the level of training intensity - 84% HR max versus 78% HR max. The increase in maximal oxygen uptake by playing soccer is obvious in all participants regardless the level of experience and previous training experience. Mentioned training adaptations occurred due to the intensity of a game that is above 80% HRmax (Bangsbo et al., 2010). Almost all the studies that examined the impact of playing recreational soccer on a change of the composition of the body found the reduction of adipose tissue, android and gynoid fat as well (Knoepfli-Lenzin et al., 2010), and increase in lean body mass. Significant changes were found in both men and women regardless of age, level of physical activity, and health status. Considering the complexity of soccer game, energy consumption and motivating factor, active energy derived probably from metabolism of accumulated fat deposits. The fact that soccer game dominantly requires energy of aerobic type according to the intensity of playing (Stølen, Chamari, Castagna, & Wisløff, 2005) explains the mechanisms of reduction of the total amount of fat in recreational players. In the long terms, playing soccer with decreased frequency helps maintain existing lean body mass (Morten Bredsgaard Randers et al., 2010). The possibility of maintaining a optimal body weight by playing recreational soccer does not have a stronghold, and represents area that should be further explored. According to Faude (2010) body composition in children is very difficult to change by playing soccer. Some of the reasons may be increased food intake due to increased appetite caused by training, hormonal changes and loss of control. On the other hand, perhaps the most efficient activity of soccer games should be in childhood, due to the process of biological development in which everything is rapidly progressing. The loss of

body fat is probably a consequence of accelerated oxidation and high energy consumption, which is approximately 750 kcal per training session (Krustrup et al., 2013). Increase of muscle mass is likely due to increased protein synthesis, induced by strong muscle contractions during the game, where muscles overcome large external loads, concentric and eccentric muscle contractions. The positive effect of aerobic exercise on reduction of SBP and DBP pressure from 2 - 4 mm/Hg is a proven fact (Fagard, 2001). Recreational soccer training programs have determined the reduction of blood pressure in the range of 5 -12 mm/Hg. These results are probably due to the relatively higher training intensity and shifts of high intensity intervals. SBP and DBP reductions caused by playing football are complex and involve remodeling activation of the autonomic nervous system as well as the reduction of vascular resistance (Lars Juel Andersen et al., 2010), and improvement of blood flow through dilated capillaries, caused soccer physical activity. (Krustrup et al., 2009). Yet, the most likely reduction of blood pressure is a result of reduced sensitivity of sympathetic nervous system. The downward tendency in blood pressure was not resumed after 12 weeks of playing recreational football (Morten Bredsgaard Randers et al., 2010). Most likely, during the period after the 12 weeks, due to the reduced intensity and frequency of training, capillarisation process was stopped. The process of soccer training did not produce reduction in DBP in a standing position in relation to supinated (Knoepfli-Lenzin et al., 2010) as acute training effects of recreational soccer. As the authors stated, mentioned phenomenon occurred due to irritation of the parasympathetic nervous system in the aftermath of exercise, and that change of a body position from lying down to standing, additionally stimulates the activation of the parasympathetic nervous system. School soccer program implemented for a period of 10 weeks, did not cause a decrease in blood pressure in children aged 9 to 10, due to the low intensity of the game - as author mentions (Krustrup et al., 2014) even though the children were classified as normotensive. Lowering LDL and increase of HDL incurred as a result of playing recreational soccer. Many factors affected the changes in the level of blood fats such as drugs for the treatment of hypertension, decreased liver function and obesity. Long time playing programs are necessary in order to establish the exact impact of soccer on change of the level of blood fats as well as changes in the metabolism of blood lipids (Lars Juel Andersen et al., 2010). A significant reduction in LDL in 12 weeks of playing recreational soccer 2-3 times a week, did not persist over the next 40 weeks of playing soccer with reduced frequency of 1-2 times a week (Morten Bredsgaard Randers et al., 2010). It is obvious that the intensity of the football game is appropriate and causes a positive change considering that 30 minutes of high-intensity activities (blood lactate > 4 mmol/L) causes a negative effect in terms of relations between LDL and HDL (Aellen, Hollmann, & Boutellier, 1993). As a reason for insignificant reduction in the level of LDL, were cited inadequate appearances of high intensities while playing soccer among untrained men (Krustrup et al., 2009). Long term reduction of LDL can be theoretically achieved only if recreational soccer when played 3 times a week. The metabolism of HDL and its increase is related to the process of



aerobic training and increased energy consumption (Durstine & Thompson, 2001). As Randers (2010) states, training load of recreational soccer is adequate for increase of HDL when the energy consumption is about 3000 kJ, but the minimum weekly frequency of training should be 3 times per week for 60 min. Also with similar mechanisms of adaptation, recreational soccer influenced the lowering the triglycerides levels in the blood. Analysis of RCTs dealing with the impact of recreational soccer on health status, has confirmed the postulates about the positive effects of playing soccer. The results showed that the best effects were seen when soccer trainings were organized as a small sided games (SSG). What needs to be precisely established, are intensity, volume and training frequency regarding the structure subjects playing recreational soccer so that it could accurately and systematically act for the prevention and treatment of specific conditions and diseases. The appropriate format of the small sided games and court dimensions are most certainly a segment that controls the intensity of recreational soccer. Future researches should focus and estimate the effects of playing recreational soccer on stress

reduction as one of the major triggers of severe disease.

## Conclusion

Soccer is efficient physical activity and can be used for prevention and treatment of noncontiguous modern diseases. Recreational soccer when played for 2 to 3 times a week for 60 minutes, has a tremendous effect on the increase in VO<sub>2</sub>max, weight management while reducing the total amount of body fat and on the increase of lean body mass, systolic and diastolic blood pressure and on the regulation of level of blood lipids, respectively. Recreational soccer equally well affects the improvement of the health status of both men and women, regardless of age, job they do, level of activity and training. Recreational soccer is the right solution for the lack of physical activity as it provides fun, competitive, motivational activity with unconsciously ensured high intensity exercise. According to the author, practicing recreational soccer organized as a SSG, is difficult to implement because it requires adequate infrastructure and equipment.

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**EFEKTI REKREATIVNOG NOGOMETA NA POBOLJŠANJE ZDRAVSTVENOG STATUSA****Sažetak**

*Background: Fizička neaktivnost i sjedilački način života vode ka pojavi modernih bolesti kao što su povišen krvni tlak, dijabetes, gojaznost te kardiovaskularna oboljenja poput srčanih insuficijencija, arterijskih komplikacija i iznenadne srčane smrti. Rekreativno igranje nogometa može da bude zabavan i svrsishodan vid fizičke aktivnosti koja može poboljšati zdravstveni status.*

*Methods: Klasifikacija i selekcija relevantnih radova izvršena pretragom relevantnih baza podataka: MEDLINE, Pub Med, SPORTDiscus, Web of Science i Google Scholar upotrebom kombinacije ključnih riječi: rekreativni nogomet, ulični nogomet, zdravlje, maksimalni primitak kisika, efekti nogometa. Od 514 dostupnih članaka procesom filtracije detektovano je 27 RCTs članaka prema postavljenom kriteriju koji su korišteni kao relevantni.*

*Results: Statistički značajna povećanja VO<sub>2</sub>max igranjem rekreativnog nogometa nakon 12 - 16 sedmica iznose od 8 -13% kod muškaraca bez prethodnog igrackog iskustva svih uzrasnih kategorija. Kod žena maksimalni primitak kiseonika za isti period se povećao od 14 -16%.*

*Ukupna količina masnog tkiva smanjena je od 3% pa čak do 13% kod muškaraca i žena. Uočeno je i blago povećanje ukupne mišićne mase, te segmentarno na donjim ekstremitetima.*

*Srednji arterijski pritisak (MAP) igranjem rekreativnog nogometa značajno se snižava, a posebno kod muškaraca sa blagom do srednjom hipertenzijom. Sistolni krvni pritisak (SBP) igranjem rekreativnog nogometa opada od 8 do 12 mm/Hg, dok dijastolni krvni pritisak (DBP) se snizi za 5 – 8 mm/Hg.*

*Promjene lipidograma pod uticajem programa rekreativnog nogometa ogledaju se u smanjenju LDL holesterola i triglicerida do 6% uz blago povećanje HDL-a.*

*Conclusion: Igranje rekreativnog nogometa 2 – 3 puta sedmično promoviše aktivan način života te poboljšava zdravstveni status podizanjem opštih fizičkih sposobnosti, poboljšanjem srčane funkcije, regulacijom tjelesne težine smanjivanjem krvnog pritiska i krvnih masnoća. Redovno igranje nogometa se preporučuje kao dodatna nemedikamentozna terapija i prevencija modernih bolesti.*

**Ključne riječi:** Poboljšanje zdravlja, SSG, nogomet, vježbanje, tjelesna kondicija.

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## DIFFERENCES IN MOTORIC AND ANTHROPOMETRIC SPACE BETWEEN 12-YEAR OLD BOY BASKETBALL PLAYERS AND STUDENTS

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*Original scientific paper*

### Abstract

The study included a total of 113, 12-year old male students. 55 students were regular students in grade 6 of lower secondary school, while 58 were of the same age but they attend regular exercises at basketball school. The sample was treated with 7 anthropometric variables, 4 basic motoric tests, and 6 situational motoric basketball tests. The purpose was to confirm relations and to determine what is the effect of active involvement of these students in regular workouts at the basketball school on differences in development of anthropometric features as well as basic kinaesthetic skills and situational skills in basketball game.

**Keywords:** Correlations, differences, basketball players, students.

### Introduction

Establishment of a large number of basketball schools in our country in recent years poses another additional demand to recognize basic principles for programme development that are as qualitative as possible for player transformation. This fact gives us the opportunity to measure and compare kinaesthetic treatment effects in the sample, which regularly undergoes workout sessions. To reach the goal we need to consider multi-dimensional status of humans as well as the complexity of correlations among dimensions, especially in the research sample, which is at the most critical phase of growth and development. A large number of authors have addressed the similar topics to the one in this present study. Bojan Matkovič, a study published in 1984 with a sample of 115 basketball players aged 15-17 years old examined relations between morphologic characteristics and explosive strength. Authors S. Trninić, D. Dizdar and Z. Fresel (1999), have confirmed differences in situational anthropometric and motoric indicators, where the players' status differed depending on anthropometric features and completion of motoric tasks. The study was completed with a sample of 115 players of 12 representations participating in Olympic Games in Atlanta in 1996. Another interesting study focused on diagnosing motoric and functional skills in basketball player selection is the one of the following authors: D. Milanovic, I. Jukic, 1996. Also, B. Dezhman (1996) has confirmed morphologic and motoric status of young basketball players, which is important information for effectiveness of basketball game.

### Research purpose

Based on variables included in the study and methods selected for data processing, the research purpose relies on the following:

- Confirming relations between morphological and kinaesthetic spaces in two samples.
- Confirmation of relations between basic kinaesthetic and situational spaces.
- Confirmation of significant differences in two spaces between the samples.

### Hypothesis

Based on the research purpose, the following hypotheses are presented:

- H1 - significant correlations will be obtained between two spaces.
- H2 - significant differences will be found between sportsmen and non-sportsmen.

### Research sample

Research sample consists of 58 male students in grade 5, aged  $12 \pm 6$  months in elementary school, and 55 students of the same age but who also exercise regularly at a basketball school. Since students attend school regularly and they complete tasks envisioned in physical education curriculum, then it is natural to assume that they are all able in terms of their psychophysical skills to go through such a test. We continuously took note of students' health condition during testing, and the sequence of tests was done in such a way that anthropometric measures were completed in the first afternoon, basic kinaesthetic tests were completed in the second, and situational movements were completed in the third one.

### Variables

Anthropometric variables

To research anthropometric space, the following dimensions were included:

1. ABW- body weight
2. ABH-body height
3. AAL-arm's length
4. ABAL-both arms' length
5. AFL-foot length
6. ATHP-thigh perimeter
7. ACP-calf perimeter.

**Measuring instruments**

- Anthropometer
- Medicinal scale
- Millimetre stripe

**Basic motoric variables**

1. MSLJ-Stunding long jump
2. MHJ - High jump
3. MR20m- 20 metres ruunig
4. MBTH 1kg-throwing medicine ball weighing 1kg

**Situational motoric variables**

1. MR3X10m-running 3X10m forward-backwards
2. MSBD-slalom ball dribbling with 5 obstacles in a straight line
3. MSBDZ5- slalom ball dribbling with 5 zigzag obstacles
4. MTHBCH-throwing the ball from the chest in length
5. MTHBCH3S- throwing the ball from chest in 3 steps in length
6. MTHBW2m-throwing the ball to the wall from 2 metres distance.

**Data analysis methods**

Applied methods to execute the tasks for this study included descriptive statistical methods (parameters of central tendency, distributions, and correlations) and scientific method of condensation and transformation of results. Results have been analysed using SPSS 17.0 version software. Central tendency parameters included the following:

- Arithmetic mean
- Standard deviation
- Minimum and maximum values
- Skewness
- Kurtosis, and
- Correlations and cross-correlations.

**Interpretation of basic statistical anthropometric parameters among students**

Based on the results in the tables, it is worth mentioning that in most variables their distribution is within normal distribution limits, which implies that groups were homogenous in completing the tasks for fulfilling respective tests. Higher heterogeneity is observed among body weight and body mass parameters which is acceptable considering that we have a sample of students with significant differences in their body weight, especially considering their delicate age.

*Table 1. Basic statistical anthropometric parameters among students*

	N	Mini	Maxi	Mean	Std. Deviation	Variance	Skewness	Kurtosis
abw	58	300.00	619.00	405.74	77.93	6073.18	0.96	0.16
abh	58	1330.00	1590.00	1471.95	67.03	4492.86	0.10	-0.79
aal	58	570.00	718.00	640.97	31.93	1019.30	-0.06	-0.02
abal	58	1301.00	1630.00	1476.88	80.32	6451.58	-0.08	-0.34
afl	58	680.00	938.00	851.97	47.87	2291.75	-0.73	1.68
athp	58	333.00	610.00	454.07	54.68	2990.31	0.67	0.39
acp	58	262.00	390.00	307.57	29.90	894.14	0.85	0.20

*Table 1. Basic statistical motoric parameters among students*

	N	Mini	Maxi	Mean	Std. Deviation	Variance	Skewness	Kurtosis
mslj	58	120.00	185.00	151.93	16.54	273.47	-0.01	-0.69
mhj	58	23.00	40.00	29.91	4.22	17.83	0.24	-0.84
mr20m	58	3.58	4.99	4.36	0.28	0.08	-0.22	-0.01
mbth 1kg	58	300.00	560.00	410.79	55.85	3118.83	0.19	-0.09
mr3x10m	58	9.13	12.94	10.52	0.96	0.92	0.98	0.48
msbd	58	2.19	4.63	3.35	0.52	0.27	0.31	0.38
msbdz5	58	3.91	6.88	5.21	0.74	0.55	0.36	-0.26
mthbch	58	5.20	13.92	8.90	1.62	2.62	0.44	0.73
mthbch3s	58	4.50	11.20	7.42	1.38	1.90	0.46	0.55
mthbw2m	58	6.00	12.00	8.74	1.62	2.62	0.13	-0.76

Based on the results in the tables, it is worth mentioning that in most variables their distribution is within normal distribution limits, which implies that groups were homogenous in completing the tasks for fulfilling respective tests. Significant heterogeneity,

but which did not miss normal distribution limits of results shown in the test of Mv3X10m, which implies that there were differences among students in acquiring tasks pertaining to immediate and drastic change of direction.

### Basic statistical anthropometric parameters among basketball players

Table 3. Basic statistical anthropometric parameters among basketball players

	N	Mini	Maxi	Mean	Std. Dev	Variance	Skewness	Kurt
abw	55	309.00	910.00	526.42	118.62	14069.91	0.60	0.68
abh	55	1380.00	1823.00	1571.96	95.47	9115.04	-0.10	-0.05
aal	55	590.00	830.00	682.75	49.71	2471.45	0.43	0.91
abal	55	1100.00	1850.00	1500.27	134.36	18051.83	-0.73	2.08
afl	55	775.00	1035.00	916.00	59.27	3512.89	-0.48	0.10
athp	55	390.00	660.00	498.20	61.45	3776.39	0.46	-0.36
acp	55	280.00	435.00	338.60	37.93	1438.43	0.49	-0.59

Based on the results in the tables, it is worth mentioning that in most variables their distribution is within normal distribution limits, which implies that groups were homogenous in completing the tasks for fulfilling respective tests. Contrary to regular school

students' group, the students of basketball school did not show heterogeneous values with regard to body weight. Which is reasonable considering that regular activities during exercise sessions have affected the students not to have higher body weight values.

Table 4. Basic statistical motoric parameters among basketball players

	N	Minimum	Maximum	Mean	Std. Deviation	Variance	Skewness	Kurtosis
mslj	55	120.00	200.00	149.56	19.81	392.36	0.82	0.27
mhj	55	15.00	46.00	32.13	6.30	39.63	-0.56	0.55
mr20m	55	3.50	5.03	4.17	0.32	0.10	0.18	0.69
mbth 1kg	55	3.40	10.20	6.80	18.69	33.23	0.55	-1.00
mr3x10m	55	8.04	11.67	9.80	0.64	0.41	-0.27	2.20
msbd	55	2.41	4.46	3.28	0.38	0.15	0.77	0.94
msbdz5	55	3.93	6.97	5.11	0.44	0.20	1.08	5.32
mtbch	55	4.50	14.00	11.00	1.74	3.01	-1.01	2.80
mtbch3s	55	5.10	11.20	8.40	1.23	1.51	-0.40	0.47
mtbhw2m	55	9.00	14.00	11.40	1.01	1.02	-0.22	0.24

Table 2 shows basic statistical parameters, which analysed the means, standard deviation and distribution of results around their arithmetic mean as well as normality of distribution of results for basketball players. Regarding this analysis in these

tables, it is worth mentioning that in most variables the distribution is within normal distribution limits, which implies that groups were homogenous in completing the tasks for fulfilling respective tests.

### Correlations among variables

Correlations between anthropometric and motoric variables among students

Table 5. Coorelations among studentes sampel

	apt	alt	agikrah	agikrahah	agikemb	apkofish	apker	mkvgiat	mkvlart	mr20m	mhmhu	mr3x10m	mtsd	mtsz	mgjfb3h	mgjtbl	mgjtblm
abw	1.000																
abh	0.669**	1.000															
aal	0.675**	0.859**	1.000														
abal	0.603**	0.813**	0.800**	1.000													
afl	0.601**	0.772**	0.733**	0.648**	1.000												
athp	0.870**	0.492**	0.608**	0.488**	0.448**	1.000											
acp	0.866**	0.555**	0.578**	0.533**	0.473**	0.880**	1.000										
mslj	-0.232	-0.015	0.026	-0.004	-0.119	-0.244	-0.131	1.000									
mhj	0.051	0.133	0.039	0.043	0.198	0.017	0.124	0.250	1.000								
mr20m	0.165	0.079	0.061	0.006	-0.084	0.168	0.168	-0.228	0.503**	1.000							
mbth 1kg	0.370**	0.543**	0.555**	0.586**	0.456**	0.279*	0.430**	0.257	0.254	-0.169	1.000						
mr3x10m	0.388**	0.171	0.164	0.218	0.159	0.417	0.364	-0.583**	-0.165	0.219	-0.144	1.000					
msbd	0.211	0.060	0.148	0.059	0.145	0.320	0.195	-0.384**	-0.109	0.169	-0.288*	0.636**	1.000				
msbdz5	0.024	-0.109	-0.028	-0.072	-0.074	0.153	0.046	-0.351**	-0.153	0.157	-0.301*	0.357**	0.475**	1.000			
mtbch	-0.046	0.131	0.062	0.131	0.002	-0.112	-0.002	0.571**	0.248	-0.277*	0.500**	-0.460**	-0.520**	-0.588**	1.000		
mtbch3s	-0.205	0.006	-0.020	0.042	-0.082	-0.241	-0.126	0.451**	0.223	-0.240	0.472**	-0.460**	-0.416**	-0.465**	0.736**	1.000	
mtbhw2m	-0.001	0.174	0.106	0.207	0.046	-0.071	0.117	0.439**	0.148	-0.151	0.532**	-0.390**	-0.584**	-0.397**	0.651**	0.618*	1.000



Table above shows correlation coefficients between anthropometric and motoric variables among students. From the obtained results we observe that in most cases the values do not show any significant correlations. There were significant correlations in the following tests: throwing medicine ball with all anthropometric tests. Other anthropometric variables did not show any correlations with motoric tests. Running 3x10m with the body weight had a

value of 0.388. More significant correlations were observed among situational motoric tests, where all tests were strongly correlated among themselves, which is understandable or applied tests were strongly correlated and did not pose any major problem.

Correlations between anthropometric and motoric variables among basketball players

Table 6. Correlation among basketball players sampel

	apt	alt	agjkrab	agjkrabsh	agjkemb	apkofsh	apker	mkvgjat	mkvlart	mvv20m	mvv3x10m	mutsd	mutsz	mgjrb3h	mgjrb1	mgjrb2m	mhmmbu
abw	1.000																
abh	0.430**	1.000															
aal	0.317*	0.785**	1.000														
abal	0.469**	0.813**	0.689**	1.000													
afl	0.277*	0.836**	0.718**	0.725**	1.000												
athp	0.864**	0.137	0.070	0.300*	0.095	1.000											
acp	0.787**	0.271	0.182	0.405**	0.256	0.859**	1.000										
mslj	-0.224	0.338*	0.316**	0.244	0.302*	-0.367**	-0.238	1.000									
mhj	-0.197	0.308*	0.206	0.190	0.386**	-0.327*	-0.152	0.598**	1.000								
mr20m	0.101	-0.324*	-0.409**	-0.155	-0.230	0.241	0.200	-0.658**	-0.504**	1.000							
mr3x10m	0.216	-0.269*	-0.283*	-0.148	-0.217	0.316*	0.280*	-0.644**	-0.452**	0.718**	1.000						
msbd	-0.002	-0.124	-0.184	0.062	-0.091	0.064	0.107	-0.348**	-0.461**	0.533**	0.435**	1.000					
msbdz5	0.085	-0.317*	-0.250	-0.145	-0.242	0.224	0.246	-0.533**	-0.497**	0.557**	0.669**	0.640**	1.000				
mtbch	0.210	0.508**	0.391**	0.399*	0.463**	0.099	0.202	0.428**	0.528**	-0.439**	-0.452**	-0.504**	-0.510**	1.000			
mtbch3s	0.074	0.120	0.026	0.124	0.179	0.009	0.212	0.166	0.165	0.027	-0.090	-0.034	-0.165	0.325*	1.000		
mtbhw2m	0.202	0.411**	0.428**	0.329*	0.473**	0.140	0.209	0.538**	0.481**	-0.500**	-0.407**	-0.305*	-0.338*	0.535**	0.099	1.000	
mbth 1kg	0.413**	0.163	0.109	0.264	0.235	0.451**	0.433**	-0.319*	0.155	0.107	0.087	-0.172	0.109	0.283**	0.161	0.006	1.000

The above tables shows correlation coefficients between anthropometric and motoric variables among basketball players. From the obtained results we observe that compared to results from the students group, basketball players are a more homogenous group. This occurs because this is a selected group and the tests for them are easier to be executed and subsequently their results are better. We observe weak correlations in body weight variable with motoric tests with exception of the test with ball throwing where the obtained value is quite high at .413 at level of significance of 0.005. In general, anthropometric variables do not show strong correlations with motoric variables, which means that the age of the research sample is developing and we still don't see a significant development. The test with throwing the ball from the chest does not show significant correlation with other variables, except for variable of throwing the ball in three steps, which had a level of significance of 0.01. The majority of obtained results do not show any significant correlation or significant correlation value. Significant correlation values were obtained only in the following tests: throwing of medicine ball with all anthropometric tests. Meanwhile other motoric tests did not show any significant correlations with motoric tests. Running of 3x10m with body weight had a coefficient of 0.388. A more significant correlation was found in situational motoric tests, where the majority of tests have strong correlations among them and obtained values show higher correlations, which is understandable or applied tests were correlated among themselves and practice.

### Differences between students and basketball players

To research differences between students and basketball players, the t-test methods was used. Through this method, differences between arithmetic

average between the two groups are compared. The following table shows differences between the two arithmetic averages, t-test value, and level of significance. Based on the obtained results from this method, we can state that significant statistical differences were obtained in most tests included in the research. With regard to anthropometric space, significant statistical differences were found in all variables, with exception of ABALvariable where t value is -.888 and level of significance is Sig. .379. In all other variables the t-value and level of significance meet the statistical validity requirement to confirm significant statistical differences. In all cases where significant statistical differences were found, those differences are in favour of basketball players. This overview of results conclude that regular engagement in basketball-related exercising activities have contributed to better development of growth dimensions of body height and limbs as well as values of perimeter of thighs and calf. In the basic motoric space differences found in all tests are in favour of basketball players which shows a higher level of basic kinaesthetic skills among the active basketball players' group compared to students' category. In all tested variables regarding arms and legs explosive force and speed of executing movements basketball players were more successful. In the situational motoric space, there were no significant differences only in slalom dribbling, and certainly this was a result of very short time for executing the task 3-5 sec and use of manual technique to measure beginning and end of the task (a hand chronometer was used) and the age tests is quite delicate and heterogeneous due to fast growth of the body and delays in muscle development, and subsequently difficulties might have occurred among basketball players of this age group to execute coordination movements. In all other variables that required speed of running forward and backwards, explosive force of arms to throw the ball and precision in throwing the ball from one player to

another, basketball players were more successful. Based on these obtained results through the t-test method where differences between groups were examined, we can state that the group of basketball players showed significantly better results both in anthropometric and basic motoric space as well as in situational motoric. Studies of other authors have also found similar differences when we compare groups of sportsmen and non-sportsmen in various ages and categories. This highlights one more time

the importance of sports activities for younger age groups in order that they not only develop and grow better but also to affect their kinaesthetic skills which would play a significant role in completion of sports tasks as well as in completing other daily life activities.

T-test between basketball players and students in motoric and anthropometric variables

Table 7. Differences among two groups

		Paired Differences			95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	abw	-118.29	147.98857	19.95478	-158.29782	-78.28399	-5.928	54	.000
Pair 2	abh	-97.56	126.10559	17.00407	-131.65475	-63.47252	-5.738	54	.000
Pair 3	aal	-40.69	62.48226	8.42511	-57.58223	-23.79959	-4.830	54	.000
Pair 4	abal	-19.10	159.63508	21.52519	-62.26450	24.04632	-.888	54	.379
Pair 5	afl	-58.38	86.85375	11.71136	-81.86168	-34.90196	-4.985	54	.000
Pair 6	athp	-42.36	81.76080	11.02462	-64.46668	-20.26060	-3.843	54	.000
Pair 7	acp	-30.20	51.55809	6.95209	-44.13811	-16.26189	-4.344	54	.000
Pair 8	mkvgjat	2.29	23.09134	3.11364	-3.95156	8.53337	.736	54	.465
Pair 9	mkvlart	-2.36	7.97766	1.07571	-4.52030	-.20697	-2.197	54	.032
Pair 10	mvr20m	.18745	.40672	.05484	.07750	.29741	3.418	54	.001
Pair 11	mhmbu	-208.07273	196.63793	26.51465	-261.23141	-154.91405	-7.847	54	.000
Pair 12	mr3x10m	.75691	1.10082	.14844	.45931	1.05450	5.099	54	.000
Pair 13	msbd	.07582	.66915	.09023	-.10508	.25671	.840	54	.404
Pair 14	msbdz5	.10473	.92203	.12433	-.14453	.35399	.842	54	.403
Pair 15	mthbch	-2.12473	2.17065	.29269	-2.71154	-1.53792	-7.259	54	.000
Pair 16	mthbch3s	-1.07182	1.71816	.23168	-1.53630	-.60734	-4.626	54	.000
Pair 17	mthbw2m	-2.67273	1.99123	.26850	-3.21103	-2.13442	-9.954	54	.000

### Confirmation of hypotheses

Applying appropriate methods and procedures for transformation of results, we managed to confirm hypotheses:

- H1. That significant correlations would be obtained between two spaces, this was partially confirmed, since relevant relations were

found between anthropometric and motoric dimensions.

