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FACULTY OF SPORT AND  
PHYSICAL EDUCATION  
UNIVERSITY OF SARAJEVO



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Dear readers,

It is our pleasure to inform you that associate professor Husnija Kajmovic, graduated from the fourth edition of the International Coaching Enrichment Certification Program (ICECP) on May 1st in Lausanne, Switzerland as a representative of the Olympic Committee of Bosnia and Herzegovina, Judo Federation of Bosnia and Herzegovina and the Faculty of Sport and Physical Education, University of Sarajevo. The coaches who benefitted from an Olympic Solidarity scholarship, began the International Coaching Enrichment Certification Program on October 2011 and represent 32 nations, five continents and 10 olympic sports. Mr. Husnija Kajmovic was developed and realized project "Notational Analysis in Function of Educating Coaches of the Judo Federation of Bosnia and Herzegovina." The ICECP is offered to National Olympic Committees (NOCs) worldwide, and consists of lectures, guest speakers, participant presentations, group work and field trips, which are spread among four modules, including an apprenticeship with a U.S. national team or college team. As a part of the fourth and final module, all 29 graduates presented final projects to the ICECP Academic Board at the IOC headquarters in Lausanne. The objective of the program is to provide national-level coaches with a program that develops proficiency in sport sciences, talent identification, athlete development, coaching education, coaching management, grassroots sport development and ethical aspects of coaching at all levels of competition and across multiple sports, with the aim of improving national coaching infrastructures around the world. The aim of Olympic Solidarity is to organize assistance to NOCs, particularly for those who have the greatest need. This assistance takes the form of programs elaborated jointly by the IOC and NOCs, with the technical assistance of the International Federations, if necessary.



**Husnija Kajmović**

# The Effect of Volleyball on The Sole Contact Areas and Maximal Forces of Female Volleyball Players

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*Original scientific paper*

## Abstract

The aim of the present study was to compare the pedobarographic parameters of contact areas and maximal forces for 11 contact areas of foot-soles in professional female volleyball players and healthy people and to investigate the effect of volleyball on the foot-sole. The study consisted of 27 female Volleyball players without any foot-related complaints and, as the control group, 28 female volunteers. EMED-SF plantar pressure analysis system was used in the study. Any statistically significant difference between the averages of the study and the control groups was examined using non-parametrical Mann Whitney U test, and the extent of the linear relationship between the physical structure and the variables of the foot-sole was examined by calculating the Pearson (r) coefficient. Based on the results of the study, it was found that all results showed similarities in contact areas in comparisons between female volleyball players and the control group, and 1 parameter in each of the right and left foot maximal forces had differences. It was concluded that there was a close relationship between the type of sports done by the volleyball players and the variables relating to the foot-sole, the sports activity didn't harm the foot-sole, causing much less changes in the foot-sole as compared to basketball and, especially, wrestling, and had similarities with the results of the control group.

Key words: **Foot-Sole, Contact Area, Maximal Force, Pedobarographic**

## Introduction

Volleyball is a high-tempo, dynamic physical game without a definite playing time based on agility, strength, mobility, flexibility, endurance and the action of bounding (Akalin, 1995; Erhan, 1995; Şimşek, Ertan, Göktepe, & Yazıcıoğlu, 2007). Volleyball is generally considered a competitive sports branch with a high level of injury in the musculoskeletal system. Blocking and spiking are two basic actions in volleyball and bounding and landing actions are particularly investigated in the musculoskeletal system (Salci, Kentel, Heycan, Akin, & Korkusuz, 2004). Bounding which is one of the factors having a direct effect on the performance is the type of action frequently preferred both in offence and in defence and affects the performance substantially. Such actions as spiking and blocking based on bounding form the basis of this sports branch. These actions are performed very frequently during the match at different intervals and bounding high is an important factor in success (Akalin, 1995).

Volleyball is not a particularly dangerous sports branch despite the fact that it is played in halls or on sand. Injuries seen in both male and female volleyball players share similarities and are mostly consist of excessive use, ankle sprain and deformities in the shoulder. Ankle sprains are the most common injuries that occur both before and during the game in male and female volleyball players (Bahr & Bahr, 1997; Ekinci, 2011; Kılıçoğlu, 2009;

Reeser, Verhagen, Briner, Askeland, & Bahr, 2006; Stasinopoulos, 2004). Ankle injuries are more common in certain sports branches. Ankle injuries make up 45% of all injuries in basketball, 25% in volleyball and 31% in football (Kılıçoğlu, 2009). Athletes who have to bound frequently in volleyball have a higher risk of ankle sprain. In other words, 90% of ankle sprains are after the blocking action. Following the ankle sprains, the most common problem is the occurrence of functional changes in walking in 15-60% of athletes having pain and this causes different pressure spots on the foot-sole to emerge (Stasinopoulos, 2004).

Metatarsalgia is one of the main foot-sole disorders (Kang, Chen, Chen, & Hsi, 2006). Metatarsalgia is related to repetitive loadings of metatarsal heads, and is one of the most common foot disorders in the general population. The load that is borne by the metatarsal heads while walking varies from person to person. A greater part of the patients consulting the orthopedic polyclinics have complaints of metatarsalgia (Eils et al., 2002; Kılıçoğlu, 2009). Its causes include such problems as pes cavus, pes planus (flat feet), hallux valgus, capsulitis, synovitis, periostitis, stress fractures, plantar plate tears, neurinomas, callus, Freiberg's disease, fat pad atrophies, flexor tendinitis. It is known that the imbalances in the load distribution and the increase of load on metatarsal heads are the major causes of metatarsalgia (Kang et al., 2006).

Stress fractures in metatarsal bones are micro-fractures caused by the load on the physiological boundary lines to the bones. Stress fractures in the foot are more commonly seen in runners, in sports branches requiring bounding action and in dancers. Stress fractures are most commonly seen in the second metatarsal head which is the longest metatarsal head and which bears most of the load in cases of abnormal loading. The proximal diaphysis stress fracture in the fifth metatarsal head has different characteristics to other diaphysary metatarsal fractures. It is most commonly seen in overweight athletes. It is frequently accompanied by hidden or clear pes cavus deformity (Kılıçoğlu, 2009).

In recent years, with the popularization of new methods developed for the measuring pressure on the foot-sole, it has been possible to get a quantitative measurement of the load on metatarsal heads (Aydos, 2011; Hughes, Clark, Linge, & Klenerman, 1993; Luger, Nissan, Karpf, Steinberg, & Dekel, 1999; Uzun, 2012). Determination of the amount of load and pressure distribution on each metatarsus in healthy people will help determine the diagnosis and treatment programs for metatarsalgia (Eils et al., 2002). Also, it will facilitate the defining the different walking types; the explanation of mechanisms causing their formation, understanding the foot problems we face in the clinic and determination of treatment protocols (Kanatli et al., 2008). Despite the speed at which these methods are developed, the knowledge on the pressure distribution types on metatarsal heads is still a subject of discussion (Aydos, 2011; Kanatli et al., 2008; Kang et al., 2006; Queen, Haynes, Hardaker, & Garrett, 2007; Uzun, 2012)

Diabetes Mellitus, Rheumatoid Arthritis and Leprosy are the major disorders affecting the foot and emphasizing the importance of foot pressure measurements. The measurement of foot pressure distribution, prevention, treatment and rehabilitation of deformities which such disorders would cause in the foot and the provision of suitable shoes have gained importance (Patil, Thatte, & Chaskar, 2009).

Spiking and blocking actions in volleyball which involve bounding actively and directly affect the foot and the foot-sole of the athlete. Especially in professional athletes with their physical characteristics which develop in periods of 10 to 15 years, these actions are used more frequently in training exercises and in matches everyday.

The aim of the present study is to demonstrate the factors affecting the load borne by the metatarsal heads in volleyball players and to investigate the effect of volleyball on the foot-sole by comparing the contact area and maximal forces for various regions of the foot-soles of female volleyball players and healthy individuals during walking barefoot and by examining the common disorders in the foot and the foot-sole. This study further aims to measure the load applied on metatarsal heads in volleyball players and to contribute to the studies towards the use and development of shoes specially built for volleyball players.

## Methods

The present study was approved by the Local Ethics Committee of the Faculty of Medicine, T.R. Gazi University (February 25, 2008; approval number 074 for non-pharmacological clinical studies).

The study included 27 professional female volleyball players who had no feet complaints (aged  $23,0 \pm 2,8$  years) and a control

group of 28 female volunteers (aged  $27,5 \pm 1,4$  years). The average age at which the sportsmen started volleyball players was found to be 11 years. Those with a foot disorder, a neurological disease affecting the movement system, a peripheral neuropathy; those who had a previous foot or ankle surgery; and those who had a previous fracture in this area were excluded from the present study.

Pedobarographic (sole pressure measurements) measurements of the study participants were performed using an EMED-SF (Novel GmbH, Munich, Germany) plantar pressure analysis system at the Gazi University Faculty of Medicine Department of Orthopedy and Traumatology walking laboratory. The system uses a 71 Hz sampling frequency; its dimensions are  $44.4 \times 22.5$  cm; it includes two receptors per  $\text{cm}^2$ ; and it is mounted on a wooden platform of  $7 \times 1$  m and covered by a thin layer of leather.

The respondents walked freely on a 7-meter walking band before stepping on the pedobarograph and the area where the measurement was performed is not stated. The measurements were performed with naked feet and two dynamic measurements were performed for each foot. The sole was divided into 11 areas, each of which was evaluated in terms of contact area ( $\text{cm}^2$ ) and maximal force (N/cm) (Figure 1).

## Statistical Evaluation

The data obtained was analyzed using SPSS software (Version 18). The two measurements of the experimental and control groups were averaged and the non-parametrical Mann Whitney-U test was used to test whether there was a statistically significant difference between the related averages. The extent of the linear relationship between physical structure and the variables for each sole measurement was examined by calculating the Pearson coefficient ( $r$ ). A 95% reliability interval was used and the level of significance was accepted to be  $P < 0.01 - 0.05$ .

## Results

The difference between age, height and BMI averages of the volleyball players and of the control group was found to be significant to the level of  $P < 0.01$ . Based on this, while the age, body weight and body mass index of volunteers in the control group were higher, their average height was lower. (Table 1).

The difference between the averages in the comparison of total right-left feet levels and 11 contact areas for the female volleyball players and the control group on all the results weren't found significant ( $P < 0.01 - 0.05$ ). (Table 2)

The difference between the averages in the comparison of total right foot levels and maximal force on 11 contact areas for the female volleyball players and the control group, and the results for 2nd metatarsal head of right and left foot were found significant ( $P < 0.01 - 0.05$ ) (Table 3).

The extent of the linear relationship between continuously measured variables was examined using Pearson's correlation coefficient ( $r$ ) for categorical comparisons and significant positive and negative relationships were observed (0,01 ve 0,05) in comparisons of age, height, body weight, BMI and right-left foot contact areas and maximal power comparisons. (Table 4)

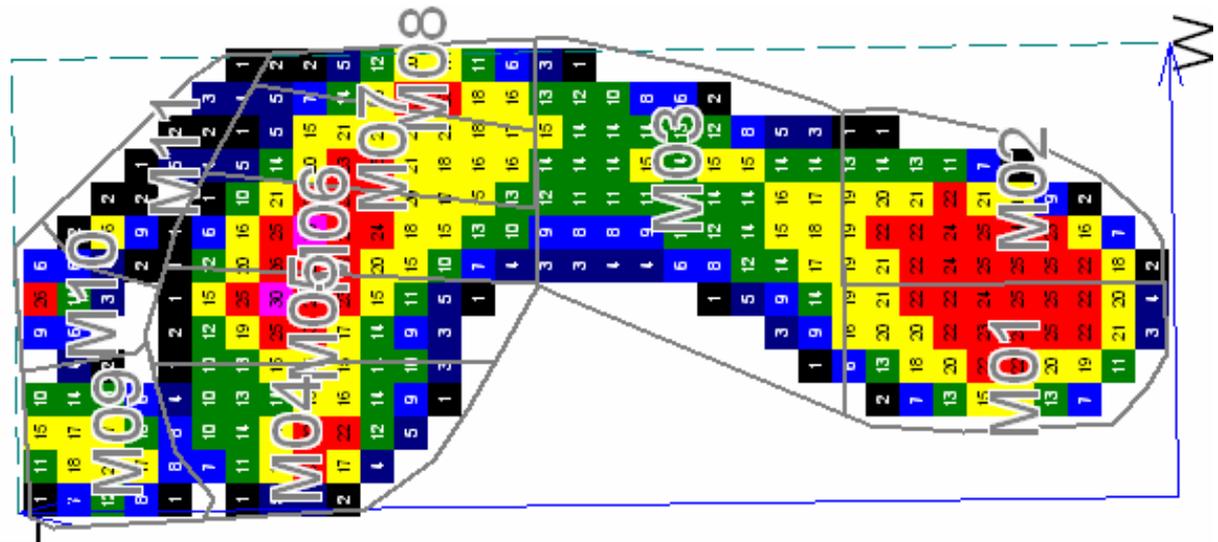


Figure 1. Mask areas in pedobaography (M01: medial of heel, M02: lateral of heel, M03: midfoot, M04: 1st metatarsal head, M05: 2nd metatarsal head, M06: 3rd metatarsal head, M07: 4th metatarsal head, M08: 5th metatarsal head, M09: pollex M10: 2nd finger, M11: 3rd 4th and fifth fingers).

## Discussion

In our study, contact area and maximal forces of various foot-sole areas of the participating volleyball players were examined and compared with those of the control group consisting of healthy people. While the height and body mass index (BMI) for the participating volleyball players and the control group were found statistically significant, the difference between their body weights and ages was not found to be statistically significant. The study shows that the volleyball players are younger than the members of the control group. In consideration of the heights and body weights of the volleyball players and of the control group, the fact that the height levels of volleyball players are higher than those of the control group while their body weight levels are close to each other has caused the difference between their body mass indexes (BMI) to be statistically significant (Table 1).

Feet provide balance while standing, walking and running. Feet have five main functions. They are the basic support for the body, adaptable to flat, non-flat and rough surfaces with shock-absorbing ability while walking, and present the driving force and transverse plane leg rotation in the leverage. The loss of any of these functions is indicative of foot disorder and may be harmful for the person (Patil et al., 2009). An important aspect of the plantar pressure analysis is that it is capable of measuring the pressure distribution on various anatomical parts of the foot. During walk-

ing, high pressure takes place on the pollex, and a lower pressure takes place on the central parts of the foot (Bennett & Duplock, 1993). In studies dealing with mobility and balance parameters; it was demonstrated that the balance parameters of most people with walking dysfunctions were not normal (Cavanagh, Hewitt Jr, & Perry, 1992; Duncan, Chandler, Studenski, Hughes, & Prescott, 1993; Eils et al., 2004).

In comparison of 11 contact points of right and left soles of volleyball players and control group, difference between averages (Table 2) was in general lower in volleyball players, whereas no statistically significant difference was found.

In a study researching effect of basketball on the sole and examining ground contact areas of the foot, with respect to the differences between averages, it was reported that tip of 2nd and 3rd metatarsi of right foot, middle part of left foot, and tip of 2nd and 3rd metatarsi were smaller than in healthy subjects not doing sports, and that contact area of 2nd finger of left foot was smaller by 23.11% cm<sup>2</sup> than in the control group (Uzun, 2013). In a study conducted by Aydos in elite wrestlers, in comparison of 11 contact areas, he reported that the difference between averages in right heel medial, left heel lateral, tip of 3rd metatarsus of right foot was 11.18%, in tip of the 4th metatarsus was 11%, and in the tip of 5th metatarsus was 10.77% cm<sup>2</sup> higher in the control group than in the wrestlers (Aydos, 2011).

Table 1. Physical Characteristics of Female Volleyball Players (1) and Control Group (2)

Variables	Gender	Art. Mean.	S.D	X1 - X2	Min.	Max	t.	P
Age (year)	1	23,00	2,828	4,00	19,00	27,00	122,000	**,093
	2	27,50	1,469		19,00	36,00		
Height (cm)	1	179,33	8,387	10,63	160,00	190,00	86,000	**,005
	2	168,70	2,443		157,00	187,00		
Weight (kg)	1	65,66	6,230	-1,04	57,00	78,00	166,000	,696
	2	66,70	2,075		53,00	80,00		
BMI (kg/m <sup>2</sup> )	1	20,41	1,252	3,15	18,30	22,30	76,000	**,002
	2	23,56	,819		19,73	31,25		

\*\* P < 0.01 \* P < 0.05

According to these results, it was seen that the volleyball sport did not lead to any increase or decrease in contact areas of the sole, and that foot contact areas of female volleyball players had similar values with the control group.

When compared the maximal force of the total of 11 contact areas of right and left feet in volleyball players and control group, it was found that the difference in averages for tip of 2nd metatarsus of right foot was 19.57%, and for tip of 2nd metatarsus of left foot was 5.30% higher in the control group than in volleyball players, and that the difference was statistically insignificant (Table 3).

In a study conducted on 40 healthy subjects (age 25.3, weight 70.8 and height 176.5 cm) using EMED-SF (Novel GmbH, Munich, Germany) plantar pressure analysis system, Eils et al. observed that while there was a similarity between peak pres-

sure distribution results and those of those of the basketball players, they were lower in comparison to the results of the control group (Eils et al., 2002). In the study researching the maximal force applied by the contact areas of foot sole in basketball players, it was reported that for tip of 1st metatarsus of right foot, it was 63.38%, for tip of 2nd metatarsus of left foot, it was 21.16%, for toe of right foot, it was 56.56% lower in basketball players than in subjects not doing sports, and for tip of 4th metatarsus of right foot, it was 29.97, for 2nd finger of left foot, it was 43.66% higher (Uzun, 2013). For wrestlers, it was found that for right foot total, it was 10.56%, for left foot total, it was 7.24%, for right heel medial, it was 30.44%, for tip of 2nd metatarsus of right foot, it was 27.75%, for tip of 2nd metatarsus of left foot, it was 19.47%, for tip of 5th metatarsus of left foot, it was 37.22% higher in the control group than in the wrestlers (Aydos, 2011).

Table 2: Comparison of Right and Left Feet Contact Areas of Female Volleyball Players (1) and Control Group (2) (cm<sup>2</sup>)

Variables	Group	Right Foot				Left Foot			
		Mean	S.D	Mann-Whitney U	P	Mean	S.D	Mann-Whitney U	P
foot- TOTAL	1	129,27	18,03	151,000	,396	135,35	21,94	148,000	,502
	2	136,3	16,96			130,62	18,54		
MO1: The medial part of heel	1	16,13	4,699	134,000	,177	17,61	2,74	164,500	,866
	2	17,97	2,452			17,55	2,480		
MO 2: The lateral part of heel	1	15,97	4,710	160,000	,558	17,58	2,00	145,500	,453
	2	17,17	2,202			17,27	2,185		
MO 3: midfoot	1	23,91	7,432	144,000	,292	26,58	9,31	142,500	,402
	2	26,40	8,433			24,02	10,03		
MO 4: The 1st metatarsal head of foot	1	11,86	3,184	150,000	,378	12,264	2,55	134,000	,270
	2	12,65	3,403			13,05	1,986		
MO 5: The 2nd metatarsal head of foot	1	9,63	3,018	140,000	,239	10,23	2,64	144,000	,426
	2	10,82	1,893			10,32	1,995		
MO 6 The 3rd metatarsal head of foot	1	10,72	1,926	122,000	,088	11,52	1,85	125,500	,172
	2	11,65	1,581			10,70	1,901		
MO 7: The 4th metatarsal head of foot	1	9,25	1,507	166,500	,689	9,76	1,26	129,000	,208
	2	9,22	,880			9,25	1,642		
MO 8: The 5th metatarsal head of foot	1	6,02	2,032	140,000	,239	6,61	1,08	134,000	,265
	2	6,70	,849			6,12	,901		
MO 9: pollex	1	10,47	3,362	175,500	,895	11,58	2,06	166,500	,915
	2	11,07	1,664			11,42	1,822		
MO 10: 2nd finger of foot	1	4,22	1,437	173,500	,848	3,97	1,69	167,500	,939
	2	4,50	1,589			3,77	1,34		
MO 11 : 3.4.5. fingers of foot	1	7,38	2,464	145,000	,304	7,50	2,21	143,000	,409
	2	8,07	2,875			7,05	2,714		

\*\* P < 0.01 \* P < 0.05

It was found that there was difference between female volleyball players and control group only in the tips of 2nd metatarsi (Figure 1: M05) of right and left feet, and that there were similar results in other parameters. It was reported in the studies (Aydos, 2011; Eils et al., 2002; Uzun, 2012, 2013) that particularly in several sports branches, there was difference in tips of 2nd metatarsi in both female and male athletes and in subjects not doing sport. This may be attributed to weight exercises to the M05 (Figure 1) site on soles, overloading in matches, and strength of particularly the upper extremities in the subjects doing sport. It was determined that the volleyball sport leads to less change in maximal pressure distributions of the sole than both basketball and wrest sports. The fact that this change is higher in basketball players and wrestlers and lower in volleyball players may stem from the gender difference in the studies conducted shouldn't be ignored.

In a study conducted on 22 people using 19 shoes of different models on different pressure sensors, the effects of the distribution of regional forces on the foot-sole on shoe production was

examined. All of the shoes were high quality running shoes. Mechanical characteristics of the shoe was determined using a device measuring the pressure, and the pressure distribution and data on natural walks made at a speed of 3.3 m/sn were collected. It was seen that the pressure was increased more in medial foot sides than lateral in foot strikes on 22 models. In this study, the distribution of pressure inside the show was analyzed and the statistical relationships between shoe production and shoe-related complaints were determined (Hennig & Milani, 1995).

According to the study results, a linear and positive relationship was found between age, length, body weight, body mass index (BMI) and the contact area of right-left foot and maximal forces (0.01 and 0.05). Lowness of the pedobaragraphic records in the volleyball players may be attributed to age, BMI, and lower extremities' having a strong and durable balance. Moreover, differences were found in 11 contact areas on the sole, and in maximal force on several sites of right and left feet between volleyball players and control group. The reason of this is thought to

Table 3: Comparison of Right and Left Feet Maximal Forces of Female Volleyball Players (1) and Control Group (2) [N]

Variables	Group	Right Foot				Left Foot			
		Mean	S.D	Mann-Whitney U	P	Mean	S.D	Mann-Whitney U	P
foot- TOTAL	1	891,25	105,60	166,500	,693	886,91	105,24	166,500	,693
	2	888,20	124,28			890,56	123,47		
MO1: The medial part of heel	1	297,37	54,23	153,500	,438	292,61	52,13	153,500	,438
	2	288,67	43,96			321,66	68,46		
MO 2: The lateral part of heel	1	242,98	41,27	178,500	,965	260,01	46,00	178,500	,965
	2	249,05	46,63			267,95	55,75		
MO 3: midfoot	1	158,12	99,11	172,000	,815	175,48	93,46	172,000	,815
	2	153,57	80,27			140,38	110,37		
MO 4: The 1st metatarsal head of foot	1	140,20	77,03	163,500	,630	162,38	57,94	163,500	,630
	2	130,18	79,50			151,22	64,03		
MO 5: The 2nd metatarsal head of foot	1	174,84	44,81	109,000	,038*	189,68	38,42	109,000	,038*
	2	209,07	44,68			199,75	38,49		
MO 6 The 3rd metatarsal head of foot	1	191,50	66,46	159,000	,539	181,25	33,55	159,000	,539
	2	206,55	41,09			192,26	40,48		
MO 7: The 4th metatarsal head of foot	1	129,00	63,24	162,000	,599	111,28	28,83	162,000	,599
	2	130,50	36,00			129,86	33,64		
MO 8: The 5th metatarsal head of foot	1	86,90	48,91	159,500	,549	81,83	48,65	159,500	,549
	2	74,48	25,55			63,56	22,22		
MO 9: pollex	1	155,72	77,47	156,500	,492	164,93	66,54	156,500	,492
	2	132,71	57,46			135,26	51,26		
MO 10: 2nd finger of foot	1	32,72	10,58	154,500	,456	29,55	10,45	154,500	,456
	2	33,72	20,57			25,53	16,03		
MO 11: 3.4.5. fingers of foot	1	31,94	17,44	167,500	,715	34,93	22,48	167,500	,715
	2	35,13	21,91			27,20	19,09		

\*\* P < 0.01 \* P < 0.05

Table 4: Correlation between Physical Structure and Foot-Sole Variables of Female Volleyball Players and Control Group (2)

Variables	Age		Height		Body Weight		BMI	
	1	2	1	2	1	2	1	2
Right Feet Contact Areas Total	,380	,397	,723**	,058	,504*	,349	-,350	,262
	,119	,083	,001	,807	,033	,131	,155	,264
Left Feet Contact Areas Total	,201	,357	,736**	,007	,816**	,236	,002	,204
	,440	,123	,001	,977	,000	,315	,994	,389
Right Feet Maximal Forces Total	-,156	,471*	,649**	,204	,886**	,919**	,331	,703**
	,535	,036	,004	,389	,000	,000	,180	,001
Left Feet Maximal Forces Total	-,121	,424	,665**	,205	,940**	,876**	,286	,664**
	,668	,062	,007	,387	,000	,000	,301	,001

\*\* P < 0.01 \* P < 0.05

be that the basketball players use their feet much more actively and effectively than the control group. In a study titled "The interaction between wrestling shoes and wrestling mats", Newton et al., (2002) examined the effect of sweat on the friction produced between wrestling shoes and a wrestling mat. The study examined the factors that help friction and the vertical and linear force occurring between the tap and wrestling mat surface were measured. The study evaluated variations in friction when using 3 different types of old and new shoes and 12 positions on new /old and wet/ dry wrestling mats. The friction coefficient was found to be 36% higher in the new mat than in the old mat and was found to be 23-28% lower in old shoes than in new shoes. The highest friction coefficient for a more secure grip (thereby reducing the risk of ankle and knee injury) was found when combining a new mat and a new shoe (Newton et al., 2002).

In a study where Fong et al. (2008) had 15 people wearing cloth shoes and evaluated the time-pressure integral with 10 testing walks on a walking road on a 5 m. long wood which were dry, sandy, wet and lubricated and compared 9 parts on the foot-sole for surfaces that are oily or not, while the peak pressure increased by 30% on the pollex, time-pressure integral increased by 79% and in the lateral fingers the increase was by 34%. Peak pressure on the medial and lateral heel decreased by 20-24%. During the walk on the lubricated surface, the peak pressure increased from outside to inside, and the time-pressure integral increased from inside to outside. Based on these results, it was demonstrated that peak pressure walking surface of the time-pressure integral can be affected by other variables (age, height, body weight) (Fong, Mao, Li, & Hong, 2008).

According to the results of this study conducted on female volleyball players and control group, in comparison of the measured age, length, body weight, body mass index, maximal force and contact area of right and left feet, it was seen that foot contact areas were similar, and with respect to the pressure applied to the sole, the maximal forces in tips of 2nd metatarsi of right and left feet of volleyball players was lower than in the control group. In comparison of pedobarographic records between the two groups, when reviewed the total results, it was seen that the

results of both contact area and maximal force were insignificant (0.01 - 0.05), but that the results were higher for the control group. Based on the study results, it may be concluded that the wrestling sport caused more effects on the sole due to several reasons such as anatomical structure of the feet, body weight, foot movement range, feet's being more forced in several positions (Aydos, 2011), that the basketball sport caused less effect on the contact areas (Uzun, 2012) and that the volleyball sport caused less change on the sole.

