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fasto

Dear readers,

It's our pleasure to inform you that the employer of Faculty of Sport and Physical Education, University of Sarajevo mr.sc. Amel MEKIĆ has become the European Champion in -100 kg weight category on European Judo Championship for seniors, which was held in Istambul (Turkey) on April, 2011. Let's wish all together to our champion great success on his „way" to the Olympic Games in London 2012.

Editorial

Amel MEKIĆ – EUROPEN JUDO CHAMPION

Almir Atiković[1]

The impact of biomechanical parameters on initial vault values following the fig rules in men's artistic gymnastics

[1] *Faculty of Physical Education and Sport, University of Tuzla, Bosnia and Herzegovina*

Original scientific paper

Abstract
The primary objective of this paper is to establish precisely how and which biomechanical parameters explain and define the initial vault value. The study sample includes 64 vaults as per the Code of Points of the International Gymnastics Federation (FIG). The sample of dependent variables includes all points ranging from 2 points to 7.2 points, while the sample of independent variables includes 12 biomechanical variables expressed in various measure units. All data were analysed using SPSS Statistics 17.0. With regression analysis we explained 92.4% of the difficulty vault value. Only three biomechanic variables were predictors: degrees of turns around transversal axis, degrees of turns around longitudinal axis and body's moment of inertia around transversal axis in the second flight phase. Factor analysis has resulted in isolating the following four factors: degrees of turns around transversal axis in the second flight phase, first flight phase, longitudinal body axis in the second flight phase, and the support on the table. The results of the research may serve as a starting point for launching an initiative for changing the FIG rules on awarding points in relation to the existing Code of Points (2009). This type of research has confirmed that, from a biomechanical point of view, initial vault values can be far more realistically determined by the expert panel of the men's FIG technical committee.

Key words: **Code of Points FIG, Valut, Artistic Gymnastics, Biomechanics**

Sažetak
Primarni cilj ovog rada je utvrditi koji biomehanički parametari objašnjavaju i definiraju početnu vrijednost skoka na preskoku. Uzorak varijabli uključuje 64 skoka iz Bodovnog pravilnika Međunarodne gimnastičke federacije (FIG, 2009). Uzorak zavisnih varijabli su sve ocjene u rasponu od 2 do 7.2 boda, dok uzorak nezavisnih varijabli uključuje dvanaest biomehaničkih varijabli izraženih u različitim mjernim jedinicama. Svi podaci su analizirani pomoću SPSS 17.0 za statistiku. Sa regresionom analizom je objašnjeno 92,4% težišne skoka na preskoku. Rezultati dobiveni u manifestnom prostoru definiraju samo tri varijable: alfa x i y osi u drugoj fazi leta i moment inercije JX u drugoj fazi leta. Faktorska analiza je rezultirala u grupisanju sljedeća četri faktora: faktor količine okreta oko čeone ose u drugoj fazi leta, faktor prve faze leta, faktor količine okreta oko uzdužne ose tijela i faktor upora na stolu. Rezultati istraživanja mogu poslužiti kao polazna osnova za pokretanje inicijative za promjenu FIG pravila o dodjeli bodova u odnosu na postojeći Bodovni pravilnik (FIG, 2009). Ovaj tip istraživanja potvrdio je, da sa biomehaničkog stajališta, početne ocjene mogu biti daleko realnije određene od strane muškog tehničkog komiteta FIG.

Ključne riječi: **Bodovni pravilnik FIG, preskok, sportska gimnastika, biomehanika**

Introduction

First ever uniform instructions on Code of Points (COP) in gymnastics under FIG – International Gymnastics Federation date back to 1949. The FIG technical committee improves and further develops the COP every four years. Many biomechanical researches have been conducted in the past by Soviet, German, American, Japan, English, Slovene and other researchers (e.g. Šlemin & Ukran, 1977; Gaverdovsky & Smolevsky, 1979; Brueggeman, 1994; Prassas, 1995; Krug, 1997; 1998; Takei, 1998; Čuk & Karácsony, 2004; Marinšek, 2010; Ferkolj, 2010, etc.) and knowledge of physical parameters of vaults are generally-known. However, rules have not always followed the ever-changing nature of vaults since 1949. More specifically, rules have been late when it comes to the definition of the vault difficulty level. With inclusion of the saltos in the second flight phase (fp), the vault difficulty becomes defined primarily by body position: tucked, piked and stretched, number of rotation around the transversal and longitudinal body axis (COP FIG, 1964; 1971; 1978; 1985; 1989; 1993; 1997; 2001; 2006; 2009). Difficulty value (DV) have changed on the basis of the total number of rotations performed around transversal and longitudinal axis. Usually COP rewarded each new vault with more DV, old vaults had to be awarded fewer DV although the vault remained the same. The overview of changes and correlations between the DV is one of the evidence shown in (Table 1) that there have been no significant changes in the past years where correlations are rather high between the DV awarding rules that have been applied up to now.

Table 1. Correlations between FIG Codes of Points (COP) from 1965 to 2009

Year of publication	2009-2006	2006-2006	2006-2001	2001-1997	1997-1993	1989-1985	1985-1978	1978-1971	1971-1965
R	1	0.986	0.99	0.93	0.89	0.87	0.875	0.946	0.976
R^2	1	0.972	0.99	0.87	0.79	0.76	0.766	0.894	0.952

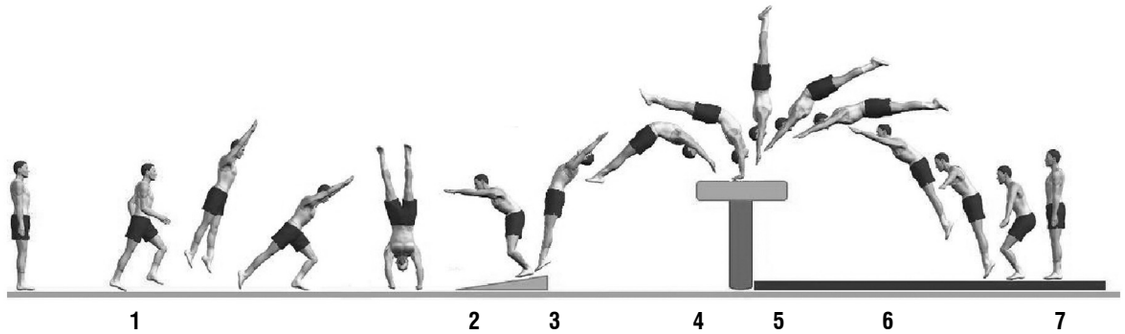

Figure 1. Vault phases: 1-run, 2-jump on springboard, 3-springboard support phase, 4-first flight phase, 5-support on the table, 6-second flight phase, 7-landing

Each vault in COP can be divided in the following seven phases (Figure 1) (Prassas, 2002; Čuk & Karácsony, 2004; Takei, 2007; Ferkolj, 2010) run, jump on springboard, springboard support phase, first flight phase, support on the table, second flight phase, and landing.

In (Table 2) we see that from 1964 to 2009 year, 96 vaults, increased the number of jumps on the vault. Analyzing (Table 3) we see that since 1997 year in the fifth group is the most vaults in comparison with other groups. Number of vaults by groups should be equal in the distribution of groups is not what this is

Table 2. Development of COP for assessing the number of elements in individual apparatus

Men's events	2009	2006	2005	2001	1997	1993	1989	1985	1978	1971	1964	Sum	Ave.
FX	137	130	132	136	116	134	123	103	98	109	75	1156	115.6
PH	113	118	112	115	182	230	202	82	131	113	57	1342	134.2
RI	142	145	141	126	148	145	122	97	116	115	83	1238	123.8
VT	115	114	114	105	109	86	61	48	45	32	19	733	73.3
PB	151	149	147	143	249	235	184	149	138	137	90	1621	162.1
HB	143	143	143	148	176	193	156	115	121	112	83	1390	139
Sum	801	799	789	773	980	1023	726	594	649	618	407	7358	735.8
Ave.	133.5	133.1	131.5	128.8	163.3	170.5	141.3	99	108.1	103	67.8		

Legend: floor exercise (FX), pommel horse (PH), rings (RI), vault (VT), parallel bars (PB) and horizontal bar (HB)

Table 3. Development of COP for assessing the number of elements in structural groups

Valut	2009	2006	2005	2001	1997	1993	1989	1985	1978	1971	1964	Sum	Ave.
I	7	7	7	7	7	12	8	9	19	16	14	113	18.8
II	6	6	6	6	28	7	2	4	1	0	0	66	11
III	32	31	31	27	29	22	22	19	20	15	4	252	22.9
IV	22	22	22	22	9	27	21	16	5	1	1	168	28
V	48	48	48	43	36	18	4	0	0	0	0	245	40.8
Sum	115	114	114	105	109	86	57	48	45	32	19		
Ave.	23	22.8	22.8	21	21.8	17.2	11.4	9.6	9	6.4	3.8		

Table 4. Development of COP for assessing the number of elements in difficulty elements

Valut	2009	2006	2005	2000	1997	1993	1989	1985	1978	1971	1964
1	A	A	A	A	A	A	A	A	A – 7.0	7	7.5
2	B	B	B	B	B	B	B	B	B – 8.0	7.5	8
3	C	C	C	C	C	C	C	C	C – 9.0	9	9
4	D	D	D	D	D	D	D	D	D – 9.4	9.3	9.5
5	E	E	E	E	E	E			E – 9.8	9.5	9.8
6	F	F	F						F – 9.4	9.6	10
7	G									10	
Sum	7	6	6	5	5	5	4	4	6	7	6

Table 5. Development of COP in terms of the range of points

Valut	2009	2006	2005	2001	1997	1993	1989	1985	1978	1971	1964
Range	2.0-7.2	2.0-7.2	4.5-7	7.5-10	7.5-10	8.6-9.8	8.7-9.6	9-9.6	7-9.8	7-10	7.5-10

now. The first unique instructions FIG for evaluation of gymnastic exercises were created in 1949. known as "*Code of Points*." for the assessment of the artistic gymnastics includes seven levels of degree of difficulty. Initial degree of severity represents the level A, and the next levels are B, C, D, E, F and G (FIG, 2009). The latest one is the greatest degree of severity. The main purpose and goal of the COP for evaluating is provision of more objective evaluation of exercises. In (Table 4) shows the development of difficulty vaults from cycle to cycle. It may be noted that since 1985 year with the release of each new COP increases in DV than the previous one. In (Table 5) notes that the range of ratings ranged from 0.60 points in 1985 to COP for the 5.20 points COP (FIG, 2009).