- H2. That significant differences would be obtained between sportsmen and non-sportsmen samples, this was fully confirmed since differences were found in favour of basketball players' sample.

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## RAZLIKE U MOTORIČKOM I ANTROPOMETRIJSKOM PROSTORU IZMEĐU 12-GODIŠNJIH DJEČAKA KOŠARKAŠA I UČENIKA

### Sažetak

*U istraživanju je sudjelovalo ukupno 113, 12 godina starih učenika. Učenici su redoviti učenici 6. razreda niže gimnazije, dok je 58 bilo iste dobi, ali su redovno trenirali u školi košarke. Uzorak je tretiran sa 7 antropometrijskih varijabli, 4 osnovna motorička testa i 6 situacijskih motoričkih košarkaških testova. Cilj je bio utvrditi odnose i odrediti kakav je učinak aktivnog uključivanja tih učenika u redovne treninge u košarkaškoj školi na razlike u razvoju antropometrijskih značajki, kao i osnovnim vještinama kinestetičkih i situacijskih vještina u košarkaškoj utakmici.*

**Ključne riječi:** Korelacije, razlike, košarkaši, učenici.

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## SPEED TRAINING IN DIFFICULT AND EASIER CONDITIONS

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*Original scientific paper*

### Abstract

*Different biological, motor, energy, cognitive and other factors affect the quality of speed manifestation. Speed in the form of sprint is one of the most important motor skills. It defines success in many sports situations. Speed training in difficult conditions refers to increased stress during sprint, while speed training in the easier conditions refers to assistance when performing sprint exercises. The effects of these specific training are: higher frequency and stride length. During the speed training in difficult to easier conditions, it is very important to determine the level of resistance and speed of performing an exercise in relation to competitive activity. These specific loads should not disturb coordination. It is very important to integrate the benefits of speed training in specific movement structures of a certain sport. Training in difficult and easier conditions is intended for well-trained athletes.*

**Keywords:** Speed training, speed qualities, sprint, specific loads.

### Introduction

Speed trainings of athletes demand high engagement of muscle, skeleton and central nervous system. Methods and pressures which are applied during the speed of movements cause changes in athletes body in order to ensure higher level of speed: in conditions of higher pressure, (exercises should be performed with maximum intensity); in easier conditions of training (with the condition where exercises are performed in great speed and intensified rhythm); in dynamic conditions of training (in which there is various repetition of exercises and stoppings at first signs of lassitude) (Malacko & Rađo, 2004). Trainings in difficult and easier conditions do not need to be performed before increase of speed and frequency of certain movements. of Training program for increase of specific speed implies previously adequate motor and functional preparation, which is precondition for quality adjustment for further pressure in speed training. Problem of this paper includes the analysis of the performance of training of sprint in difficult and easier conditions, in order to display specific models increase of athletes speed.

### Sprint training in difficult conditions

Sprint training includes the conditions of higher intensity of pressure. This type of training is intended for increase of speed and acceleration through performance of explosive concentric movements. The aim of the sprint training in difficult conditions is to reduce the time of contact with the ground and to keep the frequency on the same or higher level in relation to the sprint without pressure. (Dintiman, 2010). It also affects the increase of steps length during sprints. The external resistance is used for the purpose of performing different exercise, methods and levels of pressure, training aids and place of training performance. Examining the science articles in period's 1970-2010, this treated the effects of training in difficult conditions in relation to speed abilities of athletes Hrysomallis (2012) states that sprint training with external resistance increases running speed. However in most cases it hasn't

been more efficient than ordinary sprint training. Still, there are certain proofs that sprint training with external pressure can affect the beginning of acceleration. Therefore, in training the use of sprint trainings in difficult conditions can be justified, especially in sports with short distance sprints, and movement shifting. Also, sprint training in difficult conditions can be more efficient with trained athletes.

### Pressure dosage

Resistance in sprint training in difficult conditions is higher than competitive activity while the speed of performing exercises is lower. Because of high intensity of stress, the volume of training in difficult conditions should be lower in relation to ordinary sprint training. It is recommended to use less repetition with short distances and longer breaks. 2-3 exercises can be used with 3-4 repetitions (for example 3 exercises x 3 repetitions). After performing six days program with external resistance (pulling sledges; 8-10 accelerations on distances of 10-30m and resistance 2,5% - 5% - 7,5% - 10% of total body weight of athletes) Rumpf and associates (2014) pointed to positive effects of sprints of young athletes. They also state that this type of training can have positive effects on speed of sprints of young and older athletes. The external resistance during sprint of 5-10% of body mass of an athlete, the athlete intentionally increases speed potential. Stress that is over allowed means can affect negatively on quality of motor movements. It is import to stress that speed of sprints should not be lower than 8-10% in relation to its maximum level in normal conditions.

### Exercises

This type of training with increased resistance can be performed in 2 ways: flying start (with gradual resistance), and stoppage (with instant resistance). Dintiman (2010) presents certain activities which can be used for speed training in difficult conditions:



a) Sprint with pulling weights, placed on special metal slippery surface; pulling tire, elastic rope; sledges, parachute or some other object which created optimal external resistance. Objects are attached to special belt around the athlete's waist.

Also, the resistance can be sparring partner.  
b) Up-hill sprint. Optimal slope of field is around 5°.  
c) Sprint with resistance of sprint machine.  
d) Sprint up the stairs.  
e) Sprint with carrying heavy vest.

Table 1. Example of sprint training in difficult conditions

EXERCISE	NUMBER OF REPETITION	LENGTH OF ROAD (M)	BREAK (MIN)
Up-hill sprint or sprint up the stairs	3	20-30	2-5
Sprint with vest	3	20-30	2-5
Pullin objects (e.g. sledge)	3	20-30	2-5

### Sprint training in easier conditions

Sprint training in easier conditions includes lower external resistance but it does not include lower intensity of training. In professional sport, this type of training is used to increase the efficiency of acceleration and overcoming speed obstacles. Training with the assistance or help in performing exercises enables athlete to achieve better frequency of steps. For example, when athlete sprints down-hill muscles which move off the ground, perform in easier conditions in relation to the muscles which amortize movements and initiate new fast movements. During sprint in easier conditions it is important to stress the frequency of steps contrary to the strength during sprint. Focus of sprint training, should be on effective transition of neuromuscular stimulus which causes increase of frequency of steps.

### Dosage of pressure

Sprint training in easier conditions includes lower external resistance than competitive one. Speed in performing exercises exceeds the maximum limits of an athlete (aprox. 103-105%). It is necessary to stress that supra-maximum speed of sprint which

exceeds the maximum limits of an athlete (>5%), can disturb the coordination of movements or cause injuries. When using down-hill as external resistance Holman & Hetinger (2000) state that the optimal slope should be between 2° and 5°, while Bompá (2001) states that slope of 3° is optimum. Volume of sprint training in easier conditions should be lower in relation to the training of ordinary sprint. As in the case of sprint training in difficult conditions, in sprint training in easier conditions it is recommended to perform less repetitions and longer breaks. It is optimal to perform 2-3 exercises with 3-4 repetitions (e.g. 3 exercises x 4 repetitions). In easier conditions athlete increases his speed potential adjusting neuromuscular system on higher speed of sprint, which is necessary to integrate in competition conditions of a certain sport.

### Exercises

a) Down-hill sprint. Stress higher frequency of movements of legs and arms.  
b) Sprint while pulling (sprint machine). Elastic rope helps an athlete to fulfill his speed potential.  
c) Sprint on treadmill.  
d) Sprint down the wind

Table 2. Example of sprint training in easier conditions

EXERCISE	NUMBER OF REPETITION	DISTANCE (M)	BREAK (MIN)
Down-hill sprint	4	40	2-5
Sprint with elastic rope	4	40	2-5
Sprint down the wind	4	40	2-5

The contrast model of training, which includes combination of different exercises in difficult and easier conditions followed by exercises of situational conditions, is often used in training practice. For example: specific exercises in difficult and easier conditions are performed first, and then these tasks are repeated without caused pressures. Performing theses exercises creates post-activity potential, which is used for higher external forces in situational work conditions. Maio Alves and associates (2014) state that contrast trainings with gradual increase

of intensity of 5% in 15 days can produce positive effects on speed of sprint. Contrast model of sprint training is highly demanding in terms of motor abilities and energy.

Table 3. Example of contrast model of sprint training

EXERCISE	NUMBER OF REPETITION	DISTANCE (M)	BREAK (MIN)
Pulling sledges + sprint	3	40	2-5
Running down-hill + sprint on flat surface	3	40	2-5
Running up-hill+ sprint on flat surface	3	40	2-5

**Useful advice**

- ✓ Exercises of sprint in easier or difficult conditions should not disturb coordination of movements.
- ✓ Perform pressure gradually on this type of training.
- ✓ Training is intended for trained and experienced athletes.
- ✓ Sprint training in difficult and easier conditions needs to be adjusted to competition demands of a certain sport.
- ✓ The main condition of the sprint training is that an athlete is fully rested.

**Sprint training in easier conditions**

Speed training in difficult and easier conditions can cause increase of frequency and length of steps i.e. higher speed of sprint. During performance of exercises in difficult and easier conditions a large number of muscles activate in relation to the normal conditions of practice. Increased number of mobilized muscle units can be used, if an athlete repeats the same exercises without pressure, after a break. This activity potential can contribute increase of level speed of athlete. This activity potential decreases when athlete is having a longer break. It can be concluded that efficient sprint training in difficult or easier conditions depends on duration of athlete's rest and exercise repetition. Trainings in difficult and easier always include risk of injuries of athletes. Therefore it is necessary to perform them with caution.

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**TRENING BRZINE U OTEŽANIM I OLAKŠANIM USLOVIMA****Sažetak**

Različiti biološki, motorički, energetski, kognitivni i ostali faktori utječu na ispoljavanje brzinskih kvaliteta. Brzina u formi sprintanja je jedna od najvažnijih motoričkih sposobnosti, koja definira sportsku uspješnost u mnogim sportskim situacijama. Trening sprintanja u otežanim uslovima se odnosi na uslove povećanog opterećenja, a trening sprintanja u olakšanim uslovima na asistenciju pri izvođenju vježbi. Efekti ovih specifičnih treninga su veća frekvencija i dužina koraka. Pri treningu sprintanja u otežanim ili olakšanim uslovima vrlo važno je odrediti nivo otpora odnosno brzinu izvođenja vježbe u odnosu na takmičarsku aktivnost. Specifična opterećenja ne smiju narušiti koordinaciju pokreta. Benefite treninga brzine važno je integrisati u specifičnu kretnu strukturu određenog sporta. Trening u otežanim i olakšanim uslovima je namijenjen utreniranim sportistima.

**Ključne riječi:** Trening brzine, brzinski kvaliteti, sprintanje, specifična opterećenja.

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# QUANTITATIVE CHANGES OF SPECIFIC MOTOR ABILITIES OF STUDENTS UNDER THE INFLUENCE OF REGULAR AND ADDITIONAL ACTIVITIES IN SPORT AND PHYSICAL EDUCATION

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*Original scientific paper*

## Abstract

The aim of this research was to be based on a longitudinal study determined the level quantity changes specific motor skills under the influence of regular and additional classes of sport and physical education, with the students. The subjects for this study are the students of 6th, 7th and 8th grade of elementary school "Mak Dizdar" in Zenica, ages 12 to 14 years, which in addition to attending regular classes of physical and health education (second half) two hours per week, included in the semi-programmed work in the optional teaching of the four sports games basketball, football, volleyball and handball. Random variables in this study are hypothetical cover areas specific motor with 16 variables, in order to determine quantity changes using discriminative Reviewing. Discriminant analysis in the space situational - motor abilities, obtained one function that shows a very high correlation of the data set on which it was carried out discriminant analysis results. General to make conclusions about the effectiveness of the program of work is concluded that the semi-annual work program carried out on a sample of 120 students a positive impact primarily on SMOSSODB - school service, SMKSLKOŠ - kicking a ball, SMRŠRUK - kicking meter, SMOVCODB - shooting target peak over the net, SMOOPODB - refusal fingers repeatedly against the wall, SMNNZNOG - juggling and SMRBHRUK - throwing and catching balls handball. There are obvious positive changes in the final measurement in relation to the initial one.

**Keywords:** Basketball, football, volleyball, handball, extracurricular activities, students.

## Introduction

Teaching process of sport and physical education encourage all-round development of personality and satisfy biopsychosocial needs for modern living and working conditions. The success of every student should always be seen as a dependent variables, which depends on a number of permanent and changing factors, and in this context we can certainly say that the physical activity in the matter in any way, contribute to the general development of all vital functions and activities (Tanovic, 2006. ). It is evident that in the field of physical education students should be allowed greater space for action, to the teaching process can expect better results the impact of exercise on psychological students. (Reljic, 1970; Findak and Neljak, 2006 and 2007). It is believed that high levels of motor skills essential prerequisite for effective learning of new motor structures, their development and successful use (Wolf and Rado, 1998). The aim of this study is to determine quantitative changes situational motor skills performance in sports games of pupils aged 12-14 years under the influence of the programmed plan and program of regular and of sport and physical education.

## Methodology of research

### Sample of subjects

The study was conducted on a sample of 120 students in school "Mak Dizdar" in Zenica, boys aged 12 -14 years, as in the school categorization represents students 6, 7th and 8th grade. Definition of the population from which the sample is represented the population from which the sample was selected students 6th, 7th and 8th grade of elementary school "Mak Dizdar" in Zenica, ages 12 to 14 years, which in addition to attending regular classes of physical and health education (second half) two hours per week, included in the semi-programmed to work extra work from all four sports games.

### The sample of variables

Random variables in this study a hypothetical will cover areas specific motor 16 variables, as follows: Basketball 4 variables, 4 variables football, volleyball and handball 4 variables.

R.b	SPORT	Test code	Test name
1.	Basketball	SMKMLKOŠ	Turning the ball around the hull 24 sec.
2.		SMKBLKOŠ	Throwing a basketball with breasts out of place with two hands
3.		SMKSVKOŠ	Dribbling in slalom
4.		SMKSLKOŠ	Dribbling in the paint with shots under the basket (ICER) for 24s.

5.	Football	SMNNZNOG	Juggling balls for 30s.
6.		SMNSVNOG	Dribbling in slalom
7.		SMNHONOG	The speed of the ball 20m
8.		SMNBVNOG	running speed with the ball 20m
9.	Volleyball	SMOSSODB	Front " bottom " - School service,
10.		SMOVCOBDB	Shooting target over the network with your fingers from the basic attitude,
11.		SMODOODB	" Lower 'refusal - hammer within 30s,
12.		SMOPODB	Continuous refusal fingers.
13.	Handball	SMRBHRUK	Throwing and catching a ball against the wall for a period of 30s,
14.		SMRSVRUK	Dribbling slalom 10m,
15.		SMRŠRUK	Throw from 7.m
16.		SMRBVRUK	The speed of the ball 20m.

## Results and discussion

In this study, discriminant analysis is to determine whether there are differences between the initial and final measurement that occurred under the influence of the applied program. Since we have two measurements (initial and final), discriminant analysis was done so that the initial measurement treated as a single group, and the final measure as the other group.

Analysis of quantitative change of situational - motor skills

In Table 1, boxes M test we tested the null - hypothesis (equality of the identity matrix) through the determinants. The difference between the covariance matrix is statistically significant (sig. .00), Which are created conditions for further procedure discriminant analysis.

Table 1. Test results

	Box's M	746,044
F	Approx.	5,024
	df1	136
	df2	121065.753
	Sig.	,000

Table 2 shows that isolating one discriminant function groups and discriminant function that is significantly different groups, indicating high discriminative value, which is confirmed by the canonical correlation coefficient group (.75)., And speaks of the high correlation, while the typical root (eigenvalue) isolated discriminant function is 1.34, and the degree of variance of 100%. In further analysis will show several variables that make a significant contribution to the discriminant function.

Table 2. Eigenvalues

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	1,345	100,0	100,0	,757

Significance isolated discriminant functions were determined by Wilks lambda test (Table 3), which is commonly used in the discriminant analysis and represents the multivariate equivalent of the F-test. Its value is relatively low (.42) indicates the existence of differences between groups, and that the groups have different arithmetic mean can be seen and the level of significance and no significant (sig. = .00).

Table 3. Wilks' Lambda

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1	.426	161.927	16	.000

Table 4 shows the value of standardized coefficient of discriminant function and strukturalni discriminatory factors (correlations between discriminating variables - Var. And standardized canonical discriminant functions - Function) used to construct the discriminant function. Structure coefficients are a more reliable indicator of the relative strength of discriminating variables for which have been used to create a discriminant function. Analyzing projections on discriminant function of certain variables situational motor skills, it is evident that the most important projections are variable: SMOSSODB - school service, SMKKSLKOŠ - kicking a ball, SMRŠRUK - kicking meter, SMOVCOBDB - shooting target peak over the network, SMOPODB - refusal fingers repeatedly against the wall, SMNNZNOG - juggling and SMRBHRUK - throwing and catching handball lopte. Variable define precision, coordination and repetitive force. Looking at the values of variables interpreted noticeable positive changes in the final measurement in relation to the initial one. Programmed regular and supplementary education has given the desired effect (positive) in a variety of sports games, which shows the quality of the same. All four sports games are included.

Table 4. Structure Matrix

Function	
	1
SMOSSODB	,539
SMKSLKOŠ	,537
SMRŠRUK	,383
SMOVCODB	,359
SMOPODB	,258
SMNNZNOG	,210
SMRBHRUK	,206
SMNBVNOG	-,195
SMNHONOG	,193
SMRVLRUK	-,181
SMKSVKOŠ	-,130
SMRSVRUK	-,129
SMKMLKOŠ	,126
SMODOODB	,100
SMKBLKOŠ	,052
SMNSVNOG	-,044

Table 5 shows the centroid of the group where we were for one group, it is evident that this group is located in the in the negative part of the discriminant function, which is defined by variables that have a negative impact on the discriminative funkciju. Za another group, it is evident that this group is in the the positive part of the discriminant function, which is defined by variables that have a positive impact on the discriminant function.

Table 5. Functions at Group Centroids

GROUP	Function
	1
1	-1,154
2	1,154

O. Bajric, M. Šmigalović, I Bašinac, Bajric S. (2012) explored the global quantitative changes of basic motor and situational-motor skills under the influence of the three-month experimental program of volleyball as part of additional classes. Based on the results of discriminant analysis it was found that there was a statistically significant global quantitative changes in the area of basic and situational-motor skills, and a most important changes have taken place in the test precision serving (SMRSE), the ball rebounding into the circle on the wall (SOPKNZ ) the ball rebounding forearms (SOPPOZ) of space situational motor and explosive strength test (MEST) from the basic motor skills. For a sample of 72 young basketball players aged 15, who was covered sports treatment for a period of one school year, Salihu, H. (2007) examined the degree of the quantitative changes of some indicators of young players under the influence of kinesiology operators. At the beginning and end of the treatment the subjects

for this study were measured with 10 variables, by 5 for general motor dimensions with a focus on explosiveness and 5 specific basketball tests. Results were analyzed under the model t-test for paired samples, and showed that there has been significant progress in all analyzed variables. In specific tests larger differences were achieved in tests involving dribbling and dribbling, as interpreted by the fact that this element of the game of basketball a little faster than adopt jump shot or throwing the ball into the distance. The results showed the applicability of the work of the basketball schools, to raise specific skills and knowledge of young players to a higher level. The treated sample that has reached a higher level of technical training should be more applied in the game and deal with all the unpredictable situations that brings game. And this work, through its intention and results once again confirms the theory that constant innovation and changes in working methods most important to gaming (children's) creativity and abilities come to the fore. In fact it is necessary for the development of specific skills that will enable the successful execution of all tasks specific to sports games in a match each one.

## CONCLUSION

The aim of this research was to be based on a longitudinal study determined the level and effects of additional nasatve of sports games of basketball, football, volleyball and handball quantitative changes specifically - motor, with students aged 12 to 14 years through the curriculum of regular and extra classes . With students aged 12-14 years are programmed and implemented training procedures in order to determine the achieved effects. The sample numbered 120 students. Discriminant analysis in the space situational - motor abilities, obtained one function that shows a very high correlation of the data set which it was carried out discriminant analysis results. General to make conclusions about the effectiveness of the program of work is concluded that the semi-annual work program carried out on a sample of 120 students a positive impact primarily on SMOSSODB - school service, SMKSLKOŠ - kicking a ball, SMRŠRUK - kicking meter, SMOVCODB - shooting target peak over the network, SMOPODB - refusal fingers repeatedly against the wall, SMNNZNOG - juggling and SMRBHRUK - throwing and catching balls handball. There are obvious positive changes in the final measurement in relation to the initial one. Programmed regular and additional classes is given effect in a variety of sports games, which indicates the quality of the conducted curriculum. All four sports games are included.



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## KVANTITATIVNE PROMJENE SPECIFIČNO MOTORIČKIH SPOSOBNOSTI UČENIKA POD UTCAJEM REDOVNE I DODATNE NASTAVE TIZO-A

### Sažetak

*Cilj ovog istraživačkog rada bio je da se na osnovu longitudinalne studije utvrdi nivo kvantitativnih promjena specifično motoričkih sposobnosti pod uticajem redovne i dodatne nastave TIZO-A, kod učenika. Ispitanici obuhvaćeni ovim istraživanjem su učenici 6., 7. i 8. razreda iz OŠ "Mak Dizdarević" u Zenici, uzrasta od 12 do 14 godina koji pored pohađanja redovne nastave tjelesnog i zdravstvenog odgoja (drugo polugodište) dva časa sedmično, uključeni su u polugodišnji programirani rad u dodatnoj nastavi iz četiri sportske igre košarka, nogomet, odbojka i rukomet. Odabrane varijable u ovom istraživanju hipotetski su pokrile prostore specifične motorike sa 16 varijabli. U cilju utvrđivanja kvantitativnih promjena korištena je diskriminativna analiza. Diskriminativnom analizom u prostoru situaciono – motoričkih sposobnosti, dobijena je jedna diskriminativna funkcija, koja pokazuje vrlo visoku povezanost skupa podataka na osnovu kojih je vršena diskriminativna analiza rezultata. Općenito donoseći zaključke o efektivnosti samog programa rada zaključuje se da je polugodišnji program rada proveden nad uzorkom 120 učenika pozitivno uticao u prvom redu na SMOSSODB – školski servis, SMKSLKOŠ – šutiranje lopte, SMRŠRUK – šutiranje sedmerca, SMOVCODB – gađanje cilja vršno preko mreže, SMOOPODB – odbijanje prstima uzastopno o zid, SMNNZNOG – žongliranje i SMRBHRUK – bacanje i hvatanje rukometne lopte. Uočljive su pozitivne promjene u finalnom mjerenju u odnosu na inicijalno.*

**Ključne riječi:** Košarka, nogomet, odbojka, rukomet, dodatna nastava, učenici.

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## THE IMPORTANCE OF THIGH STRENGTH IN BASKETBALL AND VOLLEYBALL

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*Scientific review paper*

### Abstract

*Systematic isokinetic evaluation of the knee joint in the preparation period is very useful in highlighting the risks for athletes in case of injury quadriceps and hamstring. Isokinetic evaluation of the strength of the quadriceps (Q) and hamstring (H), during the concentric (con) and eccentric (ECC) mode muscle contraction, is an important part of a comprehensive evaluation and rehabilitation of athletes. The main purpose of this communication is to present the main invention of various studies relating to this question.*

**Keywords:** Muscles, sports, knee, volleyball, basketball.

### Introduction

The isokinetic evaluation of the strength of the main drivers of the knee joint is an important part of a comprehensive evaluation and rehabilitation of athletes. Testing on the isokinetic system provides us with important information regarding

- Absolute or relative strength of the quadriceps (Q) and hamstring (H)
- The existence of bilateral differences in the strength
- The existence of asymmetries of power using any conventional power ratio: Hcon / Qcon (HQR) or the ratio of the dynamic control (also functional ratio): Hecc/Qcon (DCR). Team sports such as volleyball and basketball require a lot of jumping, rapid changes of direction, running and sprinting, where the strength of the quadriceps and hamstring is very important for sports performance and injury prevention. In basketball acute injuries of ACL are the most common acute knee injuries in the both genders [2,3,18,19]

Due to high jumping demands in basketball and volleyball patellar tendinopathy or jumper's knee is the most common overuse injury [46] and therefore systematic isokinetic evaluation of the knee joint in the preseason or the preparation period is very useful in highlighting the athletes at risk for such injury. The purpose of this paper is to present some of the studies on the strength including hamstring and quadriceps in team sports in order to give the reader an idea about that, (1) the protocol used when testing the power, (2) strength of the quadriceps and hamstring, (3) asymmetries in

power and (4) strength ratios in these athletes. We are certain that this short review could be of great interest and importance to the doctors, trainers and physical-fitness and conditioning experts as a benchmark for the strength and the strength ratios of the quadriceps and hamstring muscles during rehabilitation, training and selection of roles in team sports. We searched the archives of Isokinetic and Exercise Science (IES) in November 2011, looking for words that include isokinetics and knee joint as well as a team sport of interest (eg. basketball and volleyball). We identified 4 studies that matched the search and namely: basketball - 2 studies [12, 32] and volleyball - 2 studies [14,26]. We included only studies that were actually recorded torque of Q and H. These studies have recorded the results obtained by different test speeds. We summarize the data from these studies in Table 1 using a common denominator that has been tested at speeds of 60° / s. Where there were no bilateral differences ratio of forces we have them calculated from the results. After that (where necessary) we have combined these results with the works obtained from the PubMed database. We used the same research series of words as we stated above, the only difference is that we are limited to works published in English in the last 10 years and that record value strength of the quadriceps and hamstring for athletes of team sports without chronic physical or mental conditions.

### General remarks

Choice isokinetic speed

A wide range of test speeds (from 30° / s to 240° / s) has been included in the studies. However, the most common speed was 60° / s followed by the speed of 120° / s and the speed of 180°/s. Only one test speed used in some of the studies, and the most commonly

used speed for such tests was  $60^\circ / \text{s}$ . Angular velocity of  $60^\circ / \text{s}$  was used in studies where there is more testing sets. This speed is always part of the test that is usually combined with testing at higher speeds to as  $120^\circ / \text{s}$ ,  $180^\circ / \text{s}$  or  $240^\circ / \text{s}$ , only two studies have included testing with lower speeds and with the speed of  $30^\circ / \text{s}$ . On this basis, we suggest that isokinetic testing in team sports should be performed using two testing angular velocity, which are  $60^\circ / \text{s}$  and  $120^\circ / \text{s}$  or  $180^\circ / \text{s}$ . The rationale behind this proposal is that possible power deficits are best noticed at low concentric mode speed (eg  $60^\circ / \text{s}$ ), where repeated tests give great results, and the ability to compare our data with those already known, and in the end only testing will be time consuming. When we compare these findings with works from PubMed (for basketball) it appears that testing at a speed of  $180^\circ / \text{s}$  is used much more frequently than at the speed of  $120^\circ / \text{s}$ . We believe that testing at three different speeds (or more) may be reasonable only if the ratio of the force - speed is a point of interest, because different testing is time consuming and can become exhausting for people and will not provide significant additional or relevant clinical information. We also believe that testing on concentric mode low speed (eg.  $60^\circ / \text{s}$ ) may be sufficient for purposes of a preliminary screening when dealing with a large number of respondents. While testing the additional test speeds could be an option for those with abnormal results obtained during initial testing.