## Conclusion

According to these results, it may be concluded that there is a correlation between the sport being done by female volleyball players and the variables of the sole, that the sport they do does not harm the sole, and that particularly the shoes they use are successful in supporting and protection the sole.

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# Conformity of athletes: roles of type of sports, gender and competition experience

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*Original scientific paper*

## Abstract

The subject of the present research was conformity as athletes' behavioural manner toward coach and club management. The aim of study was to establish differences in the conformity degree between groups of athletes, categorized under 3 criteria: type of sports, gender and athletes' competition experience. Sample of examinees was consisted of 160 athletes. The research instrument was conformity scale (The Conformity Scale, Mehrabian, & Stefl, 1995), used and confirmed in 2 earlier researches of Vučković et al. (2009, 2010). Data were analysed by non-parametric Mann-Whitney test. Upon analysis, it's been confirmed that: a) athletes are bigger conformists toward coach than club management, b) team sport athletes are bigger conformists toward coach, c) there no differences between male and female athletes in conformity toward coach and club management, d) there is no statistically significant differences between experienced and less experienced athletes in their conformity degree toward coach and e) less experienced athletes expressed bigger conformity toward club management in all examined statements .

Key words: **conformity, athletes, coaches, club management**

## Introduction

Sport coaches and sport sociologists think that every sport team must have clearly defined social relations between athletes, coaches and club management. The most common attachment of socialization process is conformity (Koković, 2000, 82). Conformity is one's adjustment to attitudes, opinions and behavioural forms and to a certain group standards. Conformists easily adapt themselves to a sport team and club discipline. They are favourite players of authoritarian and tenacious coaches. Uncertain, intellectually unformed, frustrated, authoritarian persons with lower group social status are more susceptible to conformity. Marjanović (1995) has researched conformity of 40 girls and 40 boys, students of Belgrade high schools utilizing Asch's technique. Analysis of variance has shown that degree of conformity is significantly higher in gender homogenous groups than heterogeneous ones. The highest degree of conformity was noted among males in regard to instructed male subjects, followed by girls in regard to instructed female subjects, after those girls in regard to instructed male subjects and the least degree of conformity was present at males in regard to instructed female subjects. Atkinson (2002) has investigated for three years reasons why Canadian women undergo tattooing. He concluded that one of the main reasons for that was pressure from social environment. Conducting a research on 149 students, Niemand (2006), based on 11 items Lickert scale, found that women were bigger conformists than men in terms of life and racial prejudices. He stated that majority of authors came to the conclusion that women were bigger conformists. Joksimović and Matić (2006), were examining value orientations among 628 adolescents, and they mea-

sured degree of conformity by scale that contained statements of inevitability to accept opinions of majority, importance of group fitting and adjustment to demands and expectations made by others. Positive relationship between conformity and altruistic value orientation was explained by student-conformists' desire to be popular and accepted. Conformity was more evident among students whose parents had lower educational level. Such parents insisted on respect for authority and adoption of conformity values. Researches of athletes' conformity indicate that players- newcomers quickly adjust their behaviour to older players and the team leader (In: Carron, 1980). Younger adolescents and their parents have great expectations from coaches (Martin et al., 1999). They think that coaches should be educated, competent, ambitious, hard working, etc. Authors conclude that young players have low level of conformity because: a) their relatively short sport experience and b) parents' involvement in sport activities. Sherman et al. (2000) explored attitudes of Australian athletes about "coach's preferable behaviour". Amongst other things, authors concluded that female athletes had more tolerance for coach's autocracy, in other words they were bigger conformists than male athletes. After talks he had with doped athletes, Mendoza (2002) claimed that certain percentage of athletes used doping because they have seen other athletes used it too. Jowett and Cockerill (2003) made analysis of relationships between Olympic medal winners and their coaches, and they consider athletes' readiness for complete concordance with coach's training rules and principles indicator of "positive conformity", because such relationship had led to success. Vučković and Gadžić (2009) not-

ed high degree of conformity in basketball players of Bosnia and Herzegovina toward coach, and moderately elevated toward club management. They found surprising (and disappointing!) disposition of players who approve club management interference with coaches' professional and educational expertise. Conducting further research of relations between basketball players' social characteristics and their conformity toward coach, Vučković et al. (2010) established non existence of significant relations between a majority of basketball players' social characteristics and their conformity toward coach and club management, which indicates that some other factors were responsible for high conformity of basketball players. Authors expressed surprise with such findings because a number of authors claimed that athletes' conformity was in a large proportion influenced by social factors. Finally, they conclude that primary determinant of tested basketball players' conformity could be coaches' quality (their managerial style, knowledge, experience, reputation, etc.). Group pressure should not be ignored either, which consequently results in individual conformity. Voelker et al. (2011) have analysed experiences of ex captains from high school basketball teams (7 male, 6 female). All examinees stated that they received little or no practical advices from coaches that could help them in performing captain duties. Their behaviour was based on previous life experiences, such are: a) observations of predecessor captain (conformity) and b) learning through trial and error. Steinfeldt et al. (2011), examined conformity among 143 females athletes and non athletes according to gender norms in sports, sport participation and own body perception. Results shown that female athletes and non athletes do not differ in conformity degree to "female norms", however, female athletes had higher level of conformity to "traditionally male norms", such are: high desire for winning, taking risks, aggressiveness, strength.

Definitely, considering coach-athlete relations, a number of researches have shown high degree of conformity among athletes, regardless individual or team sports (In: Wildman, 2006).

Study aim was to establish differences in the conformity degree between groups of Bosnia and Herzegovina athletes, categorized under 3 criteria: 1) type of sports (individual or team sport), 2) gender and 3) athletes' competition experience (less and more or equal to 10 years). Based on quantitative indicators, certain conclusions have been drawn. These conclusions, alongside few more future studies, should contribute in creation of theory of athletes' conformity as a final goal.

## Method

### Examinees

Sample of examinees was consisted of 160 athletes from 8 sports. Out of that number, 79 were female, and 81 were males. There were 81 athletes involved in individual sports (athletics, tennis, karate, and boxing) and 79 in team sports (basketball, football, handball, volleyball). Average age of athletes was 25 years and 2 months, and competition experience 9 years and 10 months.

Table 1. Differences between individual and team sport athletes in conformity degree

	Leader	Conspl	Coastr	Coaide	Manres	Manben	Manwor	Opman
Mann-Whitney U	3041.50	2699.50	2743.00	1979.50	2760.00	3105.50	1482.00	1754.50
Z	-.797	-2.297	-1.766	-4.537	-1.584	-.345	-6.080	-5.125
Asymp. Sig. (2-tailed)	.426	.022	.077	.000	.113	.730	.000	.000

## Instruments

Modified Conformity Scale was used as the research instrument (*The Conformity Scale*, Mehrabian, & Steffl, 1995). Modification considered lingual adaptation of statements, without change of its essence. Internal reliability of modified conformity scale was  $\alpha = .57$ . In previous Vučković et al. (2009, 2010) researches, where same research instrument has been used, reliability was  $\alpha = .74$ .

Conformity related statements were: 1) "Coach is the team leader and therefore should be respected" (Leader); 2) "It is a good thing when coach consults athletes regarding certain questions" (Conspl); 3) "Coach is under a lot of stress, so even when he makes a mistake, he should be understood and forgiven" (Coastr); 4) "All coach's ideas should be obediently realized" (Coaide). Statements referring to conformity toward club management were: 1) "Club management runs the club and therefore should be respected" (Manres); 2) "Club management is benevolent, its only interest is the prosperity of the club" (Manben); 3) "Club management should have influence on coach's professional work (content of trainings, player's treatment by the coach, etc.)" (Manwor); 4) "Opinion of club management regarding professional issues (player's quality, player's competitive level form, etc.) must be respected" (Opman). Athletes have evaluated their agreement with provided statements on five point Likert scale, where point 1 stands for "strongly disagree", point 2 – "partially disagree", point 3 – "unsure", point 4 – "partially agree" and point 5 – "strongly agree" Dependant variables were: 1) type of sport (individual or team sport), 2) gender and 3) competition experience (less and more or equal to 10 years).

## Procedure

Questionnaire procedure has been conducted in specially selected room within training hall. Apart from interviewer and athletes nobody else attended procedure.

Hypotheses of difference between two means were tested by non-parametric Mann-Whitney test.

## Results

It is notable from table 1 that statistically significant differences exist between individual and team sports in statements "It is a good thing when coach consults athletes regarding certain questions" (Conspl), "All coach's ideas should be obediently realized" (Coaide), "Club management should have influence on coach's professional work (content of trainings, player's treatment by the coach, etc.)" (Manwor) and "Opinion of club management regarding professional issues (player's quality, player's competitive level form, etc.) must be respected" (Opman). In statements: "Coach is the team leader and therefore should be respected" (Leader), "Coach is under a lot of stress, so even when he makes a mistake, he should be understood and forgiven" (Coastr), "Club management runs the club and therefore should be respected" (Manres) and "Club management is benevolent, its only interest is the prosperity of the club" (Manben) no significant differences were found.

Table 2. Descriptive statistics in regard of type of sport

	GROUP	N	M
Leader	1	81	4.79
	2	79	4.78
Conspl	1	81	4.68
	2	79	4.84
Coastr	1	81	4.11
	2	79	4.43
Coaide	1	81	4.00
	2	79	4.42
Manres	1	81	3.91
	2	79	3.65
Manben	1	81	3.49
	2	79	3.51
Manwor	1	81	3.27
	2	79	1.85
Opman	1	81	3.96
	2	79	2.97

Legend:

GROUP 1 – individual athletes

GROUP 2 – team sport athletes

N – Number of athletes by group

M – Arithmetic mean for answers on five point Likert scale

Table 2 reveals size and direction of differences between groups of athletes in proposed statements. Two facts are easy to notice: a) athletes of both groups are bigger conformists toward coach than to club management and b) team sport athletes are bigger conformists toward coach, and athletes from individual sports toward club management respectively.

Results from table 3 show existence of statistically significant differences between male and female athletes in statements: “Coach is the team leader and therefore should be respected” (Leader) and “Club management is benevolent, its only interest is the prosperity of the club” (Manben).

After analysis of tables 3 and 4, it could be learned that for majority of statements there are no significant differences in conformity degree between male and female athletes.

From table 5 it is obvious non existence of significant differences between less experienced and experienced athletes in conformity degree toward coach. On the other hand, significant differences do exist in all statements referring to conformity toward club management.

Although statistically insignificant, older athletes are somewhat bigger conformists toward coach (Table 6). Younger athletes are significantly bigger conformists toward club management.

Table 3. Differences between male and female athletes in conformity degree

	Leader	Conspl	Coastr	Coaide	Manres	Manben	Manwor	Opman
Mann-Whitney U	2695.50	2900.00	2760.50	3195.50	2760.00	2001.00	2788.00	3060.00
Z	-2.541	-1.374	-1.699	-.015	-1.586	-4.398	-1.457	-.495
Asymp. Sig. (2-tailed)	.011	.169	.089	.988	.113	.000	.145	.621

Table 4. Descriptive statistics in regard to athletes' gender

	GROUP	N	M
Leader	1	81	4.89
	2	79	4.68
Conspl	1	81	4.80
	2	79	4.71
Coastr	1	81	4.20
	2	79	4.34
Coaide	1	81	4.19
	2	79	4.23
Manres	1	81	3.58
	2	79	3.99
Manben	1	81	3.12
	2	79	3.89
Manwor	1	81	2.43
	2	79	2.71
Opman	1	81	3.48
	2	79	3.47

Legend:

GROUP 1 - male

GROUP 2 - female

N - Number of athletes by group

M - Arithmetic mean for answers on five point Likert scale

## Discussion

Analysing **individual and team sport athletes**, it could be said that both groups are to a great extent conformists toward coach. Team sport athletes are a little bit bigger conformists toward coach. These findings are very close to Vučković and Gadžić (2009) results. Examining conformity of senior basketball players, they noticed high level of confidence in coach and willingness to submit his psycho-physical demands. Moreover, this is in concordance with opinion of the most famous North American sport sociologist. In his numerous studies (Carron, A. et al., 2002a, 2002b, 2003, 2005), Carron claimed that for team success, among other things, it is essential to have athletes' conformity toward coach. Comparing successful and unsuccessful American teams at Atlanta Olympic Games, Gould et al (1999) investigated causes of failure for certain teams. Besides lack of team cohesion, experience and mental readiness, authors suggest that low level of conformity toward coach, additionally contributed to poor results. Athletes who were not ready to completely obey coach and his programme made poorer results. In their research of athletes' inclination to individuality or collectivism, McCutcheon and Ashe (1999) found that “individualists” - persons who devalue collective effort to success, underrate importance of relations within team and prefer high level of personal autonomy and self-sustaining. Despite the fact of somewhat lower level of individual athletes conformity toward coach noticed in this research, it is very clear that level is quite sufficient (on scale from 1 to 5, it equals  $\approx$  4.4).

Table 5. Differences between less experienced and experienced athletes in conformity degree

	Leader	Conspl	Coastr	Coaide	Manres	Manben	Manwor	Opman
Mann-Whitney U	2921.50	2864.00	2925.00	2844.50	1932.50	2002.00	2073.50	2056.00
Z	-.074	-.343	-.042	-.353	-3.778	-3.576	-3.186	-3.257
Asymp. Sig. (2-tailed)	.941	.732	.966	.724	.000	.000	.001	.001

Table 6. Descriptive statistics in regard to athletes' competitive experience

	EXPERIENCE	N	M
Leader	1	103	4.78
	2	57	4.81
Conspl	1	103	4.75
	2	57	4.77
Coastr	1	103	4.22
	2	57	4.35
Coaide	1	103	4.18
	2	57	4.25
Manres	1	103	4.01
	2	57	3.37
Manben	1	103	3.71
	2	57	3.12
Manwor	1	103	2.84
	2	57	2.07
Opman	1	103	3.73
	2	57	3.02

Legend:

COMPETITIVE EXPERIENCE 1 - athletes < 10 years (less experienced)

COMPETITIVE EXPERIENCE 2 - athletes ≥ 10 years (experienced)

N - Number of athletes by group

M - Arithmetic mean for answers on five point Likert scale

Considering conformity of individual and team sport athletes toward club management, it could be surprising the opinion of individual athletes that club management should have influence on coach's professional and educational work. Probably, this is a case for athletes (particularly tennis players) whose parents are members of club managements.

**Male and female athletes** expressed higher conformity toward coach than to club management. In majority of statements there were no differences found between male and female athletes in conformity toward coach and club management. This result is inconsistent with findings of Niemand (2006) and Sherman et al. (2000) who concluded that women were bigger conformists than men.

Conformity degree toward coach has shown no differences between **less experienced** and **experienced** athletes. However, less experienced athletes expressed bigger conformity toward club management in all provided statements. It seems that less experienced athletes have weaker understanding of club management role. It is essential to be involved in sports for a number of years in order to clearly distinguish coach's role from club management one. Different authors have obtained diverse results. Martin et al. (1999) concluded that older players are bigger conformists. Earlier researches, summarised by Carron (1980) indicate that younger players are bigger conformists. Opposite to those findings, Vučković and Gadžić (2009) did not find statistically significant differences between older and younger basketball players in their level of conformity.

## Conclusion

Conformity toward coach of tested athletes is at high level. Having in mind opinion of world leading sport sociologists, that is quite all right, because without athletes' readiness to accept coach's way of work there is no success. On the other hand, results obtained in present research indirectly speak about quality of coaches. Apparently coaches have high professional, educational, working and ethical qualities and therefore "deserve" conformity of athletes they have been coaching. To a certain extent, surprising is equal conformity of male and female athletes toward coach and club management, considering that results of majority of previous researches have shown female athletes to be bigger conformists than male athletes. (To) high level of conformity of less experienced athletes toward club management has been attributed to their poor knowledge about assignment of duties between coach and club management. Some future research should include open type questions, where athletes could explain their opinion about given statement. Moreover, it would be useful to compare conformity of Bosnia and Herzegovina athletes with conformity of world elite athletes (for example Olympic level athletes).

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# Blockade of peripheral nerves and prevention of unwanted consequences

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Original scientific paper

## Abstract

The Regional anesthesia is evolving rapidly and becoming increasingly popular. The reason is that conductive anesthesia is widely integrated in the treatment of pain, during the pre, intra and postoperative period. Nerve blocks are available for the management of sports related injuries and injection of local anesthetics in the vicinity of nerve is used for both diagnostic and therapeutic purpose in sports medicine. However, regional anesthesia carries certain risk from nerve injury, caused by intraneural injection. For their prevention today are in use few different methods, but the nerve injury can still occur.

The purpose of this work is to determine the values of pressures which appear during intraneural and perineural application of local anesthetic, and to compare those values in order to avoid cases of intraneural injections in clinical practice with consequential complications.

In this experimental study there have been used 12 Wistar rats. After general anesthesia, the sciatic nerves (n=24) were exposed bilaterally. Under the direct visual control, the needle was placed intraneural or perineural and 3 ml of lidocaine 2% was injected using an automated infusion pump (3 ml/min). Injection pressure data were acquired using a manometer coupled to a computer. After application and awakening from general anesthesia, the animals were subjected to neurological examination during the next 7 days.

Even though all perineural injections resulted with the pressure  $\leq 27,92$  kPa, the majority of intraneural injections were combined with the injection pressure  $\geq 69,8$  kPa. The difference between average values of intra and perineural injections (with 95% safe interval) was significant ( $t=3,14$ ;  $df=6$ ;  $P=0,02$ ). Also, residual neurologic impairment was present only in those hind limb after intraneural injections which was associated with injection pressures  $> 69,8$  kPa.

Injection application in different tissues results in different values of injection pressures, which depends on structure, compactness and elasticity of tissue. As long as the injection pressure is low, injection into poorly compliant tissue can be avoided and the neurological damage can be prevented.

Key words: **sport injuries, nerve blocks, injection pressure**

## Introduction

Regional anesthesia is evolving rapidly and increasing in popularity as evidences by the large number of publication on the topic (1,2,3). This is because conductive anesthesia is widely integrated in the treatment of pain, during the pre, intra and postoperative period. With its application, we can suppress pain from various injuries, sprains, dislocations, bone fractures, pain caused by nerve root compression or pain due to inflammatory processes.

Peripheral nerve block is commonly performed to provide surgical anesthesia and postoperative analgesia. Nerve blocks are available for the management of sports related injuries and injection of local anesthetics is used for both diagnostic and therapeutic purpose in sports medicine (4,5).

## Sažetak

Regionalna anestezija se razvija veoma brzo i postaje sve popularnija. Razlog tome je što je regionalna anestezija široko integrirana u terapiji bola, u toku pre, intra i postoperativnog perioda. Blokade perifernih nerava se koriste kod sportskih ozljeda, a injiciranje lokalnih anestetika u blizini nerava ima primjenu i za dijagnostičke i terapijske svrhe u sportskoj medicini. Međutim, regionalna anestezija nosi određeni rizik od nervne ozljede, prouzrokovane intraneuralnom injekcijom. Za njihovu prevenciju danas su u upotrebi nekoliko različitih metoda, ali ozljede nerava se još uvijek dešavaju.

Cilj ovog rada je ustanoviti vrijednosti pritisaka koji se javljaju tokom intraneuralnih i perineuralnih aplikacija lokalnog anestetika, i usporediti te vrijednosti kako bi se izbjegli slučajevi intraneuralnih injekcija u kliničkoj praksi sa posljedičnim komplikacijama.

U ovoj eksperimentalnoj studiji koristi smo 12 Wistar pacova. Nakon opće anestezije, ishijadični nervi (n = 24) su bili izloženi bilateralno. Pod direktnom vizualnom kontrolom, igla je plasirana intraneuralno ili perineuralno, a 3 ml 2% lidokaina je ubrizgano koristeći automatsku infuzionu pumpu (3 ml/min). Podaci o pritisku su dobiveni pomoću manometra spojenim za kompjuter. Nakon aplikacije i buđenja iz opće anestezije životinje su podvrgnute neurološkom pregledu tokom narednih 7 dana.

Iako su sve perineuralne injekcije rezultirale pritiskom  $\leq 27,92$  kPa, većina intraneuralnih injekcija su bile udružene sa injektionim pritiskom  $\geq 69,8$  kPa. Razlika između prosječnih vrijednosti intra i perineuralnih injekcija (sa 95% sigurnosnim intervalom) je bila značajna ( $t= 3,14$ ;  $df = 6$ ,  $P = 0,02$ ). Također, rezidualni neurološki deficit bio je prisutan samo na onim stražnjim ekstremitetima nakon intraneuralnih injekcija udruženih sa injektionim pritiskom  $> 69,8$  kPa.

Injekciona aplikacija u različita tkiva rezultira različitim vrijednostima injektionog pritiska, što ovisi o strukturi, kompaktnosti i elastičnosti tkiva. Sve dok je injektioni pritisak nizak, injekcija u slabo popustljivo tkivo može biti izbjegnuta, a neurološka ozljeda prevenirana.

Ključne riječi: **sportske ozljede, nervne blokade, injektioni pritisak**

Nerve damage after regional anesthesia is appropriately regarded as a major complication. There are many possible causes for such injuries. One causative factor that has been the subject of intense discussion involves the direct intraneural injection of local anesthetics. The deleterious effect of such injuries was demonstrated by Salander nearly 30 years ago (6). Since that time, we have been advised to avoid direct contact between the needle and nerve.

Scientists have been searching for a method which would prevent intraneural injection. Today are in use few different methods: paresthesia, peripheral nerve stimulator and ultrasound. However the injury can still occur, independent from the used techniques.

Injection application in different tissues results in different values of injection pressures, which depends on structure, compactness and elasticity of tissue.

The purpose of this work is to determine the values of pressures which appear during intraneural and perineural application of local anesthetic, and to compare those values in order to avoid cases of intraneural injections in clinical practice with consequential complications.

## Materials and Methods

In experimental study there have been used 12 Wistar rats (300-350 g, 3 months old). Animals were housed in central animal care facility and given rat chow and water ad libitum. The study was performed at the Faculty of Medicine in collaboration with Columbia University from New York. All study procedures were approved by the Ethical Committee of the Faculty of Medicine University of Sarajevo.

On the day of experiment, the rats were anesthetized with pentobarbital sodium (30 to 50 mg per kilogram of body weight) administered intraperitoneally. The sciatic nerves (n=24) were exposed bilaterally through a gluteal muscle-splitting incision using aseptic technique. Under the direct visual control, the needle (Becton Dickinson Microlance 000800), with the diameter 27 G (gauge), 12,7 mm long cut, under the angle of 45°, in the direction distal - proximal was placed intraneural (subperineural) into sciatic nerve on one side, and then perineural (subepineural) to the other side of both examination groups. Using the automatic syringe charger (PHD2000; Harvard Apparatus, Holliston, MA), which regulates the volume and the speed of applied solution, in previously mentioned structures we applied 3 ml of 2% lidocaine (Bosnalijek, Sarajevo), with speed of 3ml/min.

In this study the following methods have been used:

1. Measuring and analyzing of intraneural and perineural injection pressure
2. Evaluation of neurological status of the animals

- The data of achieved pressures during intraneural and perineural applications we registered using the manometer (PG5000; PSI-Tronics Technologies Inc, Tulare, CA) (Figure 1.) connected to the computer by analogue digital converter (DAQ card 6023; National Instruments, Austin, TX), The data of pressures we analyzed using the special software package BioBench 1.2; National Instruments, Austin, TX, intended for registration and analysis of data which are obtained in various medical researches, as well for educational needs. In this study we used BioBench program in order to register and analyze the values of pressures during intraneural and perineural application, registering also the time interval needed for the application.

After executed injection application and awakening of animals from general anesthesia the methodic neurological examination has been implemented, in certain time intervals (immediately after awakening, each two hours during the 12 hours of first day, and one time during next 7 days). Neurological examination has been conducted by Thalhammer's neurological examination (7), and included assessment for the proprioception, motor function and nociception by the following criteria:

- Proprioception was evaluated by testing postural reactions (tactile placing response - the rat was kept in a normal resting posture, toes of one foot were flexed with their dorsal

placed onto the supporting surface, and the ability to reposition the toes was evaluated). The functional deficit was graded as: 0 - normal; 1 - slightly impaired; 2 - severely impaired; 3 - absent.

- Motor function was evaluated by measuring the extensor postural thrust: the rat was held upright with the hind limb extended so that the body's weight was supported by the distal metatarsus and toes, and the extensor postural thrust could be measured as the force applied to the digital balance, the force that resists contact of the platform balance by the heel. The reduction in the force, representing reduced extensor muscle tone, was considered as a deficit of motor function and expressed as a percentage of the control force.
- Nociception was evaluated by observing the withdrawal of the limb in response to a noxious stimulation as:  
4 - normal withdrawal reaction, brisk withdrawal of the paw, vocalization, bites the forceps;  
3 - slower withdrawal reaction, weaker withdrawal of the pinched extremity, vocalization, no attempts to bite the forceps;  
2 - slow withdrawal reaction, no vocalization, no attempts to bite the forceps;  
1 - barely perceptible withdrawal, no vocalization, no attempts to bite the forceps;  
0 - no withdrawal, no vocalization, no attempts to bite the forceps;  
The lasting of block is defined as time which passes until the response returns to score 3 (75 % of normal).

**Statistics:** Statistical analysis has been executed by using SPSS program, version 11.5. Maximum pressure value during intraneural and perineural injection has been compared using paired t-test. The occurrence of neurological injuries is compared between intraneural and perineural injections using McNemar's test for paired proportions. P value < 0.05 is considered significant.

Figure 1. Manometer



## Results

### The results of acquired application pressures

All injections were characterized by increase of pressure in the beginning of application, resulting in maximum pressure, which was then followed by significantly lower pressure during the remaining part of application.

Even though all perineural injections resulted with the pressure  $\leq 27,92$  kPa, the majority of intraneural injections were combined with the injection pressure  $\geq 69,8$  kPa.

In rats, during intraneural applications, the maximum pressure was 124,13 kPa, while the minimum pressure was 69,8 kPa, achieved in peak effect. Maximum pressure reached in all perineural applications was 26,52 kPa and minimum was 13,26 kPa, also achieved in peak effect (Charts 1, 2).

The average value of maximum pressure achieved in peak effect for intraneural injection was  $94,23 \pm 30,01$  kPa (the average value  $\pm$  standard deviation), in comparison to  $23,03 \pm 5,58$  kPa for perineural injection ( $P \leq 0,05$ ). The difference between average values of intra and perineural injections (with 95% safe interval) was significant ( $t=3,14$ ;  $df=6$ ;  $P=0,02$ ).