Methods

Sample of the examinees

The study sample included 64 vaults out of the possible 115 as listed in the COP (FIG, 2009), from which we managed to obtain data from the researches conducted so far. In collecting the data, we could not reach all vaults because some of them, for example, second group vaults have not been performed since last 20 years. Analysing all reading materials and video recordings from large world competitions, men's perform some 30 different vaults, accounting for quarter of all vaults. A total of 64 different vaults have been collected with 12 variables. The sample of dependent variables includes DV (COP) ranging from 2 to 7.2 points, while the sample of independent variables include biomechanical variables shown in (Table 6).

In the analysis, we selected the following variables: degrees of turns in x and y axis in the first and second flight phase (variable names: *alpha in the x and y axis – the first and the second flight phase* – shown on the basis of the COP (FIG, 2009) and defined by the quantity of rotations. The moment of inertia was calculated by cylindric model of Petrov & Gagin (1974), (*J=ml2/12*) for *the first and second flight phases and the moment of inertia in the x and y axis* (Table 7). Morphologic data of vault specialists were used for calculation of moment of inertia body height 167.35 cm and body weight 68.15 kg. Čuk & Karácsony (2004) with the g=9.81 m/s2 and the Dempster body model Winter (1979). Some time parameters: *vault run speeds – maximum run speed on springboard, first and second flight phase* determined as the average value from all vaults were calculated from elite gymnasts (N=230) performing at the 2006 World Championship (WC) in Aarhus – Denmark after analyzing video recordings from FIG (IRCOS-Instant Replay and Control System) as recorded at 50 frames per second.

Data procesing methods

Data were processed as follows: in analysing descriptive parameters of variables applied in vaults, Kolmogorov-Smirnov test to determine the normality of distribution of the results for further multivariate analysis, regressive analysis with vault difficutly values as criteria and selected biomechanical variables as predictors (according to the method enter). For the significance of the regression analysis F test was used. The regressive analysis will help us establish whether independent variable biomechanical parameters depend on the current initial value. Factor analysis helps us determine the latent structure of manifest variables applied. As vaults are continuous actions where vault phases build on one another, we therefore selected only independant variables (variable can not be a mathematical function of two or more known variable, as the variablility of such varibles do not bring any new variance). For that reason specifically, the analysis includes the trajectory, the moment of inertia and individual vault phase times. We will take into consideration correlations and multiple correlations at the significance level of ($p<0.05$).

Table 6. Descriptive characteristics for (N 64 = vaults)

Variables (N = 64 vaults)	Min.	Max.	Mean	Std. Dev.	Skew.	Kurt.	K-S test	Sig.
COP – FIG, 2009. (points)	2.00	7.20	5.021	.170	-.174	-.617	.758	.614
BCG velocity on springboard (m/s)	6.00	10.90	7.841	.117	1.240	2.300	1.018	.252
Time of first flight phase (s)	.08	.33	.193	.007	.910	-.207	1.637	.009
Time of second flight phase (s)	.70	1.20	.928	.014	.077	-.177	.679	.747
Time of support on the table (s)	.08	.28	.159	.006	.637	-.367	1.203	.111
Alpha in x axis second flight phase (°)	120	900	482.81	28.860	-.032	-.395	2.658	.000
Alpha in y axis second flight phase (°)	0	1170	348.44	38.496	.788	-.305	1.537	.018
Alpha in x axis first flight phase (°)	90	160	133.75	4.018	-.505	-1.659	2.968	.000
Alpha in y axis first flight phase (°)	0	360	45.00	8.504	2.048	6.155	2.842	.000
Moment of inertia Jx axis 1st flight phase (kgms^2)	1.145	1.978	1.745	.0280	-2.045	3.274	2.023	.001
Moment of inertia Jy axis 1st flight phase (kgms^2)	.000	.555	.192	.032	.701	-1.505	2.905	.000
Moment of inertia Jx axis 2nd flight phase (kgms^2)	.458	1.731	1.266	.071	-.466	-1.744	2.911	.000
Moment of inertia Jy axis 2nd flight phase (kgms^2)	.000	.127	.103	.006	-1.640	.711	3.543	.000

Legend: N – no. of performances; M – mean; Min, Max – lowest and highest value; SD – standard deviation; Skew., Kurt. – coefficients of skewness and kurtosis; K-S test – Kolmogorov Smirnov test normality of the distribution - significant at the 0.05 level.

Table 7. Moments of inertia as calculated for various body positions in the first and second flight phases

Calculated as per the model (J/g)	Body axis	Such, J. (2007.)	Petrov, V., J. Gagin (1974.)	Groups of vaults and body position in the flight phase
1.706	x	-	-	I – Direct vaults
1.978	x	-	-	II – Vaults with full turns in preflight
1.771	x	-	-	III – Front handspring and Yamashita style vaults
1.874	x	-	-	IV – Vaults with 1/4 turn in pre-flight
1.145	x	-	-	V – Round-off entry vaults
0.458	x	0.356	0.60	Tucked
0.738	x	0.662	0.50 – 0.70	Piked
1.731	x	-	1.70	Stretched
0.127	y	-	0.17	Shoulder width
0.555	y	-	-	Arch-like position in group IV vaults

Results and Discussion

In the (Table 8) predictor system of variables (R Sguare) explains 92% of the common variables with criteria, while the correlation of the entire predictor system of variables with criteria, the coefficient of multiple correlation amounts to 0.96 (RO). The analysis of impact of individual variables (Table 9) shows that the highest and statistically most important influence of the criteria variables are with the following variables: alpha x in the 2nd fp (Beta) .835, alpha y in the 2nd fp (Beta) .375, and the moment of inertia Jx in the 2nd fp (Beta) .373 which is deemed significance level of ($p<0.05$). Prediction has been found significant only with three variables, meaning that the present vault difficulties COP (FIG, 2009) is defined by these three variables of the 2nd fp. The regressive analysis clearly shows that the initial value prediction is very high. Degrees of turns around transversal and longitudinal axis, body position in the 2nd fp are the only predictors and the most significant predictors in the COP (FIG, 2009). It can be noted that the FIG technical committee only considered the 2nd fp starting with the table take-off onwards to just before landing. Hence the 5 different vaults to support on the apparatus have no significant predictions to initial jump difficulty level. While Pearson correlation between DV value and runway velocity is the highest in regression analysis all the variance of the velocity goes to other parameters, probably mostly to alpha x in 2nd flight phase (r=.748). Bruggemann (1987) and Kwon (1996) noted that the DV is often increased by adding more rotations of somersaults into it's basic form. Bruggemann (1987) reviewed the research literature on gymnastics valuting, based largely on his work on continous rotation vaults. He reported that the higher skilled gymnasts were better able to increase the linear and angular moment at horse take off than the lower skilled gymnasts. He concluded that approach velocity was of high significance to the overall preformance of vault. It would apper that the success of a vault could be attributed to a large extent to the preflight characteristics. However, Bruggemann (1994) noted that the purpose of 2nd fp is to alter the preflight phase. This is establishes by generating lift through a higher vertical velocity and maintaining sufficient momentum for the postflight since the main goal of the vault was to establish height and distance in the postflight phase, wich contains the actual difficulties of the vault.

Table 8. The regressive analysis of the criteria variable COP (FIG, 2009)

R	R Square	Adjusted R Square	Std. Err. of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
.961[a]	.924	.906	.418	.924	51.768	12	51	.000

Variables	Unstandardized Coefficients		Standardizd Coefficients	t	Sig.	95,0% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
(Constant)	-2.063	1.410		-1.463	.150	-4.894	.768
BCG velocity on springboard (m/s)	.219	.120	.151	1.832	.073	-.021	.459
Time of first flight phase (s)	.941	1.731	.043	.543	.589	-2.535	4.416
Time of second flight phase (s)	1.418	.886	.121	1.599	.116	-.362	3.197
Time of support on the table (s)	-.679	1.355	-.024	-.501	.619	-3.400	2.042
Alpha in x axis second flight phase (°)	.005	.001	.835	6.638	.000	.003	.006
Alpha in y axis second flight phase (°)	.002	.000	.375	7.308	.000	.001	.002
Alpha in x axis first flight phase (°)	-.003	.005	-.066	-.583	.562	-.012	.007
Alpha in y axis first flight phase (°)	.000	.001	.007	.128	.899	-.002	.002
Moment of inertia Jx axis 1st fp (kgms^2)	.300	.381	.049	.787	.435	-.465	1.065
Moment of inertia Jy axis 1st fp (kgms^2)	-1.116	.689	-.211	-1.621	.111	-2.498	.266
Moment of inertia Jx axis 2nd fp (kgms^2)	.888	.137	.373	6.489	.000	.613	1.163
Moment of inertia Jy axis 2nd fp (kgms2)	-.544	1.481	-.020	-.367	.715	-3.517	2.430

Table 9. The impact of individual variables on the criteria variable COP (FIG, 2009)

Factor analysis results have resulted in insolating four major components (Table 10) accounting for the overall variability (Cumulative %) with 72% common variables within the entire system (Table 10). Factor analysis has resulted in isolating four factors (Table 11), as follows: 1.) degrees of turns around transversal axis in the second flight phase (alpha x 2nd fp .951, duration 2nd fp .838, 2.) 1st flight phase Jy 1st fp .894, alpha x 1st fp -.823, Jx 1st fp. .725, alpha y 1st fp .717, 3.) longitudinal body axis in the second flight phase alpha y 2nd fp .859, Jy 2nd fp .848, 4.) the support on the table .807.

Table 10. The matrix of characteristic roots and explained parts of common variance

Com.	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Var.	Cum. %	Total	% of Var.	Cum. %	Total	% of Var.	Cum. %
1	3.168	26.400	26.400	3.168	26.400	26.400	3.016	25.134	25.134
2	2.813	23.439	49.838	2.813	23.439	49.838	2.685	22.372	47.506
3	1.607	13.395	63.233	1.607	13.395	63.233	1.714	14.285	61.791
4	1.098	9.151	72.384	1.098	9.151	72.384	1.271	10.593	72.384

Extraction Method: *Principal Component Analysis.*

Table 11. The structure matrix

Variables	Component			
	1	2	3	4
BCG velocity on springboard (m/s)	.796	-.095	.055	-.147
Time of first flight phase (sec.)	-.692	-.303	-.186	-.365
Time of second flight phase (sec.)	.838	.019	.063	-.299
Time of support on the table (sec.)	-.139	.154	.035	.807
Alpha in x axis second flight phase (°)	.951	-.021	-.211	.088
Alpha in y axis second flight phase (°)	.044	.067	.859	.138
Alpha in x axis first flight phase (°)	.023	-.828	-.084	-.121
Alpha in y axis first flight phase (°)	.027	.717	-.005	.096
Moment of inertia J in x axis 1.f.p. (kgms^2)	-.064	.725	.016	-.361
Moment of inertia J in y axis 1.f.p. (kgms^2)	.149	.894	.119	.207
Moment of inertia J in x axis 2.f.p. (kgms^2)	-.497	-.139	.384	.382
Moment of inertia J in y axis 2.f.p. (kgms^2)	-.037	.101	.848	-.073

Rotation Method: *Varimax with Kaiser Normalization*. Rotation converged in 5 iterations.