#### Mode of the muscle contraction

Selection of muscle contraction mode has been always a problem creating good isokinetic testing protocols. In previous studies, concentric muscle contraction mode was used less frequently than a combination of concentric and eccentric muscle contraction mode. Therefore, we suggest that the test is carried out using both modes and concentric and eccentric muscle contraction mode. Considering the eccentric mode testing must be emphasized that it can be annoying for some respondents. We must not forget the importance of the force of the quadriceps in eccentric fashion in some pathological conditions such as patellar tendonitis, or jumper's knee, where the use of such testing would be appropriate and clinically useful [30]. Eccentrically testing power hamstring (tendons) is of great importance when identifying athletes at risk of a ruptured anterior cruciate ligament and hamstring strains [27] and therefore should be part of the test protocol even when quadriceps eccentrically testing is not performed. This allows calculation of DCI, as first proposed by Dvir [20], which has a slightly

better sense of the identification of athletes at the high risk for reinjury in comparison to conventional HQR [1].

#### The difference between unilateral and bilateral testing

Asymmetries force between the quadriceps and hamstring is associated with the function of the knee, which is often observed as a risk factor for the violation of the lower extremities. That is why we propose that testing should be conducted bilaterally whenever possible. You should record all the data on the deficit of power between the dominant and non-dominant side or the difference between the injured and healthy sides.

#### Basketball

Only two papers in the archives of Isokinetics and Exercise Science reported results of Q and H in basketball [12,32]. Dauty and others. [12] compared the 15 players, who have unilateral patellar tendinopathy, with 42 control cases. They found that the movement of the knee extension is asymmetrical at a speed of  $60^\circ / \text{s}$  and higher, we identified 10% of the injured players with a probability of 66%. Kim et al. [32] prospectively investigated the relationship between HQR and overall injuries of the lower extremities in the group of basketball players and football players during a season. She found a trend that HQR lower than 0.6 is associated with the rate of injury, but unfortunately the results are not recorded in a manner that could allow discrimination between the sexes or players of different sports. Estimate power Q and H as well as the ratios H / Q in players of various ages and sexes was observed in other papers (Table 2). Bamac [5] compared the concentric quadriceps and hamstring strength as a conventional ratio of hamstring and quadriceps between basketball and football players at speeds of 60, 180 and  $300^\circ / \text{sec}$ , but significant differences found only at high speeds and in favor of volleyball. Buchanan [7,8] researched the differences in the strength of Q and H between the sexes and different age groups. He came to the conclusion that with the normalization of body weight - height, age and gender differences are small. Gerodimos [23] studied the concentric and eccentric mode power Q and H in young male basketball players at a speed of 180 (in the age of 12-17g.) Applying tests at speeds of 60 and  $180^\circ / \text{s}$ . Normal power (Nm / kg) H and Q ranges from 0.98 to 2.29 and 1.53-3.69 Nm / kg, at any age, at any speed and at the level of muscular action.

Table 1. Quadriceps and hamstring peak torque to body weight, strength ratio and strength asymmetry in team sports

BASIC DEMOGRAPHIC CHARACTERISTICS														EXTENSORS				FLEXORS				STRENGTH RATIOS				ASYMMETRY				
Autor	Sport	Level of play	Sex	N	Age	BW(kg)	BH (cm)	Sub-groups	(N)	LEFT D				RIGHT OR ND				LEFT OR D				RIGHT OR ND				HQR	Left	Right	DCR	IN PERCENT %
										CON	ECC	CON	ECC	CON	ECC	CON	ECC	CON	ECC	CON	ECC	CON	ECC	CON	ECC					
Daury 2007		2nd French league	M	57	26	90	192	patellar	30	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	5	25			
					25	92	195	Healthy	27	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	6	5			
Kim 201	K	3rd NCAA division	M	82	20	92	192	Male	40	X	X	X	X	X	X	X	X	X	X	X	X	0.56	X	0.54	X	X	X	X	X	
			F	20	92	92	195	Female	42	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Kellis 2001	K.F	Young players	M	158	10	37	142	10Y	14	2.01	2.6	1.97	2.62	1.32	1.87	1.28	1.84	0.66	0.65	0.94	1.29	0.94	0.65	X	1.29	3	2	2		
				11	11	37	144	11Y	31	2.07	2.66	2.16	2.65	1.38	X	1.29	1.76	0.67	0.60	0.85	0.82	0.85	0.60	0.85	0.82	7	4	4		
				12	12	41	149	12Y	23	2.13	2.75	2.07	2.69	1.33	X	1.25	1.70	0.62	0.60	0.87	0.83	0.87	0.60	0.87	0.83	6	3	3		
				13	13	47	156	13Y	18	2.41	3.09	2.38	2.99	1.53	X	1.44	1.81	0.63	0.61	0.81	0.76	0.81	0.61	0.81	0.76	6	1	1		
				14	14	60	169	14Y	24	2.56	2.24	2.51	3.1	1.67	X	1.56	2.00	0.65	0.62	0.81	0.81	0.81	0.62	0.81	0.81	7	2	2		
				15	15	62	171	15Y	19	2.55	3.39	2.51	3.2	1.77	X	1.64	2.14	0.69	0.65	0.89	0.68	0.89	0.65	0.89	0.68	8	2	2		
				16	16	69	176	16Y	18	2.79	3.58	2.79	3.58	1.75	X	1.68	2.11	0.63	0.60	0.81	0.76	0.81	0.60	0.81	0.76	4	0	0		
				17	17	73	178	17Y	11	2.92	3.75	2.89	3.51	1.93	X	1.86	2.30	0.66	0.64	0.79	0.80	0.79	0.64	0.79	0.80	4	1	1		
Tourmy-Chalet 2000	F	Amateur	M	21	22	75	180	*		2.05	2.62	2.03	2.66	1.36	1.65	1.29	1.57	0.66	0.64	0.80	0.78	0.80	0.64	0.80	0.78	5	1	1		
Daury 2003	F	Elite player	M	28	23	76	180	injured	11	X	X	X	X	X	X	X	X	X	X	0.65	X	0.65	X	X	X	X	X	X		
				23	23	73	177	Non-injured	17	X	X	X	X	X	X	X	X	X	X	0.80		0.80	X							
Olmo 2007	F	High level	M	22	26	80	182	PFPs	11	2.75		3.35	1.53	1.53		1.74		0.56	0.52		X	0.56	0.52		X	X	X	X	X	
Houweling 2009	F	Semi-professional	M	21	24	75	177	H - injury	10	X	X	X	X	X	X	X	X	X	X	0.74	0.77	0.74	X	0.74	0.77	24	15	15		
										X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	9	8	8		
Brio 2010	F	Sub-elite	M	18	22	70	177	Pre training	10	3.03	2.93	2.93		1.56		1.51		0.51	0.52	X	X	0.51	0.52	X	X	X	X	X	X	
								Post training		3.17		2.98		1.77		1.66		0.56	0.56	X	X	0.56	0.56	X	X	X	X	X	X	
Daury 2001	O	National level	M	10	24	80	190	1st season	10	2.29	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
								2nd season		2.38	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Hadžić 2010	O	National division	M	95	22	80	188	x		2.7	2.91	2.7	2.92	1.56	1.71	1.62	1.69	0.58	0.61	0.64	0.64	0.64	0.61	0.64	0.64	X	X	X	X	

Legend: B – basketball, S – soccer, V – volleyball, F- female, M – male, BW – body weight, BH – body height, BHR – bilateral hamstring ratio, BHQ – bilateral quadriceps ratio.

**Table 2. Reported quadriceps and hamstrings peak torque to body weight (PT/BW) at 60°/s and strength ratios in basketball players**

Autor (year)	Sex	Age	N	Extensors PT/BW		Flexors PT/BW		Strength ratios	
				D CON (ECC)	ND CON (ECC)	D CON (ECC)	ND CON (ECC)	HQR D (ECC)	DCR D(ND)
Theoharopoulos et al. [42] (2000)	M	21	12	3.27	3.16	2.13	1.99	0.65 (0.63)	X
Buchanan et al. [8] (2003)	M	11-13	10	1.37	1.24	0.66	0.59	0.47 (0.46)	X
		15-17	9	2.28	2.04	0.99	0.98	0.43 (0.47)	X
	Ž	11-13	11	1.6	1.43	0.65	0.62	0.41 (0.51)	X
		15-17	11	1.57	1.40	0.80	0.75	0.47 (0.43)	X
Gerodimos et al. [23] (2003)	M	12	30	2.09 (2.81)	X	1.31 (1.79)	X	0.62	0.87
		13	30	2.24 (2.90)	X	1.44 (1.87)	X	0.64	0.84
		14	30	2.45 (3.18)	X	1.71 (2.19)	X	0.70	0.89
		15	30	2.53 (3.32)	X	1.70 (2.20)	X	0.68	0.87
		16	30	2.73 (3.42)	X	1.78 (2.29)	X	0.66	0.85
		17	30	2.76 (3.69)	X	1.84 (2.28)	X	0.68	0.84
Bamac et al. [5] (2008)	M	24	20	2.91	X	1.47	X	0.49	X
Delextrat [15] (2008)	M	25	8	2.02	X	X	X	X	X
		22	8	1.76	X	X	X	X	X
Delextrat [16] (2009)	Ž	25	10	1.63	X	X	X	X	X
		26	10	1.65	X	X	X	X	X
		25	10	1.35	X	X	X	X	X
Buchanan et al. [7] (2009)	M	9-10	6	1.56	1.42	0.83	0.74	0.54 (0.52)	X
		12-13	11	1.96	1.85	1.01	0.92	0.52 (0.50)	X
		16-22	7	2.31	2.37	1.46	1.41	0.64 (0.61)	X
	Ž	9-10	7	1.56	1.44	0.79	0.68	0.62 (0.49)	x
		12-13	10	1.72	1.65	0.8	0.74	0.45 (0.44)	x
		16-22	9	1.83	1.77	1.07	0.96	0.58 (0.55)	x
Buchanan [7] (2009)	M	9-10	6	1.56	1.42	0.83	0.74	0.53	0.52
		12-13	11	1.96	1.85	1.01	0.92	0.52	0.5
		16-22	7	2.31	2.37	1.46	1.41	0.63	0.59
	Ž	9-10	7	1.56	1.44	0.79	0.68	0.51	0.47
		12-13	10	1.72	1.65	0.8	0.74	0.47	0.45
		16-22	7	2.31	2.37	1.46	1.41	0.63	0.59
Buchanan [7] (2009)	M	28	15	3.00	2.65	1.90	1.74	0.65	0.68
		19	10	3.2	3.09	1.93	1.77	0.60	0.58
Carvalho [10] (2011)	M	15	27	2.53 (3.23)	x	1.40 (2.32)	x	0.55	0.92
Carvalho [9] (2011)	M	15	55	2.64 (3.39)	x	1.59 (2.41)	x	0.60	0.91

Legend: D – dominant, ND – non dominant, CON – concentric, ECC – eccentric.

In the other, previous studies on the power of the Q and H used the same speed (60° / s 180° / s) and in the case of 12 players showed no dominant side effects as well as more power hamstring than what it was before written down [42]. Schiltz et al. [39] conducted a study on 15 professional and 10 junior basketball players and from 20 healthy control cases. Relative isokinetic and functional performance of basketball players (professional players) were similar to those of a young basketball player, no dominant side effects. While the history of

knee injuries in professional athletes is reflected in the bilateral isokinetic asymmetry.

Carvalho [9,10] is a unilateral recorded the maximum torque Q and H at basketball twice. In the first study [10] investigated the reproducibility of the day-to-day testing isokinetic strength in concentric and eccentric muscle contractions in young basketball players aged 14 to 16 years. He noted the ICC between .72 to .89, and coefficients of variation between 8.1 and 17.4%, suggesting additional familiarizaciju sessions to enhance the reliability of



concentric and eccentric results at a speed of  $60^\circ / \text{s}$  at basketball adolescents. His second work [9] refers to the isokinetic strength with concentric and eccentric muscle actions Q and H at adolescents basketball players in relation to the time before and after the predicted age of maximum torque speed. It was found that the performance of power are largely mediated by the appropriate changes in overall body mass and the maximum torque of flexors in the eccentric mode is not changed about 2 years after the start of the maximum torque level indicating the possibility of optimal age limit for testing eccentric muscle strength in the back HQO hand at basketball. To sum up, strength and power ratios Q and H may represent an important role in the basketball skills. In addition, there are significant difference in effect between different playing positions in basketball suggesting that a particular fitness regime for the quads, the gaming position can be useful [16]. In addition to sporting success, power Q and H and evaluation was strength in basketball plays very important role in injury prevention [12, 32,34,35]. It is very important to note in Table 2 that lacks studies of basketball players, which is interesting given the fact that the rate of ACL injuries in women's basketball is higher than in men [3,18].

#### Volleyball

Since there has been a change in the game, volleyball has become popular. But at the same time has become a physically demanding sport athletes, requires highly developed muscle skills such as strength, power, agility and speed. Extension knees are maximally active during the descent phase (slowing down and controlling the knee flexion during eccentric work) and during the phase jump. Sudden changes of direction that usually occurs in volleyball require eccentric leg strength and short amortization phase (plyometric), ie. A swift transition from eccentric muscle actions to concentric. In light of such an important observation concerning the Q and H, there is still a lack of information about relevant data concerning odbajkašica. Dauty [14] tested the reproducibility so as to measure the maximum torque K with concentric and eccentric muscle contractions. The results showed reproducibility of very good to excellent for the concentric isokinetic strength and eccentric maximum torque at a speed of  $30^\circ / \text{s}$ ,  $60^\circ / \text{s}$   $180^\circ / \text{s}$ . (ICC: 0.83 to 0.94), indicating that power knee flexion at these speeds can be used to estimate the performance volleyball player. Unfortunately, only power values of H are observed in this study. Hadzic and others. [26] recorded in 95 professional volleyball bilateral torque concentric and eccentric Q and H, as well as the ratios of strength and power asymmetry by age, position in the game and level of play. Recorded a speed of  $60^\circ / \text{s}$ . The results showed a significant effect of the level of play that is relative to PT ( $P = 0.001$ ) and the ratio of forces ( $p < 0.05$ ), where international players ( $p < 0.05$ ) had significantly greater strength and hamstring ratio dynamic control (DCI) right leg in relation to the first and / or second national division players. There was no sign of the asymmetry of power, regardless of the muscle group tested, regardless of the muscle

contraction. Furthermore, there was no age-related differences or position in a game that is related to the Q and H normalization of torque or force ratio snaga. Dervišević and others [17] also showed the strength and power ratios Q and H at 159 volleyball players at a speed of  $60^\circ / \text{s}$ . Central concentric power Q and H varies from 2.31- 2.34 Nm / kg and 1.25 to 1.29 Nm / kg. HQR is an average of 0.56, while the DCR is 0.61. There was no sign of the asymmetry of power, regardless of the muscle group tested, regardless of the muscle contraction. ( $F = 3.84$ ,  $p = 0.052$ ). These results highlight some concentric and eccentric relative weakness in hamstring at volleyball players who may favor the acute knee injury. To summarize, there are very few studies about the power of the Q and H at volleyball players. In contrast, the forces of other muscle groups relevant for volleyball (ie, internal and external rotators of the shoulder) are very well described in the literature [4,11,21,33]. We believe it is necessary to carry out more research in this particular sport in order to assess the role of the forces Q and H as well as the ratios of forces Q and H for injury prevention and enhanced sporty performance in volleyball.

#### Conclusion

Based on the results of the studies presented in this review, we can confirm our original claim. And that is that isokinetic strength testing Q and H in basketball and volleyball is crucial for training purposes as well as for rehabilitation. Provides doctors and coaches with valuable information regarding the shortage of strength in specific muscle groups. Furthermore, both HQR and DCR have predictive values for the most common acute injuries as well as injuries from overuse of muscles in team sports. The same is true for the bilateral asymmetry of muscle strength. However, we also noticed some flaws that are obvious in these studies. First, the studies are generally done with the male players, so that there is a need for studies of female athletes because injuries differ between the sexes (eg. Second, there is great heterogeneity in the choice of speed, as well as ways of recording the main findings of studies. Based on available results that we have available we believe that the protocol testing should include testing at a speed of  $60^\circ / \text{s}$  because this speed best illustrates the failure of power production in the muscle. The extra testing speeds are required for comprehensive evaluation and should not be the choice for the first time testing, but are rather chosen based on the study goals. We do not support testing in three or more speed because it is time-consuming, exhausting and without additional clinical value. Part of the problem is also the way in which data is reported. We believe that one should use a standard method of reporting data. For example: the maximum torque to body weight, HQR and DCR (if eccentric was tested), bilateral power difference (if bilaterally tested). Such a standardized method of recording data derived from isokinetic testing Q and H will also allow meta-analysis with the possibility of comparing statistical findings from a variety of team sports.

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## VAŽNOST SNAGE NATKOLJENICE U KOŠARCI I ODBOJCI

### Sažetak

*Sistematska izokinetička procjena zgloba koljena u pripremnom periodu je vrlo korisna, naglašavajući rizike za sportaše u slučaju ozljede kvadricepsa i tetiva koljena. Izokinetička procjena jakosti kvadricepsa (Q) i tetive koljena (H), tijekom koncentrične (CON) i ekscentrične (ECC) kontrakcije mišića, važan je dio sveobuhvatne procjene i rehabilitacije sportaša. Glavni cilj ovog rada je predstaviti glavne zaključke različitih studija koje se odnose na ovo pitanje.*

**Ključne riječi:** Mišići, sport, koljena, odbojka, košarka.

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## PREDICTION OF THE SPORTS MANAGING WORK LEVEL WITH THE HELP OF MANAGEMENT INDICATORS

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*Original scientific paper*

### Abstract

*The aim of this empirical research was to identify the effect of management indicators in sports on prediction of the sports managing work level. The research was conducted on a sample of 57 sports managers of the city of Mostar. The results were obtained by interviewing active sports managers who work in sports (author D. Đedović/F. Varešlija, processed according to D. Mujkic). There was a total of 45 indicators, out of which 44 were the predictors, and the sports managing work level was the criterion variable in the multivariate regression analysis. The prediction criteria were significant ( $p = 0.022$ ) with the determination coefficient of 0.609 and multiple correlation at even 0.957. Predictor system of variables in explaining the overall variance criteria, accounts for 60.9%. In the explanation of the total variability of the criterion variable, sports managing work level (WORK), the following variables participate the most: LITERATURE-scientific literature (-0.939), SEMINAR-attending seminars (0.915), SPECIAL EDUCATION-the importance of educating managers (0.858), WORK SUPPORT-support at work (0.812), ORGANIZATION COOPERATION-assessment of cooperation between sports organizations in Bosnia and Herzegovina (-0.581), SEMINAR DURATION-duration of seminars (0.550) and BUSINESS-I WORK-duration of work (0.543).*

**Keywords:** Sports managers, prediction, work level, regression analysis.

### Introduction

Sports management could be defined as a process of organizing and managing sport or sport organization in order to achieve sports and other goals with rational use of limited resources. There are two management levels: the global level (managing sport at the level of a country, region, canton, city) and the micro level (managing a sports organization itself). The basic purpose of management is to ensure the functioning of the integrated system of the sports organization, leading it from one lower into a desired higher position, with the dominant consideration for general sports and sports organization goals, highly valuing all human and positive achievements, found in theory, practise and philosophy of sports (Malacko, Rađo, 2006). Thus, we distinguish three management levels:

- Top management – it deals with goals, but also strategies for accomplishing strategic objectives. Those are the objectives which have to be precisely defined by top management (market position, innovation, financial and physical resources, productivity, social responsibility and profit).
- Functional management – it represents the correlation between two managements, their number and structure depends on the size, the structure and the type of activity of the organization. The work is divided into specific areas, marketing, finance and accounting.
- Operative – it ensures the transformation of strategic long-term plans into operative action plans. The holders of the operative activities are the lower level managers, and those are sportsmen, coaches and sports experts.

All of the above shows that the subject of this paper are sports managers from various sports

clubs, as well as their management indicators. The main aim of this empirical research was to identify the effect of management indicators in sports on prediction of the sports managing work level. Today's social structures have experienced not so long ago major changes, but what they are characterized by still lives in their living elements – the people. The transition into a new state is not easy, sturdy system that existed leaves traces of the past and attempts to "restore" a previous state. You could say that these areas have not yet passed the civil society because it is not acceptable 'to throw away' all these people into the dustbin of history like some gear components. Transition, as the process of introducing the state ownership or management into private ownership, has a number of implications in all society areas. Under these circumstances, somewhere more – somewhere less, economic and social crisis, management crisis, crisis caused by the legal system and political crises, changes of awareness, lack of education of managers for the new management conditions, slow changing of the traditional relationships, etc. occur (Hadžiahmetović and associates, 2007).

The goal of every organization, and thus a sports one too, is to do a successful and profitable business, and that the economic gains are greater than the investments. It is clear that without educating staff for specific business processes in sport, it most certainly isn't possible to achieve long-term goals as evident in the current state of the Bosnian-Herzegovinian sport. Almost all sports clubs can barely make ends meet and some of them even stop working. In times of recession at all government levels, when people lose their jobs, it is hard to expect higher sponsorships and donations. Also, many public companies have financial problems, so they are unable to finance sports organizations.

## The work method

### The sample of respondents

The research was conducted on a sample of 57 sports managers of the city of Mostar. The results were obtained by interviewing active sports managers who work in sports (author D. Đedović/F. Varešlija, processed according to D. Mujkic). The questionnaire consisted of 46 social type of questions (indicators).

### The sample of variables

The sample of variables consisted of the following indicators: work level, completed education, work duration, work experience, attending seminars, participating in international projects, seminar duration, seminar organizer, access to scientific literature, support at work, professional literature, knowledge gained through education, the importance of lifelong learning, information about the new accomplishments in science and technology, use of computers, knowledge of information technologies, use of the Internet, the importance of foreign languages, foreign language skills, the importance of participating in international projects, information about international projects, the manager's sports genesis, the importance of the manager's training, the type of the manager's training, the willingness to attend classes, the importance of the person in the organization, timeliness of the information on projects in Bosnia and Herzegovina and around the world, regular contact with the state, federal and cantonal ministries, contact with the sports federation, information about the project from relevant ministries, assessment of sports development level in Bosnia and Herzegovina, assessment of cooperation between sports organizations in Bosnia and Herzegovina, the sports law has solved all the problems, the sport strategy has solved all the problems, financing organizations by state, federal and cantonal ministries, financing organizations by the sports federation, sponsors, donors, own income and other sources, the existence of the development strategy and a completed business plan of the sports organization.

### The data processing method

Data analysis was performed by SPSS 19.0 for Windows. Regression analysis was used with the goal to determine the impact of indicators as predictors on the sports managing work level variable as a criterion. Regression analysis determines the significance and size of the impact of the whole predictive system on a single criterion, and the results prediction is performed in any criterion variable based on the individual impact of each variable of the predictive system.

## The results and discussion

Based on table 1, the descriptive statistics of the criterion variable- the sports managing work level- are shown, in which we can see that out of 57 respondents, there were 11 people who are directors of sports federation (19.3%), 12 sports club directors (21.1%), 19 general secretaries (33.3%), 4 sports managers (7%), and 11 people

who are club chairmans (19.3%). The results are represented graphically (Chart 1).

Table 1. Descriptive statistics of sports managing work level

	Frequency	Percent	Valid Percent	Cumulative Percent
<b>The director of sports federation</b>	11	19.3	19.3	19.3
<b>Sports director at the club</b>	12	21.1	21.1	40.4
<b>General secretary at the club</b>	19	33.3	33.3	73.7
<b>Sports manager</b>	4	7.0	7.0	80.7
<b>The chairman</b>	11	19.3	19.3	100.0
<b>Total</b>	57	100.0	100.0	

Based on table 2, the results of regression analysis of criterion variable WORK are shown – sports managing work level and sports management indicators (predictors). After examining the chart we can see that the correlation of the predictor system of variables and criterion variable is at a statistically significant level ( $p=0.022$ ) and that the multiple correlation coefficient is very high and amounts to  $R=0.957$ . The coefficient of determination is 0.609, which means that the predictor system of variables in explaining the overall variance criteria, accounts for 60.9%. The remaining 39.1% of unexplained information of residual variability is the result of linear regression model errors and the characteristics of sports managers, which weren't taken into account. The explanation of the total variability of criterion variable sports managing work level (WORK) was realized by five positive and two negative individual predictors, such as the following variables: LITERATURE – scientific literature – 0.939 ( $p=0.017$ ), SEMINAR – attending seminars 0.915 ( $p=0.017$ ), SPECIAL EDUCATION – the importance of the manager's education 0.858 ( $p=0.028$ ), WORK SUPPORT – support at work 0.812 ( $p=0.027$ ), ORGANIZATION COOPERATION – assessment of cooperation between sports organizations in Bosnia and Herzegovina -0.581 ( $p=0.023$ ), SEMINAR DURATION-duration of seminars 0.550 ( $p=0.006$ ) and BUSINESS-I WORK-duration of work 0.543 ( $p=0.034$ ). This means that these variables individually contribute the most to explaining the dependent variable, when the variance explained by all the other variables in the model is subtracted. The applied system of predictor variables has a significant prediction on the criterion variable, i.e. the work level that will be performed by managers in sports organizations. It is clear that the modern era constantly brings new information and new discoveries, so managers must continually keep track of the scientific journals, organize and visit various



seminars, in order to expand their knowledge, acquire new experience and thus successfully manage a sports organization. In addition, manager's special education is of great importance for the prediction of the work level. High quality and professional sports managers, as well as managers who have the experience, knowledge and skills will be able to

overcome all the difficulties in their work, and with all this they must have support at work. Nowadays, managers do not work as individuals, instead they require a circle of trusted, experienced and smart people around them, and only with an approach like this may they lead a sports organization in the right direction.

Table 2 – The results of hierarchical multiple regression analysis

VARIABLES	P -R	P-R (Sig.)	Beta	Beta (Sig.)
SCHOOL	.341	.005	.345	.103
BUSINESS-I WORK	.165	.110	.543	.034
WORK EXPERIENCE	.028	.419	-.231	.339
SEMINAR	-.068	.309	.915	.017
INTERNATIONAL PROJECT	.083	.270	-.515	.159
SEMINAR DURATION	.287	.015	.550	.006
SEMINAR ORGANIZATION	.110	.207	.082	.726
SCIENTIFIC LITERATURE	-.240	.036	.164	.492
WORK SUPPORT	.060	.328	.812	.027
LITERATURE	-.043	.375	-.939	.017
EDUCATION-KNOWLEDGE	-.071	.300	.132	.661
LIFELONG EDUCATION	-.059	.331	.167	.488
INFORMATION	-.018	.447	-.207	.405
USE OF COMPUTER	-.004	.488	.279	.298
KNOWLEDGE-INFORMATION TECHNOLOGIES	-.101	.228	-.057	.841
FOREIGN LANGUAGE	.080	.278	.253	.237
FOREIGN LANGUAGE SKILLS	-.085	.266	-.141	.676
PROJECT PARTICIPATION	-.087	.261	-.554	.185
INFORMATION-PROJECTS	.120	.186	-.106	.695
SPORTS MANAGERS	.236	.039	-.452	.076
SPECIAL EDUCATION	.260	.026	.858	.028
EDUCATION ORGANIZATION	-.100	.229	.469	.085
MANAGEMENT CLASSES	.054	.344	-.289	.161
ROLE-ORGANIZATION	.159	.118	-.196	.383
REGULAR INFORMATION	.226	.045	.335	.170
STATE MINISTRY	.410	.001	.336	.183
FEDERAL MINISTRY	.451	.000	.392	.313
CANTONAL MINISTRY	.453	.000	.508	.202
SPORTS FEDERATION	.180	.090	.267	.197
PROJECTS-MINISTRIES	.409	.001	-.073	.840
SPORTS LEVELS	-.020	.441	-.438	.064
COOPERATION-ORGANIZATION	.067	.310	-.581	.023
SPORTS LAW	.006	.482	-.300	.285
STRATEGY-SPORT	.200	.067	-.072	.795
FINANCES-STATE	-.240	.036	.132	.576
FINANCES-FEDERATION	.092	.248	.432	.057
FINANCES-CANTON	-.260	.025	.217	.236
FINANCES-SPORTS FEDERATION	-.029	.416	.626	.097
FINANCES-SPONSOR	.120	.188	.261	.262
FINANCES-DONOR	-.023	.431	-.006	.980
OWN INCOME	.099	.232	-.001	.998
FINANCES-OTHER	.125	.178	.427	.070
STRATEGY	-.067	.311	.280	.290
BUSINESS PLAN	-.346	.004	.193	.388
R		R <sup>2</sup>	F	Sig
	.957	.609	2.984	.022

Legend: P-R - correlation; PR (Sig.) - The statistical significance of correlation; Beta - standardized partial regression coefficient, Beta (Sig.) - statistical significance of Beta partial coefficient; R - multiple correlation coefficient, R<sup>2</sup> - determination coefficient; F - approximate Fisher's value; Sig. - The statistical significance of the model.