Chart 1. Intraneural application in rats

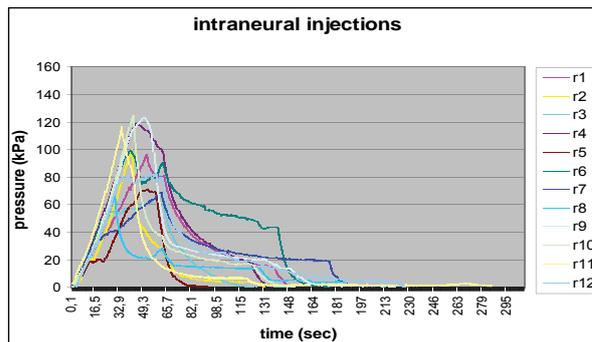
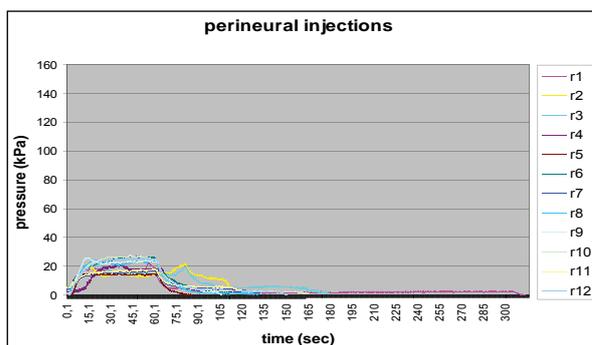


Chart 2. Perineural application in rats



### Results of neurological examination of experimental animals

After executed neurological exam, it has been established that all intraneural injections joined with high application pressure resulted with failings which lasted more than 24 hours, and neurological deficits were evident yet at the end of experiment, after 7 days, which clearly shows that intraneural injection caused the nerve damage. On the contrary, all injections combined with low injection pressure, whether they intraneural or perineural didn't result

with neurological sequels at the end of experiment. Furthermore, in most cases neurological deficit has withdrawn within first 24 hours of experiment, (Charts 3,4,5).

Chart 3. Proprioception of hind limb after injection application of 2% of lidocaine

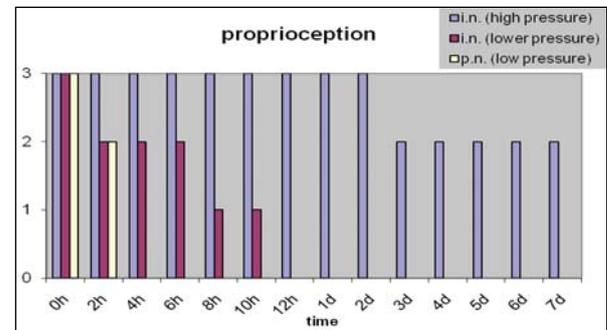


Chart 4. Motor function of hind limb after injection application of 2% of lidocaine

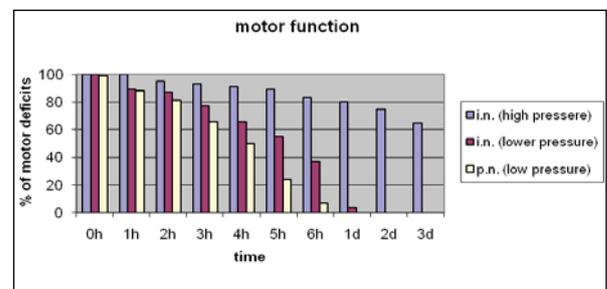
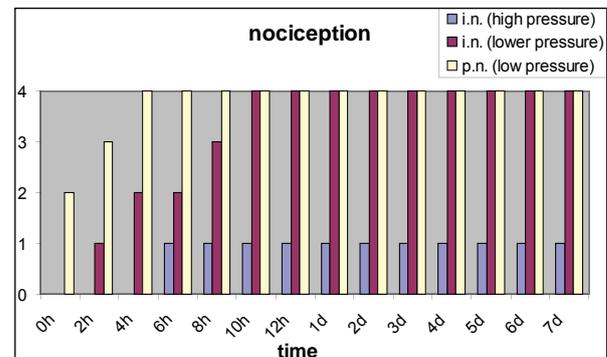


Chart 5. Nociception of hind limb after injection application of 2% of lidocaine



## Discussion

In the last few decades there has been a great development of regional anesthesia; all the postulates are defined and all the techniques of usage are perfected. The world trend of favoring various techniques of regional anesthesia is a result of the advantages that the regional anesthesia comes with, especially in comparison with the general anesthesia, like avoiding hemodynamic instability and lung complications and enabling faster mobilization and earlier release of the patients to their homes (8). In this healthcare environment, continual assessment of the safety and efficacy of clinical practice is critical. Neurologic complications of regional

anesthesia can result in disability and are feared by patients and clinicians. Our study shows that detection of pressure during peripheral nerve blocks is unique as a nerve localizing technique in terms of being able to avoid needle-nerve contact and potentially prevent direct trauma to nerves.

The incidence of permanent nerve damages during periphery nerve blocks varies between 0,02% and 0,04%, depending on the type of damage and the amount of time spent observing (9). The incidence of persistent neurological damage decreases with time. The proofs of neurological abnormality can be found in 19 % of patients in first 24 hours, then they are decreasing to 3-8% through 4-6 weeks, and in 1 year they are reduced to 1% (10).

Based on the available data it can be noticed that so far none of the methods of prevention of unwanted complications of regional anesthesia can insure the avoidance of intraneural injection of local anesthetic. There are many discussions about how to prevent intraneural injection and nerve damage coupled with periphery nerve block, and all debates are focused on methods of nerve localization (paresthesia, nerve stimulator and ultrasound).

The oldest method in detection of nerve structures during peripheral nerve blockade is method of paresthesia. Many anesthesiologists intentionally cause paresthesia during the execution of periphery nerve blockade in order to reliably localize nerve structures. But causing paresthesia can represent a direct trauma with needle and theoretically increased risk of neurological injury. Selander and associates reported a high incidence of nerve damages in patients that had parasthesia that was intentionally caused during the axillary block (11). Aurory and associates noticed that all cases of radiculopathy, after blockade of periphery nerve, were coupled either with paresthesia during the placement of the needle or with painful response to injection and they had the same topographic distribution like connected paresthesia (12). Does causing parasthesia present direct needle trauma, which increases the risk of nerve injury, still remains questionable. However today there is a tendency toward the abandonment of this method in many centers.

In present clinical practice for the detection of nerve structures most often are used periphery nerve stimulators. However, it should be pointed out that the nerve stimulators used in blockade of peripheral nerves quite vary in their characteristics, like stimulating frequencies, maximal production of voltage, duration of stimulus and their preciseness (13,14).

Today's progress of ultrasound technology enables visualization of nerve before the insertion of a needle, which represents one new, not invasive method in localization of nerve structures in procedures of regional anesthesia. Observing the advancement of a needle in real time under ultrasound navigation improves the preciseness and safety of the procedure of peripheral nerve block. Ultrasound apparatus sends sound waves with the frequency greater than 20,000 cycles per second (20 kHz). Ultrasound controls the beam under the laws of reflection and refraction. However, the quantity of ultrasound reflection depends on acoustic mismatch. Propagation through dense objects, like bone for example which is filled with almost all reflected rays of ultrasound, produces hyperechoic (bright) image, as a strong signal returned to the emitter. In the contrary, fatty tissue and tendons have low reflection, therefore they produce hypoechoic (dark) images. The contours of structures are best delineated when the ultrasound beam is used under the angle of 90 degrees. Generally speaking, in transversal presentation the nerves can be seen as round or

oval structures which are nodular and hypoechoic, usually with centrally located hyperechoic shadow (15,16,17).

So far the experience of using ultrasound in procedures of regional anesthesia showed to be useful for the following: visualization of nerves which helps in defining the best place for the insertion of a needle, placement and advancement of a needle securing the real time navigation of the needle towards the targeted nerve, which avoids or at least minimizes unnecessary randomized movements by executor in trying to achieve wanted level of anesthesia and observation of spreading of local anesthetic during the injection securing its deposit around the nerve.

Contrary to high successfulness in achieving wanted level of anesthesia and even higher safety during the procedure of regional anesthesia, the use of ultrasound method has also some important disadvantages (high price of ultrasound apparatus, making it less accessible, and its big size, making it less portable). This is exactly what distinguishes our methods, detection of nerve structures using application pressure. Also, presently available ultrasound technology does not differentiate between peripheral nerves and tendon fibers, which with sometimes poor picture resolution presents additional disadvantage of this method.

Anesthesiologists often rely on subjective estimate of abnormal resistance to injection during the performance of periphery nerve block, knowing that intraneural injection results with bigger resistance to injection. Hadzic and associates showed that the perception of the resistance can rather vary among the anesthesiologists and that this method is inconsistent and can be affected by different designs of needles (18). The earlier studies carried out on rabbits showed that generally higher pressure (higher than 76,78 kPa) is needed in order to inject local anesthetic into intraneural space, in comparison to paraneural application (19). Also the injection of local anesthetic into sciatic nerve of a dog resulted in high application pressure (20,21). In our study the majority of intraneural injections into sciatic nerve of rats were combined with injection pressure greater than 69,8 kPa, while not even one perineural injection resulted in pressure greater than 27,92 kPa.

As in previous studies, in our study as well all perineural injections of local anesthetic (appropriate doses and concentrations) have not resulted with significant damage of nerve fibers.

In contrast to perineural injections, the intraneural injections of local anesthetic may result with nerve damage. In summary, high injection pressure during intraneural injection may be indicative of intrafascicular injection and predicts development of neurologic injury.

## Conclusion

Based on our research it is obvious that the measuring of pressure during the nerve blockade is very important in order to decrease the risk of neurological complications. It is also clear that a small, mobile, and financially quite available apparatus for pressure measurement can help in differentiation between paraneural and intraneural injection. Avoiding high injection pressure prevents from lodging the needle into intraneural space followed by consequential complications.

The usage of this apparatus can find its application in other blockades of periphery nerves, and in other branches of medicine as well, for example in everyday practice of giving intramuscular

injections of different medicines (antibiotics-penicillin, corticosteroids and similar) into gluteal or deltoid region, because the application into different tissues results with different values of injection pressures, which greatly depends on structure, compactness and extensibility of the tissue.

The method of monitoring application pressure in detection of neural structures is still in its developmental stage, and the clinical experience of its usage is limited. However this study shows that there exist a great potential in improvement of block performance resulting in better successfulness and lesser risk of lesions of nerves and blood vessels. In the near future the monitoring of injection pressure might exist in order to avoid intraneural injection and to more objectively document the procedure of periphery nerve block. Applying these results to clinical practice, during periphery nerve blocks, the risk of unwanted complications can be reduced. It should be pointed out that none of the techniques can be a substitute to a good knowledge of anatomic relations.

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# Coordination tests predictive value on success during the performance of dance and aerobics motion structures

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*Original scientific paper*

## Abstract

The aim of this study was to determine the predictive value of coordination tests in achieving of students success at the Faculty of Sport and Physical Education in the performance of stylized movement structures in classes of Dance and Aerobics. The significance of this research is to define those coordination tests that have a real / realistic predictive contribution of achieving success in these classes during the study and could be rightly used for selection of students in universities entrance examination.

The sample for this study consisted 80 students (male) third academic year at the Faculty of Sport and Physical Education in Sarajevo. The sample of variables to evaluate coordination consisted three tests: (MKRKUS) - side steps, (MKROSS) - eight with bending, (MKRBUB) - not rhythmic drumming. The variables for the estimation of basic dance structures (total of 9 variables) and aerobic movement structures (a total of 5 variables) accounted for the dance elements of the English waltz, Vienna waltz, Cha-cha-cha and the basic steps Hi-low aerobics.

All of these movement structures students learn and pass within the practical teaching of dance and aerobics in universities. Assessment of success performing stylized movement structures was undertaken by three competent evaluators, numerical grade from one to five, corresponding Linker scale of assessment. To determine the significance of the predictor variables of the system (coordination tests) on each criterion (the total efficiency in dance and total efficiency in aerobic) it was used Regression analysis.

Results of regression analysis confirmed a significant predictive contribution to tests of coordination in achieving success in performing stylized movement structures of the male sample. Test of coordination in rhythm, not rhythmic drumming - (MKRBUB) has the highest predictive value, and therefore it is suggested that as one of the measuring instruments should be included in a battery of tests for selection of students in the entrance exam and admission to the Faculty of Sport and Physical Education.

Key words: **relation, coordination, dance, aerobics**

## Introduction

Sports dancing can be described as a specific combination of art and sport, which in an original way allows a dance pair a unique expression of sincere emotion provoked by various music and converted in harmony and fluency of most beautiful movement and motions (Lukić, 2011). The art of connecting and synchronization of complex dance structures of different dances, in a certain rhythm, time and space, causes the aesthetic impression, is what makes dancer an artist. The basics of dance form the basis for many other aesthetic movement activities. For example, hi-low aerobics as a form of recreational exercise takes the basic steps and connecting them to the dance aerobics choreography with appropriate musical accompaniment. In view of the fact that

aerobic was built on the foundations of dance is not surprising that these two areas are treated side by side. It is indisputable that the quality of technical performances and artistic movement structures of dance and aerobics depends on a wide range of motor skills and coordination among them takes an important place. Coordination (lat coordination - regulated entities) is a basic motor skill that is specific to its significant points in relation to other motor skills. It is believed that coordination is the least explored motor skill. Regardless, through its indirect indicators, her factors can point us to the level of its development and success. Coordination is the ability of athlete to dominate the distinctive and economical movements in expected situations (stereotype), unplanned situations (adaptation) and relatively quickly overcome sports movement (Frey, 1977, according Weineck, 2007). It is

believed that the high level of coordination skills is basic precondition for the efficient performance of stylized movement structures, their development and successful use. In previous studies of relations and size of the impact of basic motor skills on success in sports where is predominant the performance of stylized movement structures prevailing attitudes that the most important motor skills are: coordination (Kioumourtzoglou et al., 1997; Rutowska-Kucliarska and Bober 1998; Šebić –Zuhrić 2003), coordination in rhythm (Wolf-Cvitak 1984; Srholtj 1989; Persicshini et al., 1998; Jelavic-Mitrovic et al. 2006.), flexibility (Srholtj, 1989; Hume et al., 1993) and power (Wolf-Cvitak 1984; Srholtj 1989; Hume et al., 1993).

Coordination as a global neurological power quality has a dominant role in achieving success in many sports disciplines. Good coordination is essential for learning and mastering new motor tasks. Studies at the Faculty of Sport and Physical Education are very specific and demanding a serious task that should satisfy the prospective students is an entrance exam. Candidates are selected on the basis of the evaluation results of the entrance exam, which consists of a series of motor tests, and greater number of these tests is exactly coordination tests. The interest of this study was to determine whether there are coordination tests that have a significant predictive value in relation of achieving success in the field of stylized movement structures which students will be encounter with in course of the study subjects in the Aerobics and Dance.

## Method

The sample for this research is consisted of 80 male students in stable phase of growth without any cognitive, conative or motor aberrations. All students are regularly involved in teaching the subject Aerobics, Rhythmic gymnastics and dance. It was estimated their success in performing stylized movement structures that form an integral part of the examination from these cases and

3 tests to evaluate of coordination abilities: side steps (MKRKUS), eight with bending (MKROSS) and, not rhythmic drumming (MKRBUB). The variables for the evaluation of basic dance structures (total of 9 variables) are consisted of: English Waltz - basic Step (EVALBA), turn in place (EVALOK), turn in space (EVALP) Viennese Waltz - basic Step (BVALBA), turn in place (BVALOK), turn in space (BVALPR) cha- cha- cha - basic step (CACABA), the opening of New York (CACANY), turn (CACAOK). Variables for evaluation of aerobic movement structures (a total of 5 variables) are accounted of the basic steps of hi-low of aerobic: side to side (ASTS), leg curl (ALEC), V step turn (AVST), box step (ABOX) and chasse mambo (ASMA). To determine the significance of the predictor variables of the system (coordination tests) on each criterion (the total efficiency in dance and the total efficiency in aerobic) it was used Regression analysis.

Assessment of success performing stylized movement structures was undertaken by three evaluators, a professor of sport and physical education, numerical grade from one to five what corresponds to Linkers scale of assessment (Table 1).

Table 1. Criteria for evaluation of stylized movement structures of dance and aerobics

## Results and discussion

Relations between the investigated areas of coordination and dance movement structures are shown in the matrix Cross-correlations (Table 2). The variable not rhythmic drumming (MKRBUB) achieved the highest number of statistically significant relationships with all other variables to estimate movement structures of dance. A statistically significant relationship has achieved variable for assessing the coordination side steps (MKRKUS) with variables for assessing structure of Cha-cha-cha dance. This relationship is quite logical because the basic step of this is just sideways movement of the "chasse" step is very similar to the side steps that are performed in the test side steps.

ASSESSMENT	GENERAL IMPRESSION TECHNIQUE	COORDINATION OF MOVEMENT	ERROR PERFORMANCE
<b>5 (five)</b>	The technique is fully correctly.	The optimal range of motion and suitable speed and rhythm of performance. Extremely good coordination of the whole body. Element is refined aesthetic.	No mistakes in the initial position, body position, foot position, hand position, and the final position.
<b>4 (four)</b>	Less insecurity and inaccuracy.	The optimal range of motion, slightly slower performance.	The maximum number of minor faults 1-3.
<b>3 (three)</b>	Elements are still performed well but there is uncertainty and inaccuracy.	Lack of range of motion, a smaller loss of balance, improper posture, but the whole structure of the movement is not disrupted.	The maximum number of minor faults 2-4.
<b>2 (two)</b>	The technique is significantly affected, loss of balance. There was a violation of the structure of the movement.	Low tension of all muscles, violated the balance position, the movement is incomplete. The obvious is poor coordination of the whole body.	There are major errors in almost all of the above technical requirements.
<b>1 (one)</b>	The technique is completely wrong done, the greater the loss of balance or fall.	Poor range of motion, there are larger gaps and structure of the movement is substantially violated complete loss of balance or fall.	Elements is poorly performed, with many faults, it does not recognize the structure of the movement.

Table 2. Matrix Cross-correlations coordination and dance movement structures

	IVALBA	EVALOR	EVALPR	BVALBA	BVALOK	BVALPR	CACABA	CACANY	CACAOK
<b>MKRKUS</b>	-,161	-,196	-,114	-,291	-,242	-,171	<b>-,407</b>	<b>-,369</b>	<b>-,380</b>
<b>MKROSS</b>	-,157	-,230	-,118	-,277	-,258	-,233	-,233	-,248	<b>-,306</b>
<b>MKRBUB</b>	<b>,336</b>	<b>,441</b>	<b>,451</b>	<b>,503</b>	<b>,488</b>	<b>,450</b>	<b>,415</b>	<b>,457</b>	<b>,436</b>

Relations between the studied areas of coordination and aerobic movement structures are shown in the matrix Cross-correlations (Table 3). The greatest number of statistically significant relationships was again variable not rhythmic drumming (MKRBUB), while the variable side steps (MKRKUS) and eight with bending (MKROSS) achieved in most cases considerably smaller and statistically insignificant low correlation with other variables for assessing aerobic movement structures.

Table 3. Matrix Cross-correlations coordination and aerobic movement structures

	<b>ASTS</b>	<b>ALEC</b>	<b>AVST</b>	<b>ABOX</b>	<b>ASMA</b>
<b>MKRKUS</b>	-,225	-,248	-,281	-,289	-,272
<b>MKROSS</b>	-,117	-,181	-,188	-,243	-,106
<b>MKRBUB</b>	<b>,541</b>	<b>,576</b>	<b>,545</b>	<b>,469</b>	<b>,606</b>

In processing the data by applying regression analysis it has been defined the criterion variable as the first principal component in which is condensed overall efficiency in the performance of dance structures (PLESUE), which is then projected in space of predictor variables (tests of coordination). The value of the coefficient of multiple correlation (Table 4) is  $R = 0.633$ , which indicates that the applied system of predictors (tests of coordination) was statistically significantly connected with the criteria variable (success in performing dance movement structures). This explains 40% of common variability ( $R^2 = 0.401$ ). An insight into contribution of individual predictive variables of coordination, variable not rhythmic drumming (MKRBUB) has statistically significant predictive contribution to the level of sig-

nificance, 000 The variable side steps (MAGKUS) is located on the verge of statistical significance and its contribution to the level of significance is 0,072. To Understand and identify the rhythmic configuration allows a cognitive ability, and performance of dance structure allows component of rhythmic abilities. Moving in rhythm is consequence of natural instinct for movement, and rhythmic skills are developed in parallel with motor skills (Miletic, 2006). The impulse for action, i.e. moving in rhythm of music manifests by tapping, knocking or clapping and it is easily visible by the listener. In perception of rhythm the whole body is engaged with the five primary skills: a sense of duration, a sense of intensity, auditory imagination, motor imagination and motor impulse (Seashore, 1960).

Authors Metikos & Hosek (1972) had defined the dimension of coordination in rhythm as the ability to perform a set movement in a given or arbitrary rhythm. Later research (Hosek et al., 1973) confirmed good psychometric properties of some tests (MBUB, MPLH, MP3R, MPUK, MBNR) for assessing hypothetical factors of coordination in rhythm. Viskić - Štalec, (1989) has isolated the factor of coordination in rhythm and it is interpreted as a factor stimulation of rhythm movement on the sample of 693 men aged between 19 and 27 years.

### Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	<b>,633</b>	,401	,377	,957

### ANOVA

Table 4. Regression analysis of overall efficiency in the performance of dance structures

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	46,600	3	15,533	16,937	<b>,000</b>
	Residual	69,702	76	,917		
	Total	116,302	79			
Model		Unstandardized Coefficients	Standardized Coefficients	t	Sig.	Model
		B	Std. Error	Beta		
1	MKRKUS	-,268	,147	-,172	-1,826	<b>,072</b>
	MKROSS	,093	,067	,135	1,401	,165
	MKRBUB	,206	,032	,608	6,431	<b>,000</b>

In processing the data using regression analysis it has been defined the criterion variable as the first principal component of which is condensed overall efficiency in performing movement structures (AEROUE). Criterion variable is as a latent dimensions projected in space of predictor variables consisting of 3 coordination tests.

Observing results of the regression analysis (Table 5), we conclude that the multiple correlation coefficient  $R = 0.514$ , which indicates how the system is applied predictors (tests of coordination) was statistically significantly connected with the criteria variable (success in performing aerobic steps). This explains 26% of common variability ( $R^2 = .264$ ). An insight into predictive contribution of variables of coordination only one variable not rhythmic drumming (MKRBUB) has statistically significant predictive contribution at the level of significance 0,001. By the similar data in the study came Jelavić-Mitrović et al. (2006), where a statistically significant contribution in explaining the association of predictors (motor skills) with the criterion (dance steps), there are only with variables for assessing coordination in rhythm (MKRBNR) where  $\beta = .68$  at the level of significance of 0.00.

The cognitive factor that is very noticeable in the coordination of their stronghold finds in Fleishman's (1955, By: Hosek, 1981) definition of the coordination as a motor intelligence. This is repeatedly confirmed in previous studies e.g. Ismail and Gruber (1967), Mejovšek, (1975). However, there is another approach, which is also based at the previous one, but his main goal was to calm the effects of previous approaches, but, more importantly, provide a more systematic insight into the essence of the phenomenon of movement coordination. This approach, called in theory and as a functional, which originates from the theoretical settings Bernstein (1947), Anokhin (1970), Chaidzea (1970) and empirically-based settings Kurelić et al. (1975), Gredelj et al. (1975), based on the identification of functional mechanisms latently contained in a complex system of functioning of the central nervous system. Rhythmic coordination of movement is determined by the central nervous system. Scientists have suc-

ceeded, thanks to precision technology of measuring instruments to find a place in the brain that coordinate the movement and rhythm. One such place is cerebellum, so called little brain which its actions in everyday situations "helps" big brain, because it regulates and develops repetitive movements. The second place in which comes to the coordination of rhythm and movement is under the area of large brain called the basal ganglia which participates in a complicated, unusual movements. Basal ganglia's in these moments send electrical vibrations which are spread in brain and fulfill rhythm of coordinated the muscles responsible for performance of movement structures. Motor skills and neurological processes of a healthy brain can be trained by rhythmic coordination of movements. The simplest example of this is the art of dance movements in the proper rhythm. Conscious knowledge of steps and listening to music, we determine their rhythm (slow or accelerated motion). Dancing awareness of the desired motion directs the activities of the brain. With training where the movements performed in a set rhythm of the music we are improving brain activity in the community and with him we achieve the desired results. The theory of Multiple Intelligence, by Hauard Gardner (Gardner, 1983, by Miletic, 1999), suggests that there are at least seven ways in which we process and understand information from the external world. Among others, this theory promotes the body-kinesthetic intelligence - the wisdom of the body and the ability to control physical movement and musical-rhythmic intelligence - the ability to recognize sounds and sensibility of rhythm. From the all the above it is clear that the ability, of coordination in rhythm cannot be ignored, and that the test "not rhythmic drumming" has a significant predictive contribution of achieving success in performing dance and aerobics stylized movement structures.

### Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,514	,264	,225	,880

### ANOVA

Table 5. Regression analysis of overall efficiency in performing movement structures

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	15,822	3	5,274	6,805	,001
	Residual	44,178	57	,775		
	Total	60,000	60			
Model		Unstandardized Coefficients	Standardized Coefficients	t	Sig.	Model
		B	Std. Error	Beta		
1	MKRKUS	-,181	,163	-,137	-1,112	,271
	MKROSS	-,039	,071	-,072	-,554	,581
	MKRBUB	,118	,033	,437	3,608	,001

## Conclusion

This study represents one of the researches in area of polystructural aesthetic activities of dance and aerobics, activities which aim to achieve an aesthetic criterion for performing a specified movement with the rhythm of music. Proper technical execution of the aesthetic movement structures requires an excellent sense of rhythm, and plasticity of expression and movement. Powerful and dynamic rhythmic accents make the movement structures harmonious and such motion that satisfies the basic aesthetic criteria. That is why it is not surprising that tests that assess coordination of in rhythm have the highest predictive value in achieving success in the execution movement structures of dance and aerobics. Tests for estimating coordination in rhythm have particular prominent place in many other disciplines, so that may have justified its practical applicability in the selection of students on the entrance exam of the Faculty of Sport and Physical Education.

Estimated level of rhythm coordination abilities in the student population creates the preconditions for the successful implementation of teaching and improving the quality of work on the subjects Rhythmic Gymnastics, Dance and Aerobics.

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# Situation efficacy of basketball players and number of extreme evaluations on a Likert scale

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*Original scientific paper*

## Abstract

The main objective of this study was to determine the correlation between the frequency of extreme estimations on Likert's scales in psychological measuring instruments and the parameters of situational efficacy at Croatian elite senior basketball players. The final sample of 74 players is selected from the initial sample of 107 senior male basketball players from the teams in A-1 Croatian basketball league championship in 2006/2007. The results revealed that the correlation between the number of extreme estimations of the certain instruments for measuring the conative characteristics and perceived team cohesion with the parameters of situational efficacy is not statistically significant. However, the size of canonical correlation and a number of statistically significant univariate correlations, indicate the importance of considering potential reasons for this correlation, such as controlled risk taking and taking responsibility for the success of the team.