Conclusion

In determining the impact of biomechanical parameters of vault value in men's artistic gymnastics and it's initial values, we have attempted to identify and maximise the correlation between the present COP (FIG, 2009). The results obtained at this moment in the manifest space define only three variables of vault values as follows: alpha x in the second flight phase, alpha y in the second flight phase and the moment of inertia Jx in the second flight phase. Research conducted so far has not considered structural groups of vaults and the very phase leading to the apparatus which is represented by various moments of inertia. Further research requires consideration of all parameters that have been used by other authors, including Brüggemann (1987, 1994), Kwon (1996), Takei (1998), Prassas, S. (2002), Ferkolj and Čuk (2010), in order to determine within the latent space whether only 8% of the variance refers to the: run time/velocity, support on the table and some other parameters. Factor analysis has resulted in isolating the following four factors: degrees of turns around transversal axis in the second flight phase, first flight phase, longitudinal body axis in the second flight phase, and the support on the table. The results of the research may serve as a starting point for launching an initiative for changing the FIG rules on awarding points in relation to the existing COP (2009). It would be good to make 3D kinematic analysis for every vault, but for this type of research, we mention in the subject and in the problem, the individual jumps are difficult to collect because they are not being performed for many years. Only ¼ of the total number of vaults from COP (FIG, 2009) are being performed on competitions.

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Discriminant analysis of soccer tactical elements in the phases of attack and defense determined by cluster analysis

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Abstract
The aim of this study was to determine the differences between groups of tactical elements in the phases of attack and defense in soccer. It was defined 117 tactical elements of soccer game whose importance was estimated with 30 variables that indicate the basic segments of the football game. The sample of entities in this study is represented by 93 offensive and 24 defensive tactical elements that are described with 15 variables for the phase of attack and 15 variables for the phase of defense. For the determination of entities through a total of 30 variables, it was used an expert knowledge of ten competent soccer experts. Relying on their own experience and using the assessment system with grades ranging from 0 to 5 the experts graded the impact of tactical techniques on the properties (attributes) of soccer, attack and defense. In the phase of the attack there were identified three homogeneous groups of tactical elements, and several subgroups at a lower level and in the phase of defense, four groups were identified. The first discriminant function had a higher discriminative power in relation to the second discriminant function. The results have shown statistically significant difference between groups of entities (tactical elements of attack) at the level of significance $p<0.01$, with high canonical correlation coefficients (Rc1-0.93 and Rc2-0.75). Discriminant analysis for defined group of tactical elements indicates to the posibility for differentiation of potential programs and sub-programs of the tactical preparation for players and economization of training.

Key words: **soccer, tactical elements, homogeneous groups, discriminant analysis**

Sažetak
S ciljem utvrđivanja razlika između grupa taktičkih sredstava u fazi napada i obrane u fudbalu definirano je 117 taktičkih sredstava fudbalske igre čija je važnost procijenjena na 30 varijabli koje označavaju temeljne segmente fudbalske igre. Uzorak entiteta u ovom istraživanju predstavljaju 93 napadačka i 24 obrambena taktička sredstva koja su opisana sa 15 varijabli faze napada i 15 varijabli faze obrane. Za određivanje karakteristika entiteta kroz ukupno 30 varijabli, korišteno je ekspertno znanje desetorice kompetentnih fudbalskih stručnjaka. Eksperti su ocenama 0 – 5 na osnovu vlastitih spoznaja procijenili utjecaj svakog entiteta (taktičkog sredstva) na pojedine varijable koje opisuju fudbalnu igru u fazi napada i fazi obrane. Na osnovu vrednosti koeficijenata objektivnosti utvrđen je visok stupanj slaganja mišljenja eksperata oko predmeta u svim atributima napada i obrane. Izračunate su Mahalanobisove distance između taktičkih sredstava te su prikazani odgovarajući dijagrami udruživanja u klastere. U fazi napada identificirane su tri homogene grupe taktičkih sredstava i nekoliko podgrupa na nižoj nivou, a u fazi obrane identificirane su četiri grupe. Razlike između grupa taktičkih sredstava napada utvrđenih klaster analizom testirane su na multivarijatnom nivou diskriminacijskom analizom. Zbog premalenog broja entiteta u grupama taktičkih sredstava obrane, razlike između grupa testirane su na univarijatnom nivou Kruskal–Wallisovim testom. U svrhu usporedbe prosečnih ocena važnosti po grupama izračunate su aritmetičke sredine rangova taktičkih sredstava za svaku grupu. Na kraju se može zaključiti kako se Diskriminacijskom analizom utvrđenih grupa taktičkih sredstava klaster analizom ukazuje na mogućnosti njihova razlikovanja. Time se mogu identificirati potencijalni programi i potprogrami taktičke pripreme fudbalera (ekonomizacija treninga).

Ključne riječi: **fudbal, takticki elementi, homogene grupe, diskriminativna analiza**

Introduction

Soccer is currently the most popular sport with demands that are increasing, requiring greater motor and energy-supply abilities and the use of quicker and more efficient tactical techniques. In the nearest future, further development of the game dynamics is expected (Kuhn Humboldt, 2003). Tactics in soccer include technical elements applied in different situations such as a variety of group movements, measures and procedures carried out with the aim of solving certain tasks during the game (Toplak, 1985). The familiarity with the game structure includes understanding of various phases of the game and individual players' positions, which leads to the recognition of specific game situations. The players must understund those phases and transisitons from one phase to another and solve the tasks in the game by using appropriate technical and tactical programs (Lanham, 1993). Several studies exist concerning the game structure and frequency of tactical techniques used in soccer (Barišić, 1996). There are also numerous studies that analyse the impact of and correlation between specific tactics and structural elements and performance of the soccer team (Luhtanen, 1993; Jerković, Barišić, Birkić & Šimenc, 1996; Bishovets, Gadijev & Godik, 1993; Ćurčić, 2005; Yamanaka, Hughes & Lott, 1993; Hughes, 1993). Furthermore, Barišić (1996) has analyzed successful and unsuccessful performed technical-tactical elements in the game on a sample of 18 variables collected at the final eight games of the World Championships in Italy (1990). He has concluded that the winners in seven games had higher quantitative and qualitative grades of passing the ball, and the analysis of steals showed rarely use of tackling, while much more common were the interseptions of the ball in front of the opponent kick by leg (the ball coming on the ground) and by head (the ball coming in air). Jinshan, Xiaoke, Yamanaka and Matsumoto (1991) have analyzed conceded goals in 13th (Mexico, 1986) and 14th (Italy, 1990) world soccer championship. They have found that nearly 70% (80%) of goals were scored after a pass from the wing position and after shots from the central area. Argilaga and Jonsson (2003) have found that the conventional soccer analysis mainly

focuse on elementary statistics and drafts of the field that provide information such as frequency and field distribution of players' passes, shots on goal and defense formation. It turned out that players' efficiency is often driven by strategy and tactics that resulte in the same patterns of behaviour. Some of these patterns can be seen by coach, while others require much more detailed methods and analysis to be noticed. Current studies are focused on the discovery and analysis of complex internal and external separate samples (T-samples) and comparison of polar coordinates in soccer. The results show that the two approaches are used to monitor elements in the game such as measurement of the event, passing the ball, the structure of players. It should be noted that this type of analysis are useful in enhancing existing methods used in the analysis of soccer.

Nowadays, elastic mode of the game in soccer is dominating, with great responsibilities of each player. The modern style of play requires dynamism and versatility of each player individually. No matter what part of the games is, the lines must cooperate and communicate, which is influenced by certain factors and the level of communication skills of players.

The primary objective of this study was to determine the differences between the formed homogeneous groups and to determine the importance of certain homogeneous group of tactical elements for the realization of the game at every position. The secondary objective was to determine the difference in every sub-phases of the game as well in each type of game in particular. Discriminant analysis for identified groups of tactical elements by cluster analysis indicates the possibility of their differentiation. This can identify potential programs and subprograms for tactical preparation of soccer players.

Methods

Ten soccer experts assessed the importance of tactical techniques that define the structure of soccer. A soccer coach, an expert advisor, a top player or a college professor teaching soccer at the Faculty of Kinesiology, a coach of a soccer team competing in the European Football Club championships, a coach or a member of expert staff of the national soccer team participating in the European Championships or World Cups, a footballer from a team competing in the European Football Club championships or a member of the national team participating in the European Championship or World Cup were regarded experts in the research study. Relying on their own experience and using the assessment system with grades ranging from 0 to 5 the experts graded the impact of tactical techniques on the properties (attributes) of soccer, attack and defense. The entity sample comprised 117 tactical techniques of soccer in the phases of attack and defense (Table 1). If a certain soccer technical element is applied in the training process or the game itself with the aim of advancing the ball, keep it in the possession, take over its possession, pass it to a teammate or trying to score as well as obstructing the opponent from scoring at any given moment and in any given situation, then the same element represents a tactical technique.