## The conclusion

At the level of statistical significance ( $p = 0.022$ ), multiple linear regression analysis showed the existence of a linear correlation between the criterion variable (sports managing work level) and all predictor variables (management in sport), and that the applied predictor system of variables explained about 60.9% of the common variance criterion variable. The largest statistically significant effect of predictor variables on the criterion variable has five positive individual regression coefficients: attending seminars, the importance of managers' education, support at work, duration of seminars and work, while negative values of standard individual regression coefficients can be found

in the following indicators: scientific literature and assessment of cooperation between sports organizations in Bosnia and Herzegovina. It is clear that the modern era constantly brings new information and new discoveries, so managers must continually keep track of the scientific journals, organize and visit various seminars, in order to expand their knowledge, acquire new experience and thus successfully manage a sports organization. In addition, manager's special education is of great importance for the prediction of the work level. High quality and professional sports managers, as well as managers who have the experience, knowledge and skills will be able to overcome all the difficulties in their work, and with all this they must have support at work.

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## PREDIKCIJA NIVOA RADA SPORTSKIH MENADŽERA POMOĆU INDIKATORA UPRAVLJANJA

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### Sažetak

*Cilj ovog empirijskog istraživanja bio utvrditi utjecaj pokazatelja upravljanja u sportu na predviđanje razine rada sportskog upravljanja. Istraživanje je provedeno na uzorku od 57 sportskih menadžera u gradu Mostaru. Rezultati su dobijeni intervjuiranjem aktivnih sportskih menadžera koji rade u sportu. Bilo je ukupno 45 pokazatelja, od kojih 44 su prediktori, a razina rada sportskog upravljanja je kriterijska varijabla u multivarijantnoj regresijskoj analizi. Kriterij predviđanja bio je značajan ( $p = 0.022$ ), s koeficijentom determinacije od 0,609 i multipla korelacije na čak 0.957. Prediktor sistema varijabli objašnjava ukupni kriterij varijance, za 60,9%. U obrazloženju ukupne varijabilnosti kriterijske varijable, u razini rada sportskog upravljanja (rad), najviše sudjeluju sljedeće varijable: znanstvena literatura (-0.939), pohađanje seminara (0.915), specijalna edukacija - važnost obrazovanja menadžera (0,858), podrška na poslu (0,812), organizacija saradnje - procjena saradnje između sportskih organizacija u Bosni i Hercegovini (-0,581), trajanje seminara (0.550) i vrijeme rada (0.543).*

**Ključne riječi:** Sportski menadžeri, predviđanje, razine rada, regresijska analiza.

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## THE EFFECTS OF FOOTBALL PROGRAMMES ON THE TRANSFORMATION OF ANTHROPOLOGICAL CHARACTERISTICS OF YOUNG FOOTBALL PLAYERS

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*Original scientific paper*

### Abstract

The research was conducted on the sample group of 137 football players, ages from 14 to 16, from football clubs in the area of Central Bosnia Canton. 9 variables for assessment of morphological characteristics, 15 variables for the assessment of motor skills and 12 variables for the assessment of situational motoric skills were conducted. The main objective of this research was to determine the effects of experimental football programs over a period of six months with 72 training units on the transformation of morphological characteristics, motor skills and situational motor skills of young players. The canonical discriminant analysis was conducted with the aim of establishing the effects of the experimental program on the transformation of morphological characteristics, motor skills and situational motor skills of young players. The general quantitative changes that developed within certain variables of the motoric skills and situational motoric behavior are the result of a significant increase in efficiency of a number of physical abilities, especially during the period of the experimental football program.

**Keywords:** Football players, morphological, motor skills, situational – motor skills, discriminant analysis.

### Introduction

Modern football is characterized by high intensity of the game, the universality of players, technical and tactical training and rationality and the high demands placed upon igrače. To contributed significantly to the development of a new, modern training technology, especially in the segment of working with younger teams players. Working with younger teams players increasingly advanced, and the scientists are putting a lot of effort to the new programs of work as many perceive their implementation in daily football practice. Football coaches who work with young football players are very much interested in (or at least should be interested) in new knowledge about all the factors that influence the success primarily because they face every day and they are registered in the training practice (Gabrijelić, et al., 1983, Dujmovic, 2000). For this reason, following the developmental traits and abilities of young players is the primary task of all football coaches, because no objective indicators and scientific foundation, it is not possible quality and objective program, not realize the transformation process and to reach the desired results (Talović, M., 2001, Bajrić, O. 2012). Football coaches who over a long period "create" top soccer players in order to meet the demands of today's football, you need to know, connecting in practice apply scientifically based information, relating to different technology training processes into a single structural unit. It is known that one technology in today's football development level is not sufficient for the maximum development and integration of all the necessary traits and abilities in specific oral football action. Today in the training practices are increasingly using different technologies and models of work in programming training process. A special place in the programming of the training take situational training models that footballers maximum approaching the terms of the actual game on the field. It is also a guarantee of success of the implementation of the training transformation process and the formation of an integrated players in the senior age (Molnar

et al. 2007). To be able to objectively programmed transformational processes, it is necessary to monitor the developmental characteristics of young players through the process of training (Findak, 2003). This will be the best way to reduce the effects of many generators unacceptable variations that may occur in the process of training in younger age groups players (Malacko, J. Wolf, B., 2004, Lolić, V., Bajrić, O., 2011).

### Methods

#### The sample of respondents

The population from which the sample of 137 respondents is defined as a population of cadets aged 14-16 years in the area of Central Bosnia Canton. All of them were registered players who play for their cadet team in the cantonal league SBK F/BiH. In selecting the subjects for this study were taken into account the following elements: that all respondents aged 14 to 16, that all subjects registered players mentioned cadet team, that all subjects medically examined as a license to perform on the primary and cup matches.

#### The sample of variables

The variables for assessing morphological characteristics

Body height	(ABH)
Length of the leg	(ALL)
Length of arm	(ALA)
Biacromial range	(ABIR)
Knee diameter	(AKD)
Diameter hock	(ADH)
Body weight	(ABW)
Scope thigh	(AST)
Midrange chest	(AMRC)

### The variables for the assessment of motor abilities

For the assessment of motor abilities were selected tests that measure: explosive power, speed, coordination, repetitive strength, flexibility. All mentioned motor skills Tested with three tests which are standardized and in publications.

Long jump from place	(MLJ)
Vertical jump	(MFVJ)
Triple jump	(MTJ)
Taping-foot	(MTF)
Taping-foot-wall	(MTFW)
Sprint at 20 m-high start	(MS20HS)
Slalom with legs-with two balls	(MSLTB)
Side steps	(MSS)
"Envelope" test - run in the rectangle	(MET)
Push-ups	(MPU)
Sit-ups from lying down for 30"	(MSU)
Deep squats	(MDSQ)
Reach on box	(MROB)
Side gap	(MSG)
Active Straight-Leg Raise(from lying back)	(MASLR)

### The variables to assess situational - motor skills

Straight foot precision - vertical target	(SSFP VT)
Elevational foot precision - vertical target	(SEFP VT)
Elevational head precision - horizontal target	(SEHP HT)
Horizontal ball rebounding from the wall 20 sec	(SHBR)
Speed keeping the ball in the slalom	(SSKSL)
Speed keeping the ball in a semicircle	(SSKSC)
Speed keeping the ball with change of direction at right Angle	(SSK CDRA)
Running speed in a semicircle	(SRS SC)
Running speed with the change of direction at right angles	(SRS CDRA)
Running speed in slalom (winding run)	(SRS SL)
The force of the ball, foot	(SFB F)
The force of the ball, head	(SFB H)

### Experimental work program

Experimental work program was fully adapted to the age characteristics and abilities of young players, because they take account of the characteristics of the development of players age between 14 and 16, the time length of involvement in the systematic training process of learning football, knowledge of methods applied in the training and training

elements of soccer techniques, the need to adopt the envisaged model of football games in the most basic elements, the duration of the experimental program as well as the training of each unit individually. Time component of the work program is based on six-month implementation of training activities, such as the respondents had three training sessions and one game a week. The total number of six-month training program is 72, and the duration of each workout 80-90 minutes. The structure of each workout is designed on the principles and the principles of the theory and practice that treats methodology of work with football players aged 14 to 16 years. Each training is structured in three parts: introduction, preparation, main and final, in which implemented certain goals and tasks in terms of emotional, intellectual and physiological workload.

### Data processing methods

To establish global quantitative differences (global quantitative effects), in tests of morphological characteristics, motor skills and situational-motor skills applied the canonical discriminant analysis manifest space. Criteria for discriminative strength of variables, was called. Wilks Lambda. Odrđivanje statistical significance of each discriminant variables was done on the basis of Bartlett's Chi-square test. For interpretation used are important discriminative variable and it explains how certain percentage of variability.

### Results and discussion

The discriminative analysis of the changes applied anthropological characteristics Table 1. shows the results of canonical discriminant analysis applied anthropological characteristics of respondents - young players. Based on the results listed in Table 1 to analyze the differences between the initial and final measurements of quantitative changes in motor abilities, motor and situational-motor skills produced by the program of football for a period of six months from 72 the training units. By analyzing the results in the table below we can see that the isolated One statistically significant discriminative function whose coefficient is  $R = .65$ , which tells us what is the correlation between variables of morphological characteristics, motor and situational-motor abilities on the basis of which is carried out discriminant analysis and results the discriminant function. To test the effectiveness of the applied program of football is measured at the beginning and end of the program 9 morphological characteristics tests, 15 tests, which are supposed to have a good measure of the studied motor and 12 tests, which are supposed to have a good measure of the study situational-motor space. A review of the results shown in Table 2. shows that the largest contribution to discriminant function has a test to assess ball handling (SHBR), test running speed (MS20HS), explosive strength test (MLJ), repetitive power test (MPU), and test flexibility (MASLR). On the basis of correlation with the discriminant function (structure discriminate function) Table 3, thus a variable that distinguishes the initial maximum of final measurements, we can see that the test is to assess ball handling (SHBR), most responsible for the changes introduced, followed by tests to evaluate repetitive the power of arms and shoulders (MPU), Active Straight-Leg

Raise from lying on the back (MASLR), running speed by a semicircle (SRS SC) and the test for the evaluation of power hitting through the ball head (SFB H), followed by tests to evaluate the speed of movement of the legs (MTF), slalom legs with two balls (MSLTB), running speed with a change of direction at right angles (SRS CDRA), keeping the speed of the ball on a semicircle (SSKSC). These said motor and situational-motor tests have influenced the resulting effects caused by the applied program of football. Looking at the correlation with isolated discriminant function (matrix structure), ie, a variable that varies the initial maximum of final measurements, we can see that in almost all administered tests of motor and situational-motor skills achieved statistically significant correlations. Monitoring the implementation and evaluation of actual effects of different programs are valuable property factor for improving the training process in football and incentives for coaches for quality and creative programming of training activities. Previous studies (Bajrić et al. 2012; Šunje et al., 2011; Radaković et al. 2012), have shown that the application of programs structured on the basis of the structure of movement similar conditions of a real game, can produce significant changes in those abilities that primarily affect the success of the football. Selected programs and facilities typical football movement performed for various purposes with increasing scope and intensity of the load, have led to improved performance in tests of motor and situational-motor skills. Also, the contribution of the global quantitative changes probably can be attributed to the experience gained by the participants in the interval that included the program of football in which they could learn about the complexity and structure of the football movement. Based on the presented results we can conclude that the program of football by their structure, duration, frequency and choice of loads led to significant positive transfer in the area of motor and situational-motor skills. From the results of discriminant analysis can be concluded that there was a statistically significant global quantitative changes in motor and situational-motor space. Test to assess running speed (MS20HS) and explosive strength of the lower extremities (MLJ), which in this population of patients significantly more likely to depend on the genetic code, does not differentiate significantly quantitative shifts, from which it can draw two possible conclusions: from previous studies it is known it is a motor skill that is largely conditioned by the genetic code and is little room to get to their significant changes under such training treatment; content of the applied software process is not sufficiently programmed so as to cause significant changes in this motor skill. Winning the global quantitative changes in certain variables in motor and situational-motor behavior are the result of a significant increase in efficiency in a number of physical abilities, especially the increased fund specific motor information at the interval that included the program of football.

*Table 1. Results discriminant analysis applied anthropological variables*

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	,721(a)	100,0	100,0	,647

*Table 2. standardized matrix Wilks' Lambda*

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1	,581	137,968	36	,000

*Table 3. structure matrix*

Variables	Function	Variables	Function
	1		1
ABH	-,329	SHBR	,469
ALL	,042	MPU	,352
ALA	,040	MASLR	,299
ABIR	,121	SRS SC	-,285
AKD	,252	SFB H	,271
ADH	,300	MTF	,265
ABW	,089	MSLTB	-,263
AST	-,270	SSK CDRA	-,253
AMRC	-,028	SSKSC	-,239
MLJ	-,432	SFB F	,238
MFVJ	,055	MTJ	,233
MTJ	,184	MSU	,228
MTF	,226	SEFP VT	,227
MTFW	-,163	MFVJ	,221
MS20HS	,423	MDSQ	,207
MSLTB	-,371	SEHP HT	,191
MSS	-,096	ADH	,186
MET	,076	SSK CDRA	-,184
MPU	,357	MROB	,183
MSU	,191	ABIR	,175
MDSQ	,079	MSS	-,156
MROB	,136	MET	-,140
MSG	-,030	MTFW	,133
MASLR	,402	SSFP VT	,127
SSFP VT	,115	ALA	,125
SEFP VT	,256	MS	,121
SEHP HT	,241	SRS SL	-,114
SHBR	,512	AKD	,113
SSKSL	,068	ABH	,101
SSKSC	,130	MLJ	,090
SSK CDRA	,082	SSKSL	-,089
SRS SC	-,075	ABW	,089
SRS CDRA	-,324	AMRC	,072
SRS SL	,126	AST	,048
SFB F	,188	MS20HS	-,036
SFB H	,072	ALL	,020



## Conclusion

The selected program contents typical football structure movement, have led to an increase in the level of applied anthropological characteristics and their real use value in a football game. The contribution resulting from the global quantitative changes included anthropological characteristics, in addition to adopted motor skills, probably can be attributed to the experience that the participants gained during the period that included the program of football, during which they met the complexity and structure of the football movement. Thus, the global improvement of the results of anthropological characteristics in the second measurement realized, probably, more repeats of tasks, which leads to the formation of automatism movements, and thus reduced the time needed to understand and remember the order of the tasks in the tests of football, which is always present at the first meeting with complex motor situations. Applying the football

program led to significant positive transfer in the area of basic skills and situational-motor abilities of transfer in motor abilities. Based on these results it can be concluded that the program content is managed to improve motor and situational-motor skills, while the objectives of global quantitative changes in the morphological characteristics of partially realized. From the analysis of the results of global quantitative changes in the area of motor and situational-motor abilities when it comes to the treatment applied in this study of 72 the training unit, it can be concluded that the program of football by their structure, duration, frequency and choice of loads led to significant positive transfer in the area of motor and situational-motor skills. The results of this model of programmed training work can be used as guidance and kind guidance trainers and experts on possible courses of action in methodics and methodology of work with young footballers.

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## EFEKTI PRIMJENE PROGRAMA NOGOMETA NA TRANSFORMACIJU ANTROPOLOŠKIH OBILJEŽJA MLADIH NOGOMETAŠA

### Sažetak

*Istraživanje je provedeno na uzorku od 137 nogometaša uzrasta 14 do 16 godina iz nogometnih klubova Srednjobosanskog kantona Federacije BiH. U istraživanju je primijenjeno 9 varijabli za procjenu morfoloških karakteristika, 15 varijabli za procjenu motoričkih sposobnosti i 12 varijabli za procjenu situaciono – motoričkih sposobnosti. Osnovni cilj istraživanja bio je da se utvrde efekti eksperimentalnog programa nogometa u trajanju od 6 mjeseci sa 72 trenažne jedinice na transformacije morfoloških karakteristika, motoričkih i situaciono-motoričkih sposobnosti mladih nogometaša. U cilju utvrđivanja uticaja eksperimentalnog programa nogometa na transformaciju morfoloških karakteristika, motoričkih i situaciono-motoričkih sposobnosti mladih nogometaša primijenjena je kanonička diskriminativna analiza. Dobijene globalne kvantitativne promjene kod određenih varijabli u motoričkom i situaciono-motoričkom prostoru posljedica su značajnog povećanja efikasnosti u većem broju tjelesnih sposobnosti, a naročito povećanog fonda specifičnih motoričkih informacija u intervalu koji je obuhvatio program nogometa.*

**Ključne riječi:** Nogometaši, morfološke karakteristike, motoričke sposobnosti, situaciono – motoričke sposobnosti, diskriminativna analiza.

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## THE FAT CONTENT IN THE BODY STRUCTURE OF THE EIGHTH AND NINTH GRADE STUDENTS

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*Original scientific paper*

### Abstract

*This study uses a sample of respondents aged 13 to 14. Five tests used for measuring morphological characteristics were applied for the pattern of the variables and three tests for the assessment of the body composition. The main aim of this study was to show the current state of students attending the final grades of primary schools and to compare their results with the results of certain criteria tables and previous studies. The results show that there is a significant difference in comparison with the results of the previous studies, a less significant difference from the Eurofit test battery criteria tables and appurtenance to average results according to International Health Federation.*

**Keywords:** *Students, morphological characteristics, body composition, body fat, criteria tables.*

### Introduction

The morphological characteristics are the subject of many studies by different authors of contemporary scientific research papers. The results got in most of these researches were the results of the tests on the selected samples of this population, for example, the students involved in individual sports (Palic 2014, Mahmutovic 2011). The general opinion of many authors dealing with research in the scientific field "Methodology of sport" assumes that there is a lack of longitudinal follow-up of definitive shaping of the morphological characteristics in younger age groups. Nowadays, establishing the body composition has a special significance in anthropological population and epidemiological research. Relations formed in between the two spaces are becoming more and more interesting, the excess of body fat in the body composition and high blood pressure, increased cholesterol level (hypercholesterolemia), and diabetes -all dangerous factors for developing cardiovascular diseases. If you think about it, we feel that this is a problem already identified which the society today doesn't understand. There is an evident increase in children obesity. According to a number of European studies, it is estimated that 10 to 30 per cent of children and 8 to 25 per cent of adolescents are overweight, wherein the highest prevalence is recorded in Italy, Malta, Spain and Greece (Lobstein, Frelut 2004). According to the epidemiological data obtained in Serbia and Montenegro, the prevalence of obesity in the early childhood amounts to 13, 1 per cent (Pavlovic, Belojevic, Balac, Kadvan 2001). After the part of the text devoted entirely to the influence of body fat on health, it is also necessary to point out that the above mentioned body fat has a negative influence on motor skills. Given all the reasons, when measuring morphological characteristics, diagnosing body fat should represent an essential part. As it was proven before, in the age 12 to 15, many quantitative and

qualitative changes take place in the body of girls. Some of the biggest changes in this age are the rapid growth and increase in body fat (Marcus et al. 1985). Along with the growth and maturation of the reproduction system, the percentage of body water decreases rapidly whereas the weight of fat increases (Frisch, 1998). The results of Bogalusa Heart Study showed that being overweight in childhood increases the possibility of developing obesity in adulthood for four times (Freedman et al, 2005). Three periods in early life are marked as critical in the development of obesity: the prenatal period, the period of rapid increase in fat mass, which begins at the age of 6, and adolescence stage. In defining obesity, it is recommended to use the body mass index, which proved to be a useful indicator of nutritional status which simultaneously correlates well with the fat mass and the risk of developing metabolic and cardiovascular complications of obesity. However, it is not a useful indicator when it comes to fat mass, because in its calculation, it uses total body weight, which, besides body fat, includes muscle, bone and connective tissue. The development of modern technologies resulted in initiating the development of instruments used for diagnosing the amount of body fat. The newest method for the most accurate reading of body fat content is the so called BOD POD system. When we talk about the most advanced methods used for medical purposes and kinesiology, we mustn't forget to mention the method that has been the predecessor to all others, and has been responsible for many essential results. It's a method that uses the generalized equation by Jackson and Pollock (1985). The aim of this work is to show the current state in which students attending the final grades of primary schools are, and to compare their results with the results of certain criteria tables and previous studies. The specific interest is to determine the direction in which the body fat moves, based on the results of previous studies about the impact of modern life and movement.

## The method

The sample of this study consisted of 405 primary school students aged 13 to 14. The sample consisted of 177 students who were attending the eighth grade of primary schools, and 228 students who were attending the ninth grade of primary schools from three different geographic areas (Mostar, Bihac, Jablanica). Therefore, the research was conducted in primary schools whose work is based on the Curriculum issued by the Pedagogical Institute of the Herzegovina-Neretva Canton (HNK) and the Pedagogical Institute of the Una-Sana Canton (USK).

## The sample of variables

The five variables used for the diagnosis of the morphological characteristics of our research were taken from the (IBP) International Biological Programme, from which we chose measurements the most relevant for our research (AVISTJ, AMASTJ, ANANAD, ANAPOT, ANATRB). The other three variables used to assess nutritional status and body fat content were obtained by Bioelectrical Impedance Analysis (BIA) technique which operates

on the velocity principle of conducting low-frequency electric power through the body structure (BMI, Fat% Fat Mass).

## The results

By analyzing the descriptive indicators, the measures of the central tendency and variability of distributing variables' results for assessing morphological characteristics and the eighth grade students' from Mostar, Bihac and Jablanica body composition (table 1), the following can be noted: in two (2) variables out of eight (8) in the eighth grade students from Mostar, lower variable values were registered as opposed to the arithmetic mean, and those are: AVISTJ, BMI. Thus, the registered values of the variables in students from Mostar contribute to homogeneity of respondents, that is, the results are in the similar value zone. Skewness, in almost all variables for assessing morphological characteristics and body composition, in respondents from Mostar, Bihac and Jablanica, has a positive skew indicating a negative asymmetry and a number of better results with higher values than the arithmetic mean. Only with variable AVISTJ, skewness has a negative skew and indicates positive asymmetry.

*Table 1. Descriptive indicators of the morphological characteristics and the eighth grade students' from three different geographic areas body composition*

	Range	Min.	Max.	A. S.	Std. Dev.	Var.	Skewness	Kurtosis
AVISTJ	36.7	147.3	184.0	165.290	7.0685	49.964	-.030	-.127
AMASTJ	70.7	27.9	98.6	55.979	12.1932	148.673	.811	1.350
FAT%	43.2	2.2	45.4	18.578	9.7022	94.133	.407	-.745
FAT MASS	44.2	.6	44.8	11.136	7.6068	57.864	1.172	1.739
ANANAD	32.0	5.0	37.0	18.669	8.2301	67.734	.327	-.787
ANAPOT	42.0	3.0	45.0	19.470	8.8746	78.759	.467	-.435
ANATRB	46.0	3.0	49.0	18.541	9.6774	93.653	.659	-.011
BMI	20.8	12.9	33.7	20.287	3.6161	13.076	1.059	1.635

By analyzing the descriptive indicators, the measures of the central tendency and variability of distributing variables' results for assessing morphological characteristics and the ninth grade students' from Mostar, Bihac and Jablanica body composition (table 2), the following can be noted: In two (2) variables out of eight (8) in the ninth grade students from Mostar, lower variable values were registered as opposed to the arithmetic mean, and those are: AVISTJ, BMI. Thus, the

registered values of the variables in students from Mostar contribute to homogeneity of respondents, that is, the results are in the similar value zone. Skewness, in almost all variables for assessing morphological characteristics and body composition, in respondents from Mostar, Bihac and Jablanica, has a positive skew indicating a negative asymmetry and a number of better results with higher values than the arithmetic mean.

*Table 2. Descriptive indicators of the morphological characteristics and the ninth grade students' from three different geographic areas body composition*

	<b>Range</b>	<b>Min.</b>	<b>Max.</b>	<b>A. S.</b>	<b>Std. Dev.</b>	<b>Var.</b>	<b>Skewness</b>	<b>Kurtosis</b>
AVISTJ	37.6	151.0	188.6	169.576	8.4656	71.667	.124	-.651
AMASTJ	66.8	33.6	100.4	59.684	11.8902	141.378	.605	.318
BMI	20.7	14.2	34.9	20.538	3.4058	11.600	.980	1.401
FAT%	42.2	2.3	44.5	18.972	9.1023	82.852	.393	-.624
FAT MASS	37.8	1.0	38.8	11.794	7.0823	50.160	1.160	1.763
ANANAD	36.7	4.3	41.0	18.225	8.3049	68.971	.496	-.557
ANAPOT	41.2	4.0	45.2	18.172	8.8638	78.567	.807	.070
ANATRBT	44.4	3.6	48.0	18.012	9.5425	91.060	.753	-.066

### The discussion

The average body height in the eighth grade students from three different geographic areas belongs to the average Eurofit test battery values. The results are closer to the upper limit, which is yet another evidence that children living in the modern society grow faster. When you consider the longitudinal dimensions from twenty years ago, these standards, if this kind of growth acceleration continues, will not be valid in the near future. Similar results were obtained by comparing the variable "body mass" with the Eurofit test battery standards, which are also moving towards the upper limit. By comparing the values of the morphological characteristics and the eighth grade students' body composition, obtained by our measurements, with the values of the same variables from the research conducted on respondents of the same age by I. Mahmutovic (2011), we have found that three out of four variables used in both researches have higher values. Only one variable, and that is the "abdominal skinfold" has a lower value in our study than in the research by Mahmutovic (2011). It is assumed that these results are affected by the factor of rapid growth and development that comes with the so called "contemporary way of living." Just like with the eighth grade students, the ninth grade students, when it comes to the morphological characteristics and body composition, have higher values in all variables in our research than in the one by I. Mahmutovic (2011). Also, one of the possible reasons why we got such results, can be found in a variety of lifestyles that are adapted to the area in which the students live. Babin, Katic, Vlahovic in their study (2001) aimed to prove that programmed classes of PE (Physical Education) with the constant participation of the PE professor in contrast to the

disorganized class management, bring better results and make a greater impact on the morphological characteristics, which could be one of the reasons why there was a difference in our research. However, by comparing the results of the variables BMI and FAT% in the eighth and ninth grade students in our study, with the values of international tables issued by the American Journal of Clinical Nutrition, we come to the conclusion that the target population of this age meets all the criteria of the average value.

### The conclusion

In this study, the results obtained were interpreted from different aspects and compared with different criteria tables. The values are such that if we compare them with the Eurofit test battery criteria tables issued in the eighties, we can see that today's population have significantly greater longitudinal dimensions and body mass. By comparing the same results with the results of the research by Mahmutovic, we can see that the values obtained in this study are significantly increased if we take into account the relatively short time span between the two measurements. If we make a parallel between the results of our research and the results issued by the International Health Federation, we can see that our results belong to the framework of average results. It is also assumed that one of the major factors why our image of the researched area is not better, is that the students have a heavy work schedule which takes up much of their free time, and all this at the expense of reduced physical activity.