Key words: **canonical correlation, conative characteristics, performance**

## Sažetak

Glavni cilj istraživanja bio je utvrditi povezanost čestine ekstremnih procjena na skalama Likertova tipa psihologijskih mjernih instrumenata s parametrima situacijske učinkovitosti vrhunskih hrvatskih seniorskih košarkaša. Finalni uzorak od 74 košarkaša, selekcioniran je iz inicijalnog uzorka od 107 košarkaša devet muških seniorskih momčadi A-1 Hrvatske košarkaške lige iz prvenstva 2006/2007. Rezultati su pokazali da povezanost između broja ekstremnih procjena u pojedinim instrumentima za mjerenje konativnih karakteristika te percipirane kohezije momčadi s parametrima situacijske učinkovitosti nije statistički značajna. Međutim, visina kanoničke korelacije i veći broj statistički značajnih univarijantnih korelacija ukazuju na važnost razmatranja potencijalnih razloga ove povezanosti, kao što su upravljana sklonost riziku i preuzimanje odgovornosti za uspjeh momčadi.

Ključne riječi: **kanonička korelacija, konativne karakteristike, izvedba**

## Introduction

Basketball is a complex pollystructural, variable activity for which cycle and acycle types of movement prior to a basic goal of the game are characteristic, as well as to block the opponent player to make a shot. The game itself in course of the play is divided into three basic phases: defense, attack and transition (Jukić, 1998). It is a complex team sport made of simple and compound movement whose main goal is, under conditions of collaboration of all team member and opposition with rival team, to make a shot as well as blocking the opponent team player to make a shot (Gabrijelić, 1977). Basketball can be seen as series of duties every player has to perform regarding place and role inside a team within a certain concept of the play (Tomić, 1995). The basic assumption for successful activity of the individual in terms of accomplishment of series of mentioned duties is an assembly of chosen characteristics, of the anthropological status, linked into an integral set of optimal sport readiness. With regard to the characteristic of the play and numerous limitations defined by the rules of the play, playing basketball requires following characteristics: optimal morphological characteristics (the importance of height); high level of physical condition (functional capacity); high level of development of all motor capacities; a large number of motor and informatics knowledge with high level of practice (large number of repetition). Basketball scientific research so far examined relations of the elements of described equation of specification and achievement in basketball. The problems of the described research were defining situation condition of the play, relations between indicators of situation efficacy and the result in the basketball competition (match, championship, or tournament). Latent structure of the situation space of the basketball

play had been analysed, and we determined anthropological characteristics and indicators of the situation efficacy of each type of basketball player. Monitoring and analysis of the situation efficacy of the players and teams in the basketball play contribute to the easier following for the spectators and it is extremely helpful for the coaches and basketball experts as a material for the comparative analysis of the players and team as a whole and as a such have their place in the planning and programming coach process (Maršić, 1999, from Nakić, 2004). For the purpose of monitoring events at the basketball matches FIBA (Federation International Basketball Association) standardized thirteen indicators of situation efficacy observed at every official match. On the base of these indicators it is possible to calculate different derived parameters, on problems of measuring a real quality of basketball players there have been numerous scientific research (Elbel and Allen, 1941, Dežman, 1996, Erčulj, 1997, Swalgin, 1994, 1998, Dizdar, 2002). These kinds of research were mainly directed to develop expert systems for evaluation of real quality of the basketball players (Swalgin, 1994, Trninić, Perica, Dizdar, 1999). Therefore distinctions, gained by different methods of evaluation, of the real quality of basketball players were compared with estimation of basketball experts (experienced experts) on quality of the play of evaluating basketball players (Swalgin, 1998, Dizdar, 2002). Dizdar (2002) classified two basic methods for evaluation of overall efficacy or real quality of basketball player: procedures for objective evaluation of the situation efficacy of basketball players and procedures for subjective evaluation of situation efficacy of basketball players whose main characteristic is subjective evaluation of the independent group of basketball experts who define a group of basketball players with one or more criteria.

It turned out that the most common variants with variable of the overall quality of basketball players, has a method for estimation of overall quality of basketball players "PC system for evaluation of basketball players". However, it is equally efficient a method of *partially pondered linear combination* (Dizdar, 2002) which uses coefficient of the score efficacy instead of statistic data on number of achieved points and number of unsuccessful scores which we use in this research. As it turned out that there was no statistically significant association between a set of variables from conative space (mental toughness, one-dimensional and multidimensional perfectionism and perceived group cohesion) with sets of variables of situational effectiveness of basketball players (Sindik, 2009). Therefore, we attempted to correlate extreme values in the evaluation of Likert – type scales with sets of variables of situational effectiveness of basketball players. Sindik (2006) has summarized the results of three previous own studies, in which psychology students achieved significantly lower scores on the "control scale of numbers used in the extreme estimations." They use significantly less extreme values in the evaluation of responses to the assertions with Likert-type scales of psychological measuring instruments, in relation to all other tested group. Results are explained with assumption of "mental health" desirable answers of psychology students. In fact, knowing more about "neurotic" or "mental health" view, undesirable patterns of behaviour, in order to maintain a positive self image, psychology students may give answers according to their own vision of "mentally healthy" person. And since the psychology students know the control scales for measuring test behaviour, for example socially desirable answering, it is probable a hypothesis about the specific "selfscreening tested behaviour" (to avoid giving relevant information about yourself to the examiners). When they do not know what answer to a particular item is desirable, psychology students prefer neutral evaluation ("neither agree nor disagree") rather than complete agreement or complete disagreement with the contents of the items. In other words, the number of extreme values used to estimate Likert – type scale could be used not only as a "rough" indicator of testes behaviour not only of the entire sample of the subjects (e.g. psychology students), but also as an indicator of test behaviour of individuals.

Thus, in this study is assumed that the use of more extreme estimations in the population of "non – psychologist" may reflect not only valid respond to the items in the questionnaire, but also one's tendency to take risk, inclination to determination, acceptance of responsibility (Sindik, 2009). Therefore, it has been used four last variables as predictors of success in basketball, linked to the use of extreme estimations on scales of individual measurement instruments. The main objective of this study was to determine the number of used extreme estimations on the scales of psychological measuring instruments with parameters of situational efficacy of top Croatian senior basketball players. The detection of connection of situational efficacy in basketball with these variables could contribute to better understanding of the overall situational efficacy of top Croatian senior basketball players. On the other hand, we assumed that it could contribute to better work of coaches, who could, with gained knowledge, focus their own action, on the basketball training and competition.

## Methods

### Subjects

The population from which the intentional sample of subjects is taken represented a top senior basketball players from nine

male senior teams Croatian A-1 men's basketball league from 2006/2007 championship: «Cedevita», «Svetlost», «Borik», «Kvarner», «Dubrava», «Dubrovnik», «Alkar», «Šibenik» and «Osijek». Age range of participants was large (17-40), with average age of  $23.94 \pm 4.89$ . The final sample of participants (74 basketball players) was selected from the initial sample of 107 participants. The requirement for the selection of players in the final sample was at least 10 minutes in the game per match and minimum of eight matches in which individual participated. Team players were tested with the permission of Croatian Basketball Federation, clubs and the players themselves, within a period of playing 6<sup>th</sup> to 8<sup>th</sup> round of A-1 league championship (from December 2006 to mid-January 2007).

### Variables

Criteria for quantitative evaluation of the players were taken from previously referenced and published papers (Dizdar, 2002). In this paper we used a method of *partially pondered linear combination* for evaluation of overall quality of basketball players (Dizdar, 2002). There are thirteen standard situational efficacy parameters which include data on the success of shots for one, two or three points, rebounds (offensive and defensive), won and lost balls, assistances, blocks, personal fouls. Based on the standard parameters of situational efficacy, there was seven performed coefficients of situational efficacy of basketball players: effectiveness of two-point shots, three – point shots, effectiveness of free throws, efficacy of two points shots, efficacy of three point shots, efficacy of free throws and overall situational efficacy (Dizdar, 2002). Number (frequency) of "extreme" evaluation on the estimation scales of evaluation for each item in the psychological measurement instruments, thus number of estimation for items in which estimation of agreement with the contents of the items were the maximum, number of estimations for items where the estimations of agreement with the contents of the items were minimal and the overall number of estimations for both "extremes", i.e. the number of maximum and minimum estimations on the extreme points (not at all true/agree or completely true/agree) of the Likert scale (Sindik, 2006), in the questionnaires: SHS (Short Hardiness Scale); MSSP (Multidimensional Sport Perfectionism Scale); BPS (Burn's Perfectionism Scale); GEQ (Group Environment Questionnaire). The overall sample of the matches was consisted of sixteen matches for each team. Thus, there is "double-round" system of competing where every team with each of the other teams plays one match in "domestic" and one match in "visitor" field.

### Statistical analyses

In addition to the usual indicators in the field of descriptive statistics, for a detailed analysis of the relationship of individual variables between two data sets (parameters of situational efficacy and number of extreme evaluation) we have calculated Pearson's univariate correlation and canonical correlation using software package Statistica.

## Results

The values of the means and standard deviations, obtained for the standard and derived parameters of situational efficacy are obvious in the Table 1. Based on the value of max D, it can be seen that from the normal distribution statistically significantly deviate unsuccessful one-point shots, assistances and number of offensive rebounds. Distributions are direct consequence of standard parameters involved in the linear combination of these parameters of situational efficacy. All distribution of numbers of extreme estimations on items of all measurement instruments

are distributed normally. In order to compare the average number of extreme estimations for different measuring instruments there were used the results of the relative values of arithmetic mean (absolute value of arithmetic mean divided by the number of items for each measuring instrument). The highest relative number of extreme estimations was used in the MSSP, while the lowest was in the GEQ. However, it should be noted that different scales of estimations in different measuring instruments could partially condition the average number of used extreme estimations. The average deviation for number of used extreme estimations is calculated by dividing the absolute value of standard deviation with the number of items for each measuring instrument. The highest relative number was for the GEQ, while for the other measuring instrument was the same.

The canonical analysis tried to correlate the number of extreme estimations in each instruments for measuring conative characteristics and perceived cohesion of the team with standard pa-

rameters of situational efficacy. Table 2 shows that first canonical root is not statistically significant and that there is no correlation between overall set of variables of standard parameters of situational efficacy and the number of extreme estimations in the instruments for measuring conative characteristic and perceived cohesion with the senior team players of A-1 Croatian men basketball league. We got only one pair of canonical factors that is approaching the threshold of statistical significance ( $R=0,322$ ;  $p=0,065$ ), i.e. we got one pair of canonical factors that is statistically significant. The first canonical factor is in the space of standard parameters of situational efficacy of the basketball players has following characteristics: number of unsuccessful one-point shot, number of rebounds in the defense phase and number of rebounds in the attack phase. In the space of variables of the numbers of extreme estimations for questionnaires of conative characteristics and perceived group cohesion of basketball players, the first canonical factor has following characteristics: number of extreme estimations in the questionnaires MSSP and UGO.

Table 1 - Descriptive statistics of situational efficacy of variables and number of extreme estimations of top Croatian basketball players from A-1 league

Variable	Mean	Minimum	Maximum	Std.Dev.	Skew.	Kurtosis	Max D
Situational efficacy							
successful two-point shots	<b>34,03</b>	2,00	115,00	<b>22,71</b>	1,07	1,14	0,12
unsuccessful two-point shots	26,99	4,00	79,00	15,71	0,93	0,92	0,08
successful three-point shots	12,00	0,00	39,00	9,23	0,74	0,07	0,11
unsuccessful three-point shots	23,12	0,00	61,00	16,52	0,51	-0,56	0,12
successful free throws	24,12	1,00	72,00	16,19	0,94	0,51	0,14
unsuccessful free throws	10,22	0,00	97,00	12,38	4,90	33,01	<b>0,21**</b>
number of assists	22,51	1,00	105,00	<b>19,27</b>	2,23	6,13	<b>0,18*</b>
offensive rebounds	13,88	1,00	48,00	10,68	1,28	1,32	<b>0,17*</b>
defensive rebounds	<b>31,20</b>	2,00	87,00	<b>19,40</b>	0,84	0,35	0,09
steals	14,45	0,00	34,00	<b>7,77</b>	0,24	-0,60	0,07
personal fouls	<b>33,23</b>	4,00	64,00	12,10	0,08	-0,49	0,09
turnovers	21,39	3,00	55,00	11,59	0,69	-0,31	0,13
successful two-point shots	0,54	0,17	0,72	0,10	-0,72	1,05	0,08
unsuccessful two-point shots	0,31	0,00	0,70	<b>0,15</b>	-0,39	0,68	0,16
successful three-point shots	<b>0,73</b>	0,40	1,00	0,13	-0,12	-0,29	0,07
unsuccessful three-point shots	<b>38,88</b>	0,67	147,77	<b>29,26</b>	0,74	0,14	0,14
successful free throws	8,84	0,00	34,97	7,67	0,51	-0,44	0,13
unsuccessful free throws	17,52	0,50	55,74	12,12	1,99	7,35	0,14
number of assists	100,51	-1,41	287,68	64,94	0,72	0,34	0,08
Extreme estimations - Short Hardiness Scale	6,34	0	15	2,89	0,49	0,54	0,11
Extreme estimations - Multidimensional Sport Perfectionism Scale	15,28	0	27	6,03	-0,24	-0,32	0,06
Extreme estimations - Burn's Perfectionism Scale	4,74	0	10	2,28	0,18	-0,09	0,13
Extreme estimations - Group Environment Questionnaire	6,82	0	16	4,47	0,09	-1,03	0,09

Legend: \* Max D is significant with  $p < 0,05$ ; \*\* Max D is significant with  $p < 0,01$

Table 2. Structure of canonical pairs for the first canonical factor of connections between situational efficacy of the basketball players and the number of extreme estimations on the instruments from a conative space.

Standard parameters of situational efficacy	Correlation with roots	Variance explained
successful two-point shots	-0,046	0,241
unsuccessful two-point shots	-0,108	
successful three-point shots	-0,202	
unsuccessful three-point shots	-0,292	
successful free throws	-0,275	
unsuccessful free throws	<b>-0,467</b>	
number of assists	-0,023	
offensive rebounds	<b>-0,310</b>	
defensive rebounds	<b>-0,378</b>	
steals	0,070	
personal fouls	0,076	
turnovers	-0,229	
Extreme estimations on psychological instruments	Correlation with roots	Variance explained
Extreme estimations - Short Hardiness Scale	0,012	0,061
Extreme estimations - Multidimensional Sport Perfectionism Scale	<b>-0,723</b>	
Extreme estimations - Burn's Perfectionism Scale	-0,075	
Extreme estimations - Group Environment Questionnaire	<b>-0,660</b>	
<b>Canonical correlation</b>	0,322	
<b>Significance</b>	p> 0,05	

The following canonical analysis examines the correlation between number of extreme estimations in certain instruments for measuring conative characteristics and perceived cohesion of the team with derived parameters of situational efficacy of the basketball players. However, we demonstrated that none of the canonical roots in this spaces was statistically significant ( $R=0,470$ ;  $p> 0,20$ ).

Table 3. Cross-correlations of parameters of situational efficacy and number of extreme estimations on the scales of conative characteristics and perceived cohesion at basketball players

Variables	Extreme estimations on Likert type scale for...			
	Short Hardiness Scale	Multidimensional Sport Perfectionism Scale	Burn's Perfectionism Scale	Group Environment Questionnaire
successful two-point shots	0,013	0,090	0,213	0,086
unsuccessful two-point shots	0,017	0,159	0,212	0,064
successful three-point shots	<b>0,231*</b>	0,101	0,229	<b>0,317*</b>
unsuccessful three-point shots	0,199	0,128	0,196	<b>0,321*</b>
successful free throws	0,119	0,163	<b>0,235*</b>	<b>0,255*</b>
unsuccessful free throws	0,012	<b>0,247*</b>	0,214	<b>0,249*</b>
number of assists	0,146	0,178	<b>0,329*</b>	0,119
offensive rebounds	-0,154	0,105	-0,082	0,001
defensive rebounds	-0,018	0,195	0,002	0,082
steals	0,124	0,013	0,181	0,111
personal fouls	0,050	0,104	0,142	-0,052
turnovers	0,151	<b>0,243*</b>	<b>0,358*</b>	0,231
utilization coefficient for two-points shot	0,179	-0,131	0,108	0,081
utilization coefficient for three-points shot	0,179	0,049	0,082	0,128
utilization coefficient for free throws	0,127	-0,128	0,069	0,037
coefficient of efficacy of three points shot	0,001	0,058	0,192	0,082
coefficient of efficacy of three points shot	0,217	0,082	0,217	<b>0,308*</b>
coefficient of efficacy of free throws	0,136	0,100	0,207	0,224
overall situational efficacy	0,073	0,120	0,200	0,179

Legend: \* correlation IS significant with  $p<0,05$

Despite the statistical insignificance of canonical correlation, table 3 there are several statistically significant correlations between standard parameters of situational efficacy and number of extreme estimations on the scales of conative characteristics and perceived team's cohesion. All obtained significant correlations have positive direction. At the level of number of extreme estimations, there are five significant positive correlations between number of extreme estimations for items in the GEQ and successful and unsuccessful shots for three or one point as well as efficacy of three point shots. Between number of extreme estimations for items in the questionnaire on BSP and successful one-point shots, number of assistance and number of lost points we can find positive and significant correlations. Between number of extreme estimations for items in the MSSP in the sport situations and unsuccessful shots for one point and number of lost balls, there has been found positive, low and statistically significant correlations. Only one significant correlation is found between number of extreme estimations for items of SHS and number of successful shots for three points. The most significant correlations with all the variables of numbers of extreme estimations from the standard parameters of situational efficacy have successful and unsuccessful shots for one point and number of lost balls (two significant correlations).

## Discussion

The main finding of this research is that correlation between the numbers of extreme estimations of the individual instruments to measure conative characteristics and perceived cohesion of the team with the parameters of situational efficacy is not statistically significant. However, the level of canonical correlation and larger number of statistically significant univariate correlations show the importance of analysing causes of this connection. At the level of standard parameters of situational efficacy, the most significant correlations with variables of numbers of extreme estimations have the successful and unsuccessful one-point shots and number of lost balls.

The simplest interpretation of these results would consist of confirmation that frequent use of extreme estimations may reflect a greater tendency to use "risky" technical elements in the game. These are the elements with a lower probability of positive outcomes (losses caused by risky passing the ball) or with higher probability of positive outcomes (one-point shot). Only one significant correlation between number of extreme estimations on the scales of conative characteristics and teams cohesion and derived parameters of situational efficacy refers to the positive correlation of the numbers of extreme estimations in a group environment questionnaire and efficacy of three points shot. It can be explain as a trend of potential takeover of responsibility (risk) of the player for three points shot. It is likely that such takeover of responsibility includes the discipline to assume liability (probably assigned by the coach) in the team in which he plays. Especially when it comes to three points shot, it is probable that the players who take risks are also more responsible and have more training for shots and have "permission" from the coaches to shoot at certain stages of the game. This interpretation of the relation of parameters of situational efficacy and number of extreme estimations may indicate a trend that basketball player's use of these technical elements that have high or low probability of positive outcome (e.g. One or three points shots) maybe can have tendency of accepting responsibility. And it can be reflected in a number of extreme estimations used in conative characteristic questionnaire. Conversely, it is probable that the players who avoid their own responsibility, prefer using technical elements that have mediocre

possibility of negative outcome (e.g. two point shots, rebounds, assistances) and use a low number of extreme estimations in the questionnaires. In other words, using extreme estimations in the items of the questionnaires may be reflections of the "tendency to risk", but also of the acceptance of the responsibility of basketball players for their own action in the situation of basketball game. Targeted risk in accordance with the coach and team mates is important for the outcome of the game, but in technical elements for which basketball player has good skills and in the situations (phases of the game) when this risk makes sense.

The main advantage of the study was the fact that all available players in the studied A-2 championship of the basketball league were tested. Hence, found laws can be applied for specific sample (practically the whole population) of basketball players and it can be incentive for quality coach work. However, on the lower possibility of generalization of results may influence the reasons: small and multiply selected sample of the subjects, the specificity of Croatian population of top senior basketball players, the specificity of particular competition (in the investigated championship neither team could fall out from the league, which could affect the less effort of the teams fighting for the staying in the A-1 league). In future research we could try to slightly increase the number of subjects (trying to test injured and from other reasons absent players), which can be achieved only minimally. The term "top player" in relation to enumerated specificity indeed varies considerably from country to country, depending on competitive quality of the competition in a specific country (which often depends on the financial possibilities of the clubs to the perspective players). On the quality of basketball players in our country it cannot be affected easily, expect in the long term, changing the system of the competition and financial possibilities of the clubs. Therefore, one of the solutions for further research and multiple replication of the same type research during the larger number of basketball championships, where this slight differences in the term of Croatian "top basketball player" may be reflected (Sindik, 2009). Finally, one must not forget that the use of extreme estimations can reflect the self-screening tendency, i.e. with the interpretation of "extreme estimations scale" as a control scale (Sindik, 2006). In relation to the response style, it is possible to give an interpretation from the pointview of "taking a clear position", the trend of giving categorical answers. As an addendum to this interpretation we have results: almost all correlations of the variables of extreme estimations with perfectionism (one-dimensional and multidimensional) are zero or negative direction. Determination to respond on the items, which is manifested in the more frequent choice of extreme estimations, may imply a somewhat more favourable attribution of the team. Furthermore, it is possible that the results reflect the tendency to provide extreme estimations in the direction of socially desirable responses, in the direction of lower perfectionism, greater mental strength, and greater perceived group cohesion. "Certainly, we must not forget that the number of extreme estimations in the questionnaires often interferes with the object of the measurement. There is a probability that the players who are in a constructive way more introspective (positively perfectionist) tend to give more extreme estimations in the questionnaires, and they are also more situational efficient. Nevertheless, the players of less successful teams probably take sometimes too much risk, losing at the same time self-criticism. It is likely that they shoot "without reasoning", have less successful assistances, etc. As indicated by the data on correlations between standard and derived parameters of situational efficacy with the number of extreme estimations in the questionnaires, but especially for the players of more successful and especially for the players of less successful teams (Sindik, 2009)

## Conclusion

The main finding of this research is that correlation between number of extreme estimations of the Likert – type scale in each instrument for the measurement of conative characteristics and perceived team cohesion with the parameters of situational efficacy is not statistically significant. However, a canonical correlation and a larger number of statistically significant univariate correlations indicate the importance of considering potential reasons for this association, such as controlled risk tendency and taking responsibility for the success of the team.

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# Identifying homogenous groups regarding situational-motor abilities of young football players

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## Abstract

In practical kinesiology, be it in sports training or in classes of physical education, it is often necessary to split the total amount of subjects (relatively homogenous sample) into a smaller number of homogenous groups in order to both adjust and bring in line the exercise training programs with characteristics and abilities of individuals. The number of homogenous groups or taxa is an issue which is, in statistics, dealt with by means of procedures of classification that we call taxonomic or cluster analysis (Rađo and Wolf, 2002). This research is an attempt to classify the total sample of 164 football players aged 12 to 14 described with six situational-motor abilities, in an optimum number of homogenous groups that have same or similar abilities. The aim of research was to display a model for objective selection making with young football players; creating preconditions for a better specific football training programming with this age group was also a focus of this study. Results show that five homogenous groups were isolated out of the total sample number of young football players; these are distinct in the number of subjects and their level of situational-motor abilities. Further analysis of the five isolated groups showed a latent structure of the research field; it is distinct on the basis of the number of isolated factors and the position of evident variables on these factors.

**Key words:** football players, taxonomic analysis, exercise training technology, homogenous groups

## Sažetak

U kineziološkoj praksi, bilo da se radi o sportskom treningu ili nastavi tjelesnog odgoja, često je nužno izvršiti podjelu većeg broja entiteta (relativno homogeni uzorak) na manji broj homogenih grupa kako bi se trenajni programi podesili i prilagodili prema karakteristikama i sposobnostima pojedinaca. Broj homogenih grupa ili taksona je problem koji se u statistici rješava postupcima klasifikacije koje nazivamo taksonomska ili klaster analiza (Rađo i Wolf, 2002). Ovo istraživanje je pokušaj klasifikacije ukupnog uzorka od 164 nogometaša uzrasta 12-14 godina, opisanih sa 6 situaciono motoričkih sposobnosti, na optimalan broj homogenih grupa koje imaju iste ili slične sposobnosti. Cilj istraživanja je bio da se prikaže jedan model za provođenje objektivne selekcije mladih nogometaša i stvaranja preduslova za kvalitetnije programiranje specifičnog nogometnog treninga kod ovog uzrasta. Rezultati pokazuju da se u ukupnom uzorku mladih nogometaša izolovalo pet homogenih grupa koje se razlikuju i u broju entiteta i u nivou ispoljavanja određenih situaciono motoričkih sposobnosti. Daljom analizom izolovanih grupa utvrđena je latentna struktura istraživanog prostora, koja se razlikuje i prema broju izolovanih faktora i prema položaju manifestnih varijabli na tim faktorima.

**Ključne riječi:** nogometaši, taksonomska analiza, trenajna tehnologija, homogene grupe

## Introduction

Footballers' motor abilities have so far been greatly analyzed and defined, but it is a fact that our knowledge of the variability of these abilities in the course of their ontogenetic development is still insufficient. Psychomotor abilities are predominantly genetically preconditioned; however, they are further acquired and changed through exercise training technology. This being the fact, there is the possibility to affect psychomotor ability improvement through appropriate exercise training means and methods. The motoric performance of any structural exercise in football (e.g. kicking, passing) is a complex action consisting of intellectual and motor abilities, technical and tactical knowledge i.e. it is the result of bodily activity linked to the optimal involvement of motor abilities. Therefore, the most acceptable definition of football motor abilities is that it is - the most rational and most intelligent, functional and deliberate performance of motor tasks with and without a ball in different in-game situations (Elsner and Metikoš, 1983). Situational-motor abilities have a common motor base defined by coordination, explosive power, movement and its frequency, preciseness and balance (Talović at al., 2010). Exercise training technology optimization with footballers of young age also depends on appropriate methodological information

which are a precious resource in planning and further programming of training sessions (Čolakhodžić at al., 2008; Jelešković at al., 2008). These facts serve trainers as a benchmark to adapting their training sessions properly. In football praxis, especially with footballers of young age, the problem of large inhomogeneous groups of children regarding the level of acquired motor performance is frequently encountered. In such situations, children that are inferior morphologically, functionally or because of their motor abilities can't catch up with children that are superior i.e. children that are on a higher level regarding certain skills and characteristics. Superior children's capacities are, on the other hand, restrained. Exercise training process should aim at acquiring optimum level of physical preparedness and discovering an appropriate physical stress level which has to yield in the best result possible (Čorluka and Talović, 2006). Modern football training, therefore, should include an individual approach in order for the individual to achieve their maximum potential. Due to these reasons, there is the need of creating homogenous groups in order for the exercise training technology to be adapted for the individual or individuals of similar properties. Homogenous group identification is based on same or similar properties and

characteristics of children in the exercise training process. Thus acquired information serve for an optimization of transformation processes with young footballers, more quality comprehensive anthropological development, detection of advantages and reservations, secondary selection, and a more purpose-serving exercise training process programming in football. Such approach to exercise training technology will certainly have greater impact and result in a higher level of individual motor preparedness manifestation. In this context, the selection and specialization in football can't be appropriately conducted without scientifically founded information on the typology of young footballers included in a long-term sports program.