Table 1. Attack and defense football tactical elements

1-7 Ground kicks with the: instep center, outside of the instep, inside of the instep, inside of the foot, outside of the foot, ball of the foot, heel (heel kick).	
8-12 Air-borne kicks volley and scissors kicks - forward and side volley kicks, forward and side scissors kicks, bicycle kicks (above the head).	
13, 14 Bounced-off kicks: half-volleys – forward and side half-volley kicks and punting (drop kick).	
15 Kicks with the leg closer to the oncoming ball	16 Kicks with the leg further away from the oncoming ball trajectory
17 Heading the ball (from standing)	18 Heading the ball (from jumping)
19 Heading the ball (from falling/jumping)	20 Short distance goal attacking (up to10 m)
21 Mid-distance goal attacking (10-20 m)	22 Long distance goal attacking (over 20 m)
23-36 Ball manoeuvres with the: inside of the foot dribble, outside of the foot dribble, sole of the foot dribble, back heel dribble, dribbling circles around the opponents, body feint with the outside of the foot, feint shot with the outside of the foot, fake shot with the inside of the foot, fake shot with the sole of the foot, fake shot with the heel back, body fake by moving the leg in front of the ball – outside of the foot dribble, body fake by moving the leg above the ball – outside of the foot dribble, body fake by moving the leg above the ball – inside of the foot dribble, and body fake by moving the leg behind the ball – outside of the foot dribble.	
37 - 39 Dribbling according to the positions of the attacker and his/her defender: dribbling facing the opposing defender, dribbling with the attacker's side or back to the opposing defender	
40 - 42 Dribbling according to the tactical aims in the match: purposeful dribbling (the defender uses it against the attacker when clearing or taking over the ball), positional dribbling (the attacker imposes it on the defender to create a favourable, front position), and attacking dribbling (the attacker imposes it on the defender, mostly in the goal attack zone)	
43 - 46 Advancing the ball with the:: instep center, inside of the foot, outside of the foot, sole of the foot.	
47 - 50 Advancing the ball depending on the movement direction : in a straight line, in a semi-circle, in a zig-zag line.	
51 - 53 Advancing the ball depending on the pace: basic pace, average pace, submaximal pace and maximal pace.	
54, 55 Advancing the ball depending on the tactical aims in the game: individual action (in combination with dribbling, most often as an introduction to the finishing sub-phase) and favourable position creation (most ofen in the build-up and peak of the attack).	
56 - 59 Openings (getting free): actual opening (in the direct cooperation with a co-player by passing over or/and receiving the ball), deceptive opening (enables a co-player to move into free space), supporting opening (supporting a co-player with the ball when he/she does not establish a contact with the third co-player by passing over the ball), and safety opening (the indirect participation of co-players in the attack until game focus changes).	
60 - 79 Ball control or receiving: shock absorption of parabolas with the: center of the instep, inside of the foot, upper leg, chest and the head; shock absorption of an oncoming ground ball with the inside of the foot; a bounced-off parabola reception and carried out with the sole of the foot, with the inside and the outside of the foot, with the body and the head, maneuvering an oncoming ground ball with the: center of the instep, inside and outside of the foot; manoeuvring a parabola with the: center of the instep, inside and outside of the foot, upper leg, chest and head.	
81 - 87 Ball passing depending on the direction: passing the ball to the oncoming player, passing the ball to a co-player forwards into free space, passing the ball to a co-player backwards into free space, passing the ball to a co-player across the football pitch, reverse ball passes, forward diagonal ball, backward diagonal ball, parallel cross ball	
88 - 90 Ball passing over: short distance (up to 10 m), mid-distance (10m to 30m) and long distance (over 30m).	
91 - 93 Positions' changes with the aim to: pass the ball timely and efficiently create free space for a co-player, destroy the positioning of the opposing defensive players.	
94, 95 Marking the opposing players: man-to-man marking and zone defense	
96, 97 Obstructions: obstructing opposing players and goal keeper.	
98, 99 Takeover: active and passive takeover (with and without the change of position in the basic players lineup).	
100 - 104 Clearing the ball: kicking out an oncoming ground ball in front of the opposing player, kicking out a parabola in front of theopposing player, kicking out the bounced-off ball in front of the opposing player, heading out a parabola and heading out the bounced-off ball in front of the opposing player.	
105 - 107 Ball takeover depending on the moment of takeover: before it is obtained by the opposing attacker (tackle the ball in front of the opponent), when the opposing attacker is taking hold of it (tackle the ball in front of the opponent) and after it is obtained by an opposing attacker.	
108 - 117 Ball takoever depending on the way it is done: basic takeover – frontal relationship between the defender and attacker, basic takeover – sideways relationship betwen the defender and attacker, basic takeover – the defender is behind the attacker. Ball takeover by pushing out the opposing player from the lead (by shouldering), frontal slide tackle, sideways slide tackle, slide tackle from behind oncoming ground ball takeover by tackling the ball in front of the opposing player, a parabaola takeover by tackling the ball in front of the opposing player, bounced-off ball takoever by tackling it in front of the opposing player.	

Thirty variables (Table 2) were created that determine the basic elements of soccer in relation to the teams' positions in the game and in the phases of attack and defense, the field zones, game phases, sub-phases of attack and defense and types (styles) of play in the phases of attack and defense. The experts assessed, weighted and graded the importance of each tactical technique with regard to each of these 30 attributes to the game of soccer. The research did not comprise the goalkeeper's positions in the game nor his/her tasks. This will be the subject of future analyses of soccer.

Table 2. Attributes of the game of football

	Positions of players in the game:
1	POF – positions of forwards
2	POCM – positions of centre midfielders
3	POWM – positions of wing midfielders
4	POIF – positions of inside forwards
5	POWM – positions of wide midfielders
6	POFDP – positions of front defensive players
7	POFCB – positions of front centre-backs
8	POFW – positions of front wingbacks
9	POFB – positions of full-backs
10	POBW – positions of back (rear) wingbacks
	Sub-phases of the game :
11	FSP – finishing sub-phase
12	TADLBF – transition from attack to defense after losing the ball in the finishing sub-phase
13	PASP – point of the attack sub-phase
14	TADLBA – transition from attack to defense after losing the ball at the point of attack
15	ABSP – attack build-up sub-phase
16	TADLBAB – transition from attack to defense after losing the ball in the attack build-up
17	WDS – wide defense sub-phase
18	TDABTWD – transition from defense to attack after the ball takeover in the wide defense zone
19	MDS – midfield defense sub-phase
20	TDABTMD – transition from defense to attack after the ball takeover within the midfield defense zone
21	CDS – core defense sub-phase
22	TDABTWC – transition from defense to attack after the ball takoever within the core zone
	Attack types:
23	PAC – progressive attack: continuous attack
24	PACA – progressive attack: counter-attack
25	CA – combinedattack
26	NPA – non-progresive attack
	Defense types :
27	CD – combined defense
28	CDZ – core zone defense
29	MD – midfield defense
30	WZD – wide zone defense

The group of 30 variables was condensed (Table 3) into the groups of variables of game positions, variables of sub-phases of the game, variables of the styles of play and grouped variables together with the arithmetic mean separately for the phases of attack and defense, which resulted in the assessment of the importance of tactical techniques.

Table 3. Sum total variables in the phases of defense and attack

Sum total variables for attack :
TPPA – total of the positions of players in (POF, POCM, POWM, POIF, POWM)
TPPSPA – total of the sub-phases of attack (FSP, PASP, ABSP, TDABTWD, TDABTMD, TDABTWC)
TAT – total of the attack types (PAC, PACA, CA, NPA)
TPA – total properties of play in attack (attack variables - total)
Sum total variables for defense
TPPD – total according to the positions of defense players (POFDP, POFCB, POFW, POFB, POBW)
TPPDSP – total according to the defense sub-phases (WDS, MDS, CDS, TADLBF, TADLBA, TADLBAB)
TTD – total according to the types (styles) of defense (CD, CDZ, MD, WZD)
TPD – total according to the game properties in defense (total of defense variables)

The data were processed by means of Statistica (Data Analysis Software System), version 7.1., separately for the tactical techniques of attack and defense. Descriptive parameters were calculated for all the tested variables. The normality of the distribution of variables was examined by the Kolmogorov-Smirnov test. Differences between groups of tactical elements of attack were identified by cluster analysis (a homogeneous group of offensive tactical elements A, B, C - Table 4) were tested at the multivariate level by the discriminant analysis. Differences between groups of tactical elements of defense established by cluster analysis (a homogeneous group of defensive tactical means A, B, C, D - Table 5), due to too small number of entities into homogeneous groups were tested on a univariate level, by Kruskal-Wallis test. In order to compare the average grades of importance among groups, the mean grades of rank of tactical elements for each group were calculated.

Table 4. Homogeneous groups of offensive tactical elements A, B, C defined by cluster analysis

	The list of offensive tactical elements of group A
1	Parallel cross ball
2	Backward diagonal ball
3	Mid-distance goal attacking (10-20 m)
4	Short distance goal attacking (up to10 m)
5	Heading the ball (from jumping)
6	Heading the ball (from standing)
7	Side volley kicks
8	Side half-volley kicks
9	Half-volleys – forward
10	Forward volley kicks
11	Heading the ball (from jumping)
12	Side scissors kicks
13	Forward scissors kicks
14	Bicycle kicks (above the head)

15	Advancing the ball in basic pace
16	a bounced-off parabola reception with the head
17	Shock absorption of parabolas with the head
18	Ground kicks with the heel (heel kick)
19	Body fake by moving the leg above the ball – outside of the foot dribble
20	Fake shot and dribling with the inside of the foot
21	Back heel dribble
22	Body fake by moving the leg behind the ball – outside of the foot dribble
23	Body fake by moving the leg above the ball – inside of the foot dribble
24	Dribbling circles around the opponents
25	Fake shot and dribling with the heel back
26	Fake shot and dribling with the sole of the foot
27	Sole of the foot dribble
28	Advancing the ball in a zig-zag line
29	Advancing the ball in a semi-circle
30	Advancing the ball in a straight line
31	Advancing the ball with the sole of the foot.
32	Manoeuvring a parabola with the head
33	Ball control or receiving: shock absorption of parabolas with the center of the instep
34	Ground kicks with the ball of the foot
	The list of offensive tactical elements of group B
1	Safety opening (the indirect participation of co-players in the attack until game focus changes).
2	Supporting opening (supporting a co-player with the ball when he/she does not establish a contact with the third co-player by passing over the ball)
3	Manoeuvring a parabola with the upper leg
4	Manoeuvring a parabola with the outside of the foot
5	Mid-distance (10m to 30m) passing
6	Advancing the ball in submaximal pace and maximal pace
7	Kicks with the leg closer to the oncoming ball
8	Long distance (over 30m) passing
9	Ground kicks with the outside of the foot
10	Kicks with the leg further away from the oncoming ball trajectory
11	Kicks with the outside of the instep
12	Manoeuvring a parabola with the inside of the foot
13	a bounced-off parabola reception and carried out with the outside of the foot
14	a bounced-off parabola reception and carried out with the inside of the foot
15	Maneuvering an oncoming ground ball with the outside of the foot
16	Maneuvering an oncoming ground ball with the inside of the foot
17	Actual opening (in the direct cooperation with a co-player by passing over or/and receiving the ball)
18	Passing the ball to a co-player forwards into free space
19	Passing the ball to the oncoming player
20	Ground kicks with the inside of the foot
21	Ground kicks with inside of the instep