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## SADRŽAJ MASTI U TJELESNOJ STRUKTURI UČENIKA OSMOG I DEVETOG RAZREDA

### Sažetak

*Ovo istraživanje je rađeno na uzorku ispitanika u dobi od 13 do 14 godina. Primijenjeno je pet testova za mjerenje morfoloških karakteristika i tri testa za procjenu sastava tijela. Glavni cilj ovog istraživanja bio je pokazati trenutno stanje polaznika završnih razreda osnovnih škola i usporediti svoje rezultate s rezultatima određenih kriterijskih tabela i prethodnih studija. Rezultati pokazuju da postoji značajna razlika u usporedbi s rezultatima prethodnih studija, a manje značajna razlika Eurofit baterije testova i prosječnih rezultata prema Međunarodnoj zdravstvenoj federaciji.*

**Ključne riječi:** Učenici, morfološke karakteristike, sastav tijela, tjelesna mast, kriterijske tabele.

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## THE IMPACT OF SPORTS AND PHYSICAL EDUCATION WITH ADDITIONAL ACTIVITIES AT THE LEVEL OF QUANTITATIVE CHANGES IN BASIC - MOTOR ABILITIES OF STUDENTS

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*Original scientific paper*

### Abstract

*The general objective of this study is to determine the level of quantitative changes in basic - motor abilities of students under the influence class of Sports and Physical education with additional activities. The treated sample of respondents are students of 6th, 7th and 8th grade of elementary school "Mak Dizdar" in Zenica, ages 12 to 14 years, in addition to attending regular classes of sports and physical education (second semester) two hours per week, included in the semi-programmed work in the optional teaching of the four sports games (basketball, volleyball, soccer and handball). Random variables in this study are hypothetical cover areas of primary motor 14 variables. In order to determine the quantitative changes used discriminative analysis. Discriminant analysis (at the multivariate level) in the area of basic - motor abilities, we had a discriminant function which showed high correlation between the two sets of data. Analyzing projections on discriminant function of certain variables basic - motor abilities can be seen that the most important projections are variable: BMTN - fuse foot, BMSVZ - jump with a running start, BMSVM - jump from place to place, BMLS - lying seater (abs). So, on the basis of numerical values in the variables, we can conclude that there has been a positive change in the final compared to the initial measurement, and that the school half-year curriculum of regular and teaching in the first place favorable influence on the explosive power, segment speed and repetitive the strength of the trunk.*

**Keywords:** Discriminant analysis, sports games, students, quantity.

### Introduction

The term process exercise involves all the elements of the dynamic relations system that controls and systems to be managed, and refer to the procedures for planning, programming, implementation and control of the effects of certain processes of exercise (Findak and Prskalo, 2004). Concerned about the growing percentage of overweight and sick children and the significant decline in motor skills in students, and the need for physical exercise particularly stresses due to the negative trend in motor development (Dollman & ass. 1999). Physical exercise in schools has, as one of the main goals of a positive impact on all basic-motor abilities. Additional physical activity, according to most previous studies (Nićin, 2000 Petkovic, 2007) increases the positive effects of physical development, and basic-motor abilities. The optimal choice of methods and methodological procedures will contribute to the quality. Lots of studies show the influence of appropriate methods to the efficiency of learning motor movements (Prskalo & ass. 2003) Selected sections of the independent choice of an individual or group on the basis of material and space conditions of school (Nonković, 1992, Petrovic & ass., 1995; Brajkovic, 1998; and Nikolic, 2002), predisposition and desire to practice the chosen activity, deepen knowledge and to compete with their peers. From all this proizali and genaeralni goal of this research that reads to determine the level of quantitative changes

in basic - motor abilities abilities of students aged 12 - 14 years, and under the influence of the plan and program of regular and classes of physical and health education.

### Methodology of research

#### Sample of subjects

The study was conducted on a sample of 120 primary pupils "Mak Dizdar" in Zenica, boys aged 12 -14 years, as in the school categorization represents students 6, 7th and 8th grade. Definition of the population from which the sample is represented The population from which the sample is selected students are 6th, 7th and 8th grade of elementary school "Mak Dizdar" in Zenica, ages 12 to 14 years, which in addition to attending regular classes of Sports and Physical education (second semester) two hours per week, included in the semi-programmed to work extra work from all four sports games. Sample of variables Random variables in this study a hypothetical will cover areas of primary motor 14 variables - The variables for the assessment of motor abilities To estimate the primary-motor abilities, the author has chosen for the tests which measure explosive strength, speed, coordination, repetitive strength, flexibility. All primary-motor tests are standardized and published in publications .Gredelj, M., & ass. (1975)

r.b.	Test code	Test name
1.	BMS20	From a standing-20 meters sprint
2.	BMSVM	jump with both feet into the air from a place
3.	BMSVZ	two foot jump from the ramp
4.	BM TN	foot tapping
5.	BMKT	envelope the test
6.	BMKS	side steps
7.	BMTR	hand tapping
8.	BMDP	deep reach on box
9.	BMSDMI	two feet long jump from place to place
10.	BMLS	raising troops from lying
11.	BMSS	hand grip (hand dynamometry)
12.	BMSR	Running on 20m back and forth with a gradual acceleration
13.	BMSM	slalom with three medicine ball
14.	BMBMLP	medicine ball throw in the prone position.

## Results and discussion

General discriminative model can be defined as a special type of factor analysis in which the first isolate factors in the system of applied variables, by which respondents can be grouped on the basis of their differences, indicating that the model contains components that best separate the groups in the area of variables. In our case, we have a sample of subjects on which the measurement was performed twice, and in fact we have two sample measurement. In this study, discriminant analysis is to determine whether there are differences between the initial and final measurement that occurred under the influence of the applied program. Since we have two measurements (initial and final), discriminant analysis was done so that the initial measurement treated as a single group, and the final measure as the other group. Analysis of quantitative changes in basic motor skills In Table 1, boxes M test we tested the null hypothesis (equality of the identity matrix) through the determinants. The difference between the covariance matrix is statistically significant (sig. .00), Which are created conditions for further procedure discriminant analysis.

Table 1. Test results

	Box's M	289,687
F	Approx.	2,555
	df1	105
	df2	122135,977
	Sig.	,000

Table 2 shows that isolating one discriminant function groups and discriminant function that is significantly different groups, indicating high discriminative value, which is confirmed by the canonical correlation coefficient group (.79)., And speaks of the high correlation, while the typical root (eigenvalue) isolated discriminant function is 1.71, and the degree of variance of 100%. In further analysis will show several variables that make a significant contribution to the discriminant function.

Table 2. Significance of isolated discriminative function

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	1,721	100,0	100,0	,795

Significance isolated discriminant functions were determined by Wilks lambda test (Table 3), which is commonly used in the discriminant analysis and represents the multivariate equivalent of F-testa. Njegova value is relatively low (.36), reflecting the existence of differences between groups, and this the groups have different arithmetic mean can be seen and the level of significance and no significant (sig. = .00).

Table 3. Wilks' Lambda

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1	,368	191,184	14	,000

Table 4 shows the values of the standardized coefficient of discriminant function and strukturalni discriminatory factors (correlations between discriminating variables - Var. And standardized canonical discriminant functions - Function) used to construct the discriminant function. Structure coefficients are a more reliable indicator of the relative strength of discriminating variables for which have been used to create a discriminant function. Analyzing projections on discriminant function of certain variables of basic motor skills, it is evident that the most important projections are variable:

BMTN - foot tapping, BMSVZ - jump with a running start, BMSVM - jump from place to place, BMLS - lying seater (abs). The results tell us that these variables are treated through regular programs and additional classes. Taping foot is visible (positive), because it is through regular physical education classes practiced movements of a general nature. Then there is the present football that requires great ability of ball handling, and therefore good segmented brzina. I other sports from the plan and program of regular and of physical and health education are conditioned by the rapid movement of legs. Jump from place to place and from energy to determine the explosive power as sports games from this master's thesis require a lot of jumps and fast movements, and is in line with this and made curriculum. Ups as a factor repetitive strength expressed the simple reason that are ubiquitous in every part of the preparatory time regular classes, but in the final part of the program of additional classes. Based on the numerical values of variables, we can conclude that there has been a change in the final compared to the initial mjerjenje. Program regular and extra classes has a positive impact on segmental speed, explosiveness and repetitive strength.

Table 4. The structure of discriminative function

Function	
	1
BMTN	,590
BMSVZ	,331
BMSVM	,304
BMLS	,216
BMDP	,175
BMS20	-,158
BMSDM	,134
BMSS	,131
BMKT	-,103
BMTR	-,074
BMBMLP	,068
BMSR	,057
BMKS	-,038
BMSM	-,029

Table 5 shows the centroid of the group where we were for one group, it is evident that this group is located in the in the negative part of the discriminant function, which is defined by variables that have a negative impact on the discriminant function. For the second group, it is evident that this group is the positive part of the discriminant function, which is defined by variables that have a positive impact on the discriminant function.

Table 5. Functions at Group Centroids

GROUP	Function
	1
1	-1,305
2	1,305

In a sample of 24 primary school students M. Badrić (2010) examined the impact of programmed training on changes in motor skills involved in the

school sports club. Based on the results of the multivariate analysis of the difference between the Centroids group, it can be determined that the implemented training process for 10 weeks contributed to significant changes in motor skills of students in the experimental group. In the control group showed no statistically significant changes in motor skills. In general, the effects of the conducted training programs contributed to the development of the test motor skills in students. Students who participated in the work of the school sports club, and had a week are 2 x 45 minutes programmed training process, and in addition to attending regular classes physical education from 2 school hours a week, have made significant progress in all motor skills. D.Markuš, J. Markuš (2006) analyzed the quantitative changes under the influence of specially programmed training on changes of some motor skills of gymnastics sections. The results obtained by this are investigations suggest that the training of gymnastics generated significant quantitative changes in multivariate manifest space of motor variables analyzed. Besides its effect on motor skills, programmed kinesiology treatment had a distinct computer component. All members of the gymnastic group had to learn and practice the default gymnastic exercises that were prescribed for the competition. The assumptions in this research that there will be no significant quantitative changes in basic - motor abilities proved justified, and that the program is structured in a way that prevails "traditional" training, which in its content has a large number of runs and the general movement of the ball extremely beneficial for the development of the above abilities. However, if the students continue the qualitative and quantitative progress in the area of performance in sports games, it is inevitable in the training programs and programs in regular classes tender the documents more content to its structure utcati on better understanding the importance of a general, and you and situational motor sports as unbreakable unity and a recipe for success.

## Conclusion

Improving certain segments basic - motor, and execution of training using certain technology represents a scientific and technical problem. Sam research on this problem requires knowledge of planning and programming training programs, able to transform skills trained and age appropriate procedures to persevere in achieving a certain goal. The aim of this research was to be based on a longitudinal study determined the level of quantitative changes in basic - motor, with students aged 12 to 14 years through the regular curriculum and additional classes. With students aged 12-14 years are programmed and implemented training procedures in order to determine the achieved effects. The sample numbered 120 students.

Discriminant analysis (at the multivariate level) in the area of basic - motor abilities, we had a discriminant function which showed high correlation between the two sets of data. Analyzing projections on discriminant function of certain variables basic - motor abilities can be seen that the most important projections are variable: BMTN - fuse foot, BMSVZ - jump with a running start, BMSVM - jump from place to place, BMLS - lying seater (abs). The results suggest that the variables treated through regular programs and additional classes. Foot tapping is evident, since it is through regular physical education classes practiced movements of a general nature. Then there is the present football that requires great ability of ball handling, and thus a good segment

speed and other sports games are characterized by rapid movement of the legs. Sports games require a lot of jumps and fast movements, and is accordingly designed curriculum. Ups as a factor repetitive forces dominate because they are present in the preparation part time regular classes, but in the final part of the program of additional classes. So, on the basis of numerical values in the variables, we can conclude that there has been a positive change in the final compared to the initial measurement, and that the school half-year curriculum of regular and teaching in the first place favorable influence on the explosive power, segment speed and repetitive power of trunk.

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## UTICAJ NASTAVE TJELESNOG I ZDRAVSVENOG ODGOJA SA DODATNIM AKTIVNOSTIMA NA NIVO KVANTITATIVNIH PROMJENA BAZIČNO – MOTORIČKIH SPOSOBNOSTI UČENIKA

### Sažetak

*Genaeralni cilj ovog istraživanja je da se utvrditi nivo kvantitativnih promjena bazično - motoričkih sposobnosti sposobnosti kod učenika pod uticaje nasatve Tjelesnog i zdravstvenog odgoja sa dodatnim aktivnostima. Tretirani uzorak ispitanika su učenici 6.,7. i 8. razreda iz OŠ "Mak Dizdar" u Zenici, uzrasta od 12 do 14 godina koji pored pohađanja redovne nastave tjelesnog i zdravstvenog odgoja (drugo polugodište) dva časa sedmično, uključeni su u polugodišnji programirani rad u dodatnoj nastavi iz četiri sportske igre (košarka, odbojka, nogomet i rukomet). Odabrane varijable u ovom istraživanju hipotetski su pokrile prostore primarne motorike 14 varijabli. U cilju utvrđivanja kvantitativnih promjena korištena je diskriminativna analiza. Diskriminativnom analizom (na multivarijantnom nivou) u prostoru bazično – motoričkih sposobnosti dobili smo jednu diskriminativnu funkciju čime je utvrđena visoka povezanost između dva skupa podataka. Analizirajući projekcije na diskriminativnu funkciju pojedinih varijabli bazično – motoričkih sposobnosti može se vidjeti da najznačajnije projekcije imaju varijable: BMTN – tapin nogom, BMSVZ – skok u vis iz zaleta, BMSVM – skok u vis iz mjesta, BMLS – ležanje sjed (trbušnjaci). Dakle, na osnovu numeričkih vrijednosti primijenjenih varijabli, možemo konstatovati da je došlo do pozitivnih promjena u finalnom u odnosu na inicijalno mjerenje, te da je školski polugodišnji plan i program redovne i dodatne nastave u prvom redu povoljno uticao na eksplozivnu snagu, segmentarnu brzinu i repetitivnu snagu trupa.*

**Ključne riječi:** Diskriminativna analiza, sportske igre, učenici, kvantitet.

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## RELIABILITY OF EUROFIT TEST BATTERY WITH PUPILS FROM KOSOVO AND MONTENEGRO

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*Original scientific paper*

### Abstract

A sample of 200 male pupils at the age of 13 (100 from Kosovo and 100 from Montenegro) was tested through 9 motor tests of EUROFIT test battery. The tests were repeated three time each (they were composed of 3 items). The basic goal of the research is to assess the tests' reliability as a measurement characteristic. The obtained data is processed by the basic statistic parameters: mean, standard deviation, skewness and kurtosis, and reliability is established by three coefficients of reliability: Cronbach  $\alpha$ , Spearman-Brown's coefficient of reliability and inter items coefficient of correlation. The obtained results suggest the conclusion that all of the applied tests demonstrate quite high and satisfactory coefficient of reliability. The conclusion is in favour of applying the test in practice.

**Keywords:** Measure characteristics, motor tests, male pupils, coefficients of reliability.

### Introduction

Reliability is one of the essential measure characteristics of tests. According to Mijanović & Vojvodić (2008; 2010), the term 'reliability' implies accurate measurement, namely without errors. It is clear that objective scientific conclusions are reached through conducting measuring and tests. That involved being equipped with proper measuring tools, which meet the international standard and recognition. That kind of proper measuring tools include the motor tests of EUROFIT programme. Although the mentioned tests are standard and of international application and they demonstrate satisfactory measure characteristics, it is necessary to provide a regular control on their measure characteristics. We believe that the control is particularly recommended when the tests are used for the first time in a given region or different states. That is one of the important reasons to justify the conduct of this research. The subject of the research are 13-year-old male pupils from Kosovo and Montenegro, who are tested by EUROFIT test battery. The research has it as a basic goal to establish the reliability of the EUROFIT test battery applied with 13-years-old male pupils from Kosovo and Montenegro.

### Methods

The research was conducted on 200 male pupils at the age of 13 (100 from Kosovo and 100 from Montenegro). The pupils were tested with Eurofit test battery (Adam, Klissouras, Ravazzolo, Renson, & Tuxworth, 1988): 1. Flamingo Balance test (FLB) - single leg balance test; 2. Plate Tapping (PLT) - tests speed of limb movement; 3. Sit-and-Reach (SAR) - flexibility test (using 15cm at the level of the feet); 4. Standing Broad Jump (SBJ) - measures explosive leg power; 5. Handgrip Test (HGR) - measures static arm strength; 6. Sit-Ups in 30 seconds (SUP) - measures trunk strength; 7. Bent Arm Hang (BAH) - muscular endurance/functional strength; 8. 10 x 5 meter Shuttle Run (SHR) - measures running speed and agility and 9. 20 m endurance shuttle-run (ESR) - cardiorespiratory endurance. Each of the tests was repeated 3 times, namely every repetition was an individual items (particle). Reliability as a measure

characteristics Bala (1990) and Thomas, Nelson, & Silverman (2005) of the tests is established by using the following statistic parameters: arithmetical mean (Mean), standard deviation (Std.Dev.), skewness, kurtosis, Cronbach coefficient of generalizability (Cronbach  $\alpha$ ), Spearman-Brown's coefficient of reliability (SB) and coefficient of inter items correlation (IIC). The results obtained by testing within the studied area were analyzed by statistical package STATISTICA for Windows.

### Results

Table 1. Presents the results of the pupils from Kosovo. The general record is that all of the applied tests provide logical results. That refers to the values of arithmetical means and standard deviations. According to the results obtained for skewness and kurtosis, it is a determined that the tested respondents achieved quite homogeneous results. Neither of the applied tests marks a significant digression (deviation) of the results from the normal distribution. As for the measures of reliability that is expressed by the three coefficients: Cronbach coefficient of generalizability (Cronbach  $\alpha$ ), Spearman-Brown's coefficient of reliability (SB) and coefficient of inter items correlation (IIC), they are very high for all the applied tests, above 0,955 to 0,999. Table 2. Presents the results of the pupils from Montenegro. The general record is that all of the applied tests provide logical results. In relation to arithmetical means and standard deviations, the obtained results are very similar in achievements among the respondents from Kosovo. According to the results obtained for skewness and kurtosis, it is a determined that the tested respondents achieved quite homogeneous results. Neither of the applied tests marks a significant digression (deviation) of the results from the normal distribution. As for the measures of reliability that is expressed by the three coefficients: Cronbach coefficient of generalizability (Cronbach  $\alpha$ ), Spearman-Brown's coefficient of reliability (SB) and coefficient of inter items correlation (IIC), they are very high for all the applied tests, above 0,981 to 0,999. This establishing completely covers with the results obtained from the tests of Kosovo's pupils.



Table 1. Basic statistic parameters and coefficients of reliability with 13-year-old male pupils from Kosovo

Tests	Mean	Std.Dev.	Skewness	Kurtosis	Cronbach $\alpha$	SB	IIC
FLB1	14,77	6,84	-0,23	-0,49	0,992	0,992	0,977
FLB2	14,82	7,00	-0,18	-0,40			
FLB3	14,97	7,13	-0,21	-0,56			
PLT1	10,55	1,61	0,79	1,23	0,997	0,997	0,991
PLT2	10,57	1,64	0,84	1,40			
PLT3	10,56	1,62	0,83	1,32			
SAR1	23,29	6,70	0,04	-0,51	0,995	0,995	0,986
SAR2	22,58	6,62	0,05	-0,45			
SAR3	22,81	6,72	0,13	-0,43			
SBJ1	155,71	25,26	0,09	-0,10	0,994	0,995	0,984
SBJ2	155,34	26,16	0,04	-0,42			
SBJ3	155,82	25,86	0,11	-0,39			
HGR1	26,89	7,29	0,51	0,44	0,994	0,994	0,985
HGR2	26,41	7,20	0,66	0,68			
HGR3	26,88	7,21	0,50	0,38			
SUP1	17,16	3,53	-0,35	0,21	0,984	0,984	0,955
SUP2	17,24	3,50	-0,29	0,01			
SUP3	17,24	3,62	-0,35	0,18			
BAH1	22,52	20,55	1,42	3,15	0,999	0,999	0,997
BAH2	21,94	19,93	1,40	3,01			
BAH3	22,00	20,13	1,44	3,24			
SHR1	19,82	1,49	0,35	-0,19	0,997	0,997	0,993
SHR2	19,90	1,51	0,37	-0,20			
SHR3	19,80	1,52	0,38	-0,23			
ESR1	4,64	1,79	0,73	-0,15	0,999	0,999	0,996
ESR2	4,64	1,81	0,73	-0,22			
ESR3	4,66	1,79	0,68	-0,23			

Legend: FLB - Flamingo Balance test, PLT - Plate Tapping, SAR - Sit-and-Reach, SBJ - Standing Broad Jump, HGT - Handgrip Test, SUP - Sit-Ups in 30 seconds, BAH - Bent Arm Hang, SHR - 10 x 5 meter Shuttle Run and ESR - 20 m endurance shuttle-run. "1", "2" or "3" are items ("1" are first item etc.). Mean - arithmetical mean, Std.Dev. - standard deviation, skewness, kurtosis, Cronbach  $\alpha$  - are coefficient of generalizability, SB - Spearman-Brown's coefficient of reliability, IIC - inter items correlation.

Table 2. Basic statistic parameters and coefficients of reliability with 13-year-old male pupils from Montenegro

Tests	Mean	Std.Dev.	Skewness	Kurtosis	Cronbach $\alpha$	SB	IIC
FLB1	12,90	5,50	-0,26	0,30	0,996	0,996	0,989
FLB2	14,16	5,53	-0,39	0,92			
FLB3	13,88	5,64	-0,37	0,47			
PLT1	11,45	2,23	2,84	11,82	0,999	0,999	0,998
PLT2	11,63	2,23	2,83	11,74			
PLT3	11,63	2,24	2,85	12,00			
SAR1	23,20	6,97	0,66	0,85	0,995	0,995	0,984
SAR2	22,03	6,92	0,77	1,24			
SAR3	22,53	6,89	0,74	0,78			
SBJ1	144,87	22,24	0,21	-0,30	0,993	0,993	0,981
SBJ2	137,40	21,81	0,29	-0,11			
SBJ3	137,67	22,56	0,20	-0,45			
HGR1	25,48	5,81	0,37	0,32	0,996	0,996	0,990
HGR2	24,30	5,92	0,41	0,27			
HGR3	24,32	5,81	0,30	0,08			
SUP1	18,75	5,02	-0,28	-0,81	0,995	0,995	0,987
SUP2	17,61	4,91	-0,25	-0,80			
SUP3	17,79	4,81	-0,27	-0,73			
BAH1	26,17	22,40	1,31	2,04	0,999	0,999	0,999
BAH2	25,84	22,12	1,25	1,60			
BAH3	25,77	21,86	1,16	1,11			
SHR1	20,74	2,39	0,66	-0,31	0,999	0,999	0,996
SHR2	20,56	2,40	0,62	-0,33			
SHR3	20,74	2,40	0,62	-0,38			
ESR1	5,59	1,51	0,35	0,38	0,994	0,995	0,985
ESR2	5,60	1,57	0,22	0,08			
ESR3	5,70	1,62	0,17	0,31			

Legend: FLB - Flamingo Balance test, PLT - Plate Tapping, SAR - Sit-and-Reach, SBJ - Standing Broad Jump, HGT - Handgrip Test, SUP - Sit-Ups in 30 seconds, BAH - Bent Arm Hang, SHR - 10 x 5 meter Shuttle Run and ESR - 20 m endurance shuttle-run. "1", "2" or "3" are items ("1" are first item etc.). Mean - arithmetical mean, Std.Dev. - standard deviation, skewness, kurtosis, Cronbach  $\alpha$  - are coefficient of generalizability, SB - Spearman-Brown's coefficient of reliability, IIC - inter items correlation.

## Discussion and Conclusion

Establishing the measure characteristics of the measure instruments (tests) which include motor tests as well, are goals of research with more than one author. Among them are: Metikoš, Prot, Hofman, Pintar and Oreb (1989); Cvenić (2007); Čuljak, Čorluka and Čavar (2009); Stanković, Joksimović, Raković, Michailov and Piršl (2009); Foretić, Rogulj and Čavala (2010); Mijanović and Vojvodić (2010). As well, the literature within the scope of kinesiology lists a significant number of researches that deal with the problem of reliability as a measure characteristic of motor tests. In that direction we should mention the researches of: Jennings, Viljoen, Duran and Lambert (2005); Begatović, Čuk and Atiković (2010); Bubanj, S., Stanković, Bubanj, R., Bojić, Đinđić and Dimić (2010). On the base of the listed pointS, we can say that measure characteristics of

the motor tests (measure instruments) present an object of research that remains actual. Having into consideration all of the discussed points, we assume that they are in support for the research realization. On the ground of the obtained results, the following conclusions are drawn:

1. All of the applied motor tests of EUROFIT test battery are established to have high and satisfying measure characteristics. Above all, the point is in direction to the coefficients of reliability with the pupils from Kosovo and Montenegro.
2. With reference to the applied tests, they are established to be an easy task to perform for the pupils from Kosovo and Montenegro. Considering their practical application, economic effect and the objective results of the measurement, they prove to be a reliable criterion for assessing the motoric status of the pupil from both the states.

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## POUZDANOST EUROFIT TEST BATERIJE PRIMJENJENU S UČENICIMA IZ KOSOVA I CRNE GORE

### Sažetak

*Uzorak od 200 učenika muškog spola u dobi od 13 godina (100 iz Kosova i 100 iz Crne Gore) je testiran kroz 9 motoričkih testova EUROFIT baterijom. Testovi su ponavljani svaki od njih po tri puta (bili su kompozitnog tipa i sastojali se iz 3 ajtema). Osnovni cilj istraživanja je procijeniti pouzdanost testova kao njihova mjerna karakteristika. Dobiveni podaci obrađeni su bazičnim statističkim parametrima: srednja vrijednost, standardna devijacija, asimetričnost i Kurtosis, dok pouzdanost je procijenjena na osnovu tri koeficijente: pouzdanosti tipa Cronbach  $\alpha$ , Spearman-Brownovim koeficijentom pouzdanosti i koeficijentom inter-korelacije. Dobiveni rezultati upućuju na zaključak da su svi primijenjeni testovi prilično visokim i zadovoljavajućim koeficijentima pouzdanosti. Zaključak je u korist primjenljivosti testova u praksi.*

**Ključne riječi:** Metrijske karakteristike, motoričke testove, učenici muškog spola, koeficijenti pouzdanosti.

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## EFFICIENCY OF INTERACTIVE TRAINING OF PERSONNEL FOR IMPLEMENTATION OF NEW MODELS OF SPORTS-EDUCATION IN THE EDUCATIONAL PROCESS OF CHILDREN

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*Original scientific paper*

### Abstract

The aim of research was analyzing of the practical aspects of application of skilled pedagogical practice in the proces of education of kinesiologists to be through interactive work with children of elementary school age. The research had been conducted on a sample comprising of 60 examinees of both sexes (students of master study in the field of kinesiology) who had carried out during their pedagogical practice the programme of education of non-swimmers for 2.000 children. The results of t-test showed a high level of statistical significance for variables of total students' evaluation within their pedagogical practice work ( $p < .001$ ), as well as swimming across lap independently for children ( $p < .001$ ). Percentage analyses of estimation of individual variables shows that the programme of education has been significantly influenced the level of motivation and communication during the work, noticing and fast reaction in various situations, organization of tuition as well as developing of cooperation between examinee (student) and children. The analyses of poll on impressions according to activities examinees had been included, shows as follows: 90,4% consider the tuition programme being well organized; 93,6 % consider such tuition manner has improved their experience, and 90,4% consider that both attitude and experience of the mentor in organization and carrying out the pedagogical practice work completely fulfilled their expectations. On the basis of results it can be concluded that applied programme of practical tuition of students of kinesiology showed efficient coordination of all segments whatsoever. This is the way skilled personell to be prepared to carry out all activities directed to systematic learning of the swimming elements within the frame of regular educational system of the elementary school children.