## Methodology

From a time perspective, this survey has the property of a transversal study with the aim to identify homogenous groups in situational-motor abilities with footballers aged 12 to 14 in Bosnia and Herzegovina.

### Sample of subjects

The research was conducted on a sample of 164 pioneer football league players aged 12 to 14 who compete in football leagues in Bosnia and Herzegovina. The sample consists of the following clubs: F.K. "Sloboda" – Tuzla; N.K. "Jedinstvo" – Bihać; H.N.K. "Branitelj" – Mostar; F.K. "Bjelopoljac" – Potoci. Only subjects who are healthy (i.e. subjects without morphological, psychological or other aberrations), and subjects who are registered footballers with a three-year period (at least) into the exercise training processes of the respective club have eventually been taken in account.

### Sample of variables

All tests and measurements of the sample of subjects were conducted in the club's respective sport centers. In accordance with the method of International Biological Program (IBP), anthropometric measuring was conducted in early-morning hours from 9 am to 10 am in order to avoid variations of certain body parts and. Standard measuring tools previously gauged and checked were used in the course of measurement. Situational-motor abilities were tested from 2 pm to 5 pm, in accordance with regular training activities. All subjects were properly dressed in appropriate sports outfits. Motor abilities were measured on checkpoints with proper pauses between tests in order for subjects to rest. The six chosen variables hypothetically covered the latent field of situational-motor abilities: ball manipulation, assessment of ball handling speed and ball shot power. All tests are standardized and published (Gabrijelić at al., 1983); all tests have previously determined metric characteristics and are applicable onto our sample age.

1. Horizontal bouncing off wall, 20 sec. (SNKOST)
2. Shooting at wall after ball bounced off ground (SNKUPO)
3. Ball handling speed (slalom) (SNKSLA)
4. Ball handling speed (semicircular) (SNBPVO)
5. Ball handling speed, 20 m after getaway (SNBV20)
6. Shot power, header (SNESGL)

### Data processing methodology

Collected data was processed with a computer program called SPSS (V 12.0). Homogenous groups in the field of situational-motor abilities were identified by means of hierarchical cluster analysis. The "nearest neighbor" technique was used to gather groups. Based on the graph (dendrogram) of incipient succes-

sive joining of entities we were able to determine the number of groups the subjects should be split into. Next, we applied the K-means (Quick cluster) analysis which is suitable for studies with a vast number of subjects (Rađo and Wolf, 2002). The structure of isolated clusters in the latent field was conducted by means of factor analysis. Beginning with intercorrelation variable matrices, we used Principal component analysis; direct oblimin transformation was used as the base bias of the transformations.

## Results and discussion

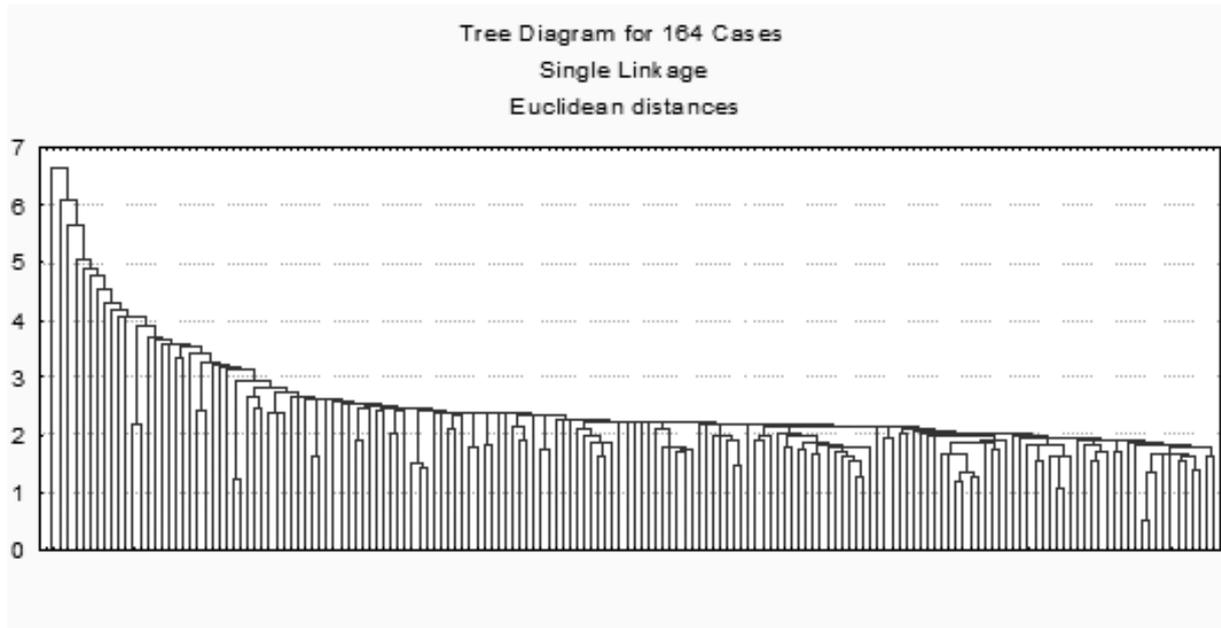
Table 1 shows basic descriptive variable parameters with footballers aged 12 to 14. The table also shows body weight and height where we can see the average value of subjects' height of footballers this age in Bosnia and Herzegovina ( $159.30 \pm 9.5$  cm and  $48.25 \pm 10.2$  kg). Compared with other studies done so far - Kurelić at al. (1975); Bilić, Rađo, Ramadanović, Talović (2003); Čolakhodžić at al. (2008) - we can state that our subjects have average values regarding height and weight which is appropriate for the given age group. If we compare the results of situational-motor abilities with studies done so far – Kvesić 2002; Bajramović, 2007; Bajramović at al., 2008) - we can notice that subjects of this study showed less effective performance on variable SNKSLAf i.e. evaluation of ball manipulation ability. Regarding the second variable on ball manipulation ability (SNKOST) subjects showed better results as compared to subjects from the above mentioned studies. Variables on ball handling speed (SNBV20) and header power (SNESGL) show that our subjects have achieved similar values as compared to other studies. Henceforth, we can conclude that results from situational-motor abilities on our sample of subjects don't vary significantly from results of studies carried out so far.

Table 1. - Basic descriptive variable parameters

Variable	N	Min.	Max.	Mean	Dev. Lev.
AVIS	164	140.20	181.00	159.3012	9.53467
AMAS	164	31.20	86.40	48.2555	10.27429
SNKSLA	164	11.22	23.59	15.2642	2.26222
SNBV20	164	3.34	6.22	4.4390	.51661
SNBPVO	164	13.31	22.31	17.3622	1.78884
SNKOST	164	6.00	18.00	13.2927	2.52588
SNKUPO	164	2.00	20.00	8.5488	3.80556
SNESGL	164	2.90	11.60	6.5928	1.49555

The incipient hierarchical joining and matching of subjects is shown on Illustration 1. We can notice the number of homogenous groups that were formed in the field of situational-motor abilities.

Illustration 1. - Techniques of joining on Euclidean distances, dendrogram



Variance analysis (Table 2) on incipient hierarchical grouping shows whether there is variability between groups and within groups. Value F indicates that our subjects show statistically significant difference on three variables testing situational-motor abilities at the significance level  $p < .01$  (SNBVPO, SNKOST, SNKUPO). At a  $p < .05$  level of statistical significance, the groups differ on the variable assessing header power (SNESGL). Subjects in given groups statistically don't differ on the variable of ball handling (SNKSLA) and the variable of ball handling speed (SNB20V). Results show that subjects grouped in the two incipient clusters don't belong to the same group on the level of situational-motor ability manifestation.

Table 2. - Variance analysis, situationa-motor abilities

Variable	Between SS	df	Within SS	df	F	p
SNKSLA	8.857	1	825.3212	162	1.7384	.189198
SNB20V	.653	1	42.8498	162	2.4699	.117996
SNBVPO	24.611	1	496.9789	162	8.0225	.005207
SNKOST	267.030	1	772.9209	162	55.9681	.000000
SNKUPO	1467.424	1	893.1854	162	266.1516	.000000
SNESGL	9.799	1	354.7808	162	4.4742	.035939

Table 3. - Arithmetic means of variables with isolated groups

Variable	Cluster No. 1	Cluster No. 2
SNKSLA	14.98809	15.45979
SNB20V	4.36397	4.49208
SNBVPO	16.90191	17.68823
SNKOST	14.80882	12.21875
SNKUPO	12.10294	6.03125
SNESGL	6.88323	6.38708

Table 3 shows the arithmetic means of variables of isolated clusters by means of hierarchical cluster analysis. A comparison of variables indicates that there are significant differences between the formed groups, which additionally supports results from variance analysis from Table 2.

The dendrogram analysis shows five distinct homogenous groups of subjects which is a precondition for further analysis and application of K-means technique in subject classification. Table 4 shows the univariate analysis of the five group's respective variances by means of K-means technique. Based on the test's statistical significance F, which shows differences in intergroup and

intragroup variance, we can conclude that subjects in the groups statistically significantly differ in each variable on a  $p < .01$  level of significance.

Tables 5 to 10 and Illustration 2 show arithmetic means of variables with respective groups, descriptive statistics of isolated groups, group belongingness, and distance to the centroid of isolated group.

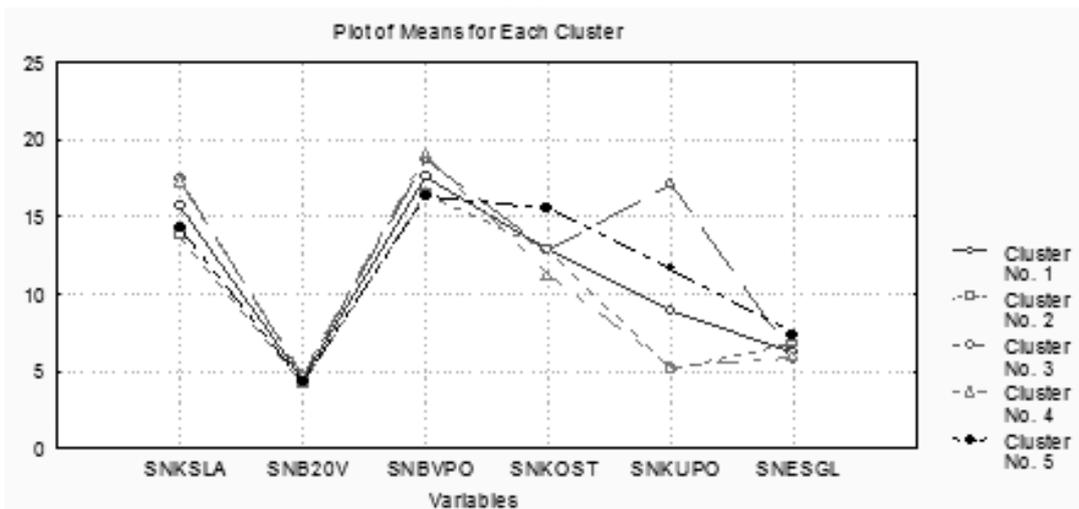
Table 4. - Results of univariate variance analysis on five isolated groups by means of K-means technique

Variable	Between SS	df	Within SS	df	F	p
SNKSLA	315.346	4	518.8315	159	24.1601	.000
SNB20V	7.119	4	36.3841	159	7.7776	.000
SNBVPO	186.156	4	335.4340	159	22.0601	.000
SNKOST	390.284	4	649.6671	159	23.8796	.000
SNKUPO	1872.843	4	487.7666	159	152.6253	.000
SNESGL	60.277	4	304.3028	159	7.8737	.000

Table 5. - Arithmetic means of variables by groups

Variable	Cluster No. 1	Cluster No. 2	Cluster No. 3	Cluster No. 4	Cluster No. 5
SNKSLA	15.7385	13.70750	17.48000	17.21909	14.23413
SNB20V	4.50825	4.17639	4.62667	4.76152	4.31609
SNBVPO	17.5745	16.52528	18.73333	19.05788	16.34783
SNKOST	12.85	12.91667	12.88889	11.21212	15.54348
SNKUPO	8.850	5.16667	17.11111	5.24242	11.63043
SNESGL	6.203	6.82444	5.85778	5.87758	7.40739

Illustration 2. - Arithmetic means of variables with isolated groups



Five homogenous groups were defined and classified in the field of situational-motor abilities. The first group counts 40 subjects, group two counts 36, group three 9, group four 33 and group five counts 46 subjects. Variance analysis and statistic value F of the test show that isolated groups of subjects significantly differ on each variable applied. Group five with 46 subjects has highest values (according to arithmetic means) in ball handling speed, ball manipulation and explicitly good header power. Next is Group two (36 subjects) with a good ball handling speed, but with lower mean variables values for assessment on ball manipulation (SNKOST, SNKUPO and SNKSLA) and header shot power (SNESGL). Group one (40 subjects) consists of subjects with arithmetic means of variables on ball manipulation, ball handling speed and header shot power. The position of Group three (9 subjects) stands out due to the fact that it has best results on the variable of ball manipulation (SNKUPO) even this group, just like Group four, has low performance on other variables.

Table 6. - Descriptive statistics, Group one (40 subjects)

Variable	Mean	St. Dev.	Variance
SNKSLA	15.73850	1.911433	3.653577
SNB20V	4.50825	.497671	.247676
SNBVPO	17.57450	1.586990	2.518538
SNKOST	12.85000	1.610064	2.592307
SNKUPO	8.85000	1.331088	1.771796
SNESGL	6.20300	1.458538	2.127334

Table 7. - Descriptive statistics, Group two (36 subjects)

Variable	Mean	St. Dev.	Variance
SNKSLA	13.70750	1.312033	1.721430
SNB20V	4.17639	.410777	.168738
SNBVPO	16.52528	1.463347	2.141385
SNKOST	12.91667	2.047647	4.192856
SNKUPO	5.16667	1.502380	2.257144
SNESGL	6.82444	1.151408	1.325740

Table 8. - Descriptive statistics, Group three (9 subjects)

Variable	Mean	St. Dev.	Variance
SNKSLA	17.48000	3.033014	9.19918
SNB20V	4.62667	.287533	.08267
SNBVPO	18.73333	1.402400	1.96673
SNKOST	12.88889	3.855011	14.86111
SNKUPO	17.11111	2.891558	8.36111
SNESGL	5.85778	.918991	.84454

Table 9. - Descriptive statistics, Group four (33 subjects)

Variable	Mean	St. Dev.	Variance
SNKSLA	17.21909	1.925078	3.705924
SNB20V	4.76152	.578981	.335220
SNBVPO	19.05788	1.356859	1.841066
SNKOST	11.21212	2.394754	5.734847
SNKUPO	5.24242	1.785887	3.189394
SNESGL	5.87758	1.011805	1.023750

Table 10. - Descriptive statistics, Group five (46 subjects)

Variable	Mean	St. Dev.	Variance
SNKSLA	14.23413	1.659382	2.753549
SNB20V	4.31609	.457784	.209567
SNBVPO	16.34783	1.395343	1.946982
SNKOST	15.54348	1.486331	2.209180
SNKUPO	11.63043	1.947747	3.793719
SNESGL	7.40739	1.734740	3.009322

Through factor analysis in the latent field of functionally isolated clusters on the basis of taxonomic analysis, we have obtained the structure of isolated clusters in this field. Two isolated factors, based on matrix structure (Table 11), make the structure of isolated cluster one (40 subjects). The first isolated factor is a general situational-motor factor since all variables in this field, except the ball manipulation variable, have very high projections on the isolated factor. The second factor in this cluster can be interpreted as ball handling ability factor since the highest projection on the factor has variable (SNKUPO).

Table 11. - Situational-motor ability structure on cluster one in latent field, matrix

Variable	Component	
	1	2
SNKSLA	.472	-.419
SNB20V	.735	-.266
SNBVPO	.669	.317
SNKOST	.691	-.061
SNKUPO	.085	.878
SNESGL	-.706	-.165

Three isolated factors make the structure of isolated cluster two (36 subjects) in the field of situational-motor abilities, based on matrix of the structure in the latent field (Table 12). The first isolated factor is a mixed situational-motor factor; variables on the assessment of ball handling (SNKSLA, SNKUPO) and variables on the assessment of ball handling speed (SNBVPO, SNB20V) have the highest projections on this isolated factor. The second isolated factor with this cluster can be interpreted as ball handling factor since variable (SNKOST) has the highest projection on it. The third isolated factor is header shot power since variable (SNESGL) has the highest projections here.

Table 12. - Situational-motor ability structure on cluster two in latent field, matrix

Variable	Component		
	1	2	3
SNKSLA	.759	-.015	-.483
SNB20V	.583	-.540	-.515
SNBVPO	.848	-.067	.039
SNKOST	.056	.937	-.082
SNKUPO	-.781	.038	.161
SNESGL	-.121	-.017	.932

The structure of cluster three (9 subjects), based on the matrix of structure in the latent field (Table 13), also consists of three isolated factors. The first isolated factor is a mixed situational-motor factor with highest projections by variables on assessment of ball handling (SNKUPO) and header shot power (SNESGL). The second factor of this cluster can be interpreted as ball handling speed factor (SNB20V). The third factor is a mixed factor – ball manipulation ability (SNKSLA, SNKOST) and ball handling on semicircle (SNBVPO).

Table 13. - Situational-motor ability structure on cluster three in latent field, matrix

Variable	Component		
	1	2	3
SNKSLA	.405	.398	.422
SNB20V	.068	.958	.096
SNBVPO	.112	.262	.814
SNKOST	.457	-.206	.780
SNKUPO	-.937	.006	-.159
SNESGL	.886	.175	.383

By means of factorization of variables in isolated cluster four (33 subjects) and based on the matrix of the structure (Table 14), we see that the structure of this cluster consists of three isolated factors. The first isolated factor is a mixed situational-motor factor with highest projections by variables on assessment of ball manipulation (SNKSLA, SNKUPO) and header shot power (SNESGL). The second isolated factor on this cluster can be interpreted as mixed ball manipulation (SNKOST) and ball handling speed (SNB20V) factor. The third isolated factor is the ball handling speed in semicircle factor with highest projection by variable (SNBVPO).

Table 14. - Situational-motor ability structure on cluster four in latent field, matrix

Variable	Component		
	1	2	3
SNKSLA	.861	-.163	-.061
SNB20V	-.032	-.740	.498
SNBVPO	-.080	.052	.940
SNKOST	-.028	.819	.173
SNKUPO	.543	-.444	-.211
SNESGL	.708	.328	-.018

The structure of isolated cluster five (46 subjects), like with cluster one, consists of two factors. According to matrix of the structure (Table 15) we see that the first isolated factor is a clear-cut ball manipulation ability factor. The reason for this is that all variables from this field have very high projections on the isolated factor (SNKSLA, SNKOST, SNKUPO). The second isolated factor can be interpreted as a mixed ball handling speed and header shot power factor – variables (SNB20V, SNBVPO and SNESGL) have highest projections on this factor.

Table 15. - Situational-motor ability on cluster five in latent field, matrix

Variable	Component	
	1	2
SNKSLA	.798	-.066
SNB20V	.278	-.722
SNBVPO	.240	-.455
SNKOST	.853	-.217
SNKUPO	.353	-.220
SNESGL	.035	.819

## Conclusion

Based on our results, we can conclude that the sample of 164 footballers was classified into five homogenous groups according to their situational-motor ability performance. Subjects were grouped from initial groups (clubs) and they significantly differ in number of subjects. Variance analysis proves that the newly formed groups statistically significantly differ on all variables on a  $p < .01$  significance level. Analysis of the structure of isolated groups confirms the taxonomic analysis results – the respective structure of isolated groups differ both in number of isolated factors and position of variables on isolated factors. A detailed analysis of isolated groups is suitable for further training session improvement and their adaptation to the individual. In future exercise training programs, especially in secondary selection, it would be inevitable to work with homogenous groups of footballers. This model can serve secondary selection of boys (footballers) in order to achieve rationalization and efficiency of optimal transformational processes.

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# Notational match analysis of the 2011 state championship of Bosnia and Herzegovina and 2010 Balkan championship in judo for female competitors

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*Original scientific paper*

## Abstract

Main goal of this research is used notational match analysis to define differences of the indicators of the situation efficiency among senior female from participants of the State championship of Bosnia and Herzegovina and Balkan's Judo Championships. Analysis has been done based on video scripts of 95 fights for BIH senior's female and video scripts of 69 fights for Balkan senior's female in all seven categories. Matches have been monitored with 17 variables of situation's efficiency in Judo. For defining differences of indicators of situation's efficiency it has been used  $\chi^2$  (Chi Square) test. The results of the  $\chi^2$  tests implicate to the statistically important differences among seniors - female in analyzed indicators of the situation's efficiency. Both groups of the examined were more efficient with throwing techniques comparing to the grappling techniques. Bosnian seniors female used more holding (osae) techniques while female from Balkan championship dominated with hand and sacrificing throwing techniques. The most efficient techniques that seniors - female used from B&H State competitors are: O Uchi Gari, Kesa Gatame, Tani Otoshi, etc, while female competitors from Balkans championship used: Uchi Mata, Ippon Seoi Nage, Kesa Gatame etc.

Key words: judo, notational analysis, female competitors

## Introduction

Judo as a sport, contains more than the fight itself since it involves dynamic conditions of activity performance, including constant exchange of attacks and defensive actions, includes breaking and re-establishing of balance, realisation or not realisation of counterattacks, readiness, preparatory actions and avoidance of opponent's actions. Also, in judo training an indispensable segment is physiological preparation which includes different types and forms of thinking, meditation, philosophy and concentration. In this way, judo many times overgrows pure usage of energetic and informational humane resources with an aim to destroy the opponent. One could even say that judo in many ways is a special life philosophy and a certain spiritual development.

Fighting in judo demands the competitor to automatically apply judo elements to right and left side, in the standing position and on floor, as well as the possibility to combine these techniques. The importance of quantification of situational efficiency parameters is in the fact that they are gathered under the conditions of real fight during the biggest competitions, among which there are European championships as well. The situational efficiency of

individual technical elements in judo is important if we focus on more aspects of preparation for competition, as well as on adequate choice of application of technique during the competition, optimal approach to the usage of these techniques through exercise in situational conditions of judo fight, application of adequate training technology and if all this is adapted to our opponent and his way of fight.

In judo there are many throwing techniques and floor techniques (IJF - Waza list, 2003), i.e. 99, but the number of techniques through which the wins are achieved is very small, therefore the situational efficiency of techniques in judo is the same. The research of ability, characteristics and knowledge of athletes focused on technical and tactical indicators for situational efficiency realised by the competitors during the competition (Milanović, 1999) represents a good basis for application of research results in the judo training technology.

A basic condition for successful implementation of transformation training processes in judo is application of successfulness

diagnose in relation to indicators of situational efficiency in judo fight at all competition levels, such as Olympic games, world, European and national championships.

Analysis of situational efficiency indicators based on standard aspects of situation efficiency of judo fight was a subject of research of many judo experts, such as (Sterkowicz, 1998; Sterkowicz and Blach, 2001; Kajmović at al., 2007; Kajmović at al., 2011).

Objective of this research is used notational match analysis to define differences of the indicators of the situation efficiency among senior female from participants of the State championship of Bosnia and Herzegovina and Balkan Judo Championships.

## Method

### Sample of participants

Specimen of the examined is defined as a total of fights (n = 95) State championship of Bosnia and Herzegovina held in Kiseljak 2011. years (B&H) and total of fights (n = 69) from Balkan Judo Championship, held in Trebinje (B&H) 2010. years for the female seniors competitors for all seven weight categories (48kg, 52 kg, 57 kg, 63 kg, 70 kg, -78 kg and +78 kg). At the Balkan's Championships further national judo teams participated: Bosnia and Herzegovina, Serbia, Bulgaria, Rumania, FRY Macedonia, Albania, Greece, Turkey and Montenegro.

### Sample of variables

Analysis of the parameters of situation's efficiency is based on official classification of judo techniques by 17 indicators of situation's efficiency (Kano, 1994; IJF – Waza list, 2010) as it follows: Groups of judo techniques: 1) Nage-Waza (Throwing techniques), 2) Katame-Waza (grappling techniques);

Subgroups of judo techniques: 3) Te-Waza (Hand throwing techniques), 4) Koshi-Waza (Side throwing techniques), 5) Ashi-Waza (Leg throwing techniques), 6) Sutemi-Waza (Sacrificing throwing techniques), 7) Osa-Komi-Waza (Holding techniques), 8) Shime-Waza (Struggling techniques), 9) Kansetsu-Waza (Lever techniques);

Quantitative of judo fights: Technical points - 10) Ippon (10pts), 11) Waza -ari (7pts), 12) Yuko (5pts), - Penalties – 13) Shido 1 (-3pts), 14) Shido 2 (-5pts), 15) Shido 3 (-7pts), 16) Hansoku-make/Shido 4 (-10pts).

17) Situation's efficiency of the separate throwing judo techniques and floor techniques.

### Data processing methods

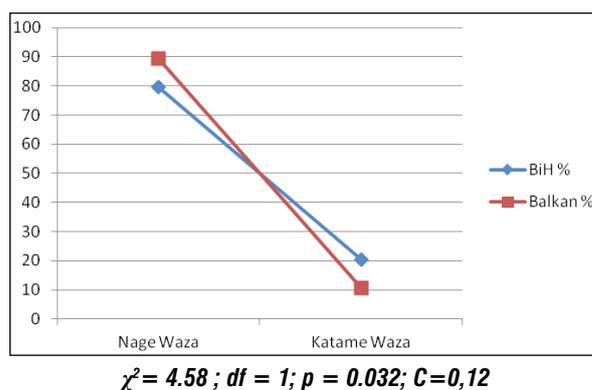
The calculation of frequencies and percentual values was performed for all included variables. For establishment of differences between the frequencies the  $\chi^2$  – test was used (Chi square test) at the level of statistical importance ( $p < 0,05$ ) with contingency tables (Petz, 1997). For testing the importance of correlations between the used variables, the coefficient of contingency was used (C). The parameters of situational efficiency were calculated according to formula (Sikorski, 1985):

**SITUATIONAL EFFICIENCY** = Number of official attacks/ number of all attacks x 100

## Results and Discussion

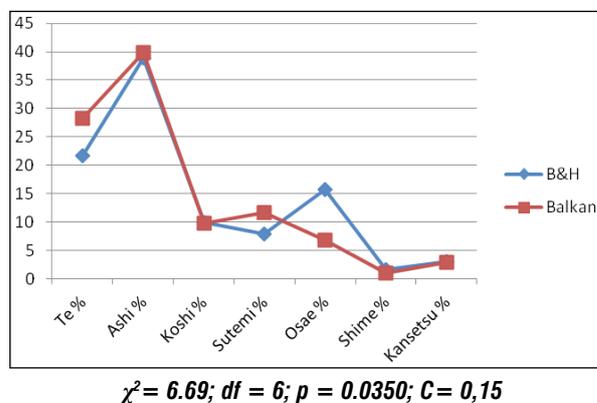
Based on the analysis of video scripts of 95 fights from State championship of Bosnia and Herzegovina and 69 video scripts of Balkan's championship held Bosnia and Herzegovina, it was presented 330 technical actions among which both groups presented 87,9% from the group Nage Waza, while a small number of the technical actions were presented from the group Katame Waza 12,1% (Figure 1). Female seniors from Balkan's dominates with throwing techniques 91,7%, comparing to the male seniors from BiH 83,3%, that have more efficiency in floor techniques 16,7%, comparing to the male seniors 8,3%. The results of the  $\chi^2$  tests ( $\chi^2 = 4.58$ ) appoint to the existence of the statistics differences among monitored frequency of the throwing techniques, comparing to the grappling techniques ( $p = 0.032$ ) with coefficient of the contingency ( $C = ,12$ ).