	The list of offensive tactical elements of group C
1	Positions' changes with the aim to disturb the positioning of the opposing defensive players
2	Positions' changes with the aim to pass the ball timely and efficiently
3	Positions' changes with the aim to create free space for a co-player
4	Deceptive opening (enables a co-player to move into free space)
5	Individual action (in combination with dribbling, most often as an introduction to the finishing sub-phase)
6	Attacking dribbling (the attacker imposes it on the defender, mostly in the goal attack zone)
7	Dribbling with the attacker's back to the opposing defender
8	Dribbling with the attacker's side to the opposing defender
9	Dribbling facing the opposing defender
10	Body fake by moving the leg in front of the ball – outside of the foot dribble
11	Feint shot and dribling with the outside of the foot
12	Body feint and dribling with the outside of the foot
13	Outside of the foot dribble
14	Inside of the foot dribble
15	Short distance (up to 10 m) passing
16	Passing the ball to a co-player across the football pitch
17	Passing the ball to a co-player backwards into free space
18	Favourable position creation (most ofen in the build-up and peak of the attack)
19	Reverse ball passes
20	Positional dribbling (the attacker imposes it on the defender to create a favourable, front position)
21	Purposeful dribbling (the defender uses it against the attacker when clearing or taking over the ball)
22	Manoeuvring a parabola with the chest
23	a bounced-off parabola reception and carried out with the body
24	Manoeuvring a parabola with the center of the instep
25	a bounced-off parabola reception and carried out with the sole of the foot
26	Shock absorption of parabolas with the chest
27	Shock absorption of parabolas with the upper leg
28	Shock absorption of parabolas with the inside of the foot
29	Passing the forward diagonal ball to a co-player
30	Long distance goal attacking (over 20 m)
31	Advancing the ball with the outside of the foot
32	Advancing the ball with the inside of the foot
33	Shock absorption of parabolas with the inside of the foot
34	Advancing the ball in a zig-zag line
35	Advancing the ball with the instep center
36	Maneuvering an oncoming ground ball with the center of the instep
37	Advancing the ball on average pace
38	Ground kicks with the instep center

Table 5. Homogeneous groups of defensive tactical elements A, B, C, D defined by cluster analysis

	The list of defensive tactical elements of group A
1	*113.* sideways slide tackle
2	*114.* slide tackle from behind
3	*112.* frontal slide tackle
4	*97.* obstructing opposing goal keeper
	The list of defensive tactical elements of group B
1	*110.* basic takeover – the defender is behind the attacker
2	*116.* a parabaola takeover by tackling the ball in front of the opposing player
3	*115.* ground ball takeover by tackling the ball in front of the opposing player
4	*108.* basic takeover – frontal relationship between the defender and attacker
5	*117.* bounced-off ball takoever by tackling it in front of the opposing player
6	*107.* Ball takeover after it is obtained by an opposing attacker
7	*111.* takeover by pushing out the opposing player from the lead (by shouldering)
8	*109.* basic takeover – sideways relationship betwen the defender and attacker
9	*106.* Ball takeover when the opposing attacker is taking hold of it (tackle the ball in front of the opponent)
10	*105.* Ball takeover before it is obtained by the opposing attacker (tackle the ball in front of the opponent)
11	*97.* active takeover, change of position in the basic players lineup
	The list of defensive tactical elements of group C
1	*99.* passive takeover *(*without the change of position in the basic players lineup*)*
2	*96.* obstructing opposing players
3	*95.* Marking the opposing players *(*zone *marking)*
	The list of defensive tactical elements of group D
1	*104.* heading out the bounced-off ball in front of the opposing player
2	*103.* heading out a parabola bounced-off in front of the opposing player
3	*102.* kicking out the bounced-off ball in front of the opposing player
4	*101.* kicking out a parabola in front of the opposing player
5	*100.* kicking out an oncoming ground ball in front of the opposing player
6	*94.* Marking the opposing players: man-to-man marking

Results

According to the results of Kolmogorov-Smirnov test of normal distribution (Table 6) evaluation of the importance for each group for tactical elements of attack obtained by cluster analysis (A, B, C) has showed no significant deviation from the normal distribution (only one variable in each homogeneous group for tactical elements of attack), which was the important condition for the applying of discriminant analysis to determine differences among the groups. The average value of importance for the group of tactical elements A (Table 6) in the sum of variables that describe the phase of attack (TPPA, TPPSPA, TAT and TPA) ranges from 2.10 to 3.15, while based on the specific attributes of the game grades range from 0.99 (PASP –point of the attack sub-phase) to 3.87 (POF -positions of forwards).

The relatively high average value of importance for the group of attacking tactical elements A in the realization of the game concerning some attributes of the attack was recorded on positions of forwards (POF), positions of centre midfielders (POCM), positions of wing midfielders (POWM), finishing sub-phase (FSP), transition from defense to attack after the ball takeover in the wide defense zone (TDABTWD), progressive attack: continuous attack (PAC) combined-attack (CA). The mentioned group A is being marked by tactical elements of attack over the wing area and final phase of the attack after making the long pass (typical kicks to the head).

Table 6. Descriptive parameters

	A (*n=34*)	B (*n=21*)	C (*n=38*)
	Mean±SD	Mean±SD	Mean±SD
POF	3.87±0.64	4.20±0.60	4.42±0.46
POCM	3.73±0.77	4.76±0.22	4.52±0.58
PKVN	3.50±0.99	4.57±0.29	4.23±0.63
POIF	2.30±0.93	4.58±0.37	3.14±0.80
POWM	2.36±1.08	4.41±0.42	2.77±1.04
FSP	3.32±1.05	4.56±0.41	4.32±0.59
ABSP	1.66±0.77	4.53±0.36	3.82±0.71
PASP	0.99±0.45	4.14±0.78	2.13±0.95
TDABTWD	3.10±1.28	4.57±0.49	4.46±0.57
TDABTMD	2.27±1.27	4.62±0.37	4.37±0.49
DABTWC	1.27±0.65	4.56±0.45	2.70±1.03
PAC	3.47±0.83	4.51±0.57	4.23±0.55
PACA	2.19±1.12	3.91±0.70	2.40±0.94
CA	3.10±0.99	4.65±0.33	4.28±0.70
NPA	2.37±0.91	4.39±0.55	3.98±0.88
TPPA	3.15±0.71	4.50±0.27	3.82±0.43
TPPSPA	2.10±0.55	4.50±0.36	3.63±0.42
TAT	2.78±0.66	4.37±0.28	3.72±0.47
TPA	2.63±0.51	4.60±0.61	3.72±0.34

POF – positions of forwards, POCM – positions of centre midfielders, PKVN positions of wing midfielders, POIF – positions of inside forwards, POWM – positions of wide midfielders, FSP – finishing sub-phase, ABSP – attack build-up sub-phase, PASP – point of the attack sub-phase, TDABTWD – transition from defense to attack after the ball takeover in the wide defense zone, TDABTMD – transition from defense to attack after the ball takeover within the midfield defense zone, DABTWC transition from defense to attack after the ball takoever within the core zone, PAC – progressive attack: continuous attack, PACA – progressive attack: counter-attack, CA – combinedattack, NPA – non-progresive attack, TPPA – total of the positions of players in attack, TPPSPA – total of the sub-phases of attack, TAT – total of the attack types, TPA – total properties of play in attack.

Average grades of importance for the group of attacking tactical elements B (Table 6) in the sum of variables that describe the phase of attack (TPPA, TPPSPA, TAT and TPA) ranges from 4.37 to 4.60, while the specific attributes of the game grades range from 3.91 (PACA – progressive attack: counter-attack) to 4.76

(POCM – positions of centre midfielders). Extremely high average grades of the importance for the group of tactical elements B in the implementation of certain game attribute of the attack were achieved in all attack positions (POF, POCM, POWM , POIF, POWM), in all sub-phases of the attack (FSP , ABSP, PASP), in all transitions from defense to attack after the ball was takenover in different zones (TDABTWD, TDABTMD, DABTWC), as well as in most types of attacks (PACA, CA, NPA). Slightly lower average grades of importance for group B were achieved in the counterattack. Group B is characterized by group tactical elements which are applied in all sub-phases of attack that shift the focus of the game and change the pace in the development of the attack.

Table 7. Results of discriminant analysis for the evaluation of differences between groups for the tactical elements of attack

VARIABLE	Function 1	Function 2
POF	.107	.298
POCM	.266	.194
POWM	.224	.110
POIF	.424	-.179
POWM	.301	-.287
FSP	.258	.211
ABSP	.665	.453
PASP	.599	-.259
TDABTWD	.268	.304
TDABTMD	.451	.467
DABTWC	.608	-.133
PAC	.242	.151
PACA	.244	-.300
CA	.321	.224
NPA	.384	.308
Eigen- value	6.566	1.264
Canonicl R	0.932	0.747
Wilks' Lambda	0.058	0.442
Chi-Sqr.	235.780	67.812
df	30	14
p-level	0.000	0.000

POF – positions of forwards, POCM – positions of centre midfielders, POIF – positions of inside forwards, POWM – positions of wide midfielders, FSP – finishing sub-phase, ABSP – attack build-up sub-phase, PASP – point of the attack sub-phase, TDABTWD – transition from defense to attack after the ball takeover in the wide defense zone, TDABTMD – transition from defense to attack after the ball takeover within the midfield defense zone, DABTWC transition from defense to attack after the ball takoever within the core zone, PAC – progressive attack: continuous attack, PACA – progressive attack: counter-attack, CA – combinedattack, NPA – non-progresive attack

Average grades of importance for the group of attacking tactical elements C (Table 6) in the sum of variables that describe the phase of attack (TPPA -UKPOZN, TPPSPA -UKPODN, TAT – UKNAIN and TPA –UKN) range from 3.63 to 3.82, while based on the individual attributes of the game grades range from 2.13 (PASP – point of the attack sub-phase) to 4.52 (POCM – positions of centre midfielders).

Table 8. Centroids of a Group of offensive tactical elements in the area of discrimination functions

	FUNCTION 1	FUNCTION 2
A	-2.88	-0.72
B	3.78	-1.20
C	0.49	1.31

High average grades of importance for the group of attacking tactical elements C in the realization of certain attributes of the attack were recorded on the POCM – positions of centre midfielders, POF – positions of forwards, POWM - positions of wing midfielders, FSP – finishing sub-phase, ABSP – attack build-up sub-phase, TDABTWD – transition from defense to attack after the ball takeover in the wide defense zone, TDABTMD – transition from defense to attack after the ball takeover within the midfield defense zone, in the PAC – progressive attack: continuous attack and in the CA – combinedattack.