**Keywords:** Kinesiology, learning of motoric knowledges, skilled practice, education.

### Introduction

Number of classes of Physical education per week varies from country to another. Some countries from EU determine minimal number of these classes, meanwhile some countries allow schools to make such decision. For example, in school year 2011/2012 recommended minimum of such way of education in elementary schools ranged between 37 as in Ireland and 108 as in France (EACEA, 2013). According to series of up-to-date researches (Rađo, 2000; Marius, 2009; Kondrić and ass, 2002; Marić, et al. 2013), the additional physical activity increases positive effects of body development, motoric skills with children. One of such processes was introducing Bolognese system at high education as well as those where future personell for realization of physical education programme are educated (Edginton, et al. 2011). It is reality to expect that in future the weekly number of classes of Physical education would be increased for children at elementary school, and a part of classes would be dedicated for non-swimmers training altogether as a part of advanced models of education of children in Bosnia and Herzegovina. The ultimate goal of non-swimmers training at elementary school would be a creation of correct motoric stereotype in the field of swimming and movement in water, till the end of elementary school education (Franki, 1996; Grčić-Zubčević, 1997). There is a question arising whether this could be practically applied without enough skilled personell who would implement such teaching model. It is well known as kinesiology is comprehensive science about movement – training, that predominantly explores the patterns of governing of training in physical and medical

culture, sports, sport recreation and kinesiotherapy and examine the impact of such processes uponn the changes in human body (Marrow, et al. 2005; Cools, et al. 2008). However, it is often the case that students of kinesiological faculties get only theoretical knowledges about metodology of non-swimmers' training that is not sufficient for them to be able to transfere such motoric knowledge on their students after completing their studies. When these facts are taken into consideration, it is to conclude that adequate skilled personell is in fact the basic foundation of kinesiology development and its applied fields (Findak, et al. 2008). Academic success is important concept that impacts the lives of young people. When a complete education is adequately supported, their cognitive and psycho-social development will increase that leads to a success in professional orientation (Keskin, et al. 2009). The education and training of teachers covers various programmes of education from narrow fields of pedagogy, psychology, methodology, sociology, communicology (Danilović, 2010). That way, the aim of kinesiological education is to train the students how to transfere some motoric knowledge to other persons. In order that aim to be carried out, the curriculum has to be directed to encourage the student's maximal potentials, to enhance his self-confidence, skills, interests and possibilities as well as to creation of positive image about himself (Sekulić-Majurec, 2007). The interactive education of students compensates a set of disadvantages of traditional teaching. It is about learning within social interaction where basic klowledge and experience transfer is made by direct contact contrary to individual learning where interaction is primarily made by the mean of student-teaching

material or student-media. Considering the fact that high level of sports' science, sport education, school and management technology directly conditioned by human resources in sport management (Malacko, 2008), the aim of this research has been analyzing of the aspects and efficiency of application of skilled pedagogical practice in the frame of education of kinesiologists to be through interactive work with children of elementary school age.

## Methods

### Description of research

The sample of students consisted of 60 students of master study level (Physical education - Kinesiology faculties FASTO Sarajevo, B&H) who had carried out during their pedagogical practice the training program with 2.000 children non-swimmers from elementary schools. The examinees had no any previous knowledge in practical conduct of non-swimmers training. Prior to start of the training all examinees were provided by curriculum from their mentor in order to carry out teaching units with children having full freedom of employing their creative ideas (games and work outs). Before, during and after each class the examinees had direct communication at their disposal, consulting and coordination with their mentors. Practical part lasted for two weeks (interactive model of working: mentor-student-pupils), and individually under supervision of the mentor. They have been working with groups of 8 to 10 children, every working day for 60 minutes. The programme of swimming school in gently sloped pool of 40-100 cm depth, with average temperature of 29,4 C. Evaluation of the examinees, level and quality of transferring of new skills to children was monitored by skilled team / mentors/ by the method of expert evaluation according to criteria prepared in advance (table 1) and on that basis a final grade has been defined ranging from 1 to 5.

Table 1. Sample of variables for examinee evaluation during teaching (Hadžikadunić, 2000)

Variable	Evaluation of activity realization
COM - Communication	Efficient. Good. Bad
ATT - Attitude	Efficient. Good. Bad
PRE - Prompt reaction	Efficient. Good. Bad
SOB - Situation observing	Efficient. Good. Bad
TCO - Task control	Efficient. Good. Bad
TMT - Teaching methods	Efficient. Good. Bad
COR - Class organization	Efficient. Good. Bad
TAI - Teaching aids	Efficient. Good. Bad
RPT - Relation pupil-teacher	Efficient. Good. Bad
WCP - Written class plan	Efficient. Good. Bad
TGR - Total grade	Excellent(5), Very good(4), Good(3), Sufficient (2); Insufficient (1)

The poll consisted of three questions with multiple choices:

- How do you perceive the programme of interactive teaching within pedagogical practice: non-swimmers training?
- How did pedagogical practice impact your professional experience?
- How much the attitude and experience of the mentor in pedagogical practice has fulfilled your expectations?

### Methods of data processing

Data collected on the effects of the programme of skilled pedagogical practical teaching upon the examinees (initially –finally) had been obtained by the method of expert evaluation as well as by analyzing by t-tests and by percent statistics also. For the purpose of evaluation of examinees' attitude a five degree scale had been used in which there were the answers offered to questions. Comparing of the results on efficiency of applied model of teaching swimming for children has been obtained by measuring variable denoting independently swam off lap expressed in meters (initially –finally). For the analyzes of these results, t-test was used for subordinate samples (differences are significant at  $p < .050$ ).

## Results

The t-test results (table 2) show high level of statistical significance for variable of total mark on student's work in the frame of skilled pedagogical practice ( $p < .001$ ). In relation to initial evaluation, the examinees had shown a significant progress at practical work and application of adequate methodological principles for school of swimming. Mean score (table 3) on examinees' work on final evaluation was 4.6.

Table 2. Results of t-test for the evaluation of examinee's working quality (students) at skilled pedagogical practice

	Paired Differences				t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference			
				Lower	Upper		
INIT - FINAL	-1.950	.699	.090	-2.130	-1.769	-21.6	.000

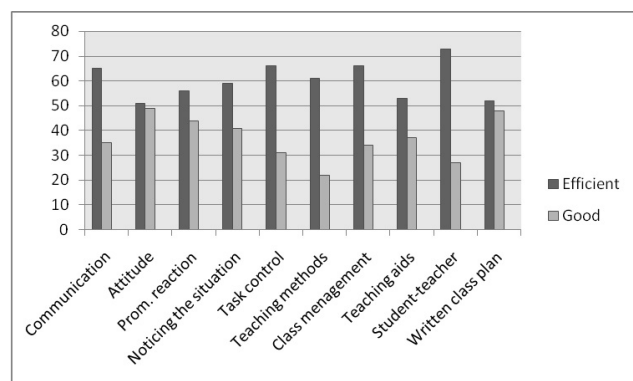
Table 3. Descriptive statistics of evaluation of examinee (students) initially-finally

	Mean	N	Std. Deviation	Std. Error Mean
INIT.	2.65	60	.75521	.09750
FINAL	4.60	60	.64309	.08302



The analyzing of the evaluation of some variables (chart 1) shows that application of interactive method of training has significantly influenced the level of motivation and communication during the work, noticing and speed of reaction in situations, teaching organization as well as developing the cooperation between examinee(student) and children.

Chart 1. Percentage lay out of individual variables analyses - final



Taking into consideration that mutual thinking about practice includes both students and mentors and equally gives the possibility to all participants to take over responsibility for state of condition in their work (Šagud, 2006). Following the research, the analyses of effects of training on children that participated in swimming training.

Table 4. Result sof T-test for independent swam off laps for children participating in the programme

	Mean	Std. Dv.	N	Diff.	Diff.	t	df	p
1. Class	3.3	6.5						
12. Class	26.8	15.1	2000	-20.63	13.05	-16.26	1999	.000

The t-test results (table 4) show high level of statistical significance for variable of independent swimming off the lap ( $p < .001$ ). This data shows that examinees have successfully applied new practical skills of tranfering motoric knowledge on children (moving in water) that resulted as the children were able to swim off independently at final testing cca 26.8 meters. The poll analyses on impressions according to activities examinees have been included in, show as follows: 90,4% consider as the teaching programme is organized very well (chart2); 93,8% consider that such way of teaching has improved their experience (chart 3), but 91 % consider that mentor's both attitude and experience in organization and realization of pedagogical practice totally fulfilled their expectations (chart 4).

Chart 2. How do you perceive the interactive training programme during pedagogical practice?

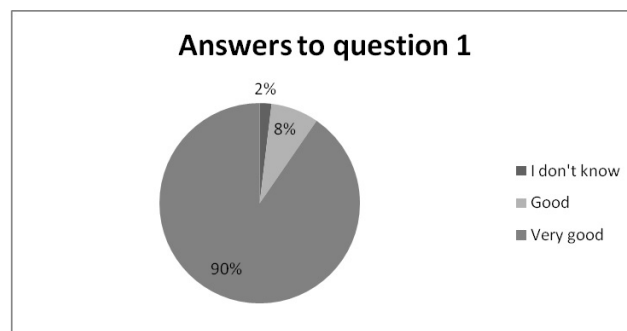


Chart 3. How did pedagogical practice of non-swimmers training influenced your skilled experience?

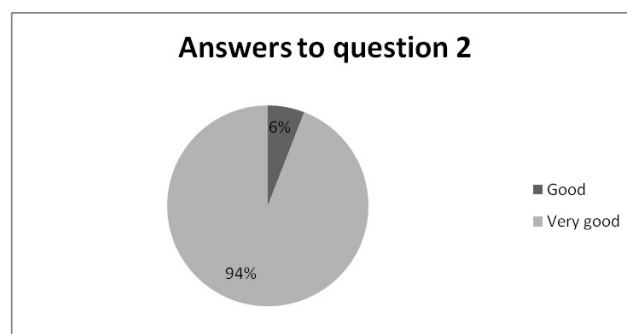
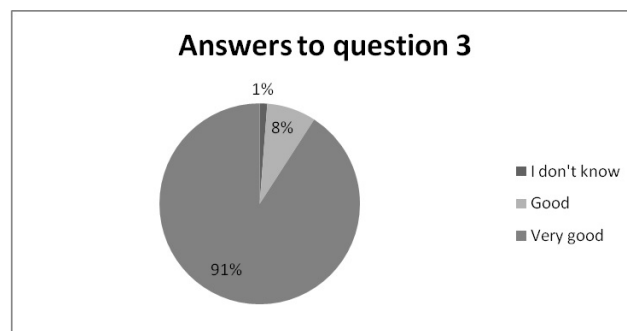


Chart 4. How much did the mentor's attitude and experience in pedagogical practice fulfilled your expectations?



## Discussion

As it could be seen from the researc results, practical working with children during educational process of teachers to-be (kinesiologists), is an efficient mean throught the application of interactive training. In this way, students have been taught how to synhronize attitudes, mutual actions, as well as how to apply an adequate communication by which gathered knowledge and practical experience are spontaneously implemented. It is inevitable that during such way of teaching students are faced with some problems they try to solve immediately. The most of them are related to adjusting a communication and coordination with the mentor and other participants in programme, problems and adjusting the dialogue between student (educator) and children, as well as independent solving of problems in practical work. During the interactive training they were able to learn from their own experience that of course, does not depend solely on level of their foreknowledge, but also of a context in which such learning takes place. This is just to



confirm the notices from the authors of similar reseraches (Nikčević-Milković, 2004; Popović, 2007), that high school training that is preparing future teachers predominantly has to transform from monologue one which is still dominant, into dialogue one, social process with participating of all persons responsible for the quality of educational process. It is of great importance to mention that in such processes these models of pedagogical practice are very important ones, and it confirms the highlight points of other studies dealing with similar topics (Buchberger, et al. 2001; Valenčić-Zuljan, et al. 2012) where it is stated that practical training sharpens perception, acting lively so foreknowledge are activated, reconstruct and become more clear ones. Data resulted from the analyses of results on how much children had progressed in grasping new motoric knowledges show that interactive pedagogical practice enabled students to transfere new movement skills successfully that is very good bases for future programmes in this field. It is necessary to point out that in overall process, mentors have without fail important role that has been stated in other reseraches (Herzog, et al. 2012). In interpersonal communication, mentors should apply acts that motivate students to be successful ones. It is confirmed from the results of other studies (Gundogdu, et al. 2015) where it is pointed out a necessity of recognizing the level of dedication of students during the teaching process and extending full support by their teachers. Poll results has shown that examinees (students) support such way of teaching that means as Bologne reform intensifies in transformation and improvement of practical programmes of students' education. It is also stated in some other studies on interactive

training (Suzić, 2002) where it is said that social action where education is organized and spontaneous one as final result has relatively permanent changes in thinking, emotions and behaviour. It is all about an open, dynamic and permanent process that understands transfer of new knowledge from various professional fields and science areas into a world of practice (Stipić, et al. 2010) as well as following the European trends in regard teaching quality to be improved. This confirms previous states (Jukić, et al. 2010) that such and similar teaching models (all together with other activities of kinesiological faculties), to be directed to leveling the quality of teaching by application of new technologies of interactive training and continuous observing and evaluating the efficiency of teaching process.

## Conclusion

On the bases of results collected, it is possible to conclude that applied model of interactive training of students within sport-educational programme had shown the efficient coordination of all segments. Rising the level of knowledge and skilled education of sports pedagogues and physical education (kinesiologists) implicates permanent acquiring of new skills that efficiently leads to increasing of capability of realization of all activities within the sport-educational teaching. This way, skilled personell can be successfully prepared to be ready in future to carry out activities directed to systematic learning of basic elements of swimming during regular educational system of children at elementary schools.

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## EFIKASNOST INTERAKTIVNOG PODUČAVANJA KADROVA ZA IMPLEMENTACIJU NOVIH MODELA SPORTSKE EDUKACIJE U OBRAZOVNOM PROCESU DJECE

### Sažetak

*Imajući u vidu da je visoki nivo sportske nauke, sportske edukacije, trenažne i upravljačke tehnologije direktno uslovljen ljudskim resursima u sportskom menadžmentu (Malacko, 2008), cilj ovoga istraživanja bilo je analiziranje efikasnosti interaktivnog podučavanja studenata Fakulteta sporta i tjelesnog odgoja za implementaciju novih modela sportske edukacije u obrazovnom procesu djece. Uzorak ispitanika činilo je 60 studenata master studija FASTO koji su u okviru pedagoške prakse realizirali program obuke 2000 djece neplivača iz osnovnih škola u Kantonu Sarajevo. Evoluaciju ispitanika, nivo i kvalitetu prenošenja novih motoričkih znanja na djecu, vršio je stručni tim (mentori) metodom ekspertne procjene prema unaprijed zadatim kriterijima. Podaci o efektima programa nastave dobijeni su mjerenjem istih varijabli u dvije vremenske tačke. Za analizu rezultata korišten je T-test za zavisne uzorke, kao i procentualna analiza. Također, za procjenu stavova ispitanika korištena je peterostepena skala u kojoj su dati odgovor na ponuđena pitanja, koja je prikazana procentualnom statistikom.*

**Ključne riječi:** Kineziologija, učenje motoričkih radnji, praktična nastava, proces edukacije.

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## EFFECTS OF 10-WEEKS ADDITIONAL PROPRIOCEPTIVE TRAINING ON BALANCE AND JOINTS FUNCTIONAL STABILITY OF YOUNG SPRINTERS

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*Original scientific paper*

### Abstract

*The aim of this research is to determine efficiency of 10-week additional proprioceptive training on balance and joints functional stability of young sprinters. Presented program is constructed as an addition to regular training in athletic sprint. Sample subjects of this research were 10 young sprinters aged from 13 to 17. Biodex Balance System and variables: Over Stability Index (OSI), Anterior/Posterior Stability Index (APSI) i Medial/Lateral Stability Index (MLSI) were used for assessment of efficiency and balance of functional stability of joints. Proprioceptive program was performed at the beginning of training. T test (Paired Samples Test) showed statistically significant differences in all three variables ( $p < .01$ ). It can be concluded that additional proprioceptive training constructed as an addition to regular athletic sprint training contributes to the balance and functional stability of joints of lower limbs. Also with this training is possible to improve coordination and precision of movements, speed of reflexes and dynamics of joints. It is also recommended that proprioceptive training is used at the beginning of training (after warm-up) and during the process of sport preparation.*

**Keywords:** Effects, proprioceptive training, balance and stability, young sprinters.

### Introduction

An athlete with constructed level of balance is able to maintain the control and stable position of body during static and dynamic activities. Good balance enables body position to change according to gravity (Malacko & Rađo, 2004). Balance and functional stability of joints helps sprinter to reach better start acceleration, maximum velocity during running, and stopping after the runs. Maintaining balance is difficult due to air resistance, friction and gravity and other external factors. Retert (2010) notes that ability of overcoming these external factors is called stability. Proprioceptive receptors have a task to transmit the information of joints position to central nervous system, which enables balance and movements control. In order to gain efficient control of muscles-joints system it is important for the nervous system to get continuous information of muscles and joints and their condition (Guyton, 1995). In order to develop balance and efficient motor control it is necessary to have continuous flow of information of sensor of movements. There are two levels of proprioceptive system: conscious-intentional and subconscious-reflexive level. Proprioceptive system on a conscious level enables regular function of locomotors system during sport activities and motor movement in general, and on subconscious level it reflects tonus, balance and stabilization of joints. Positive effects of additional proprioceptive training on the balance of the body and joints functional stability of lower limbs have been determined by many authors (Ben Moussa Zouita et al, 2013; Romero-Franco et al, 2013. i 2012; Kazazović et al, 2008; Šebić et al, 2007; Vrcić et al, 2007). Proprioceptive training affects reduction of injuries of athletes (Elis & Rosenbaum, 2001). It is considered that reflexes that are activated in proprioceptive training can quickly activate muscle stabilizers and therefore prevent injuries. In fact, conscious movements are slow to prevent injuries in urgent situations. Proprioceptive training has a good effect on subjects with unstable joints, after

rehabilitation treatment of injuries of sprained ankles. Also, this training can increase athlete's performance (Karakaya and all, 2015; Faizullin, I, & Faizullina, E., 2015). The aim of this research is to determine efficiency and quality of additional proprioceptive training on a level of balance and joints functional stability of young sprint athletes. Also this research should offer additional scientific knowledge of the effects of proprioceptive training.

### Methods

#### Sample subjects

Sample subjects of this research were 10 young male sprinters aged from 13 to 17, members of Athletics club "Sarajevo" of Sarajevo (Bosnia and Herzegovina). All sample subjects were clinically healthy.

#### Measurement procedure

Biodex Balance System is used for assessment of stability. Index of stability was an indicator of balance, in which ability of maintaining balance of body position is manifested. The following variables: Over Stability Index (OSI), Anterior/Posterior Stability Index (APSI), Medial/Lateral Stability Index (MLSI) were used in this research. Testing was conducted on the Institute of sport of Faculty of sport and physical education of University of Sarajevo (Bosnia and Herzegovina).

#### Characteristics of additional proprioceptive training

This additional training was performed within 10 weeks period, during which 30 trainings were performed (3 trainings per week). Proprioceptive training was performed during the first part of athletic sprint training. At the beginning of training young sprinters made a low intensity warm up running for 10 minutes. After warm-up typical proprioceptive exercises were performed in duration

of 20 minutes. Exercises were performed on stable and unstable pads, which included both simple and complex exercises. Also unilateral and bilateral exercises and exercises with open and closed eyes were performed. Athletes performed specific running exercises which included balance requirements.

Table 1. Level of pressure of proprioceptive training (according to Marković & Bradić, 2010).

Type of training	Number of exercises	Number of series of one exercise	Duration of a series (sec)	Duration of break between series (sec)	Break between exercises (sec)
Static training	2-3	2-3	30-40	20-40	90-120
Dynamic training	2-3	2-3	10-30	20-40	90-120

Table 2. Description of proprioceptive exercises

1)	proprioceptive exercises on a rope
2)	proprioceptive exercises on balance board (back and forth and left and right movements)
3)	proprioceptive exercises on semi balls and balls
4)	proprioceptive exercises on a special balance pad
5)	imitation of running with keeping balance of the body through specific exercises of running

### Statistic analysis

Descriptive Statistic was used for assessment of central and disperses parameters. Paired Samples Test (t test) was used for determination of differences of arithmetic means of initial and final measurement.

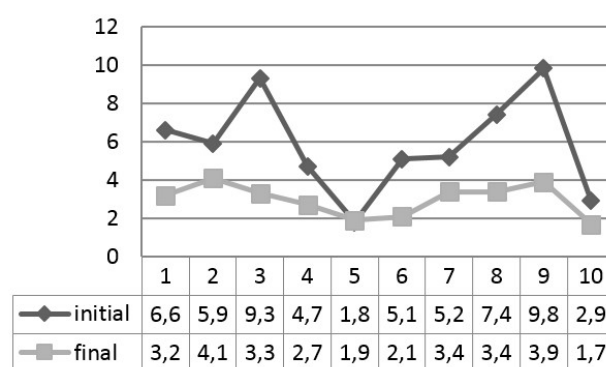
### Results and discussion

Results show lower arithmetic means in final measurement (table 3). Lower means are referred to better means. Results of t test (Paired Samples Test) show the highest level of statistically significant differences in treated variables ( $p < .01$ ).

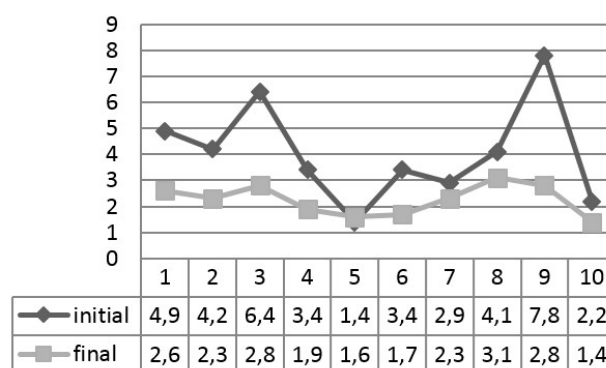
Table 3. Descriptive Statistic

Initial testing of stability index					
Variable	N	Min.	Max.	Mean	Std. Dev.
OSII	10	1.8	9.8	5.870	2.5360
APSII	10	1.4	7.8	4.070	1.9131
MLSII	10	1.3	6.9	4.340	1.7939
Final testing of stability index					
Variable	N	Min.	Max.	Mean	Std. Dev.
OSIF	10	1.7	4.1	2.970	.8341
APSIF	10	1.4	3.1	2.250	.5798
MLSIF	10	1.2	3.6	2.150	.7502

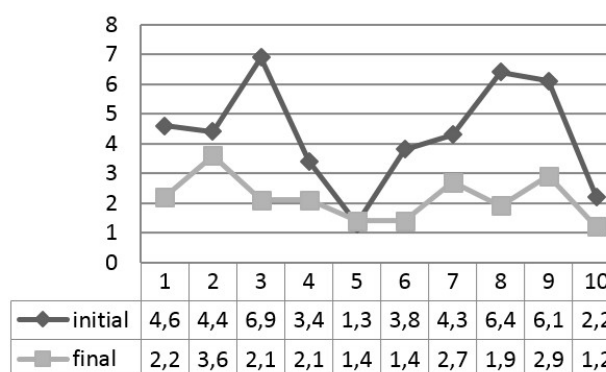
Graph 1. Individual Values of Over Stability Index



Graph 2. Individual Values of Anterior/Posterior Stability Index



Graph 3. Individual Values of Medial/Lateral Stability Index





*Table 4. Differences in values of stability index variables - Paired Samples Test*

		<b>t</b>	<b>df</b>	<b>Sig.</b>
Pair 1	OSII - OSIF	4.63	9	.001
Pair 2	APSII - APSIF	3.77	9	.004
Pair 3	MLSII - MLSIF	4.33	9	.002

It can be stated (with certainty of 99%) that presented program of additional proprioceptive training with chosen exercises, pressure and methods of training, affected improvement of balance and functional stability of joints of young sprinters. The most important role of proprioceptive training is positive effects on systems of balance and functional stability of joints. This training can affect nervous system and muscles by transmitting information from peripheral parts of nervous system. This information enable maintenance of body stability and orientation during static and dynamic activities which is referred to immediate activation or inhibition of certain muscles in relation to the influence of external factors (Hoffman & Payne, 1995). It is possible that effective transmittance of sensor of joint position and quick response of muscle stabilizers, is a consequence of combination of additional proprioceptive and athletic sprint training. Proprioceptive training can be based on exercises which are similar to the ones that are dominant in competition activities of a sprinter or they are the base for acquiring some other motor abilities. Each exercise has the goal of maintaining balance position by regulation of muscle tonus based on information from different sensor systems. Sensors that transmit the information of locomotors control are visual sensor system that transmits the information of surrounding area; vestibular system (balance organ) which transmits information of position and acceleration of head in relation to surrounding area; proprioceptive system that transmits information of position and speed of extension in joints; muscle pressure by sensors that are located on skin, joints, cartilage, aponeurosis and muscles; and auditory system which transmits relevant sound information (Gemser et al, 1999). Each proprioceptive exercise needs to have its specific influence on balance and functional stability of joints. The advantage of proprioception is that it is transmitted on all levels of central nervous system (Riemann & Lephart, 2002). Effects of proprioceptive training include quality feeling of position and movement of joints. The result of this is the improvement of the whole body. Effects of proprioceptive training on a level of central nervous system are also shown in quick increase of strength of intentional muscle contraction. Effects of proprioceptive training on peripheral level are shown in better functions of reflex. This entails effective intramuscular coordination of muscles of agonists and antagonists and better functional stability of joints by muscle stabilizers. It is important to emphasize that accident movements occur when maintaining vertical position of the body. Nervous system regulates muscle tonus which is responsible for coordination of effectors with the goal of quick correction of the whole body or certain segment of body. It is important to stress that an athlete has the most stabile support when he spreads his feet a bit wider than his shoulder width. However this position is not possible during the competition

(Retert, 2010). By controlling movements within support base (centre of feet), an athlete can safely and efficiently perform motor abilities in specific situations. Hammami et al (2014) state that rugby players have higher level of static balance in relation to athletic sprinters and jumpers. When comparing athletic sprinters and jumpers, results didn't show any significant differences. This phenomenon can be explained by the fact that rugby is the game based on different situations of unexpected and unstable conditions (change of direction of movements, stopping and contacts with opponent players). Quick positioning of the body in stabile position and correction of the body after instability is performed by regulation of intensive contraction of muscle groups which maintain projection of centre of gravity of the body above the surface of the support. Still, it cannot be stated with a certainty that positive effects of proprioceptive training are exclusively result of the presented program. During this proprioceptive program, regular training of sprinter is performed in which there is a combination of different specific exercises of sprint, exercises with resistance and exercises of coordination, frequency and explosive strength. All these exercises, which are included in regular athletic sprint training, can contribute to positive changes.