Figure 1. Notational match analysis of the groups of the judo techniques



Comparing the efficiency of the applied judo subgroups techniques among female seniors (Figure 2.), female seniors from State championship of Bosnia and Herzegovina showed that they dominates with holding (Osae) techniques by 15,5%, struggling (Shime) techniques by 0,6%. Female seniors by Balkan championship dominated in hend (Te) 28,0%, leg (ASHI) 38,1%, sacrificing (Sutemi) techniques by 12,0%. The results of the  $\chi^2$  tests (6,69) appoint to the existence of the statistics differences among monitored frequency of the throwing techniques, comparing to the grappling techniques ( $p = 0,0350$ ).

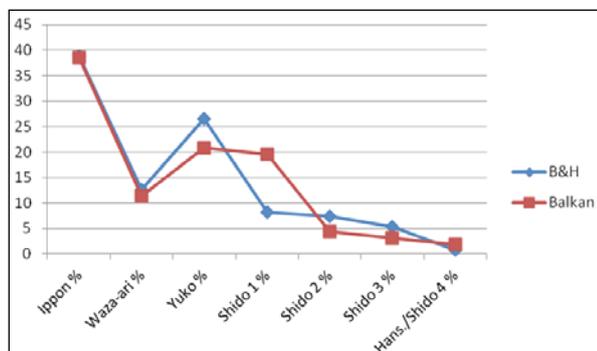
Figure 2. Notational match analysis of the subgroups judo techniques



Analyzing quantity parameters of Judo points and penalties (Figure 3.), female from State championship of Bosnia and Herzegovina showed better efficiency in points Yuko (26,1%), Waza-ari

(15,4%), penalties Shido 2 (8,2%) and Shido 3 (5,1%). Female competitors from Balkan championship, showed high value in penalties Shido 1 (20,0%). Value of point Ippon are approximately same (37,1%) on both competitions. Results of  $\chi^2$  tests (14,5) show that there no statistically important differences ( $p = 0.024$ ) in frequency of the realized quantity parameters between female judo competitors from these two competition.

Figure 3. Notational match analysis of quantitative parameters



$$\chi^2 = 14.5; df = 6; p = 0.024; C = 0.19$$

Analyzing first ten the most efficient separate judo techniques (Table 4), which B&H female seniors presented are: O Uchi Gari, Kesa Gatame, Tani Otoshi, Ippon Seoi Nage, Harai Goshi, etc. Tai Otoshi which represent hand (Te) techniques; Uchi Mata, De Ashi Barai and O Uchi Gari as techniques from leg (Ashi) throwing group; Harai Goshi as side (Koshi) throwing techniques; Tani Otoshi as sacrificing (Sutemi) techniques; Kesa Gatame as hold-ings (Osae). Female seniors from Balkan championship, the most efficiently applied techniques is Uchi Mata, Ippon Seoi Nage,

Kesa Gatame, O Soto Gari, O Uchi Gari and etc. These results saying that the leg (Ashi) throwing techniques with the balance held on one occasion throwing a dominant performance in both competitions.

Earlier studies (Kajmovic et al., 2007) investigate differences analysis of situational efficiency performances between three level of judo competition for female seniors. Techniques mostly used by female seniors from B&H championship 2006. year were: O Uchi Gari, Kesa Gatame, Tani Otoshi, Ippon Seoi Nage etc. Techniques mostly used by female participants from Balkan championship 2006. year were: Uchi Mata, Kesa Gatame, Seoi Nage, Harai Goshi, O Uchi Gari etc. Techniques mostly used by female seniors participants from European championships 2004. year were: O Uchi Gari, Uchi Mata, Te Guruma, Seoi Nage, Tani Otoshi etc. These data suggest that it is necessary to make some changes when it comes to techniques used by women in the National Championship of Bosnia and Herzegovina, and in this way were much more effective at higher levels of competition.

## Conclusion

The existence of differences between senior female competitors in situational efficiency performances based on notational match analysis, is most probably at the level of technical and tactical preparation, mental, sport selection,. The achieved results can help in better understanding of the need to monitor and analyse situational efficiency parameters in judo for female competitors. Monitoring and control of efficiency for relevant technical and tactical parameters of situational efficiency in judo performed by senior female competitors can be directly applied in the training process, in order to insure the optimal choice of content and burden of training.

Table 1. The most efficient judo techniques used by female seniors at the B&H and Balkan's championships

National Championship of Bosnia and Herzegovina in Judo for female competitors		RANK	Balkans Championship in Judo for female competitors	
%	Techniques		Techniques	%
11,8	O Uchi Gari	1	Uchi Mata	14,8
9,9	Kesa Gatame	2	Ippon Seoi Nage	12,7
9,4	Tani Otoshi	3	Kesa Gatame	11,6
8,9	Ippon Seoi Nage	4	O Soto Gari	7,9
6,6	Harai Goshi	5	O Uchi Gari	6,4
6,6	O Soto Gari	6	Harai Goshi	5,8
6,1	Seoi Nage	7	Yoko Shiho Gatame	5,3
4,7	Tai Otoshi	8	Tai Otoshi	4,8
3,3	Yoko Shiho Gatame	9	Juji Gatame	4,2
2,8	Juji Gatame	10	Ko Uchi Gari	2,6

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# Model for longitudinal analysis of an individual all-rounder athlete's potential

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*Original scientific paper*

## Abstract

The main objective of this paper is an attempt to offer an efficient model and a tool that makes it possible to realize an objective, scientifically and methodologically suitable model for individual analysis and identification of typical structures of disciplines of the particular all-rounder athlete and its interrelationship structures of athletic disciplines of heptathlon, as one of the factors of importance for the development and demonstration of own maximum potential.

Key words: **athletics, heptathlon, structure and potentials**

## Introduction

When considering the interrelationships structures among all-round athletics competition disciplines as a function of the maximum expression of an individual all-round athlete's competition potential among the most successful all-round athletes, it is necessary to take into account the heterogeneous and at the same time the contingent variability of structures of interrelationship among the all-round competition disciplines in terms of multiple influential factors.

The results of previous studies (Tidow, 1982, Xinmin, H.; Jiyingo, X, 1995, Smajlović, 2001, 2003, 2008, Sanderson, 1982, 1995, Ros, 1989, Etcheverry, 1995.) confirm that the heterogeneity of all-round competition disciplines interrelationship structures, found at the athletes at the occasion of achieving all-round disciplines results, are not the result of chaotic random and not random effects. It is also confirmed that the outgrowth of the so far manifested contingents (type groups) of related structures of all-round competition disciplines interrelationships during the sport life of the most successful world heptathletes is their individual characteristics of direction of change in their whole psychophysical potential. These contingents (type groups) are mutually irreducible in their complexity because their identity is derived from the qualitative differentiation of related structures. It is clear that the types are formed within the flexible boundaries and to monitor their changes it is necessary to have a suitable mathematical-statistical apparatus.

Considering the fact that "there are differences in the character of motor and functional structure among athletics disciplines of all-round competitions, and that there are some complex mutual relationships among psycho-motor qualities found in their basis" (Brogli, 1974), it is necessary to determine the type and level of mutual functional dependance of heptathlon disciplines, to identify the natural and prescribed structure of success performance in the heptathlon disciplines as well as the psychomotor structures used for their manifestation.

The complexity of the answer to this problem is in the fact that the athletic heptathlon is a composite activity in which each of the given disciplines requires maximum expression, of one or more of the leading psychomotor skills together with the same time positive joint action in manifestation of other psychomotor skills.

It is about a complex manifestation and relations of mutual relationships of psychomotor qualities both within one discipline and also among the qualities manifested by the given order of heptathlon disciplines.

An athlete - all-rounder manifestates his/her maximally versatile psychomotor potential in the range of interrelationships of disciplines that make up all-round structure as a specialized composite athletic discipline.

It is necessary to identify and to isolate the typical effective structures of the interrelationship among disciplines the individual uses to realize his/her current all-round disciplines potential. Therefore, the longitudinal research approach is suitable for determining the evolution of relatedness among typical taxonomic structures of the interrelationship among disciplines with the most successful heptathletes during their sport life. The purpose is to make the evolution of existing typical structures visible to the new structures as a kind of specific quality of individual development in actualization of the present potential, in other words to recognize the cascading outgrowth of the existing relationships into the qualitatively new ones.

This paper aims to offer an efficient model and tools to the athletic practice that allow to achieve an objective, scientific and methodologically based model for an individual analysis and determination of the typical structure of heptathlon disciplines of the particular heptathlete and its structures of the interrelationships among the athletic heptathlon disciplines, as a factor of importance for the development and maximal performance of their own potential.

## Method

To gain an insight into the dynamics of levels and structure of heptathlon of the particular heptathlete, her heptathlon results, achieved and measured during her career at official international athletics competitions (continental, world championships and Olympic Games) by the rules of the International Amateur Athletics Federation (IAAF), were used.

A brief sport history of heptathlon, the values and ranges of minimum and maximum absolute and points achievements in disciplines and overall scoring results, the trend and polynomial functions of their development during their sport life activities were presented. To determine the structure of results and scoring values of all-round disciplines, the subprogram Principal-Components Analysis-rotation varimax-SPSS was used.

The type and level of mutual functional dependence of heptathlon athletic disciplines were determined by the program GCSE Maths-Kury, Version 1.1 (1992).

The identification and graphical representation of the polynomial trend curve of the structure of interrelationships among the disciplines of athletic all-round competition, together with the profile of the typical groups of all-round competition disciplines, was performed by using the subprogram of Grafs Windows Statistica.

The isolation of the typical taxonomic structures according to the relatedness of the interrelationship among the athletic disciplines was performed by using Hierarchical Cluster Analysis (SPSS) - the method of the most distant neighbors and the measure of

distances expressed in cosines values. The checking of the significance of differences between the separate typical taxonomic structures and significance of the all-round competition athletic disciplines for the classification on typical groups was performed by using the subprogram multivariate analysis of Variance-SPSS.

## Results

The analyzed heptathlete (S.B.) is one of the top world heptathletes. She is the winner of a bronze Olympic medals, a gold one (twice) and a silver medal at the World championships. She has been twice European champion.

In 14 years of all-round competition career in the period from 18 to 32 years of age, this particular competitor achieved the results in the range of 6112-6986 points (Table 1) in 32 successful appearances. The important point values are found in the high jump disciplines, 100m hurdles run, long jump and 200m run and above average values in the javelin throw discipline in the group of the most successful world all-rounders.

The lowest point values are found in the shot-put discipline. The largest negative trend has been found in the discipline of 800m run. All other disciplines have shown a slight oscillatory positive trend with the mutual point values convergence at the end of career. The greatest value of the coefficient of variations was 7.35% for the discipline of javelin throw and 7.11% for the discipline of shot-put. The variability of the scoring values of these disciplines show the highest values and amounts for shot-put ( $V\%=8.35$ ) and for the javelin throw ( $V\%=8.29$ ).

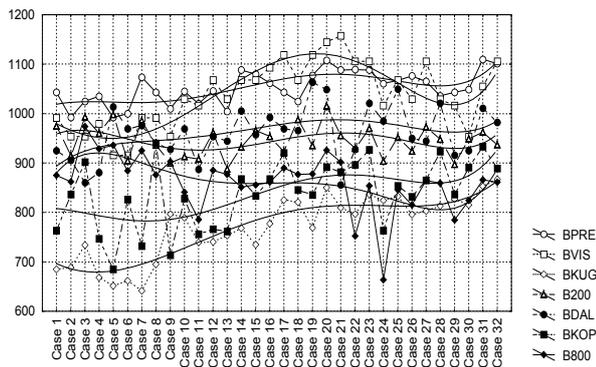
Table 1. Central and dispersion parameters of heptathlon result s- S.B.

Variable	Mean	S.E.M	StD	Range	Min	Max	V%	N
STAGOD	25.65	.76	4.28	13.94	18.62	32.56		32
RPRE	13.49	.04	.23	.81	13.10	13.91	1.70	32
RVIS	184.66	.92	5.19	19.00	175	194	2.81	32
RKUG	13.64	.17	.97	3.37	11.71	15.08	7.11	32
R200	24.38	.06	.35	1.34	23.65	24.99	1.44	32
RDAL	635.19	2.95	16.67	65.00	602	667	2.62	32
RKOP	48.82	.64	3.59	13.20	40.90	54.10	7.35	32
R800	137.30	.76	4.27	22.94	129.41	152.35	3.11	32
BPRE	1052.66	5.91	33.41	118.00	992	1110	3.17	32
BVIS	1038.03	11.67	66.03	242.00	916	1158	6.36	32
BKUG	770.75	11.38	64.35	225.00	642	867	8.35	32
B200	945.44	5.78	32.67	127.00	888	1015	3.46	32
BDAL	960.75	9.37	52.98	207.00	856	1063	5.51	32
BKOP	837.84	12.27	69.43	255.00	685	940	8.29	32
B800	862.03	10.26	58.02	310.00	664	974	6.73	32
UKUBOD	6467.66	39.75	224.83	874.00	6112	6986	3.48	32

The course of development of the all-round competition disciplines results and their interrelation during sports activities is presented in Graph 1.

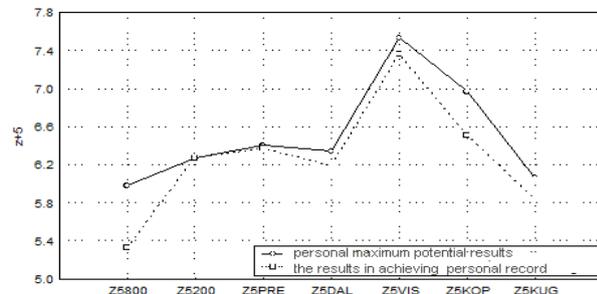
Two successful periods can be seen during a sports career. The first one in the second third and the second one in the end of the analyzed period. The discipline of 100m hurdles run, long jump, 200m run, javelin throw and shot-put after the initial heterogeneous interactions show a well-balanced development flow of mild oscillations (polynomial curves). The points values for the discipline of running 800m fall down to the very end of the sports career, in which part they dramatically improve along with the growth of points values of all other disciplines.

Graph 1. The trend of profiles of scoring values in individual competitions in the heptathlon disciplines - Sabina Braun



At the occasion of establishing her personal heptathlon record, a maximum potential was achieved in the discipline of 200m run (Graph 2.).

Graph 2. The relationship of the personal maximum potential results and the results in achieving her personal record -Sabina Braun



The results of component analysis indicate the presence of a two-component structure (Table 2). According to the values of all-round competition disciplines on the first principal component (42,8% of explained variance), some conclusions can be drawn about the important amount of homogeneity of the disciplines of 100m hurdles run, high jump, shot-put and javelin throw and about a very different character of the disciplines of running 800m and 200m, which showed high values on the second principal component.

Table 2. The component analysis of the results in the disciplines of heptathlon – Sabina Braun

Variables	Communality	Factor	Eigenvalue	Pct of Var	Cum Pct
Z5PRE	.75716 *	1	2.99512	42.8	42.8
Z5VIS	.74646 *	2	1.65182	23.6	66.4
Z5KUG	.76483 *				
Z5200	.81963 *				
Z5DAL	.27674 *				
Z5KOP	.49931 *				
Z5800	.78280 *				

Rotated Factor Matrix:

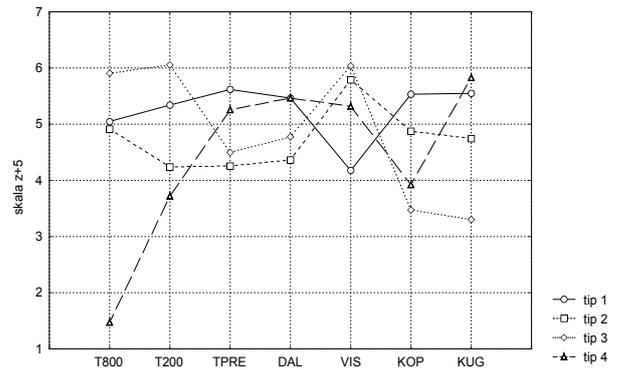
Variables	Factor 1	Factor 2
Z5PRE	.86783	.06343
Z5VIS	.86398	-.00263
Z5KUG	.79832	-.35708
Z5KOP	.70661	.00459
Z5DAL	.50375	.15159
Z5200	.25382	.86903
Z5800	-.18531	.86514

Factor Transformation Matrix	FACTOR 1	FACTOR 2
FACTOR 1	.99762	-.06897
FACTOR 2	.06897	.99762

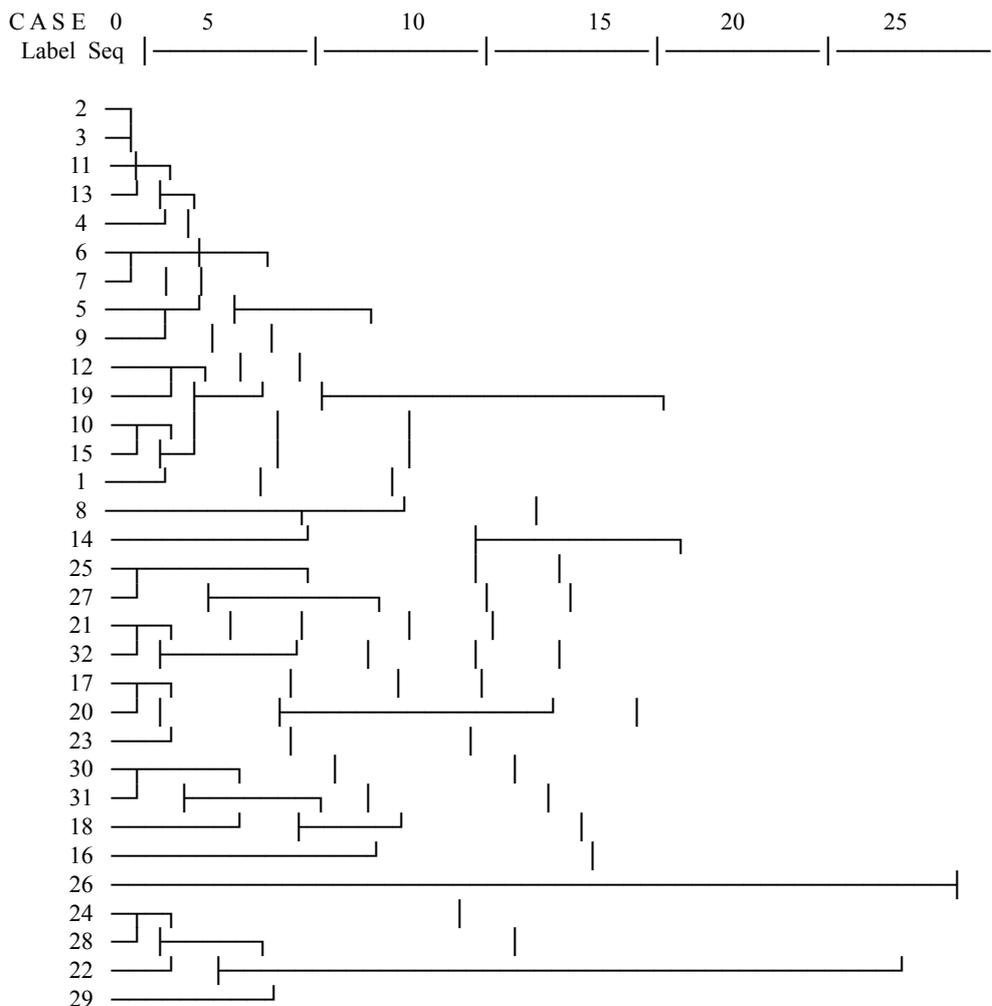
The discipline of long jump proved to be low related to other disciplines important to the first principal component and at the same time with the values of the second principal component indicating the traces of share in the disciplines of running 200m and 800m. The communality of this discipline is very low and amounts to .277.

The cluster analysis on the 12th scale of integrating, four typical clusters were isolated (Dendrogram 1.). The most successful results belong to the first cluster. The further consolidations are step-like on higher levels so that the unified cluster containing the results of low value is left on the highest level. All disciplines except the heptathlon long jump have their taxonomic significance. Typical structures of heptathlon disciplines interrelationship of this competitor are shown in the graph 3.

Graph 3. Typical structures of athletic heptathlon - Sabina Braun



Dendrogram 1. Hierarchical cluster analysis of relatedness in heptathlon disciplines structures in competitions during a successful sports career - S.B.



## Discussion

The analyzed athlete belongs to a uniform type of heptathlete, which means that she exerts a balanced interrelationship among heptathlon disciplines. It resulted in the present domination of high jump results. It is obvious that her strong qualities of speed of horizontal reflex have a positive transfer on the results in heptathlon disciplines with the similar psychomotor demands (long jump, hurdles run, 200m run and javelin throw). A somewhat lower level of the results of shot-put and running 800 m can be noticed.

However, one should be careful in making the conclusion that for the further increase in the total score system it is necessary to improve the specific strength qualities (shot-put) and endurance (800m). The development of strength is often associated with increasing mass which results in a negative transfer to the implementation of tasks in all other disciplines, just as the insistence on the development of middle-distance running endurance can have a negative transfer to speed strong qualities. However, in this particular case, the longitudinal analysis of all the results during the career shows that the better results in the 800m run resulted in better results in all other disciplines. It is obvious that a better aerobic-anaerobic preparation enabled a faster recovery between disciplines and an easier way of coping with all efforts during the two-day heptathlon competition.

In the tendency of further results development with the aim to have her best performance of her heptathlon potential, it is necessary to realize a complex and balanced approach of the score and psychomotor development for the improvement of motor knowledge essential to exploit biodynamic potential.

Since the result of the race at 800m at the occasion of achieving her personal record shows the largest fall behind for her all-round competition potential in the same discipline, one might think of the level of achievement motive or of the minimum score of being able to endure stressful situations. It refers to the last heptathlon discipline the result of which is crucial most often for the final score. The fatigue caused by all earlier disciplines has significant effects on the heptathlete's psychological state.

The cluster analysis as a part of the proposed model has shown the presence of four typical clusters (Dendrogram 1). The most successful results belong to the first cluster the characteristics of which is a balance and above average results in all disciplines except the discipline of javelin throw. This is not surprising considering the fact that the analysis of central and dispersion parameters (Table 1.) showed the largest variability in the results of javelin throw disciplines (7.35 for the score result and 8.29 for point values). Due to her personal record in javelin throw discipline, it is possible, with a good concentration and favorable weather conditions during a throw, to expect that during some competitions the result of javelin throw itself reaches the average result of other disciplines.

## Conclusion

This paper has proposed a possible model for the longitudinal analysis of an individual all-round athlete's competition potential. The model includes the following analyses:

- heptathlete sports history;
- central and dispersion parameters of all-round athletics competition results and scoring values;

- trend and polynomial functions found in the course of results development during a sport career;
- projection significance of result score and point values of athletic disciplines in main components;
- types and levels of mutual functional dependence of athletic heptathlon disciplines;
- isolation of typical taxonomic structures according to the relatedness of interrelationship among athletic disciplines.

The application of the proposed model provides an objective, scientifically based approach for having an insight into the level of individual maximum potential. It is also possible to make an optimal choice of disciplines that should be emphasized in order to determine the effective way and time of achieving the following level of individual achievement. Also, it is a way to assess the efficiency of the so far realized process of finding directions for all-round athletics competition preparations.

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# The predictive value of isokinetic assessment on the explosive strength of the lower extremities

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Original scientific paper

## Abstract

The aim of this study was to determine the connection between the performance of vertical and horizontal jumps and isokinetic force parameters of the knee extensors and ankle joint (plantar flexion) of physically active female students ( $n = 40$ ). The jump height, and Total work (jump height x body mass) were used as indicators of the vertical jump, while the length of the jump, and Total work (the jump length x body mass) were used as indicators of the horizontal jump. The knee and ankle joint were evaluated on the isokinetic dynamometer at speeds of 60 and 180°/s (knee), 30 and 60°/s (ankle joint). The results indicated that there was no significant correlation ( $p < 0.05$ ) between the isokinetic parameters and the length and height of the jump, while a medium to strong correlation exists between the isokinetic and Total work parameters. Multiple regression analysis showed that the isokinetic set of isokinetic parameters accounts for 68% of variance HJTW ( $p < 0.05$ ) and 72% of variance LJTW ( $p < 0.005$ ). Isokinetic tests on multiple joints and angular velocities can predict the explosive strength of lower extremities when it is impossible to perform a ballistic movement.

Key words: **Isokinetic, explosive strength**

## Introduction

Explosive strength, as a motor skill, is one of the determinants of success in all activities that require high expression of muscular force in the shortest amount of time possible (Metikoš et al., 1989; Kreamer and Newton, 1994). The muscle force generated during the explosive activity is not always possible to measure, and also, the manifestations of explosive movements are often limited, e.g. injuries. For these reasons the testing of muscle strength is often conducted in controlled laboratory conditions. As regards to force, isokinetic dynamometers belong to a group of the finest indicators of the real state of the muscles. They are used to obtain objective, easily measurable and comparable results. The advantage over other methods is reflected in the possibility of assessing the dynamic performances of the muscle group responsible for the movement in a particular joint. Peak torque is one of the parameters of muscle activity which is most often analyzed for clinical and research purposes. It represents the greatest muscle force generated at any time during the repetitions (Kovačević, 2009). Isokinetic dynamometer «Biodex3 system» (Biodex Corp, Shirley, NY) whose validity has been confirmed in many studies (Drouin et al., 2004; Holmbäck et al., 1999; Pincivero et al., 1997), was used to assess the ability of muscles, in this case the dynamic stabilizers of the knee and ankle joint. Taking into account the fact that the variability of results is greater in concentric isokinetic testing at higher angular velocities, it is more reliable to use lower angular velocities in order to test strength (Iga et al., 2006; Jianzhong et al., 2000), this was taken into account

in this study. Evaluating the amount of the demonstrated force is important, however, due to lack of equipment and the inability to organize laboratory testing, many turn to the usage of functional field tests. The tests most often mentioned as the tests used for assessing explosive strength are primarily the long jump and the high jump. Numerous textbooks, manuals and other publications propose the application of vertical jumping tests to assess explosive muscle strength (Astrand and Rodahl, 1986; Metikoš et al., 1989). Their use has been present in the kinesiology literature, and practice for approximately 90 years. The original description of the high jump technique was described at the beginning of the last century (Sargeant, 1921), while the high jump, that was used to assess the lower extremities explosive strength in this study, was a modified version (Seminick, 1990). The reliability of this test has been proven in previous studies (Carlock et al., 2004; Salles et al., 2010; Ditroilo et al., 2011). Taking into account that the vertical jump is a multiple joint activity and that a close connection can be made between the isokinetic parameters of the participants' joints in the vertical jump, a conclusion can be made that it is necessary to test multiple joints, primarily the knee joint and the ankle joint, in the specific movements needed for the execution of the jump. These are the extension of the knee and plantar flexion at the ankle joint. Besides the high jump, as a means of measuring the explosive strength of lower extremities, the long jump, which was also used, proved to be positively correlated with the vertical jump, the strength of the lower and also the upper extremities (Castro-Piñero, 2010). Based on current findings, these tests do not require much skill, they are highly dependent

on muscle strength and provide valid and reliable indicators of the explosive strength of lower extremities (Morriss et al., 2001). The purpose of this study was to verify the relationship between isokinetic strength parameters and functional tests of explosive strength such as a jump. The results of previous studies are inconsistent, according to (DeStaso et al., 1997) the height of a vertical jump can be predicted with a set of isokinetic parameters, however, on the other hand Atabek et al. (2009) and Anderson et al. (1991) belong to a group of researchers according to whom a set of isokinetic parameters cannot predict the height of the vertical jump.