High grades in group C were characterized by individual and group tactical elements which are applied to retain ball possession and create a favorable situation, usually in the sub-phases in the middle of the field and in the final phases of attack in the development of offensive action. Due to the small number of entities in three of the four groups (A: n=4, C: n=3 and D: n=6), differences among groups of defensive tactical elements were tested by Kruskal-Wallis test. This method has contributed to the statement that grades of the importance for a group of tactical elements of defense significantly differ in all variables.

Discussion and Conclusion

Discriminant analysis has revealed the data regarding the differences in the group entities (groups of offensive tactical elements), determined by the cluster analysis, (according to the position of group centroids in the space of discriminatory function) and how certain variables contribute to this differences (based on the correlation matrix of variables with the discriminant function). Discriminant analysis, in the area of basic attributes of the game in attack phase on the sample obtained by the three groups of entities, has established the existence of two discriminatory functions that significantly differ, as well as groups obtained by cluster analysis (Table 7).

The grades of the canonical correlation coefficients (Rc) and Wilks lambda (Wλ) indicate good discrimination of groups. Besides that, we can see that the first discriminant function had a higher discriminative power in relation to the second discriminant function. Table 7 shows a statistically significant difference between groups of entities (tactical elements of attack) at the level of significance $p<0.01$, with high canonical correlation coefficients (Rc1-0.93 and Rc2-0.75). These coefficients confirm that the discriminant function significantly contributes to the differentiation of the obtained group of entities.

The first discriminant function, with the positive projections, was determined by the attributes of ABSP – attack build-up subphase (.67), DABTWC transition from defense to attack after the ball takoever within the core zone (.61), PASP – point of the attack sub-phase (.60), TDABTMD – transition from defense to attack after the ball takeover within the midfield defense zone (.45), POIF – positions of inside forwards (.42), NPA – non-progresive attack (.38), CA – combined-attack (.32), POWM – positions of wide midfielders (.30).

The attributes (variables) that have the highest correlation with the first discriminant function indicate the game in attack phase through the first two thirds of the field by changing the focus and pace of the game with an extended ball possession. This discriminatory function is defined by the variables that are prevalent representatives of building favorable position in the attack build-up sub-phase and point of the attack sub-phase, which is a characteristic of combined-attack and non-progresive attack. Combined-attack and non-progresive attack are implemented by an individual action (dribbling and feinting) as well as with the cooperation of two and three attackers (detection, change of places, ball transfer), especially in the attack build-up sub-phase. When you build a good numerical and positional situation, the entry of the final attack phase is accelerating and also with an individual action or with a simple combination.

The second discriminant function is defined as bipolar. On its positive pole there are variables that carry information about the organization and carrying out the attack that keep a positive result, achieved in the previous game interval: TDABTMD – transition from defense to attack after the ball takeover within the midfield defense zone (.47), ABSP – attack build-up sub-phase (.45), NPA – non-progresive attack (.31), TDABTWD – transition from defense to attack after the ball takeover in the wide defense zone (.30) and POF – positions of forwards (.30).

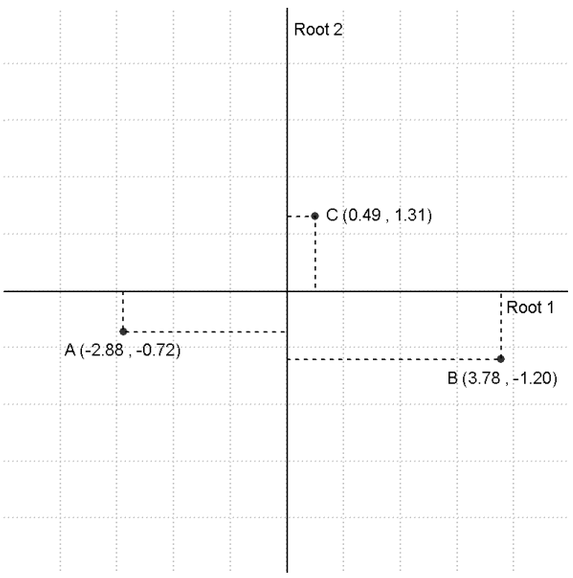
The above mentioned variables feature the regressive attack, which from the tactical point of view has its own importance or foundation, but for its effective use the attackers must be of excellent technical knowledge in terms of early openings and passing and receiving of ball at different distances. The team has occupy a large part of the field towards the horizontal and vertical relationships, the ball travels fast to free players, the volume of running is reduced, in the structure of movement running in the moderate and sub-maximal pace is dominant. On the negative pole of the second discriminant function there are variables that carry information about the organization of attack by skipping the game in the middle of the field: PACA – progressive attack: counter-attack (.30) -, POWM – positions of wide midfielders (.29) -, PASP – point of the attack sub-phase (.26) -, POIF – positions of inside forwards (.18) -and DABTWC transition from defense to attack after the ball takoever within the core zone (.13).
Counter-attack, as a surprising kind of attack, is effectively applied in combination with non-progresive attack in some intervals of the game. Its performance depends on the skills and knowledge of the players which must strive for simple forms of cooperation in order to accomplish the finishing. Based on both discriminant function and the centroid position of a group of tactical elements of attack in their coordinate system, the differences between tactical offensive elements could be determined. Further procedure of discriminant analysis has provided data on the centroid position of each of the three groups of entities in the area of discrimination functions (Table 8), which indicates the specific differences between the groups.

The first discriminant function divides the group B (classis of offensive tactical elements for the transfer of the focus of the game and for the change of the tempo in the attack development) and C (classis of tactical elements of ball possession and building a favorable situation in the realization of different types of attacks), which are located on the positive pole, from group A (classis of offensive tactical elements in the final phase of attack across the wing area) located on the negative pole (group of tactical elements A significantly differ from groups B and C according to the first discriminative function). According to the first discriminative function, the most distant are (significantly different) group A (tactical elements of attack over the wing area) and B (tactical elements for transfer the gravity of game), while group C (tactical elements of ball possession and creating a favorable situation) is between them.

In the second discriminative function on the negative pole is group B (tactical elements for transfer the gravity of game) and A (attacking tactical elements for winning the wing area and final phase of attack after pass), while on the positive pole of this function is a group C (tactical elements of keeping the ball and creating a favorable situation), or second discriminatory function largely differ group C compared to groups A and B. Groups B and C are mutually farthest on this discriminative function. Analysis of the centroid position for the group of attacking tactical elements in the coordinate system reveals that the entities do not overlap (each group entity are sufficiently distant), and each group represents a total in the technical and tactical preparation of soccer players.

Looking one-dimensionaly (Figure 1), according to the first discriminative function, the groups are in the order B, C and A. Centroid of the Group B (tactical elements for transfer the gravity of game) is located in the second box of the composition of the first and second discriminant function, the centroid of group C (tactical elements of ball possession and creating a favorable situation) is located in the first box and the centroid of group A (tactical elements of attack over the wing area) is located in the third box, which enables the description of the set of entities and their characteristics with respect to the first and second discriminant function. According to this centroid group position for each box, it is evident that based on the first discriminative function, classes differ with one side detached with offensive tactical elements in group A (shots on goal by the incoming balls from the air, running with the ball, dribbling and feinting) and on the other hand is the group of attacking elements B (passing and receiving the ball at larger distances), while between them is a group C, which partly consists of individual tactical elements of attack (dribbling and feinting, running with the ball), and partly of the group offensive tactical elements (passing and receiving the ball on medium and short distances and the change of place).

Figure 1. Centroids of a Group of tactical elements of attack in the area of discrimination functions



Root 1 - the first discriminant function, Root 2 - the second discriminant function, A, B, C - mean of the appropriate group of tactical elements of discriminant function

In the analysis of the second discriminant function, it is characteristic that at the positive pole are individual and group attacking tactical elements (group C), which are characterized by complex combinations in attack phase through the cooperation of a certain number of players, and on the negative pole are the individual (group A) and group (group B) tactical elements which are applied in individual actions and simple combinations. Discriminant analysis has proven that a group of entities defined by cluster analysis (relatively homogeneous group of offensive tactical elements A, B, C) are mutually significantly different, as well as the various contributions of individual attributes to the game in attack phase.

On the POFDP – positions of front defensive players, the highest grades of the importance are in tactical elements of group C (obstructing opposing players, passive takeover and marking the opposing players). Compared to them in POCM – positions of centre midfielders and POFW – positions of front wingbacks defensive players, high grades of importance have a tactical elements of group C and group B (active takeover, takeover in the middle and core zone defense), which can directly affect the number of conceded goals. Position of the full-backs–POFB and POBW – positions of back (rear) wingbacks, the most highly grades of the importance have a tactical elements of group B and group D (marking the opposing players: man-to-man marking and kicking out an oncoming ground ball in front of the opposing player) which is understandable because they are the last obstacle that opponent needs to cross to reach the goal.

When we talk about a wider zone of defense, the most highly grades of the importance have a tactical elements of group C, and the lowest tactical elements of group A (kicking out an oncoming ground ball in front of the opposing player and takeover by slide tackle) which coincides with the research conducted by Barišić (1996), so the tackling as a tactical element has lost a lot on a significance because it is an argument that players avoid by placing timely manner steals. Thus their chances for getting cards are reduced to a smaller extent possible. In the CDS – core defense sub-phase and MDS – midfield defense sub-phase, greatest grades of importance are in the tactical elements of group B (active takeover and basic takeover). For the CD - combined defens which is applied in modern soccer, the greatest grades of importance are also in a tactical elements of group B (active takeover and ball takeover). This is logical since nowadays we can found players who easily deal with the situation 1 on 1 and it takes a doubling and taking over their ability to neutralize a large radius of movement.

The obtained results lead to several conclusions that have broadened the kinesiological body of knowledge on soccer. In grouped data (homogenous groups of attacking tactical elements A, B and C, identified by the cluster analysis), it was revealed that the greatest importance in each segment of the game has a characteristic group of tactical elements. According to the first discriminative function there is significant difference from group A (tactical elements of attack over the wing area) and B (tactical elements for transfer the gravity of game), while group C (tactical elements of holding the ball) is located between them. The second discriminant function greatly differ group C versus group A and B, where the group B and C are mutually farthest.