### Conclusion

Presented program of proprioceptive training is combined as an addition to the regular athletic sprint training and contributes to the balance and joints functional stability of lower limbs. With this additional proprioceptive program it is possible to improve level of coordination and precision of movements, increase speed of reflex and improve dynamic characteristics of joint. The improvements of the mentioned abilities can contribute to better performance of specific movements in sprint running. Also, this type of training can be used in rehabilitation of athletes after suffering injuries. Significance of this paper is shown in confirmed knowledge of positive effects of proprioceptive training on a level of balance and joints functional stability of lower limbs. Optimal activities for development of balance and functional stability of joints are the ones created according to structural, biomechanical and functional analysis of a certain sport. In this research it is difficult to conclude whether the maximum of this program is achieved because the intense growth and development of adolescents can disturb coordination and balance abilities. The description of proprioceptive exercises and the way of determining intensity and pressure can be useful for trainers and kinesiology therapists in sport practice. Modifying exercises of treated program can be performed not only by athletic sprinters but other athletes that participate in competitions of other sports. Proprioceptive exercises can be used at the beginning of the training. Proprioceptive exercises and level of pressure need to be adjusted to personal level of training of an athlete and his needs. This type of training needs to be part of regular condition preparation of athletes. Still, the most important task is the positive effects of proprioceptive training integrate into specific structures of movements of a certain sport. The flaw of this research is the lack of experimental group, which would solve treated problem. It would be interesting, in future, to examine effects of combined proprioceptive training and flexibility at the beginning of the training.



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## EFEKTI 10-SEDMIČNOG DODATNOG PROPRIOCEPTIVNOG TRENINGA NA RAVNOTEŽU I FUNKCIONALNU STABILNOST ZGLOBOVA MLADIH SPINTERA

### Sažetak

*Cilj ovog istraživanja je bio utvrđivanje efikasnosti realiziranog 10-sedmičnog proprioceptivnog treninga na nivo ravnoteže i funkcionalne stabilnosti zglobova mladih sprintera. Prezentirani program je kombinovan kao dodatak redovnom atletskom treningu sprintera. Uzorak ispitanika je činilo 10 mladih atletičara starosti 13-17 godina. Za procjenu ravnoteže i funkcionalne stabilnosti zglobova se koristio Biodex Balance System, odnosno varijable: Over Stability Index (OSI), Anterior/Posterior Stability Index (APSI) i Medial/Lateral Stability Index (MLSI). Proprioceptivni program se izvodio u početnoj fazi treninga. Primjenom t testa (Paired Samples Test) su ustanovljene statistički značajne razlike u sve tri varijable ( $p < .01$ ). Može se zaključiti da dodatni proprioceptivni trening kombinovan kao dodatak redovnom atletskom treningu doprinosi ravnoteži i funkcionalnoj stabilnosti zglobova donjih eksteremiteta. Također ovim treningom je vjerovatno moguće unaprijediti nivo koordinacije i preciznosti pokreta, uvećati brzinu refleksa, te unaprijediti dinamička svojstva zglobova. Preporučuje se da se proprioceptivni trening koristi u početnoj fazi treninga, nakon faze zagrijavanja, kontinuirano tokom procesa sportske pripreme.*

**Ključne riječi:** Efekti, proprioceptivni trening, ravnoteža i stabilnost, mladi sportisti.

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## THE CONCENTRIC AND ECCENTRIC STRENGTH OF SHOULDER EXTERNAL AND INTERNAL ROTATORS IN HANDBALL

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*Scientific review paper*

### Abstract

The angular velocities during ball throw are extremely high and whole ball throw in handball can be described as open kinetic chain action. The ball throw in handball follows a common proximal to distal principle with the movement initiation in the hip and torso rotation. The kinetic energy is then transferred to shoulder complex and elbow and movement ends in the wrist. To perform well and to achieve high ball velocities the muscle strength (and power) as well as intermuscle co-ordination of shoulder complex is of crucial importance as well as the good concentric-eccentric coupling. Differences in IR and ER strength ratios appear to be related to injury in almost all players whose sports involve overhead throwing activities, such as baseball, water polo, tennis, handball, and volleyball. We have searched a Pubmed archive in November 2015 using a search "isokinetic and shoulder and handball" in order to identify studies of interest. Additional filter for English language was also used. The studies of interest were published in the period 1996-2015. For the purposes of further analysis we have collected a full texts of all studies to thoroughly review the testing procedures used for the assessment of shoulder external and internal rotators strength.

**Keywords:** Shoulder strength, concentric and eccentric contraction, handball.

### Introduction

Handball is a high intensity sport with frequent and allowed contact among the players. Due to numerous overhead activities in relation to ball throw and some defensive activities shoulder is one of the most frequently injured body parts in handball players<sup>14</sup>. The angular velocities during ball throw are extremely high and whole ball throw in handball can be described as open kinetic chain action. The ball throw in handball follows a common proximal to distal principle with the movement initiation in the hip and torso rotation. The kinetic energy is then transferred to shoulder complex and elbow and movement ends in the wrist. To perform well and to achieve high ball velocities the muscle strength (and power) as well as intermuscle co-ordination of shoulder complex is of crucial importance as well as the good concentric-eccentric coupling. The ball throw or arm swing in handball was already described and divided into four phases: back swing, acceleration, ball release and deceleration (Šibila, Pori in Bon, 2003). During the back swing, in which shoulder goes into maximal external rotation (cocking position), the optimal conditions are created for the phases to follow. There is an eccentric loading of the internal rotators (so called loading phase) after which there is an explosive concentric action (unloading phase) followed by a ball release and subsequent deceleration phase in which external rotators are now eccentrically loaded to control the arm movement and decelerate the upper limb (Pori in Šarabon, 2006).

Picture 1. Biomechanics of the arm swing in handball



It is clear from those findings that the strength of shoulder internal and external rotators is a prerequisite for the most common activity in handball. Of all muscle groups of the shoulder, evaluation of the shoulder external rotators (ERs) and internal rotators (IRs) is most informative because those muscle groups are responsible for dynamic stabilization of the glenohumeral joint.<sup>2</sup> One possible mechanism leading to shoulder injury may be a strength imbalance between those muscles,<sup>3</sup> which is easily assessed using isokinetic strength testing. Differences in IR and ER strength ratios appear to be related to injury in almost all players whose sports involve overhead throwing activities, such as baseball, water polo, tennis, handball, and volleyball. Furthermore, considering the asymmetric nature of shoulder movements in handball, one would expect that handball practice itself causes strength imbalances that present in the form of strength asymmetries between the dominant (D) and nondominant (ND) shoulders.

### Material and methods

We have searched a Pubmed archive in November 2015 using a search string "isokinetic and shoulder and handball" in order to identify studies of interest.

Additional filter for English language was also used.

## Results

There were 12 search results at the Pubmed under the search string "shoulder and isokinetic and handball" and additional filter for articles written in English<sup>1-5, 8, 9, 15-19</sup>. The studies of interest were published in the period 1996-2015. For the purposes of further analysis we have collected a full texts of all studies to thoroughly review the testing procedures used for the assessment of shoulder external and internal rotators strength. The further analysis of full papers has revealed that in some of the studies the isokinetic strength testing of shoulder external/internal rotation was not actually performed and that authors have tested only diagonal pattern of movement<sup>4</sup>. In some cases the authors were combining several overhead athletes all together

(e.g. volleyball, tennis, handball...)18 or they were combining injured and healthy athletes together 15, 18 disabling our main analysis in relation to strength of external and internal rotators in healthy handball players of both sexes. For those reasons we have further excluded additional 3 studies<sup>4, 15, 18</sup> leaving us with 9 eligible studies with 283 participants (180 female and 103 male healthy handball players). All studies included testing at more than one velocity, even more most of the studies included testing at three isokinetic velocities. The common denominator of studies in the relation to the testing velocity was testing at 60°/sec (8/9) as only one study did not test athletes at this velocity<sup>17</sup>, while other velocities used were 90°/sec (1/9), 120°/sec (1/9), 180°/sec (4/9), 240°/sec (3/9) and 300°/sec (5/9). To summarize the findings of those studies we have combined data only at 60°/sec into Table 1.

*Table 1. Summarized findings of isokinetic evaluation of shoulder concentric and eccentric external and internal rotators strenght at 60°/sec*

Author	Year	Sex	Age	Weight	N	Level of play	Dynamometer	Velocity	Reps	Position	ROM (ER-IR)	External rotation				Internal rotation			
												Dom	ecc	Non-Dom	ecc	Dom	ecc	Non-Dom	ecc
Pontaga	2014	m	14.6	63	14	adolescent elite	TechnoGym REV 9000	60	5	90-90	120 (20-100)	25	x	25	x	39.6	x	37.5	x
Andrade	2013	m	27.7	92.2	20	adult elite	Cybex 6000	60	5	90-90	120 (60-60)	0.51	x	0.47	x	0.71	x	0.67	x
Andrade	2013	f	13.5	53.2	17	regional level	Biodex System 3	60	5	90-90	120 (50-70)	10	x	x	x	14.6	x	x	x
		m	13.8	59.8	10							12	x	x	x	23.8	x	x	x
		f	15.5	61.6	14							17.3	x	x	x	26.9	x	x	x
		m	15.5	70.8	10							28.2	x	x	x	49.23	x	x	x
		f	17.4	68.1	13							18.2	x	x	x	26.9	x	x	x
		m	17.1	80.8	7							33.6	x	x	x	61.5	x	x	x
		f	19	67.7	8							19.1	x	x	x	28.5	x	x	x
		m	19	81.5	6							44.5	x	x	x	82.3	x	x	x
		f	24.3	71	14							18.2	x	x	x	27.7	x	x	x
		m	26.3	92.7	9							51.8	x	x	x	86.9	x	x	x
Edouard	2013	f	18	70	16	national junior	Con-trex MJ	60	3	modified neutral	70 (55-15)	0.37	0.38	0.35	0.37	0.52	0.57	0.45	0.47
Zapartidis	2006	f	20.5	62.4	16	1st division Greek	Cybex II+	60	3	90-90	150 (60-90)	15.1	x	x	x	20.1	x	x	x
Bayios	2001	m	24.9	83.1	15	1st division	Cybex II+	60	3	90-90	90 (0-90)	36.4	x	x	x	60.8	x	x	x
			26.8	85.8	12	2nd division		60	3			37.7	x	x	x	61.6	x	x	x
Andrade	2013	f	23.4	71	27	Brazilian national team	Cybex 6000	60	5	90-90	120 (70-50)	25.2	27.3	x	x	31.9	45	x	x
Andrade	2010	f	23	71	27	Brazilian national team	Cybex 6000	60	5	90-90	120 (60-60)	25	x	23.8	x	31.9	x	28.6	x

Bilateral strength testing was performed in 6/9 studies and with the exception of one study<sup>9</sup> where testing was performed in modified neutral position all testing were performed in the functional 90-90 testing position as proposed by Davies<sup>10</sup>. The overall range of motion used in testing was in the range 70°-150° (maximal external rotation 70° to maximal internal rotation 100°). In 5/9 studies eccentric testing of both internal and external rotators was performed but always at the low isokinetic velocities. The usual number of repetitions used at given velocity was 5 with only one study performing 20 repetitions at 240°/sec<sup>16</sup>. Most commonly used dynamometer was Cybex (5/9).

## Discussion

Based on the analysis of previous studies we suggest that isokinetic strength testing of the shoulder external and internal rotators in handball players should best be performed at the two testing velocities 60°/sec and 180°/sec with 5 repetitions at each testing velocity. The testing should be always bilateral and eccentric testing of at least external rotators should be performed as well, depending on the primary endpoints of the study. Although the

range of motion used in previous studies was rather large we suggest that testing could also be performed in the short range of motion 60° (90°-30°) and we will offer some reasons to support this suggestion. When choosing a testing velocity one should always consider the main reason for testing. If maximal strength is what we are interested in than slow concentric velocity (e.g. 60°/sec) is our best choice. The idea of making an isokinetic testing functional with increase in testing velocity is tempting but one must be careful not to overestimate the testing capabilities. When facing the choice of velocity the range of motion must be considered as well. To set an example we may imagine a situation in which the range of motion is 90° while testing velocity is 180°/sec, 240°/sec or 300°/sec. To perform a test through full range of motion a subject has a 0.5 sec, 0.4 sec and 0.3 sec, respectively. Taking in account the fact that average muscle activation time is 0.2 sec it is easy to understand that high velocity testing may impose physiologically limiting situation for shoulder muscles in which subject will not able to perform test properly. This is one of the main reasons that we are suggesting testing in short range of motion and at 60°/sec and 180°/sec. Increasing the number of testing velocities is also time consuming

as each additional velocity doubles the initial time needed for testing. At the same time additional velocities are not more informative in comparison to low velocities. This means that any possible existing strength deficit will be best noticed at the low velocity. The situation is somewhat different with testing in eccentric mode of contraction, as eccentric strength is clinically important and gives us additional information about the athlete. However, eccentric strength testing has some known reproducibility issues<sup>13</sup> and same impact on time needed to test. Therefore, if our primary intention is to test large number of participants (e.g. screening for strength deficits and handball athletes at risk for injury) than probably testing at single velocity in concentric mode only is sufficient enough. Such test would offer an acceptable sensitivity that enables us to reasonably downsize the number of athletes that need a thorough isokinetic strength testing of the shoulder that includes testing at multiple velocities and type of contraction. Our suggestion to test in short range of motion is based on our previous studies where we have shown that if the point where muscle reaches the peak torque is targeted with the testing and testing velocity is reasonably accommodated to allow enough time for muscle force/torque production than based on previous findings for the trunk and knee isokinetic strength testing<sup>6, 7</sup>, we can assume that the results from full ROM (FROM) to

short ROM (SROM) testing will be highly correlated, meaning that in terms of absolute strength values SROM will be as informative as FROM. The reason for this is that an optimal force-length relationship exists for the specific muscle group where actin-myosin bridges are most numerous and therefore the torque output is at its peak value. This is true only when the chosen ROM covers the optimal range of that muscle, as otherwise there could be a large change in the moment arm, compounded with the length-tension relationship, which would affect the resultant torque significantly<sup>12</sup>. To sum up, isokinetic strength testing of the shoulder in handball players is important and provides coaches and medical professionals important data about the athletes and their injury risk. For example, the relative risk reported by Edouard et al.<sup>9</sup> was 2.57 (95%CI: 1.60-3.54;  $P < 0.05$ ) if handball players had an imbalanced muscular strength profile. Therefore the inclusion of the shoulder isokinetic strength evaluation in the yearly testing of the handball players (similar to volleyball<sup>11</sup>) is important as well as the knowledge about the expected (normative) values for this population. The expected values of internal and external rotation and strength ratios are provided in Table 2 for adolescent and adult athletes based on the summarized findings from previous studies included in our short review.

*Table 2. The peak torque to body weight (Nm/kg) of shoulder external and internal rotators in adolescent and adult female and male handball players*

Age group	Strength parameter	Sex	Peak torque to body weight (PT/BW)	95% CI for PT/BW	
				Lower	Upper
adolescent	Conc ER dom	m	0.39	0.24	0.54
		f	0.25	0.18	0.33
	Conc IR dom	m	0.7	0.43	0.98
		f	0.38	0.26	0.5
	Strength ratio ERcon/IRcon	m	0.55	0.51	0.6
		f	0.67	0.64	0.7
adult	Conc ER dom	m	0.49	0.39	0.58
		f	0.32	0.24	0.39
	Conc IR dom	m	0.92	0.69	1.16
		f	0.43	0.34	0.52
	Strength ratio ERcon/IRcon	m	0.54	0.32	0.77
		f	0.73	0.66	0.8
	Conc ER non-dom	m	0.47	x	x
		f	0.34	0.25	0.44
	Conc IR non-dom	m	0.67	x	x
		f	0.43	0.13	0.73
	Strength ratio ERcon/IRcon	m	0.7	x	x
		f	0.8	0.46	1.15

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## KONCENTRIČNA I EKSCENTRIČNA SNAGA VANJSKIH I UNUTARNJIH ROTATORA RAMENA U RUKOMETU

### Sažetak

*Ugaone brzine tijekom bacanja lopte su izuzetno visoke i cijela proces bacanja lopte u rukometu se može opisati kao otvoreni kinetički lanac. Bacanje lopte u rukometu počinje od proksimalno prema distalno principu sa početkom pokreta u rotaciji kuka i torza. Kinetička energija se zatim prenosi na rame i lakat te pokret završava u zglobovima šake. Za dobre igre i dostizanje velike brzine lopte, snaga mišića (i moć) kao i intramuskularna koordinacija ramenog pojasa je od presudne važnosti, jednako kao i dobra koncentrično-ekscentrična saradnja. Razlike omjera čvrstoće u IR i ER povezane su sa ozljedama kod igrača u gotovo svim sportovima koji podrazumijevaju bacanja iznad glave, kao što su bejzbol, vaterpolo, tenis, rukomet i odbojka. Istraživanja su vršena u PubMed arhivu, koristeći pretragu string "izokinetika, rame i rukomet" kako bi se pronašle studije koje odgovaraju istraživanju. Također se koristio dodatni filter za engleski jezik. Za potrebe daljnje analize smo prikupili pune tekstove svih studija i temeljito preispitali postupke testiranja koji se koriste za procjenu snage vanjskih i unutarnjih rotatora ramena.*

**Ključne riječi:** Snaga ramena, koncentrična i ekscentrična kontrakcija, rukomet.

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## EFFECTS OF APPLICATION OF SPORTING FACILITIES IN AFB&H MILITARY TRAINING ON SOLDIER'S-RECRUIT'S QUANTITATIVE CHANGES IN MOTOR ABILITIES

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*Original scientific paper*

### Abstract

*Relationships between motor abilities and acquired motor skills are always multidimensional and complex. It is believed that high level of motor abilities is the essential prerequisite for efficient learning and performance of new motor structures. Aware of the great importance of motor abilities for the overall recruit's success during military training, we decided to undertake a research and, thereby provide a scientific contribution to the development of military training. Accordingly, many would expect that military training had an influence on quantitative changes of all motor abilities. However, a sample of 435 examinees, specifically male soldiers-recruits of AF BiH aged 19-26 years, clinically and psychologically healthy and without any locomotor defects, showed that Military training plan and program didn't affect the quantitative changes of all tested variables. In this paper we used tests which measured a total of 24 variables: strength, explosive strength, speed, coordination, repetitive strength, flexibility and balance. Based on the results obtained by canonical discriminant analysis in the area of motor skills we found quantitative changes in 12 variables. The changes are most evident with variables which make criteria for admission to AFBiH (3,2km run, sit-ups, and push-ups) and with the variables of balance, which explains the fact that the examinees wore military boots by which they stabilized and shaped their feet during the three-month training.*

**Keywords:** Motor abilities, quantitative changes, military training plan and program, recruit composition, AFBiH.

### Introduction

The main aim of the research carried out in the area of motor abilities and on a sample of members of the armed forces was to create a better training plan and thereby, raise the level of motor abilities (Horn & Bentley, 2015). Quantitative changes are essentially an indication of quality of Plan and program (curriculum), and as such, they are the subject of research by many authors (Punch, 2013; Sporiš, Harasin, Bok, Matika, & Vuleta, 2012; Stringer, 2013). A research was carried out in order to determine the general structure of the anthropological characteristics of CAF (Croatian Armed Forces) and to define specific patterns of motor abilities in the manifest and latent area of different groups of examinees. The research was conducted on the sample of 302 members of Croatian Armed Forces, which were divided into four groups. Canonical discriminant analysis in the area of motor skills showed difference in three discriminant functions in the manifest area and two discriminant functions in the latent area (Aračić, 2007). We have carried out research on a sample of 85 examinees –candidates who were on the training for admission to professional military service in AFBiH. During the three-month basic training it was determined that the military training program didn't affect the statistically significant quantitative changes (Arnaut, 2010). The research was also conducted on a sample of 307 recruits-sailor trainees, with an average age of 21, who were on specialized military training in the Croatian Navy. The aim was to determine the effectiveness of kinesiology

treatments on qualitative and quantitative changes of morphological characteristics and motor abilities as well as relationships between morphological and motor variables set. The results showed that achieved qualitative changes reflected on quantitative changes; therefore, quantitative transformation was achieved (Maleš, 2002).

### Method

The main problem of the research is to find out how sporting facilities in AFBiH military training influence on soldier's-recruit's quantitative changes in motor abilities. Based on the defined research problem, the aim of the research is defined also. It refers to determining the influence of sporting facilities in AFBiH military training on soldier's-recruit's quantitative changes in motor abilities.

### The sample

The population from which the sample was derived were soldiers-recruits who were on the three-month training at the Basic training center in Pazarić. Total sample consisted of 435 soldiers-recruits (Maleš), aged 19-26, from Bosnia and Herzegovina who have passed all medical examinations at Clinical Center University of Sarajevo.

### The Sample of variables

To assess motor skills we used tests that measure: endurance, explosive strength, speed, coordination, repetitive strength, flexibility and balance. All motor skills were tested three times or more.

## Variables for assessment of endurance

1. 3200m run. MSL TRC
2. Isometric arms exercise MSA IPR
3. Isometric flexion exercise MSA IFL

## Variables for assessment of explosive strength

4. Standing long jump MFE SDM
5. Standing high jump MFE SVM
6. Standing triple jump MFE TRO

## Variables for assessment of speed

7. Tapping with preferred foot MBR TAN
8. Tapping with preferred hand MBR TAR
9. Standing 20m sprint start MBR 20 m

## Variables for assessment of coordination

10. Three medicine ball slalom MKO S3M
11. Side lunge MKO KUS
12. Eight with bending MKO OSM
13. Envelope test MKO KOT
14. Backward jump MKO SUU

## Variables for assessment of repetitive strength

15. Pushups MRS SKL
16. Sit-ups MRS DTL
17. Deep squats MRS DCU

## Variables for assessment of flexibility

18. Bend on the bench MFL PRK
19. Flex bat MFL IPA
20. Straddle forward bend MFL PRR

## Variables for assessment of balance

21. Standing on two legs alongside a bench with eyes open MBAU20
22. Standing on two legs alongside a bench with eyes closed MBAU2Z
23. Standing on one leg alongside a bench with eyes open MBAU10
24. Standing on one leg alongside a bench with eyes closed MBAU1O

Testing of motor skills (Šoše, 1998) was done during the morning hours and simultaneously at several points on the training grounds in the Basic Training Center in Pazarić. At each checkpoint there was one timekeeper and one scorekeeper. On one measuring point, maximum of two examinees were allowed at the same time. The same group of timekeepers carried out the testing. Results were repeated loudly and recorded. Air temperature in the room where the test was conducted was around 25 degrees. Instrumentation was standard and calibrated each day before measurement. Surveyors (PhD and Masters of Sports Science, Professors of Sport and Physical Education, Training Instructors) and the test leader (the author) participated in the test. They were previously introduced with the tests, methodology and measurements.

## Results

In table 1 we used Box's M test to check significance. We got sig.000, which tells us that we can perform discrimination of motor skills by canonical discriminant analysis.

Table 1. Box's M test of motor skills

Box's M		2372.179
F	Approx.	7.683
	df1	300
	df2	2289649.261
	Sig.	.000

In table 2 we got canonical correlation .878 where one discriminant function at a time got isolated. This tells us that we got high level of correlation.

Table 2. Eigenvalues of motor skills

Function	Eigenvalues	% coefficient of variation	Cumulative %	Correlation
1	3.354a	100.0	100.0	.878

Table 3 shows the significance of .000. It also shows very low Wilks' Lambda, which is .230

Table 3. Wilks' Lambda of motor skills

Test function	Wilks' Lambda	Chi-square	df	Sig.
1	.230	1259.196	24	.000

Table 4 presents the matrix structure of motor abilities which shows changes in initial and final measurement. Variables of repetitive strength: sit-ups MRSDTL (.457) and pushups MRSSKL (.393) correlate with the greatest changes to this function. Major changes which correlate to this function are achieved with variables of balance too: standing on two legs alongside a bench with eyes closed MBAU2Z (.271); standing on two legs alongside a bench with eyes open MBAU20 (.182) and standing on one leg alongside a bench with eyes open MBAU10 (-.151), as well as variables of endurance: 3200m run MSLTRC (-.326) and isometric flexion exercise (-.187). Variables of coordination: three medicine ball slalom MKOS3M (-.176) and backward jump MKOSUU (.145). Flexibility variables: straddle forward bend MFLPRR (.177) and flex bat MFLIPA (-.146), while with variable of speed, only one change occurred: tapping with preferred hand MBRTAR (.175). Variables of explosive strength didn't achieve major changes which correlate to this function.

Thanks to the existing plan and program of physical training, which mostly consists of different types running, pushups, sit-ups and squats, we achieved major changes which correlate to this function. The first three variables in the matrix structure table isolated themselves. These three variables are also included in the Physical Fitness Test. These variables contributed to the fat melting without losing body weight. This has been observed with morphological

characteristics too. Adipose tissue mass converted into muscle mass or water. We also note that variables of balance underwent major changes which weren't planned nor covered in the existing Plan and program of physical training. This can be explained by the fact that all members wore military boots by which their foot stabilized and formed during the three-month training. In variables of explosive strength no change was achieved which correlate to this function. This can be explained by the fact that they weren't covered in the existing Plan and program of physical training and short time period needed for major changes.

*Table 2. The Matrix structure of morphologic characteristics*

Variables	Function
	1
MRSDTL	.457
MRSSKL	.393
MSLTRC	-.326
MBAU2Z	.271
MSAIFL	-.187
MBAU20	.182
MFLPRR	.177
MKOS3M	-.176
MBRTAR	.175
MBAU10	-.151
MFLIPA	-.146
MKOSUU	.145
MKOOSM	-.128
MFETRO	.115
MFKPRK	-.111
MFESVM	.101
MBAU1Z	-.081
MKOKOT	.078
MBR20m	.052
MRSDCU	-.030
MKOKUS	.020
MBRTAN	-.004
MFESDM	.003
MSAIPR	.000

Table 5 shows the group centroids. Correlation of the group centroids tells us how far they are from each other. The more distant they are, the more precise and accurate our data is. We notice that the maximum distance is from -1.829 to 1.829.

*Table 5. The group centroids of motor skills*

GROUP	FUNCTION
	1
1.00	-1.829
2.00	1.829

## Discussion

The research area of motor abilities, especially realized transformation after certain experimental program, is the subject of research by many authors. So in his research Aračić M. in 2007 (Aračić, 2007), by canonical discriminant analysis, determined that the groups of examinees differ in three discriminant functions in the manifest area and two discriminant functions in latent space. The information obtained is quite logical and in accordance with overall kinesiology engagement of certain groups which is defined by daily military activities. Thanks to the demanding three-month basic military training, soldiers-recruits have improved their motor skills and joined the Armed Forces. In a research conducted (Arnaut, 2010), he determined that there was no statistically significant quantitative change in the set of motor abilities. He explains that the reason for this lies in the fact that all candidates, who enlisted in the Armed Forces of Bosnia and Herzegovina and met the requirements specified in the application, were familiar with the selection process and with the fact that psycho-physical tests of motor abilities are included in the basic military training. Hence, they are given an opportunity to prepare for physical fitness test. All candidates who were sent to the basic military training for admission for professional military service have satisfied the criteria and entered the training process with a high level of motor abilities, which left very little space for further transformation during this period of three months (Maleš, 2002) in his study aimed to determine the effectiveness of kinesiology treatments on qualitative and quantitative changes of morphological characteristics and abilities as well as relationship between morphological and motor variables set. The results showed that realized qualitative changes reflected on quantitative changes, therefore, quantitative transformation is achieved. Based on the results of canonical discriminant analysis in this study, we can say that, thanks to the existing Plan and program of physical training, we achieved major changes which correlate to this function. First three variables (pushups, sit-ups, 3200m run) isolated themselves in the table of matrix structure. They were incorporated into the physical fitness test. Also, we note major changes with the variables of balance which weren't planned nor included in the existing Plan and program of physical training (Kraemer & Szivak, 2012). This can only be explained by the fact that members wore military boots by which they stabilized and shaped their feet during the three-month training. In the area of explosive strength, none of the variables have made major changes which correlate to this function. This can be explained by the fact that they weren't included in the existing Plan and program of physical training as well as short time period needed for major changes (Fleck & Kraemer, 2014; Sporiš et al., 2012).