The relationship between functional tests and strength parameters and the results of isokinetic testing was the subject of studies of many authors who have come to different conclusions (Table 1). The variability of results in previous studies could be explained by the fact that the maximal isokinetic torque changes with sex and age (Neder et al., 1999). They are:

## Methods

### The subjects

Subjects for this study were 40 healthy, physically active females, students of the Faculty of Sport and Physical Education, aged 19-25 years. The average height -  $168.06 \pm 4.85$ ; average weight -  $61.26 \pm 6.81$

None of the selected subjects had any history of lower extremity injuries in the last two years.

### Sample of variables

KEPT60R - Knee extensions - Peak Torque - 60°/s - Right  
 KEPT60L - Knee extensions - Peak Torque - 60°/s - Left  
 KEPT180R - Knee extensions - Peak Torque - 180°/s - Right  
 KEPT180L - Knee extensions - Peak Torque - 180°/s - Left  
 PFPT30R - Plantar Flexion - Peak Torque - 30°/s - Right  
 PFPT30L - Plantar Flexion - Peak Torque - 30°/s - Left

Author	The subjects	Peak Torque of the knee and the vertical jump	Peak Torque of the ankle joint and the vertical jump	Peak Torque of the knee and the horizontal jump
Bosco et al.	12 male athletes	0.71**		
Binet et al.	22 years old and older fit football players	0.64**		
Almuzaini and Fleck	38 physical education students, volunteers	0.363*		0.503**
Tsiokanos et al.	29 male students	JH – 0.49** JW – 0.739**	JH – 0.468* JW – 0.375*	
Gerodimos et al.	180 12-17 years old basketball players	0.61**	0.61**	
Wilson, Murphy	30 active healthy subjects	0.5-0.73		
Saliba, Hrysomallis	19 subelite AF players	0.55 – 0.69*		
Maly et al.	14 male soccer players	0.12		
Blackburn & Morrissey	20 uninjured female subjects	0.097		0.070
Atabek et al.	21 healthy young male	Vertical jump height was not significantly correlated with the isokinetic parameters		
Anderson et al.	39 male athletes	Multiple regression - no combinations that predict vertical jump		

\* - Significance at  $p < 0.05$ ; \*\* - Significance at  $p < 0.01$   
 (JH – The height of the jump; JW – Jump „Total work“)

Table 1.

PFPT60R - Plantar Flexion - Peak Torque - 60°/s - Right  
 PFPT60L - Plantar Flexion - Peak Torque - 60°/s - Left  
 LJ - Long Jump  
 LJTW - Long Jump - Total Work - according to the formula:  $TW = \text{Long jump (m)} * \text{Body mass (N)}$  (English et al., 2006)  
 HJ - High Jump  
 HJTW - High Jump - Total Work - according to the formula:  $TW = \text{High jump (m)} * \text{Body mass (N)}$  (Tsiokanos et al., 2002)

**Functional testing**

First, the subjects' height of reach was measured. After applying chalk on the fingertips, each subject had 3 attempts at a maximum vertical jump. Between the jumps they each had a one minute break. The highest fingerprint was taken into account (Almuzaini and Fleck, 2008). The height of reach was subtracted from that result providing an accurate jump height, expressed in centimeters (Anderson et al., 1991). They were instructed to jump vertically so as to land in the same position and at the same place from takeoff to avoid lateral or horizontal displacement (Yamauchi and Ishii, 2007).

The subjects were given standardized instructions on the long jump from a standing position, they were allowed to jump up from the position with bent knees, and that they can swing their arms. The distance between the starting line of the foot prints on the mat that is closest to the takeoff place, expressed in centimeters, represents the length of the jump. Each subject had 3 attempts, the best one was taken into account (Almuzaini and Fleck, 2008).

Table 2. Descriptive characteristics for the set of variables of isokinetic and functional testing

Descriptive Statistics							
	N	Minimum	Maximum	Mean	Std. Deviation	Skewness	Kurtosis
BH (cm)	40	158.5	176.5	167.488	4.6278	-.102	-.901
BW (kg)	40	46.5	75.0	60.313	6.6010	.119	-.563
HJ (cm)	40	28	49	39.20	4.724	-.162	-.286
LJ (cm)	40	170	227	196.68	13.201	-.139	-.497
HJTW (Nm)	40	181.8	309.0	230.862	30.6313	.288	-.276
LJTW (Nm)	40	889.5	1500.9	1161.683	134.0290	.450	.149
KE60R (Nm)	40	105.1	197.6	148.568	20.6261	.272	.251
KE60L (Nm)	40	104.2	205.0	147.313	26.1600	.540	-.314
KE180R (Nm)	40	67.7	135.4	104.450	15.1570	-.239	.133
KE180L (Nm)	40	61.8	138.1	105.792	16.9789	-.379	.044
PF30R (Nm)	40	56.6	148.3	107.008	24.4011	-.267	-.607
PF30L (Nm)	40	45.9	155.6	102.575	27.0621	-.232	-.383
PF60R (Nm)	40	40.8	133.6	93.857	23.6388	-.316	-.607
PF60L (Nm)	40	48.5	134.8	93.028	19.4431	-.075	.354

**Isokinetic testing**

1. Musculoskeletal screening
2. General body stretching and warm
3. Setting the optimal stabilization of the subjects
4. Aligning the joint and the axis of the dynamometer rotation
5. Verbal introduction to the isokinetic concept of exercises
6. Correction of gravitation (knee)
7. Warm-up (3 submaximal, 1 maximal repetition)
8. The maximum test at a test speed; knee - 60 and 180°/s; ankle - 30 and 60°/s (3 repetitions)
9. Testing of the contralateral extremity

**Statistical analysis**

Based on the previous authors who have dealt with this issue, this study used the Pierson correlation coefficient (Iossifidou et al., 2005; English et al., 2006), and also the standard multiple regression (Anderson et al., 1991; DeStaso et al., 1997).

**Results**

Table 2 presents the descriptive characteristics for the set of variables of isokinetic and functional testing.

Table 3, in which the correlation between functional tests and isokinetic parameters of the lower extremities is shown, it is evident that none of the isokinetic indicators of strength have any statistically significant correlation with the height and length of the jump (cm), while, in the case of Total Work indicators, explained in section "Sample of variables", there is a medium to strong positive correlation with the peak torque during the knee extension and the plantar flexion of both legs.

Table 3. Correlation between functional tests and isokinetic parameters of the lower extremities

Correlations											
	LJ	HJTW	LJTW	KE60R	KE60L	KE180R	KE180L	PF30R	PF30L	PF60R	PF60L
HJ	.592**	.617**	.015	.011	.083	.090	.195	.182	.064	.269	.041
LJ		.361*	.362*	.204	.266	.168	.287	.276	.128	.208	.141
HJTW			.711**	.361*	.514**	.358*	.452**	.504**	.467**	.542**	.374*
LJTW				.520**	.659**	.436**	.490**	.522**	.524**	.437**	.372*
KE60R					.849**	.772**	.681**	.374*	.501**	.277	.314*
KE60L						.771**	.803**	.447**	.556**	.331*	.281
KE180R							.885**	.332*	.502**	.251	.329*
KE180L								.381*	.567**	.307	.340*
PF30R									.811**	.900**	.615**
PF30L										.780**	.748**
PF60R											.718**
** Correlation is significant at the 0.01 level (2-tailed).											
* Correlation is significant at the 0.05 level (2-tailed).											

Isokinetic parameters, included in the standard multiple regression, were not predictive for the height of the vertical and the length of the horizontal jump at a satisfactory level of significance ( $p < 0.05$ ). Namely, when it comes to high jump, the connection with a set of isokinetic parameters has shown a level of significance far greater than the set one ( $p = 0.113$ ), while for the long jump it could be said that it is on the limit of significance ( $p = 0.054$ ). The display of multiple standard regression for variables HJ and LJ will be presented in table 3 (a and b).

As opposed to that, when it comes to the work that was done in the vertical (HJTW) and horizontal (LJTW) jump, standard multiple regression analysis showed that the isokinetic set of variables, that included the values of peak torque exerted at a speed of 60 and 180°/s for the knee and 30 and 60°/s for the ankle joint, explained 68% of variance HJTW ( $p < 0.05$ ) and 72% of variance LJTW ( $p < 0.005$ ). Regression analysis of HJTW and LJTW are shown in Table 4 (c and d).

a)

Model Summary							
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	F	Sig.	
dimension0	1	.564 <sup>a</sup>	.318	.143	4.375	1.810	.113 <sup>a</sup>
a. Predictors: (Constant), PF60L, KE60L, PF30D, KE180D, KE60D, PF30L, KE180L, PF60D							
b. Dependent Variable: HJ							

b)

Model Summary							
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	F	Sig.	
dimension0	1	.603 <sup>a</sup>	.364	.200	11.810	2.216	.054 <sup>a</sup>
a. Predictors: (Constant), PF60L, KE60L, PF30R, KE180R, KE60R, PF30L, KE180L, PF60R							
b. Dependent Variable: LJ							

c)

Model Summary							
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	F	Sig.	
dimension0	1	.681 <sup>a</sup>	.464	.326	25.1468	3.358	.007 <sup>a</sup>
a. Predictors: (Constant), PF60L, KE60L, PF30R, KE180R, KE60R, PF30L, KE180L, PF60R							
b. Dependent Variable: HJTW							

d)

Model Summary							
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	F	Sig.	
dimension0	1	.724 <sup>a</sup>	.524	.401	103.7643	4.258	.002 <sup>a</sup>
a. Predictors: (Constant), PF60L, KE60L, PF30R, KE180R, KE60R, PF30L, KE180L, PF60R							
b. Dependent Variable: LJTW							

## Discussion

The results of this study show that there is no correlation ( $p < 0.05$ ) between peak torque of the knee and ankle joint muscle force and absolute measures of the vertical jump height, Pierson correlation coefficient values ranging .01 - .27, and the length of the horizontal jump, Pierson correlation coefficient values ranging .13 - .29. Similar results were obtained by previous researchers (Atabek et al., 2009; Anderson et al., 1991) who found insignificant ( $p < 0.05$ ) correlation coefficients between the height of the vertical jump and peak torque extension of the knee, at the angular velocity of 60°/s. These results also confirm the results obtained by Genuario Dolgener (1980), Blackburn and Morrissey (1998), and Maly et al. (2011), however, they are opposite to the results obtained by Bosco et al. (1983) and Petschnig et al. (1998).

Maly et al. (2011), for example, have come up with results that show that the correlation between the height of the vertical jump and peak torque extension of the knee of the dominant leg, at a speed of 60°/s, was .12, which largely concurs with our findings that these values are .08 for the left and .01 for the right leg.

When it comes to the ankle joint, the findings do not deviate from some previous studies. The Pierson correlation coefficient in this study, when it comes to the set of isokinetic variables and HJ, are ranging from .04 - .27, and .13 - .28, when it comes to LJ, statistically insignificant ( $p < 0.05$ ), are very similar to the results obtained by Genuario and Dolgener, according to which Pierson's correlation coefficient between peak torque of plantar flexion and vertical jump height has a value of .17 - .42. However, in contrast to these results, Tsiokanos et al. (2002) obtained, although small, statistically significant correlation between the vertical jump height and plantar flexion. In their study, these results had a value of .46 ( $p < 0.05$ ).

Taking into consideration the correlation strength, Tsiokanos et al. (2002), concluded that there is a very small importance of individual isokinetic strength testing when one wishes to estimate the height of the vertical jump. This thesis was confirmed by our results.

However, using the formulas of previous researchers that provide Total Work, the coefficient of correlation between isokinetic and jump parameters is increased. As for the normalized values, as it can be seen in Table 3, between them and all of the 8 peak moments of force there are, on two levels, statistically significant ( $p < 0.05$ ,  $p < 0.01$ ), medium to strong correlations. Thus, between the peak moments of force of the knee muscle and ankle joint and the normalized values of the vertical jump, the correlation coefficient was in the range of .36 - .54, and the normalized values of the horizontal jump, where the range of values of the correlation coefficient was .37 - .66.

Of course, it is necessary to mention that the research carried out by Tsiokanos et al. (2002) the jump height (cm), was in a stronger positive correlation with the plantar flexion (.459,  $p < 0.05$ ) than the Total Work (.375,  $p < 0.05$ ), expressed in kpm (1 kpm  $\hat{c}$  9.81 Nm).

The values that we obtained through multiple regression analysis are not different from the previous ones. As in our study, Anderson et al. (1991) did not get statistically significant predictors of the height and length of the jump. Namely, our results, according to which a set of isokinetic variables predicts 56% of the variance

for the HJ variable and 60% for the LJ variable, were not statistically significant ( $< 0.05$ ).

However, with the product of height and jump length and body mass, that is Total Work, higher regression coefficients were obtained for both the high jump (HJTW) and long jump (LJTW). The set of isokinetic variables predicts 68% of the variance for the variable HJTW ( $p < 0.05$ ) and 72% for variable LJTW ( $p < 0.01$ ). These results are much higher than in some previous studies. For example DeStaso et al. (1997) using Stepwise linear regression came to an equation that predicts 44% of the variance ( $p < 0.01$ ) of countermovement jump. Still, nevertheless, they perfectly match the results that were obtained by Tsiokanos et al., where the regression coefficients range from 65% to 75%. This finding provides confirmation that the work carried out during a jump can be used as an indicator for the possibility of a jump when the jump itself is being predicted through maximal isokinetic force.

Since this increase of the correlation coefficient was obtained by the inclusion of the body mass in the equation, a conclusion can be made that this formula is a better indicator of the explosive strength of the lower extremities. Assuming that the two subjects have the same jump height, the one who has a higher load, that is, a higher body mass has greater explosive force.

Regression analysis has shown that there exists a strong multiple correlation between the normalized values of the vertical and horizontal jump, presented in the previous studies as Total Work, and the linear combinations of peak moments of the torque generated in the knee joint and ankle joint.

However, for this formula to be valid, it is important to note that the isokinetic tests have to be carried out on more joints and more angular velocities.

According to Hoffman's division of the correlation coefficients (2006) it can be concluded that the isokinetic parameters, measured individually on the right and left leg, have a moderately strong correlation, when it comes to the dynamic knee stabilizers, and no correlation to a weak one, when it comes to dynamic stabilizers of the ankle joint in vertical jumps. It can also be concluded that the correlation of the isokinetic parameters of the dynamic knee stabilizer is stronger in horizontal jumps, so it is moderate to strong, while the peak torque of the ankle joint, although at the same level, has slightly lower correlation coefficient than the one in vertical jumps.

Medium to strong correlation and regression coefficients indicate that there is a close connection between the maximum torque of the knee and ankle joint and jumps.

## Conclusion

Based on the presented results it can be concluded that isokinetic testing has its purpose in predicting the explosive strength of lower extremities, provided that relative-normalized values are taken into consideration. Namely, not a single separate isokinetic parameter has significant correlation coefficient with the manifestations of explosive strength such as a jump expressed in absolute units of measurement. Taking into consideration that the enormous advantage of the isokinetic test over all other forms of testing lies in the fact that with this type of resistance there is no load on the active joint (Desnica-Bakrač, 1999), and that the isokinetic dynamometer is the only safe way to dynamically load

the muscle to its maximum potential through the whole amplitude of movements, these results can be useful in the early stages of rehabilitation, especially when the patient is unable to perform a maximum jump. The predictive strength of the model used in this testing is stronger than in the former ones (Van Oteghen 1975; Bosco et al., 1983; DeStaso et al., 1997), indicating that this method can be used to predict the possibility of vertical and horizontal jumps, with relatively reliable results, of physically active women. In addition to this, it is important to note that, since the maximal isokinetic torque changes with sex and age (Neder et al., 1999) and so there may be deviations from this method when it comes to a different sample of subjects.

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# The influence of the social-economic indicator for creation of sport-recreation offers of the sports objects in Canton Sarajevo

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*Original scientific paper*

## Abstract

The goal is to determine the relationship between social economic indications (age, education, employment, and net salaries) and the way of creating the sports recreation offers in sport objects of Kanton Sarajevo. For the needs of this work there were 17 variables used (5 criteria's, 12 predictors) on the sample of 90 interviews from different ages. The processing of this data was used regression analysis. During the work it was determined that the recreational players from the governmental sector rather includes in to individual sport services, and that the commercial sector rather chooses the team sports. The variable, other kinds of recreation, that was treated in this work - research in negative correlation with the people between ages 18-30, and the positive correlation with the people aged from 31- 50 years old. That means that the group of people between ages of 18-30 rather use recreational services: form of a sport recreation- soccer, form of sport recreation – basketball, form of sport recreation- fitness, and that the people between age of 31 -50 rather choose another kind of sport recreation (walking, swimming, skiing, biking, table tennis, tennis, and running).

Key words: **Sport Objects, social-economic indicators, sport recreation influence**

## Introduction

Sports Market is made of individual groups of people and organizations that have the need and idea for exchange of goods ideas, services, and programs of nature sports. From the inner and outer environment of the sports industry. The situation on the market of sport is constantly being changed and its necessary to periodically make a marketing investigation that is important support for bringing marketing decisions (Bartoluci, 1997). Today it's not possible to think about the market as a homogeneous units, because it is necessary to recognize that the market is made of groups of buyers who are different in their needs, habits, and behavior (Shank, 2002). One of the special, research procedures in sports marketing is the segmentation of the market. The term segmentation can be defined as a division of the market to groups of consumers with similar needs and habits in shopping, where at every segment is being defined to its adjusted marketing mix (Jurkovic et al., 1995). The segmentation of the market is the start point of a successful marketing concept and strategically planning. The basics of segmentation include different characteristics of the market as the demographic in social, economical, geographical behavior of the consumer's attitudes and preferences for some attractions and experiences. The variables for segmentation of the market that are usually being used are: geographical variables, demographical variables, economical

variables, and psychological variables. The most frequently used method is social demographical method of segmentation of the market that is being preceded by dividing the market by variables: (age, standard of living, income, education, profession, religious racial and national affiliation etc.). (Dibb et al.,1991). Related to that in this work there will be made an investigation in the effort to exam the influence of the demographical indicators on the representation in positioning of the products /services of sports recreations on the sport marketing.

## Methods

In the investigation there was processed one sample that was selected by age, qualification structure and work status of the user's services. The final sample was made out of 90 interviews and potential service users, their determination for using the sport recreation offer in Kanton Sarajevo, and their need as sport consumers. Based on their age the interviews were classified:

- a). From 18- 30 years old were 48 interviews
- b). From 31-50 years old were 35 interviews
- c). Over 51 years old were 7 interviews

Based on the level of education the interviews were classified:

- a) Middle School educated were 30 interviews

- b) High School educated were 17 interviews
- c) College Educated were 43 interviews

All of the interviews were male.

According to work sector the sample was divided to: 32 interviews of the commercial sector, 29 interviews of the NGO, and 29 interviews from government sector.

**Sample of Variables**

Sample of Variables is made of 17 variables (Dependant and independent)

**Criteria of Variables**

- 1. Form of Sports recreation –Soccer
- 2. Form of Sports recreation- Basketball
- 3. Form of Sport recreation-Fitness
- 4. is not included in sport activity
- 5. Other form of recreation

**Predicator Variables:**

- 1. Age of interview from 18-30 years
- 2. Age of interviews from 30-50 years
- 3. Age of interviews over 50 years
- 4. Level of education ( Middle school)
- 5. Level of education ( High school)
- 6. Level of education(College)

- 7. Work status of interviews in the commercial sector
- 8. Work status of the interviews in the NGO sector
- 9. Work status of the interviews in the government sector
- 10. Monthly income of the interviews from 441,11 to 818,89KM
- 11. Monthly income of the interviews to 818,89 KM
- 12. Monthly income of the interviews higher than 818,89 KM

The data used in the investigation were collected by the method of survey (personal contact and e-mail) and statistically evaluated in percentages.

**Methods of data processed**

Based on the determined goal, task and the researched subject and to get science knowledge the tested example of the interviews was processed in the SPSS program. In this work the methods of inferential statistics that were used are persons coefficient of correlation, logistical regression (regression coefficient, Wald, the quotient of the like hood, pseudocorelacional coefficient , coefficient of correlation, Hi-quadrade and omnibus tests of significant. The values and levels of significance of Pearsons coefficients of correlation in the investigation of the relationships between some, in one hand socio - economical variables and segments of sports market, and in the other the using of specific sports services (products) are showed in the Tabel 1.:

**Tabel 1.** The values and levels of significance of Pearsons coefficients of correlation.

Predicator variable	Pearsons coefficient of corelation	Sport services (criteria)				
		Soccer	Basketball	Fitness	Not included in sports activities	Other kind of recreation
Age category from 18-30years old	Corelation	0,375	-0,141	0,000	-0,065	<b>-0,313</b>
	Level of significance	<b>0,000 **</b>	0,185	1,000	0,544	<b>0,003 **</b>
Age category from 30-50 years old	Corelation	-0,305	0,045	0,071	0,105	<b>0,321</b>
	Level of significance	<b>0,004 **</b>	0,676	0,504	0,325	<b>0,002 **</b>
Age category over 50 years	Corelation	-0,144	0,181	-0,130	-0,070	<b>-0,001</b>
	Level of significance	0,175	0,088	0,222	0,509	<b>0,990</b>
Category middle school educated	Corelation	0,189	0,017	-0,190	0,034	<b>-0,022</b>
	Level of significance	0,074	0,871	0,073	0,748	<b>0,834</b>
Category high school educated	Corelation	-0,061	0,256	0,089	-0,117	<b>-0,037</b>
	Level of significance	0,570	0,015 *	0,405	0,272	<b>0,731</b>
Category College educated	Corelation	-0,131	-0,217	0,109	0,059	<b>0,050</b>
	Level of significance	0,219	0,040 *	0,305	0,578	<b>0,640</b>
Commercial sector	Corelation	-0,003	0,141	-0,270	0,023	<b>0,025</b>
	Level of significance	0,977	0,185	0,010 *	0,833	<b>0,815</b>
NGO sector	Corelation	0,168	-0,020	-0,181	-0,167	<b>0,055</b>
	Level of significance	0,113	0,853	0,088	0,115	<b>0,608</b>
Government sector	Corelation	-0,165	-0,125	0,457	0,144	<b>-0,080</b>
	Level of significance	0,120	0,241	<b>0,000 **</b>	0,175	<b>0,451</b>
Monthly income (to 818,89 KM -> 818,89 KM	Corelation	-0,307	0,106	0,190	0,070	<b>0,068</b>
	Level of significance	<b>0,003 **</b>	<b>0,320</b>	<b>0,074</b>	<b>0,510</b>	<b>0,522</b>

In table number 1 you can see that for the predictor of using different sport services there are different predictors, in fact independent variables and their combinations. If you look at soccer, it is in a important positive correlation with people aged from 18-30 years, and in a important negative correlation with people aged from 31-50 years and in a negative correlation with the monthly income. That means that if somebody is aged from 28-30 years there are bigger they will use soccer and if they belong to age group 31-50 or if their salary is bigger than 818,89KM there is less chance they will use this service. The service basketball importantly and positively correlates with high school educated interviews and important negative correlates with college educated people. In average interviews with high school education are more included in basketball, and those with college education are less being included in that sport activity. Fitness as a sport service has a negative correlation with the commercial sector and positive correlation with the government sector. That means that the interviews who are working in the commercial sector are less using this service compared to other interviews, and those who work in the government sector in average include themselves more in fitness. Not including in kind of sport activity by itself isn't connected to any of the social-demographic variables and segment of sport market. When it comes to other sport services there in negative correlation to the variable of people aged from 18-30 years and in positive correlation with variable of people aged from 30 to 50 years. The review of the values of quadrate multiple pseudo correlation coefficient for some models of prediction for using some sport services (Soccer, Basketball, Fitness, not included in sport recreation and other kind of sport recreation) based on predictor variables who refer to social economical variables (life age of the group , level of education, work status, net salary) and segments of sports marketing, sectors in which the interviews are employed( commercial sector, government sector, NGO sector) is showed in table 2.

When it comes to soccer there were separated two important models of prediction of using this sport service/activity. The first model which includes predictors variable from 18-30 in its structure can explain 13,4 and 17,9 % of variation in using and not using this sport service, and the other model which includes predictor variables of people aged from 18-30 and monthly income can explain between 17,9 and 23,9 % variations of using this sport service. For Basketball there were separated two models of prediction also. The first model which includes the predictor variable of people high school educated is explained between 5,9 and 8,4% variation in using this sport service, and the other model which includes predictor variables people aged over 50 years and high school educated is explained between 10,2 and 14,5 % variation in using this sport service. For fitness there were separated just one model of prediction which includes predictor of the government sector and defines between 18,0 and 30,3% variation in using this sport service. IN the model of prediction (just one Is separated for this criteria )the using of other sport services is made by the predictor variable of people aged from 31-50 years which together with the constant value can explain between 9,7 and 17,2% variation in using other sport services.

For all separated models of prediction high quadrates are statistically important it as it can be seen from the upper table. All models for all criteria or sport activity are statistically important on levels smaller than 1%.The exception is model 1 for criteria basketball which is statistically important on level small than 5%.These results show that the separated models of prediction better prognoses the outcome of consuming some (upper listed) sport activities compared to base line predictions. Just for the variables of not using any of the sport activities (which were listed) hasn't got a important model of prediction, probably because of the fact that this variable isn't in and important correlation with any of the independent predictor variables. Models of prediction of using different sport products (services ), and based on the values of some predictor variables connected to social economical characteristics and segment of sport market are being showed in table 4.