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Trend indicators of changes in body composition in soccer players in different periods of their career

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Abstract

In order to monitor proper growth and development in a particular sport, body composition monitoring has a great significant, which gives clear indicators about the state of trainings and nutritional status of young athletes. It is very important to analyze physical system in soccer players, not only to evaluate variations of dimensions in quantitative and qualitative meaning, but also in a direction of soccer players selection in the certain competitive categories and for a certain team position. Therefore this research had the primarily aim to analyze the trend of body composition in different periods of soccer players' career. The total sample of respondents (n = 271) is consisted of seven sub-samples of different age categories of soccer players competing in Bosnia and Herzegovina, U10 (n = 28), U12 (n = 54), U13 (n = 48), U14 (n = 62), U16 (n = 27), U18 (n = 24) and seniors (n = 28). The subject of this study included the body composition of soccer players in order to analyze the trend of dimension changes during soccer career. The changes in dimensionality are analyzed by one - way analysis variance (One way ANOVA) which is the simplest model from a large family techniques dealing with analysis of variance. Analysis results showed that soccer players during their career have had a very dynamic pace of growth and development, with specific periods in which it is accelerated or slowed down. In the period since beginning of dealing with soccer to the period of senior stuff, occurs the continued growth appears with the indicators that define the height, mass, basal metabolism, amount of the fluid in the body and the amount of fat free mass in the body composition. The variable that define the body mass index (BMI), body resistance (IMPEDANCE), percentage (FAT %) and mass portion of fat tissue in body structure (FATMASS) changes of dimensionality have a different pace and sign of movement. It can be concluded that soccer players during their career have rapid growth in height, whose largest increase is between the age period of 13 and 14 (10,21 cm), they linearly gain in mass whose largest increase is between the age period of 13 and 14 (8,7 kg) and between the age period of 16 and 17 (9,1 kg). We have a continuous increase in dimensions of indicators of basal metabolism, fat tree body mass and amount of fluid in the body. Changes in body resistance, amount and percentage of fat in the overall body mass have different signs depending on the age and growth competing category and have fall of values till the age period of 18.

Key words: **soccer players, body composition, changes in dimensionality**

Sažetak

U cilju praćenja pravilnog rasta i razvoja u određenom sportu veliki značaj ima i praćenje tjelesne kompozicije koja daje jasne pokazatelje o stanju treniranosti i uhranjenosti mladih sportaša. Analizirati tjelesni sastav kod nogometaša je veoma bitno, ne samo s ciljem ocjene varijacije dimenzija u kvantitativnom i kvalitativnom smislu, već i u pravcu selekcije igrača u određenim takmičarskim kategorijama i za određene pozicije u timu. Stoga je ovo istraživanje imalo prvenstven cilj da se kod nogometaša analizira trend promjena tjelesne kompozicije u različitim razdobljima nogometne karijere. Ukupan uzorak ispitanika (n =271) sačinjen je od sedam subuzoraka različitih uzrasnih takmičarskih kategorija nogometaša u Bosni i Hercegovini, U10 (n=28), U12 (n=54), U13 (n= 48), U14 (n=62), U16 (n=27), U18 (n=24) i seniori (n=28). Predmetom ovog istraživanja obuhvaćena je tjelesna kompozicija kod nogometaša u cilju analize trenda promjena dimenzija u toku nogometne karijere. Promjene u dimenzionalnosti analizirane su jednosmjernom analizom varijance (One way ANOVA), koja predstavlja najjednostavniji model iz brojne porodice tehnika analize varijance. Analizom dobivenih rezultata utvrđeno je da nogometaši u toku svoje karijere imaju veoma dinamičan tempo rasta i razvoja, sa određenim periodima u koji je on ubrzan ili usporen. U razdoblju od početka bavljenja nogometom pa do seniorskog kadra dolazi do kontinuiranog porasta u pokazateljima koji definišu visinu, masu, bazalni metabolizam, količinu tečnosti u tijelu i količinu bezmasne mase u sastavu tijela. Kod varijabli koje definišu tjelesni indeks (BMI), otpor u tijelu (IMPEDANCE), procentualni (FAT %) i maseni udio masnog tkiva (FATMASS) u strukturi tijela, promjene dimenzionalnosti imaja različit tempo i predznak kretanja. Može se zaključiti da nogometaši u toku svoje karijere imaju ubrzan rast u visinu čiji je prirast najveći između trinaeste i četrnaeste godine (10,21 cm), linearno dobijaju na masi čiji najveći prirast je uzmeđu trinaeste i četrnaeste godine (8,7 kg) i šesnaeste i osamnaeste godine (9,1 cm). Kontinuiran porast dimenzija imamo kod pokazatelja bazalnog metabolizma, bezmasne mase tijela i količine tečnosti u tijelu. Promjene u otporu tijela, količini i procentu masti u ukupnoj masi tijela su različitih predznaka zavisno od uzrasta i uzrasne takmičarske kategorije i imaju pad vrijednosti do osamnaeste godine.

Ključne riječi: **nogometaši, kompozicija tijela, promjene u dimenzionalnosti**

Introduction

The proper guidance and monitoring of children's growth and development is the primary important significance of each sport activity. The growth is quantitative increase of dimensions in human body, while the development is qualitative increase of organs and organ systems of a certain individual. Growth status refers to the size attained in a given chronological period, usually as height and weight, while development (maturation) refers to the progress towards the biologically mature status (Malina 2003). For the purpose of proper growth and development monitoring in a particular sport, also monitoring of physical system, that gives clear indicators about the state of training and nutritional status of an athlete, has a great significant. It is also very important to analyze physical system of soccer players, not only with the aim to evaluate variation of dimension for quantitative and qualitative purpose, but also for the purpose of player's selection in the particular competing categories and for the particular team position. These data provide clear guidelines for the coach to continue monitoring, planning and programming training process. The special interests of researchers are reserves of fat tissue, because ballast mass weight adversely affects the ability of the organism. The body composition of an athlete significantly changes from year to year, and this problem has been topic for many research samples and sources of variables

and it has expanded the practical applicability in sport. The majority of the traditional methods are based on two components model of the body, according to which the total body mass consists of fat mass and fat free mass. According to this fact the fat mass consists of so called essential and unessential fat. The essential fat constitutes 2 % of fat free body mass in the shape of lipid body components and is necessary for healthy functioning of organism. The unessential fat constitute: subcutaneously fatty tissue (adipose tissue), yellow marrow transplant and abdominal visceral fat. For determining the physical structure different indirect methods were used previously as Ramadan and Byrd (1987), Green (1992), Dowson and associates (1999), where by measuring body dimensions and by the usage of adequate regression equations in a simply way, the indirect evaluation of fat content , bone-and-muscle tissue in the overall structure of athletes was obtained. Development of modern software systems, beside anthropometric, have brought many methods for estimation and establishing the body composition, the most famous and those that provide the most accurate results are : Hydrostatic Weighing, method of an air plethysmography (Bod-Pod), (Ostojic 2007; Kutac and associates 2008; Misigoj –Durakovic 2008).

Bioelectrical Impedance Analysis (BIA) as fast, noninvasive and relatively cheap method with acceptable precision, has gained the trust of both medical and sport experts in recent years. That is the method that evaluates the structure of body composition by broadcasting low, colorless dose of electric power of 800μA and the frequency of 50 KHz through human body (organism). Electric power passes through the body – without resistance through the fat free tissue (muscles, bones, internal organs), while the resistance occurs when it passes through fatty tissue (Kutac and associates 2008). This resistance is called bioelectrical impedance and it is measured by the monitors of body fat. Entering respondents' data (height, weight, age, status), based on installed software the physical structure of the respondents' bodies can be calculated. Although anatomical- physiological characteristics for all people, in particular are equal, although among them, there are significant differences that should be taken into consideration for work with children. For each coach who works in training process, is vary important to know developmental characteristic of children working with. Differences, with other factors, mostly stem from belonging to different periods of growth and development. Periods of growth have their own lawfulness and characteristics by which they differ, and their pace (tempo) cannot be skipped. The child's growth and development include many elements, from those on cells basis to those that are an integral part of single person's life, such as his social, cultural and sport activity. From conception to maturity, the processes of growth and development pass into extreme harmony, which is unique for each person, and this harmony is dependent not only to inherited characteristics (traits), but it is also dependent to effect of external factors (proper nutrition, climate, physical activity, … etc). For the age period of 12 to15 years the major transformation occurs in the child's development and that is puberty. During that period, huge changes occur in child's organism, which leave significant traces later in life. This period corresponds to juvenile period of acceleration, where is the growth in height more prominent than the increase in width.

The basic parameters of physical (body) development are height and width, as well as their structural components: muscular mass and fatty tissue. Analyzing these components the pace and lawfulness of body construction can be determined. Mean body weight show significant differences in the inter-year population growth in general as well as individual. The body weight is also the basic parameter of the level and pace development of the body structure, but it belongs to the so – called dynamic variable dimension, because it is liable to environmental influences and it can show large variations, even during the day.

The determination of fat and fat free components and the body composition of an athlete, with the knowledge of the optimal values for a certain sport, also take an important place in a contemporary training process. The relation between fat and fat free components of an athlete greatly varies (changes) depending on gender, the level of trainings, periodization and the age. Significantly higher portion of fat have female persons, and the highest ratio of fat free part to fat part is achieved about the age of 20, and the ratio is later decreased in non athletes. After the age of 20, a normal increase of 1% in body fat is expected for each decade. The upper limits of fat percentage is 25% for men and 30% for women, while the minimal values range from 5% to 10% for men and 5% to 17% for women (Wilmore, 1986; Wilmore and Costill, 2004).

According to World Health Organization (WHO) BMI lower than 18.5 is considered as insufficient weight and it could show the existence of malnutrition, improper nutrition or other health problem, while BMI higher than 25 is considered as excess of weight, and when BMI is over 30 it is considered as obesity. Total Body Water is the percentage of water in the body of an athlete and it tells us about the proper and optimal fluid intake for athletes. The normal TBW percentage varies among women from 45% to 60%, for men: 55% to 65%. For athletes, the image is approximately 5% higher than these ranges, as they have more muscular mass and bones, and muscles contain more water than fat tissue (Misigoj-Durakovic 2008). Basal Metabolic Rate (BMR) is daily minimal level of energy or calories, necessary for effective body functioning while resting. A person with a high BMR can spend (consume) a lot more calories while resting than the person with lower BMR, and this is based on the level of muscular mass. The full understanding of body metabolism enables the user to see, according to significant obtained values, how many calories he should take in accordance with his body size and lifestyle. And when an athlete has more muscles or generally more activities, he has to take more calories necessary for work, so that nutrition and characteristic of the training program can be based on this information.