## Conclusion

The main aim of this research was to determine the effects of sporting facilities on soldier's-recruit's quantitative changes in motor abilities after the three-month basic training. That's one of the key issues of every physical training. The main issue of all kinesiologists is what kind of changes occurred in the motor area after a certain period of time under the influence of certain treatments and how big these changes are. Results of this study showed positive change with variables of pushups, sit-ups and 3200m run. These variables are the condition for professional military service recruitment and that is why positive transformation occurred.

Recruits have achieved what was expected of them and that was the progress in these three segments of motor abilities while with other variables included in this research they achieved insignificant results or they didn't achieve any results at all. Based on the obtained results and indicators of this scientific research it is necessary to suggest elaboration of a new Plan and program of physical training for soldiers-recruits, which would cover all areas of motor abilities. This would enable them successful realization of daily professional tasks as well as combat tasks. Additionally, it is necessary to change the admission criteria to professional military service. This way motor abilities treated by the new Plan and program would be the admission criteria.

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## EFEKTI PRIMJENE SPORTSKIH SADRŽAJA VOJNE OBUKE NA KVANTITATIVNE PROMJENE MOTORIČKIH SPOSOBNOSTI VOJNIKA - REGRUTA OS BiH

### Sažetak

*Odnosi između motoričkih sposobnosti i usvojenih motoričkih znanja (vještina) uvijek su višedimenzionalni i složeni. Smatra se da je visok nivo motoričkih sposobnosti osnovni preduslov za efikasno učenje i izvođenje novih motoričkih struktura. Svjesni velike važnosti motoričkih sposobnosti za ukupan uspjeh regruta tokom vojne obuke, odlučili smo se istražiti ovaj prostor i time dati naučni doprinos razvoju vojne obuke. Shodno naprijed navedenom, mnogi će očekivati da smo u ovom radu utvrdili da je program vojne obuke imao utjecaja na kvantitativne promjene svih motoričkih sposobnosti. Međutim, na uzorku od 435 ispitanika, vojnika regruta OS BiH, muškog spola, sa područja cijele BiH, starosti od 19 do 26 godina, klinički i psihički zdravih i bez izrazitih lokomotornih oštećenja, utvrđeno je da Plan i program vojne obuke nije utjecao na kvantitativne promjene svih testiranih varijabli. U ovom radu uzeti su testovi kojima smo mjerili ukupno 24 varijable: izdržljivosti, eksplozivne snage, brzine, koordinacije, repetitivne snage, fleksibilnosti i ravnoteže. Na osnovu dobijenih rezultata kanoničkom diskriminativnom analizom u prostoru motoričkih sposobnosti konstatovali smo da je kod 12 varijabli došlo do kvantitativnih promjena. Ta promjena je najizraženija kod varijabli koje čine kriterij prijema u OS BiH (trčanje 3200 m, ležanje-sjed, sklekovi), te kod varijabli ravnoteže, što objašnjavamo činjenicom da su ispitanici nosili vojničke čizme, pomoću kojih im se stabiliziralo i oblikovalo stopalo u njima za vrijeme tromjesečne obuke.*

**Glavne riječi:** Motoričke sposobnosti, kvantitativne promjene, Plan i program vojne obuke, regrutni sastav, OS BiH.

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## RELATIONAL CAPITAL AS AN ELEMENT OF IMAGE OF INSTITUTIONS OF HIGHER EDUCATION IN CENTRAL BOSNIA CANTON

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### Abstract

Management of intellectual capital of institutions of higher education has a great significance because knowledge and education take an important role in all processes. Whether it's human, structural or relational, knowledge circulates in all forms, through teaching, research work or lifelong learning and projects. All processes are focused on users therefore it is necessary to examine their needs, so that the knowledge, which institutions of higher education provide, achieves desired results. Therefore it is necessary to make connections to the aimed groups of users, to examine not only their satisfaction with the services but the results these services provide. This paper has graduate students of Central Bosnia Canton as the sample subjects and examines their accomplishments after graduation which is directly connected to the image of institutions of higher education (hereinafter IHE) in the public. If the success of institution of higher education reflects on success of its students then it is necessary for these institutions to focus on elements of relational capital as a model of its image, where structural capital is internally secured, and externally legally prescribed and the human capital is a link between students and structural capital.

**Keywords:** intellectual capital, relational capital, image, satisfaction of the aimed groups, challenges of the progress

### Introduction

The term of intellectual capital is related to the age of "new economy" which emphasises internal structure and business, improvement of ideas and accumulation of knowledge in order to produce new values. The theory "hands make money" is abandoned. It's the brain that creates values through knowledge and information and makes the money. One of the first articles which mentions Intellectual capital is the article „Brainpower How Intellectual Capital is Becoming America's Most Valuable Asset" (Stewart, 1991) by Thomas A. Stewart, an editor of „Fortune" magazine. Nineties of the last centuries brought the new point of view on the importance of knowledge and information

which was reproduced even more by globalization and Internet. Idea, as an assembly of old elements presented in a new construction, knowledge as an assembly of experience, competence of an individual and information as a link of the whole process, established Smith's theory of progress of work and belief that investing in human's progress is the only way to improve the organisation (Smith, 2005). Swedish scientist Karl-Erik Sveiby published „Invisible Balance Sheets" in 1989 in which he divided intellectual capital into three categories which are now considered as three-level division of IK. ( Sundać, 2009.)

Table 1: Structure of intellectual capital

HUMAN CAPITAL		STRUCTURAL CAPITAL		RELATIONAL CAPITAL		
Management	Employees	Intellectual property	Organisational processes	Business network	Brand	Consumers
Innovation	Competence	Patents	Business organisation	Electronic networks	Creating image	Relation and communication with the current and the future consumers and achieving satisfaction and loyalty
Creativity	Qualification	Licence	Strategy Plans	Business associations	Presence on the market	
Responsibility	Communication	Copyright	Documents	Business relations with the partners	Ability of attracting new consumers	
Persistence	Critical review	Franchise	Process			
communication	Flexibility	Software	Organisational culture			
Self-initiative	Attitude		Data base			
Experience	Adaptability					
Attitude						

Sundać D., Švast N., „Intellectual capital- basic factors of competitive companies" Ministry for Economy, Labour and Business, Zagreb, 2009., page 37



The importance of intellectual capital is presented in the fact that: "Intellectual capital includes entire knowledge of the company, connecting human and relational capital by structural capital." (Jaganjac, 2014.) Relational or consumers capital is part of strategic business units of the company and connects company to the public (Carier, 2010.) i.e. it presents environment to which all business activities are focused on. Its importance in the context of higher education includes focusing on consumers, students and making business connections with external consumers which can affect the final result of business activities. The focus is conducted through strategies of attracting students as the basic elements in making decisions and activities (Mintzberg, 1978.). Sufficient number of students justifies the existence of institution of higher education. Enrolled students directly or indirectly affect base of potential students. Students that graduated in institutions of higher education create an image and ensure quality of the curriculum through their successful employment and/or businesses. Sinergetic relation among these three groups is significant for institution's survival therefore it is necessary to make permanent contacts. The satisfaction of the consumers is related to the image of the institution. Image presents "set of messages which are sent to the public and which are received by the public through their employees, work process, tasks and the clients themselves. Image is the process which never ends" (Ind, 1996.). Internally, each institution needs to continuously examine their employees as well as the satisfaction of the consumers which is also legal provision of the quality of work. One of the ways of examination is by business connections (by receiving direct data from the institutions and economic subjects). Examining the students during their studies is also valuable indicator. Evaluation of examination during the studies can contribute to the progress of business activities and cut all the negative influences, if there are any. Students emphasise the quality of a teaching process, teaching aids, quality of classes, condition of studying etc. The more relational capital is examined and obstacles removed, the higher satisfaction is among students and the employees and the balance of the communicational process is better. The aim is to reduce resignations and fluctuation of the employees as well as the consumers because this is an expensive process and this hurts the image of IHE and the business activities as well. Building and improving an image is achieved through all activities that include interests of the company which continuously invests in its human, structural and consumer capital (Jaganjac, 2014.). Relation between relational capital and image of a certain organisation can be determined by the correlation area of the mentioned independent systems. Since there is close connection between the mentioned, independent systems, the aim of this paper is to determine their influence on quality complete and individual. One of the aims of this paper is to determine structure of relational capital and the influence of each structural segment on the image of organisation of the institution of the higher education. There is an assumption that there is significant difference between correlation of the structures of relational capital of the graduate students and the image of the organisation of the institutions of the higher education in Central Bosnia Canton.

## Methods

Research was experimental and it presents transversal cross-section of the situation of institutions of the higher education. Experimental approach is based on phases of the scientific research. Some of the students stayed in contact with the faculties while the rest of them were contacted by e-mail or a phone call. Students were asked to fill out a survey about their satisfaction and their current activities. the survey was consisted of 15 questions which included: i) demographic data, gender, age, level of education, manner of studying; ii) results of studying; degree of employment in relation to departments of studying, career progress, self-employment and success in running their own businesses; and the effects on the consumers of the services. Survey had metric characteristic, objectivity and reliability. Data collection is conducted on intentionally defined sample subjects and adequate scientific methods and methods of data processing were used and their interpretation as well.

### Sample subjects

This research included three universities with 14 faculties of Central Bosnia Canton, (municipality of Travnik). Graduated students, as the elements of relational capital filled out a survey about their satisfaction. 76 students filled out a survey (51% of males and 49% of females), classified in relation to their manner of studying. Samples of data are displayed in tables 2 and 3.

### Data processing

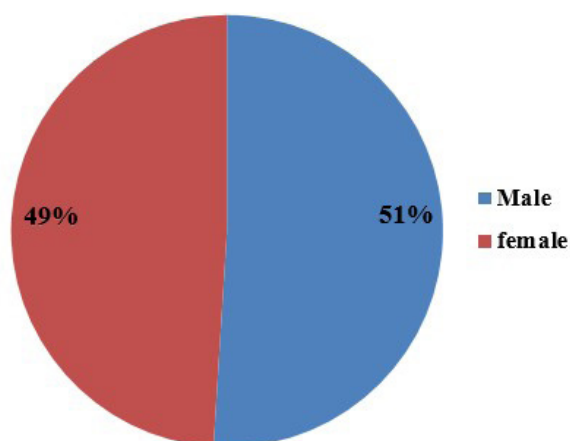
Normality of the distribution of data is determined by skewness and SE skewness. Connection between data received from the survey is determined by Spirman coefficient of level of correlation. Hi- square test ( $\chi^2$ ) is used for determination of significance of the examinations and differences. Software program SPSS 22.0 (IBM Corp) is used for data processing. Data is presented by frequency and percentage of means of the survey. Statistical significance of the conclusion is set on  $p < 0.05$ .

## Results

### Relations with students after graduation

There were four structures of the survey, intended for group of subjects named "graduate students", which included: i) level of employment in relation to departments of studying ii) career progress, iii) level of self-employment and a success in running their own business iv) expected and accomplished results of the consumers of the institutions of higher education Results of the business careers after graduation of the students and correlation of their accomplishments to the knowledge they received on a faculty directly influences on the image of IH. In the further research we examine the general classification of the students.

Graph 1: gender structure of graduated students



51% of total number of sample subjects were males (39 graduate students) and 48% were females. In relation to the manner of studying 41 student had status of regular students, 30 and 4 had status of irregular students and status of DL students.

Table 2: manner of studying

	Frequency	Percent	Valid percent	Cumulative percent
<b>Regular</b>	41	47,8	48,5	48,5
<b>Irregular</b>	30	44,8	45,5	93,9
<b>DL</b>	4	6	6,1	100

In relation to the manner of studying it is determined that 47.8% of the total number of students have status of regular students, 45% of students have status of irregular students and 6% of students have status of distance learning students.

Table 3: Duration of undergraduate studies

Year	Frequency	Percent	Valid percent	Cumulative percent
<b>Third</b>	38	50,7	50,7	56,7
<b>Fourth</b>	17	11,9	11,9	68,7
<b>Fifth</b>	21	31,3	31,3	100

In relation to duration of the studies 54% of the subjects attended three-year program, 33% of them attended master degree programs, 13% of subjects attended four year program. Grade point average during the studies was from 6.80 to 9.70. The grade average of most students was 8.

Level of employment in relation to department of studying

In order to establish the level of employment in relation to department of studying, it is examined (whether the subjects were employed at the beginning of the studies or got the job during the studies) which departments of studying are good for future employment.

Table 4: Were you employed during the studies?

Year	Frequency	Percent	Valid percent	Cumulative percent
<b>Yes</b>	36	47,8	47,8	47,8
<b>No</b>	40	52,2	52,2	100
<b>TOTAL</b>	76	100	100	

Table 4 shows that 52% of students weren't employed during the studies. The period during which subjects that weren't employed during studies, got a job or are still waiting for a job is examined. Table 5 displays results.

Table 5: if the answer is NO- did you get a job after graduation and in which period?

	Frequency	Percent	Valid percent	Cumulative percent
<b>No response</b>	32	47,8	47,8	47,8
<b>3 months</b>	9	9	9	56,7
<b>6 months</b>	1	1,5	1,5	58,2
<b>After a year</b>	6	4,5	4,5	62,7
<b>Still waiting</b>	25	37,3	37,3	100

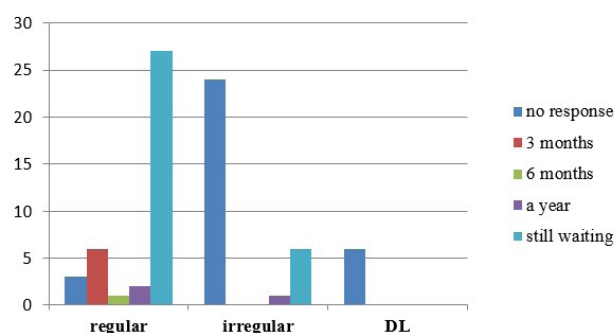
Results of the table 3 show that 52% of subjects weren't employed during their studies. 37% of graduate students are still waiting for the job offer, 4.5% were employed after a year, 1.5% were employed after 6 months, 9% were employed after 3 months. 47% didn't respond to this question (students that were already employed during the studies). Chi- Square test shows which students were employed first in relation to the department of studying and curriculum. Results are displayed in table 6 and graph 2.

Table 6: employment according to the manner of studying

		Employment					Total
		No response	3 months	6 months	After a year	Still waiting	
Manner of studying	Regular	3	6	1	2	27	39
	Irregular	24	0	0	1	6	31
	DL	6	0	0	0	0	7

Regular students were among the first ones who got the job (6 students after 3 months, 1 student after 6 months and 2 students after 12 months of graduation). Most regular students are still waiting for the job offer.

Graph 2: employment in relation to manner of studying



Graph 2 shows that regular and irregular students are still waiting for a job offer. The shortest period in which students got a job after graduation was 3 months period which is shown in table 6. Results of chi square test (in relation to department of studying) are the following:

Table 7: Chi-Square test of frequency of employment according to department of studying

	Value	df	Asymp. Sig. (2-sided)
<b>Pearson Chi-Square</b>	164.210a	80	<0.001
<b>Likelihood Ratio</b>	91.457	80	0.179

Table 8: Degree of employment in relation to department

Department	Employment					Total
	No response	3 months	6 months	After a year	Still waiting	
Management in Tourism and Catering	3	0	0	0	1	4
Finances, Banking and Insurance	2	0	0	0	0	2
Business Informatics	3	0	0	0	0	3
Marketing	2	0	0	0	0	2
Pedagogy and Psychology	0	0	0	0	2	2
Management of Public Sector and Administration	0	1	0	0	1	2
Management of Counting and Revision	2	1	0	0	0	3
Law	3	1	0	0	18	22
General Class Teaching	0	0	0	0	3	3
General Management	1	0	0	1	0	2
Textile Engineering	1	0	0	0	1	2
Business Management	10	3	1	1	5	20
Business Psychology	1	0	0	0	1	2
Business Law	4	0	0	1	0	5
Sanitary Engineering	1	0	0	0	1	2
<b>TOTAL</b>	<b>33</b>	<b>6</b>	<b>1</b>	<b>3</b>	<b>33</b>	<b>76</b>

Chi-Square test results show that Department of Business management is leading in finding a job. Students of this department manage to get a job 3 months after graduation.

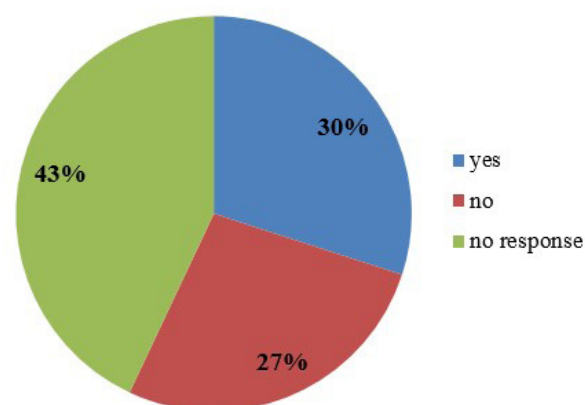
### Career progress

Students that progress in their business activities are directly connected to the institution of higher educated they graduated on. Their knowledge, skills and competence indirectly improve the institution's brand. Table 8 shows the progress of the subjects which were employed during their studies.

Table 9: Have you advanced your career after graduation?

	Frequency	Percent	Valid percent	Cumulative percent
<b>No response</b>	29	43,3	43,3	43,3
<b>Yes</b>	25	29,9	29,9	73,1
<b>No</b>	22	26,9	56,9	100

Graph 3: career advancement after graduation



30 % of the subjects who were employed during their studies have advanced their careers, 27% of them have not and 43% of them did not respond because those were the students without employment during the studies. Chi- Square test and comparative analysis show students of departments, who have advanced their careers. Table 10 displays the results.

Table 10: Chi- Square test of career advance of a certain department of studying

	Value	df	Asymp. Sig. (2-sided)
<b>Pearson Chi-Square</b>	61.901a	32	0.001
<b>Likelihood Ratio</b>	52.027	32	0.014

**Table 11: Career advance in relation to departments of studying**

Department	Career advance			Total
	No response	Yes	No	
Finances, Banking and Insurance	2	2	3	7
Business Informatics	0	2	1	3
Marketing	4	1	1	6
Management of Tourism	0	1	0	1
Management of Public Sector and Administration	1	0	0	1
Management of Accounting and Revision	1	2	0	3
Architecture	0	1	0	1
Law	13	2	5	20
Pedagogy and Psychology	0	1	0	1
General Management	1	1	0	2
Informational Technologies	0	5	0	5
General class teaching	0	1	0	1
Business Management	4	4	6	14
Business Technology	1	0	1	2
Business Law	1	4	1	6
Sanitary engineering	0	3	0	3
Total	28	30	18	76

Results of comparative analysis presented by Chi-Square test shows that there is a tendency of increase of career advancement after graduation. This especially occurs at the Departments of Informational Technologies, Business Law, Business Management, Sanitary Engineering, Finances; Banking and Insurance, Management of Accounting and Revision, Law, Business informatics, Architecture, Pedagogy and Psychology and General class teaching. Also, there is an increase students finances who were employed during their studies. Table 12 shows results.

**Table 12: Has your diploma ensured you an increase of your finances (salary)?**

	Frequency	Percent	Valid Percent	Cumulative Percent
No response	33	49.3	49.3	49.3
Yes	30	31.3	31.3	80.6
No	13	19.4	19.4	100

31 % of the subjects who were employed during their studies increased their finances after graduation, 19.4% of them did not and 43% of them did not respond because those were the students without employment during the studies. Conclusion is that the finances were increased after graduation.

Degree of self-employment and running a successful business. Results:

**Table 13: Did you start your own business?**

	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	7	10.4	10.4	10.4
No	69	89.6	89.6	100

Table 13 shows that 90% of the subjects didn't start their own business and 10% of them did. The improvement of business activities was examined of those 10% of the subjects that managed to start their own business.

**Table 14: If you had your own business did you advance your business opportunities and if yes what are they?**

	Frequency	Percent	Valid Percent	Cumulative Percent
	58	86.6	86.6	86.6
Communication	11	3	3	89.6
Eloquence	1	1.5	1.5	91
Marketing	1	1.5	1.5	92.5
Management	1	1.5	1.5	94
Organisation	1	1.5	1.5	95.5
Profit	1	1.5	1.5	97
Trainer	1	1.5	1.5	98.5
Web design	1	1.5	1.5	100

Students that started their own businesses after graduation isolate communication as crucial element of business opportunities. Apart from communication they also present eloquence, organisation and management, improvement of managing skills and profit. Chi-Square test analyses a degree of starting own business in relation to faculties. Table 15 displays the results.

**Table 15: Starting your own business after graduation in relation to the faculties**

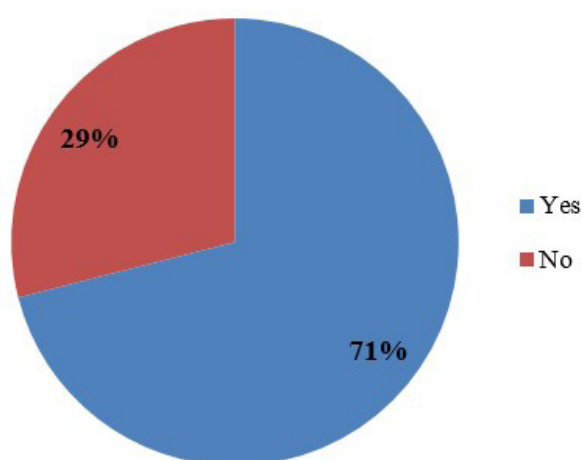
Faculty	Own business		Total
	Yes	No	
Faculty of Law University of Travnik	0	9	9
Faculty of Education	0	17	17
Faculty of Management and Business Economy	2	1	3
Faculty of Business Economy	3	32	35
Business Informatics	1	2	3
Faculty of Law	1	7	8
Sanitary engineering	0	1	1

Results of table 14 show that students of Faculty of Business Economy and Faculty of Business and Management have the knowledge and tendency for starting their own businesses. This includes students of Informatics and Business Law but in a smaller number. This research showed that one of 10 students has tendency for starting his own business.

Expected and achieved results of the users of the institutions of higher education

On the purpose of the examining the results and satisfaction of the subjects after graduation, subjects were asked whether they would like to enrol at this faculty again. The following tables show the results:

Graph 4: Would you enrol at this faculty again?



Results show positive attitude of the students toward their faculties. 71% of them would choose the same faculty again.

Table 16: is the faculty curriculum satisfactory to your needs?

	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	63	80.6	80.6	80.6
No	13	19.4	19.4	100
Total	76	100	100	

Results of table 16 show that 81% of the students are satisfied with the standard of profession they achieved on the title they received at the faculty. 19% of the students are not satisfied with the results of knowledge. They state the following elements as the important elements of the image.

Table 17: The important elements of image at the institutions of higher education of graduate students

	Frequency	Percent	Valid Percent	Cumulative Percent
Knowledge	35	38.8	40	40
Passing	8	11.9	12.3	52.3
Distinguished professors	23	34.3	35.4	87.7
Student exchange	1	1.5	1.5	89.2
Employment opportunities after graduation	1	1.5	1.5	90.8
Good student practice	3	4.5	4.6	95.4
Capacity and equipment	1	1.5	1.5	96.9
Quality of curriculum	2	3	3.1	100
Total	65	97.0	100	
Missing system	2	3		
TOTAL	76	100		

If we needed to separate the first three elements of the table those would be: good knowledge, distinguished professors and passing. The importance of elements of image according to structure of the subjects show the importance of the focusing on these elements in the future.

## Discussion

The real effect of completed program after graduation is crucial in achieving satisfaction of consumers. Four structures were examined on graduate students and those are: level of employment in relation to departments of studying; career progress; level of self-employment and a success in running their own business; expected and accomplished results of the consumers of the institutions of higher education. In terms of results students that were mostly examined in the research were students with the status of regular students. 38% of sample subjects are still unemployed. Percentage of successful employment after graduation is divided on a period from 3 to 12 months. The highest degree of employment in relation to departments of studying has the Department of Management. It is followed by Law, Management of Public Sector and Department of General Management. Percentage of the ones who managed to get a job after graduation is divided on a time period within 3 months. Students that were employed during their studies advanced their careers



( especially students of Informational technologies) Chi-Square test of differentiations of the answers shows that students of Economy have the highest percentage of increase of the salary and starting their own business, followed by students of Law and Sanitary Engineering. When it comes to business activities acquired during their studies students separate the following activities: communication, eloquence, management and administration as the important ones. As for the loyalty toward the faculty most students would enrol at the same faculty (70%) which points to the fact that communication, trust in teachers and the results after graduation have the strong motivational factor which provides positive results and the fact that 80.6% of the students are satisfied with the curriculum. Graduate students state that the advantages of the faculties they've studied in are: distinguished professors, good teaching and quality of curriculum, passing, good student practice, capacity and equipment. If we compare these results to the " Results of research of Serbia, Bosnia and Herzegovina and Montenegro" of the projects Congard Tempus published in 2014. which was intended to improve alumni organisation, strategic management, curriculum and teaching we'll notice the similarities and differences of certain questions. The project „ from research to (un)employed expert" included 7 universities and three institutions of higher education and 14.152 graduate students, within the Project Tempus the first link was satisfaction of the subjects with the program and curriculum where it's established that the subjects are satisfied (on the scale from 1 to 10 most answers were 8). However if we separate universities, students of Montenegro are the most satisfied (  $M=6,65$ ), while the students of Bosnia and Herzegovina ( research was conducted in Tuzla and Banja Luka) are the least satisfied with the curriculum. Students who wouldn't enrol at the same faculty again state that the reason for that is bad quality of curriculum, bad conditions of studying ( 25,1%), Students of Central Bosnia Canton stated quality of curriculum as the element of image and personal satisfaction (3%). If we compare the loyalty towards the faculties most students (91%) who wouldn't enrol at the same faculty are again from Bosnia and Herzegovina ( uzla and Banja Luka) while the students of Central Bosnia Canton (71%) would enrol at the same faculty again in terms of employment , there are similarities of the students who graduated shortly before the survey was conducted, therefore in both researches there is the highest number of unemployed and

inexperienced students in a three year period. Result of project Tempus Congard is 41.2% and the result of this research is 38%. Students who are still waiting for a job offer (46.4%) are from Bosnia and Herzegovina ( research of project Tempus Congard). Research of this paper show that the highest success have the students of Business Management, while research of project Tempus Congard show that the greatest success have the students of Informatics and Accounting, which questions the examination of needs of the market of labour in relation to geographic structures. Most students of Montenegro have started or continued their own businesses (53.1%), while 89.6% of graduate students of Central Bosnia Canton have not started their own business. It is interesting that increase of salary (31%) of graduate students of Central Bosnia Canton which is determined by this paper is related to Departments of Management and Business. Results of Chi-Square test of differentiate answers show that students of Economy have the highest percentage of increase of salary and starting their own businesses, followed by students of Law and Sanitary engineering.

## Conclusion

The success of the students in their career, self-employment and employment is a strong motivator for the future generations to study on that particular institution of higher education. Employment in a respectable companies or institutions shows recognition of that institution. Creating a business network in which students are employed is very important for the image and performance of all procedures in a certain institution. They are created in order to design and improve the image of that institution. The important fact: satisfaction and recognition of the consumers create an image of IHE. Satisfaction of graduate students is a link that connects structural capital , vision, and the existence to the final purpose and that is to create a society of knowledge, satisfied employees who are prepared for the challenges and trends of the market regardless of the department they studied at. Image of the institution of the higher education reflects on their students and employees: their knowledge, awareness, commitment, transparency, innovativeness and communication. Assembly of knowledge of relational capital and performing activities lays in human capital and structural determinants. Equivalent of that is the understanding and acquiring these processes in order to prosper.

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**Ključne riječi:** Intelektualni kapital, relacijski kapital, imidž, zadovoljstvo ciljnih skupina, izazovi razvoja.

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