**Table 2.** The values of quadrated multiple pseudocorelational coefficients for some models of prediction of using some sport products(services)

Dependent variable (criteria)	Model	-2 Log likelihood	Coxs and Snellovs R <sup>2</sup>	Nagelkerkes R <sup>2</sup>
Soccer	1	111,416	0,134	0,179
	2	106,613	0,179	0,239
Basketball	1	102,747	0,059	0,084
	2	98,564	0,102	0,145
Fitness	1	63,260	0,180	0,303
Not included in any sport activitie	0	-	-	-
Other recreation	1	65,165	0,097	0,172

**Tabel 3.** Omnibus test of importality of the whole model is showed in table 3.

Criteria	Step	Model	Hi-quadrat	Level of freedom	p
Soccer	1	Step	12,950	1	0,000 **
		Blok	12,950	1	0,000 **
		Model	12,950	1	0,000 **
	2	Step	4,803	1	0,028 *
		Blok	17,753	2	0,000 **
		Model	17,753	2	0,000 **
Basketball	1	Step	5,461	1	0,019 *
		Blok	5,461	1	0,019 *
		Model	5,461	1	0,019 *
	2	Step	4,183	1	0,041 *
		Blok	9,644	2	0,008 **
		Model	9,644	2	0,008 **
Fitness	1	Step	17,841	1	0,000 **
		Blok	17,841	1	0,000 **
		Model	17,841	1	0,000 **
Not included in any sport activitie	1	Step	-	-	-
		Blok	-	-	-
		Model	-	-	-
Other kind of recreation	1	Step	9,167	1	0,002 **
		Blok	9,167	1	0,002 **
		Model	9,167	1	0,002 **

\*\* Hi-quadrat is statistically important on level smaller than 1%.

**Tabel 4.**

Criteria	Step (Model)	Predicators	B	Cst. Mistake	Wald	Level of freedom	Level of importality	Exp(B)
Soccer	1	Age 18 to 30 y.	1,580	0,456	12,010	1	0,001 **	4,857
		Constant Value	-0,693	0,327	4,484	1	0,034 *	0,500
	2	Age 18 to 30 y.	1,397	0,471	8,782	1	0,003 **	4,043
		Monthly income	-1,028	0,472	4,742	1	0,029 *	0,358
Basketball	1	High-school educated	1,310	0,559	5,486	1	0,019 *	3,706
		Constant Value	-1,192	0,277	18,534	1	0,000 **	0,304
	2	Age over 50 y.	1,693	0,824	4,221	1	0,040 *	5,436
		High school educated	1,523	0,576	6,990	1	0,008 **	4,587
		Constant Value	-1,405	0,310	20,618	1	0,000 **	0,245
Fitness	1	Gov. Sector	2,614	0,702	13,863	1	0,000 **	13,647
		Constant Value	-2,962	0,592	25,023	1	0,000 **	0,052
Not included in sport activities	0	Constant Value	-2,833	0,460	37,906	1	0,000	0,059
Other kind of recreation	1	Age 31 to 50.y.	1,936	0,702	7,612	1	0,006 **	6,933
		Constant Value	-2,853	0,594	23,081	1	0,000 **	0,058

\* Walds statistic is important in a leve less than 5%

\*\* Walds statistic is important in a level less than 1%

The first prediction model related to football, has a significant predictor, age 18 to 30, which regression coefficient is positive and important at the level less than 1% (Wald-statistic is important at this level and represents the B-coefficient divided by standard error). On average, respondents who belong to this age group have 4.857 (see the Exp(B)) chance to be involved in this sport activity compared to those respondents who do not belong to this age. In the second prediction model of using services for futsal, two predictors are included: age group 18-30 and monthly salary. The first predictor in model 2 has a regression coefficient that is positive and important at the level of less than 1%, and the other predictor has a negative regression coefficient, which is important at a level less than 5%. On average, if the respondent belongs to the category aged between 18 and 30, he has a 4.043 higher chance of being involved in football. On the other hand, respondents with incomes higher than 818.89 KM, have 0.358 times smaller chance to be involved in this sport activity.

When it comes to basketball, "college degree" is included in model 1, which regression coefficient is positive and statistically important at a level less than 5%. On average, respondents with university education are 3.706 times more likely to be involved in basketball as compared to other subjects. In model 2, predictions of using basketball as sport service, two predictors are highlighted: "age group over 50", whose regression coefficient B is important at level less than 5% and positive, and "college degree" whose regression model is positive and statistically important at a level less than 1%. On average, respondents over the age of 50 are 5.436 times more likely to be involved in basketball as compared to other subjects, and respondents with college degree, chances are 4.587 times larger. Interestingly, "college degree", which negatively and significantly correlates with the criteria variable "basketball", is not isolated in any of the models. This is probably because there is high collinearity (correlation underlying the collinearity) with other predictors. Alternatively, if you look at the correlation in the first table, age over 50 is not significantly correlated with the variable "using sport service basketball", but still has an important regression coefficient identified in model 2. This is a classic example of a phenomenon, called suppressor-variable. Suppressor-variables are those variables that are associated with the criteria, but have an important correlation with other predictors or predictor in prediction model, and that, in these combinations, can substantially contribute to the prediction power of models. It can be said, that the age group over 50 years is a suppressor-variable. For fitness service, on model is isolated, that includes the predictor-variable "Government sector", whose regression coefficient is positive and important at a level less than 1%. On average, respondents who work in the governmental sector, are 13.647 times more chance to be involved in fitness activity. For the criteria-variable, also only one prediction model is isolated, which includes predictor-variable "age between 31-50 years", whose regression coefficient is positive and statistically important at a level less than 1%. On average, respondents in this age have a 6.933 times higher chance of being involved in some (of own choice) sports. From other forms of recreation, respondents answered mostly that they are running, swimming or playing tennis. Previous researches in EU and the U.S. show an increasing popularity of so-called outdoor recreational sport activities (running, walking, cycling, etc.), which are mainly individual sports (Bartolucci, M., 1998., Bartolucci M. Skoric, S., 2008.).

Our results show that one part of our interviewees participates also in that kind of recreation, but the frequency is not as big as in other countries. Of course our investigation was focused on the offer of sport services in Canton Sarajevo, which is very homogenous and

from the individual kinds of recreation offers just fitness. Except that our sample didn't include women, and researchers showed that women are dominating in certain kind of recreation (Australian Bureau of Statistics 2007). Taken by the fact that the subject of our investigation of analysis of this sport market from the perspective of a sport organization which is on the sport market offers sport products/services in Canton Sarajevo? Then we can look at the work (Masala, A., 2002.), who came to defect in his research that the service offered from the position of sports organization shows "a simple integrated sport product/complimented business sport product. That is a sport product organization in sports which is made by a connection of a sport product and some simple service and it has a program of renting sport equipment requirement, sport fields, sport spaces, sport equipment treating, administrative services, catering services, and lottery". Farral and shields (2002) made a research on the sample of N=1550 interviews who live all and N=4917 interviews who live in multimember families. The authors analyzed models of prediction of using over 80 different kinds of sport activity, based on some social demographic marks and characteristics. Using special regression analysis, it has been shown that there is a bigger likelihood of using all sport activities connected to predictor's variables with partial employments and location related to college education male sector and in total monthly incomes.

On the other hand women health problems and marriage status are related to the less possibility of using all the sport services. The research of Farral and shields was made on a much bigger sample which included female interviews what made the results different.

## Conclusion

Conclusions regarding this research derive from the results obtained in this work. A positive correlation between demographic indicators and their impact on the representation and positioning of sport products/sport and recreation services was shown in the sport market of Canton Sarajevo. All critical variables entered in at least one prediction model. Based on selected models, we can also talk about 4 segments of the target group. The segment "aged between 18 and 30 years with a monthly salary of less than 818.89 KM", which tends to use sport services for futsal. The segment "aged over 50 years and Associate degree", tend to use sport services for basketball.

The segment "government sector", which tends to use sport services for fitness and segment "age 30-50", which tends to use some other form of recreation. These results may have practical value for management of these sport organizations. For example, sport organizations that offer services for futsal can expect a greater chance that these services will be used by men aged 18-30 years, who have a monthly salary of less than 818.89 KM. Sport organization can adapt its marketing strategy for this segment of consumers.

Based on the above, we can conclude that the presence and positioning of sport products/services on the market in Canton Sarajevo are determined by the socio-economic indicators (age, education, employment and monthly salary) and based on these predictor, it is possible to create a profitable offer for sport services on the market. The process of research and segmentation of the sport market is the first step to create a sport-recreation offer and it's the key to achieve quality in work of organizations that offer sport services (Mašala, A., 2002.) on the sport market in Canton Sarajevo.

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# Influence of konativ factors on the performance elements of basketball in the teaching of sport and physical education high school student population

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*Original scientific paper*

## Abstract

The study was conducted to investigate the influence of four conative characteristics on the performance elements of basketball games implemented in the teaching of sport and physical education students in high school. A sample of 151 respondents was described by four variables for the assessment of conative characteristics and three variables to assess the situation - motor skills in basketball. When collecting data were used battery of tests F 18 PF and objectified / standard tests for situational motor abilities of students. The influence of conative variables set on the set of variables to assess specific motor skills (basketball), was estimated using regression analysis. The results suggest that there is partial correlation between conative and situational-motor abilities of students (performing elements of basketball games, realized in the teaching of sport and physical education students in high school).

Key words: **conative characteristics, basketball, situational - motor skills, secondary populations**

## Sažetak

Istraživanje je provedeno s ciljem utvrđivanja uticaja četiri konativne karakteristike na izvođenje elemenata košarkaške igre realizovane, u nastavi sporta i tjelesnog odgoja učenika u srednjoj školi. Uzorak od 151 ispitanika opisan je sa četiri varijable za procjenu konativnih karakteristika i tri varijable za procjenu situaciono - motoričke sposobnosti u košarkaškoj igri. Prilikom prikupljanja podataka korišteni su baterija testova F 18 PF i objektivizirani / standardni testovi za ispitivanje situaciono motoričke sposobnosti učenika. Uticaj seta konativnih varijabli na set varijabli za procjenu specifične motoričke sposobnosti (košarka), procijenjen je korištenjem regresione analize. Rezultati istraživanja sugeriraju da postoji djelimična povezanost između konativnih i situaciono-motoričkih sposobnosti učenika (izvođenja elemenata košarkaške igre, realizovane u nastavi sporta i tjelesnog odgoja učenika u srednjoj školi).

Ključne riječi: **konativne karakteristike, košarka, situaciono - motorička sposobnost, srednješcolska populacija**

## Introduction

Conveying the popularity of basketball games in the practical life lessons in sports and physical education, we can notice that the teachers of sports and physical education initiate a larger share of basketball games than other sports games are in the process of teaching. In the teaching contents basketball games need very little space, for example, basketball and sports equipment, basketball, then practically all placed in "their place" and also that is indicated by the fact that the concrete implementation of this context, no wonder even the interest of researchers for certain principles, and the interplay of sequence effects that occur within this sport. Findak (2001) these studies have highlighted an interesting time in the context of the whole structure we introduce and individualization of teaching and that should be implemented within the school. So there is a number of studies conducted by regarding the analysis of the corresponding relations and influence in the basketball game. A number of studies conducted in the situational-motor area showed a corresponding effect in the studied area (predictor / criterion). Mekić's research (2001) in a sample of 110 players at the municipal level and the Regional argues has conduct that basically-motor capacity can affect the throw the ball into the basket, and the same author (2002) determined the appropriate high and significant degree of influence of basic motor skills in adding precision ball in basketball. Examining the same elements and techniques of sports games (basketball). Bukvić's research (2003) finds that there is a significant and high

correlation between the basic-motor and motor-specific capabilities (explosive power, speed and balance against the ball control and shot at the basket), and Tallir et al. research (2008) in a sample of 30 players determined that through a basketball game 5 on 5 can increase the motor readiness. Another of the specifics that distinguished this research is to be found in the structure of Zorka secondary vocational school students, and where they are already. Kovac, Leskošek and Boom research (2007) conduct that there are differences in the morphological-motor structures between students of different high school curriculum, or that students of secondary vocational school achievers school curriculum compared to high school students more and Brettschneider and Nauli research (2004) has found that socio-economic status of families, parents' educational level and aspirations of the individuals have a strong influence on the motor status of young people. In accordance with this theoretical approach, the student athlete can be viewed as an intelligent receiver and interpreter of information obtained by performing movements with varying levels of effectiveness (Hodges, Starkes, MacMahon, 2006). This research was conceived to assess the influence of conative characteristics to the implementation of elements of basketball games in the teaching of sport and physical education. We are expecting a positive reaction by influence of conative functions on execution and implementation of dynamic elements in a basketball game which is continually used in class to sport and physical education as an indicator of students' knowledge of motor sport in this game. The above structure is interesting to check out because

it was established that there are influences other areas (motor and morphological) structure of the performance elements Vlasić, Oreb and Furjan-Mandić research (2007) has found a statistically significant correlation between the predictor morphological-motor space with a specific criterion situational motor elements.

## Methods

### Sample

The sample was defined as a population of male students, vocational school in Sarajevo, aged by 16-18 years. The report includes students who are in the process of testing and measurements were completely healthy. The total number of respondents in the sample was 151 students. All subjects had adequate conditions for the regular attendance of sport and physical education.

### Sample of variables

The selection and definition of the areas (conative characteristics and situational-motor skills) in this paper was carried out based on empirically validated and standardized methods of measurement and testing, and on the basis of which there have been some data on the investigated characteristics of respondents. Sample of predictor variables is defined as follows:

As a measuring instrument for the assessment of conative characteristics were used the following scale:

- 1 - A (anxiety)
- I - 7 (inhibitory conversion)
- T-15 (aggressiveness)
- L-17 (shizoid)

These scales belong to the battery 18 PF, which is based on factor analysis of verbal stimuli from Cornell Index N4, MMPI scales, and batteries constructed named MPI by Momirović (1968). This battery includes 18 tests and the extent of the primary pathological conative factors. It is interesting to state that all tests (except test of hypomania) PF 18 batteries have a high lower limit of reliability (from .74 to .96). Factor analysis showed that the battery is measured following four second order factors: asthenic syndrome, conversion syndrome, stenic syndrome and dissociative syndrome.

Sample of criterion variables (situational-motorical) defined as follows:

Variables for assessing a basketball game:

- Keeping the ball in the slalom - OKVLS (speed and coordination)
- Toss the ball with both hands on the wall - OKBLRZ (speed and accuracy handling the ball)
- Toss the ball into the basket - OKBLK (precision guessing)

These variables, among other authors, is used in the Ph.D. program for the assessment of situational motor performance of students. (Hadžikadunić, 1986.)

## Methods of Data Processing

Processing of the data obtained was performed using the software package SPSS 12.0 for Windows. At the multivariate level to determine the influence of applied regression analysis, which is extremely suitable mathematical and statistical procedures in cases where it is necessary to determine the effect of causing a variable to a set of other variables.

## Results and discussion

### The variables whose effect is achieved

Regression analysis of the criterion variables Keeping the ball in slalom OKVLS (Table 1), provides sufficient information about the influence of conative variables on the performance of the treated success criterion variable. Correlation of predictors with the criterion variable was  $R = .31$ , and explained very little (9%) together with the criterion of variability. It turned out that such a significant correlation (Sig.) at the highest level of .00. The analysis of individual influence of conative variables (Table 2), can be seen that the largest and statistically significant impact on the criterion variable with a variable inhibitory conversion (.02) and anxiety (.02), while the variables that explain the area of aggression and do not have this shizoid influence. Such a relationship setting as soon as we introduce the presence of a certain level of excitement with complex tensions, difficulties in mobilizing the energy and the different variations of the state of insecurity and fear of unknown with a touch of nervousness in the preparation and execution of basketball keeping the ball in the slalom. It is considered that the respondents in this case the task seriously, the way to access the competitive performance of the test and because of such attitudes had the appropriate dose of uncertainty and nervousness in the practical realization of the same. So before the test of keeping the ball in basketball slalom trainees / students should be adequately prepared psychologically. In order to facilitate the practical task and competition, that the specific performance, without the influence of negative features of both conative factors, achieve a better result, waiting for the appropriate award or winning better grades. The above is consistent with research Shiffrin and Schneider (1977) who confirmed that the automated processing of motor tasks requiring low level care, which is in contrast with the highly controlled information requiring attention and focusing. In contrast to the highly controlled information processing, automated processing is fast, simple and not under conscious control (Williams, AM, Davids, JG Williams, 2000). Therefore, many authors often speak of the consciousness and subconscious processes in the context of a structured research Shiffrin and Schneider (1977) and R Schneider, Dumais, and Shiffrin's (1984).

Table 1. Model Summary – OKVLS (dribbling slalom)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.314	.099	.074	.805

Table 2. ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	10.384	4	2.596	4.004	.004
	Residual	94.654	146	.648		
	Total	105.038	150			

Table 3. Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	I 7	.032	.014	.187	2.211	.029

**The variables whose effect is not achieved**

Regression analysis of the criterion variable Throwing the ball with both hands on the wall - OKBLZ (Table 4) shows that it is not isolated joint regression information about the importance of the influence of conative variables (A1, I7, T15, L17) on the success of the performance criterion variables treated (OKBLZ). Correlation of predictors with the criterion variable was  $R = .20$ , with a very low percentage of explanation of the variability of 4%. Although isolated regression function XD absent significant correlation (.17 Sig. in Table 5) was analyzed and the influence of individual variables (Table 6) which can be stated that is not entirely absent. So all four of the treated conative variables, only anxiety, shows the influence of performance basketball throwing ball with both hands on the wall (.02) significance. The realization of this motor task requires the attention and focusing so the participants

to implement this element of basketball games, which require fast movement, set up under the ball, precision and coordination, necessary and psychologically well prepared.

Regression analysis of the criterion variable Throwing the ball into the basket - OKBLK (Table 7) notes the lack of information about the existence of conative variables influence the success of the performance criterion variables treated. Correlation of predictors with the criterion variable was  $R = .16$ , with a very low degree of explanation common variability of 2%. How significant was no correlation of the regression function, so the same is absent in the individual effect of variables. So treated conative variables have no influence on the throw the ball into the basket in a basketball game so that students / trainees is not necessary to prepare psychologically for the realization of this test.

Table 4. Model Summary- throwing the ball with both hands on the wall

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.206	.043	.016	6.893

Table 5. ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	309.349	4	77.337	1.625	.171
	Residual	6948.095	146	47.590		
	Total	7257.444	150			

Table 6. Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	I 7	-.272	.122	-.194	-2.228	.027

Table 7. ANOVA– Throwing the ball into the basket

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	40.618	4	10.155	1.033	.392
	Residual	1435.329	146	9.831		
	Total	1475.947	150			

Insight into the regression analysis, and the relation of conative characteristics with the first principal component derived from three motor tests situational handball (OKVLS, OKBLRZ, OKBLK) which has a reciprocal correlation (predictor and criterion variables)  $R = .29$  (Table 8) and the coefficient of determination of  $.08$  leads us to conclude that the level of isolated features is very low. Although the significance of correlation ( $.01$ ), all predictor variables have made a constructive impact on the first principal component. By analyzing the influence of individual variables, in order to verify the relationship that has been achieved with the first principal component (Table 10), we can conclude that only one variable and 17-inhibitory conversion, a significant statistical relationship with the basketball game ( $.01$ ). This effect confirms the relationships observed in testing elements of basketball ball leading in the slalom and throwing the ball with both hands on the wall, thus confirming the importance of inhibition of conversion in the realization and implementation of elements of basketball games. These results are consistent with an explanation of the relationship between conative and motor skills by Fitts and Posner's research (1967), who found that during the process of acquiring motor skills an individual progresses through the conative stage, then the associative stage, and eventually reaches a level of automation (autonomous stage). These results confirm research and Čerenšek Baric's (2011) with the purpose of researching to find a positive relationship between ego and target orientation and before competition anxiety and establish a negative relationship between these two factors. The results of this study did not confirm their hypothesis, ie lacking the conative characteristics influence the level of implementation of elements of sport, and it was confirmed that the team sports, especially for men can have a positive effect on confidence and that team sports athletes feel less anxiety before competition. So, what are the subjects / students were less emotionally active (excited, scared the task), and better prepared technically, these are the results of the attainment of a basketball game was on a higher level.

## Conclusion

The influence of conative abilities (anxiety, inhibitory conversion, aggressiveness, shizoid) to perform three situational - motor elements of the game of basketball (dribbling slalom, throwing the ball with both hands on the wall, throwing the ball into the basket) was analyzed using regression analysis on 151 subjects - student secondary vocational schools. The goal set of the research is presupposed that there is influence of conative characteristics on performance of situational-motor elements of basketball games. The proceedings showed that only one of the variables - inhibitory conversion has significant impact on the realization of the set of elements of basketball. The same variables also isolated as a significant and near, three situational-motor element, formed latent space. As conative structure-sensitive guidance and feedback from the environment. We conclude that the performance level of teaching physical education and sport, in the case of this study was characterized by the conscious / good control over the various external influences. Also, we can state that the students / pupils motor well mastered techniques of throwing the ball with both hands on the wall and throwing the ball into the basket and by the realization of the same is not interfered with the surrounding structure of relationships (other students, teacher attendance, performance evaluation, etc.). For technical elements Keeping the ball in slalom, results appeared to influence the structure (inhibitory conversion) on the implementation of this element, which in practice is that the students appeared for the symptoms listed conative characteristics. The latent situational-motor area is formed of three treated with basketball element appeared using regression effect conative structures. Lowered into the space of individual variables is defined as the influence of one variable, and also inhibition of the conversion. It can be concluded that this effect is practically transferred from the manifest space and that the participants in the realization of a basketball game felt the level of complex tensions, difficulties in mobilizing energy, uncertainty

Table 8. Model Summary-I MAIN COMPONENT AND BASKETBALL GAMES

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.290	.084	.059	.970

Table 9. ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	12.627	4	3.157	3.355	.012
	Residual	137.373	146	.941		
	Total	150.000	150			

Table 10. Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	17	-.044	.017	-.217	-2.553	.012

and vague fear with a touch of nervousness in the preparation and implementation techniques of treated components. This was partially confirmed in practice, research goal, given that the four variables are treated, only one (inhibitory conversion) has an evident influence on the practical, situational-motor work trainees / students. In essence, for better implementation of the content of teaching trainees / students should be well prepared and technically (quality motor knowledge) because in this case we have a situation where the student / learner, the implementation element "under pressure" (which is graded or in space where it realizes there is an element of noise is made, or psychological pressure caused by the presence of other students or teachers, etc.), it performs very well and ultimately achieve better success in the classroom.

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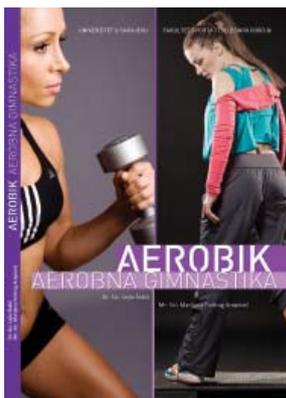
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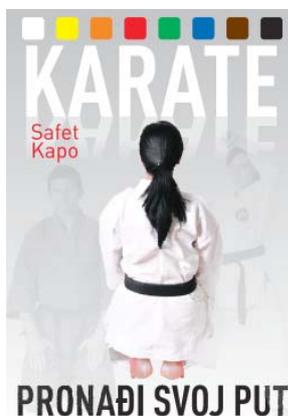


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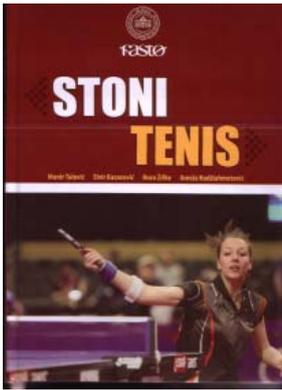
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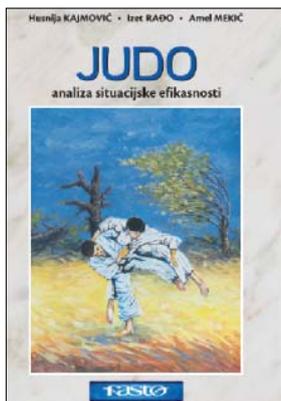
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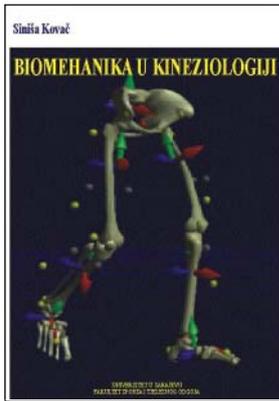
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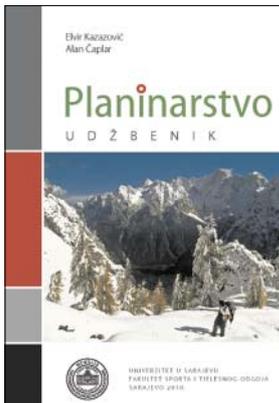


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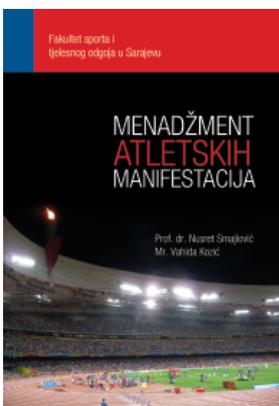


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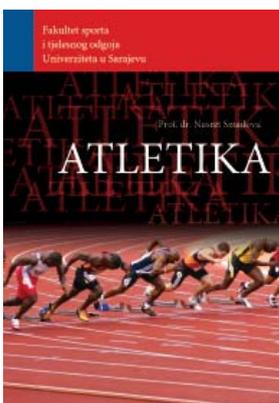


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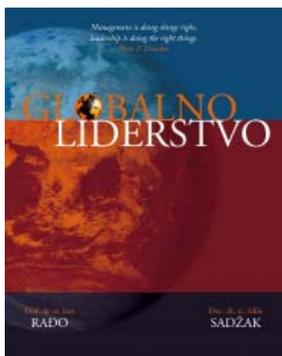
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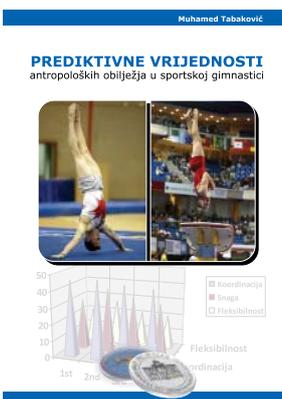
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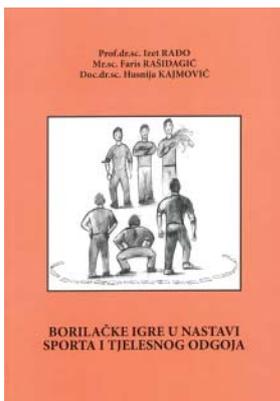
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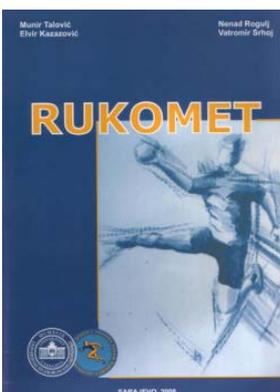
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