Methods

The Sample of Respondents

The research has been conducted on a sample of 271 soccer players, classified into seven sub-samples (U10, U12, U13, U14, U16, U18 and seniors), who represents different age competing categories of soccer players in Bosnia and Herzegovina. The main criterion for selection of respondents was to have had, at least 2 years in training process (U10), and that they have had good health status without any psychophysical aberrations.

The Sample of Variables

The body composition of players' groups was determined by the method of Bioelectrical Impedance Analysis (BIA). For that purpose the electrical balance TANITA TBF-300 (Tanita corporation of America Inc.) was used, which, on the basis of the initial date (age and height) shows **the following variables:**

1. Body height (HEIGHT)
2. Body mass (MASS)
3. Body Mass Index (BMI)
4. Basal Metabolic Rate (BMR)
5. Electric Body Resistance (IMPEDANCE)
6. The percentage of Fat in the Body (FAT%)

7. The portion of Fat in Body Mass (FAT MASS)
8. The portion of Fat Free Mass in Body (FFM)
9. Total Body Water (TBW)

in body composition of optimal values with reference to researched age of an athlete. The measures of heights were taken by standard portable anthropometry.

Data Processing Method

For each sub-sample, for all variables, central and dispersions parameters of the variables were calculated (arithmetic mean, standard deviations, minimal and maximal results), the changes in dimensionality were defined by one-way analysis of variance (One way ANOVA), that represents the simplest model from a large family techniques dealing with analysis of variance. The trend of growth, individually for each variable is graphically shown.

Results and Discussion

The results of research are shown in Tables 1-3, and the trend of growth is shown by graphs individually for each variable. The change of body height shows that the arithmetic mean of variables (AVIS) statistically significantly changes throughout the period from the age of 10 to seniors, and the slope of growth curve shows that there is a slightly intensive increase from the age of 13 to 14 years (10,2 cm) and from the age of 16 to seniors (8,5 cm). The body mass of soccer players (AMAS) up to period of puberty has slowed growth and since this period it has followed the growth of curve variable height and has continuous upward trend of growth in the period when the seniors end their growth. The variable which represents the proportion of body mass, expressed in kilograms, and square of body height value expressed in meters, up to the age of 12 years has a slight decrease of value and then there is a continuous trend of growth as well as in those 2 variables. Basal Metabolic Rate (BMR) which represents the daily minimal level of energy or calories necessary for effective organism functioning while resting, portion of Fat Free Mass in the total body mass (FFM) and Total Body Water (TBW) which represents the entire amount of water in the body, have also a continued trend of growth in this period and it moves in the continuous line with a larger increment up to senior period. Converting the amount of fluid in the total body mass, into the percentage share, we will see that the amount of fluid expressed as a percentage of body mass ranges from 59,8 % (10 years), 63,84 % (12 years), 62,31 % (13 years), 64,67% (14 years), 67,05 % (16 years), and then it comes into the period of stabilization and a slight decrease of the value in seniors. The variable that measures the amount of fat tissue in total body mass (FATMASS), a sudden increase during the age period of 12 years to the age period of 13years is evident, and during this period there was a flexion of the growth curve, and reduced but continuous decrease of the amount of fat tissue by the age of 14. And the percentage of fat tissue (FAT%) in the total subjects' mass has a similar growth curve, just what is notable here is the continued increase in the age period of 12 to 13 years (2%), and then the sudden decrease (fall) of percentage fat portion in the age period of 14 years (3,5%). The only variable in the body composition which has a continuous decrease in the value is impedance, which represents the resistance in the body of respondents. It is evident that in this period appears a significant decrease (decline) of fat tissue, and increase in muscular mass, water and other fat free components that leads towards a decrease of body resistance and to a better flow of electricity, on whose principle this research technique is based.

Table 2.- Test of homogeneity of variance in body composition variables

	Levene Statistic	df1	df2	Sig.
AVIS	,712	6	264	,640
AMAS	1,562	6	264	,158
BMI	1,288	6	264	,263
BMR	1,462	6	264	,191
IMPEND	2,733	6	264	,014
FAT%	6,100	6	264	,000
FATMASS	3,212	6	264	,005
FFM	1,827	6	264	,094
TBW	2,149	6	264	,048

Table 3.- One way analysis of variance (One way ANOVA)

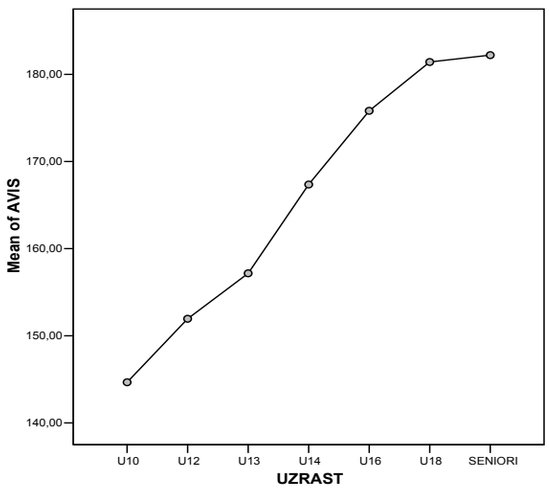
Variable		Sum of Squares	df	Mean Square	F	Sig.
AVIS	Between Groups	41566,547	6	6927,758	155,201	,000
	Within Groups	11784,246	264	44,637		
	Total	53350,794	270			
AMAS	Between Groups	45707,451	6	7617,909	127,218	,000
	Within Groups	15808,537	264	59,881		
	Total	61515,988	270			
BMI	Between Groups	960,239	6	160,040	30,986	,000
	Within Groups	1363,514	264	5,165		
	Total	2323,754	270			
BMR	Between Groups	176077472,883	6	29346245,480	96,647	,000
	Within Groups	80162127,228	264	303644,421		
	Total	256239600,111	270			
IMPEND	Between Groups	622674,209	6	103779,035	35,442	,000
	Within Groups	773029,260	264	2928,141		
	Total	1395703,469	270			
FAT%	Between Groups	2741,625	6	456,937	22,884	,000
	Within Groups	5271,489	264	19,968		
	Total	8013,114	270			
FATMASS	Between Groups	278,635	6	46,439	5,052	,000
	Within Groups	2426,701	264	9,192		
	Total	2705,336	270			
FFM	Between Groups	45986,379	6	7664,397	223,028	,000
	Within Groups	9072,389	264	34,365		
	Total	55058,768	270			
TBW	Between Groups	25097,006	6	4182,834	219,522	,000
	Within Groups	5030,329	264	19,054		
	Total	30127,335	270			

Table 1.- Descriptive parametres of body composition variables by age

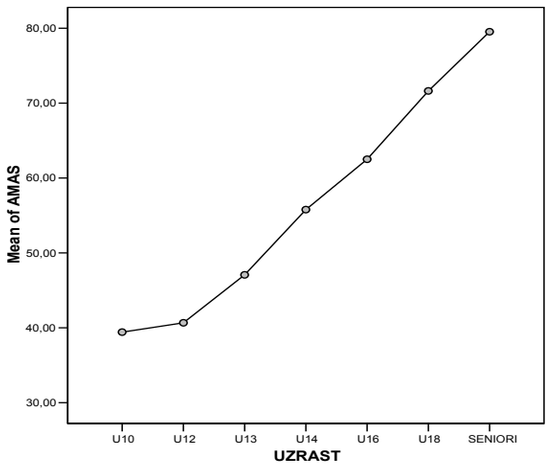
Variable	age	N	Mean	Std. Dev.	Std. Error	Min	Max
AVIS	U10	28	144,6643	6,37618	1,20499	135,00	165,00
	U12	54	151,9500	6,94096	,94454	140,20	171,60
	U13	48	157,1646	6,40623	,92466	142,50	167,20
	U14	62	167,3581	7,21357	,91612	151,20	181,00
	U16	27	175,8148	7,24986	1,39524	161,00	191,00
	U18	24	181,4167	4,97749	1,01602	174,00	189,00
	SENIORI	28	182,2071	6,36460	1,20280	172,40	197,00
	Total	271	163,7594	14,05687	,85389	135,00	197,00
AMAS	U10	28	39,4214	7,12052	1,34565	29,40	58,30
	U12	54	40,6685	6,37551	,86760	31,20	57,00
	U13	48	47,0729	7,37935	1,06512	34,20	67,40
	U14	62	55,7790	9,75761	1,23922	38,20	86,40
	U16	27	62,5037	8,55833	1,64705	45,70	80,90
	U18	24	71,6250	5,83090	1,19023	58,90	82,50
	SENIORI	28	79,5321	6,75415	1,27641	66,10	94,30
	Total	271	54,0635	15,09427	,91691	29,40	94,30
BMI	U10	28	18,7214	2,39403	,45243	14,40	23,10
	U12	54	17,5444	2,04687	,27854	12,70	24,70
	U13	48	18,9938	2,47862	,35776	14,10	24,50
	U14	62	19,7565	2,61356	,33192	15,30	28,90
	U16	27	20,1519	1,93398	,37219	16,30	25,00
	U18	24	22,1333	2,30928	,47138	18,20	29,80
	SENIORI	28	23,9750	1,50791	,28497	20,80	26,80
	Total	271	19,7594	2,93368	,17821	12,70	29,80
BMR	U10	28	5680,0714	512,74323	96,89936	4983,00	7045,00
	U12	54	5804,2222	464,13843	63,16124	5113,00	7018,00
	U13	48	6270,1250	523,99564	75,63226	5333,00	7707,00
	U14	62	6912,9677	688,81940	87,48015	5669,00	9077,00
	U16	27	7428,9259	614,76049	118,31071	6221,00	8708,00
	U18	24	7842,5000	421,32782	86,00318	7116,00	8675,00
	SENIORI	28	7985,5000	467,04084	88,26242	7198,00	9208,00
	Total	271	6695,3321	974,18456	59,17750	4983,00	9208,00
IMPEND.	U10	28	566,4643	62,80156	11,86838	465,00	678,00
	U12	54	567,5556	61,68443	8,39419	447,00	702,00
	U13	48	544,1667	50,38969	7,27312	441,00	664,00
	U14	62	485,4355	59,51763	7,55875	316,00	599,00
	U16	27	449,5556	43,50007	8,37159	395,00	559,00
	U18	24	447,7083	42,37358	8,64947	380,00	531,00
	SENIORI	28	460,1429	37,98607	7,17869	382,00	555,00
	Total	271	511,0443	71,89765	4,36747	316,00	702,00
FAT%	U10	28	17,5786	5,41557	1,02345	10,00	33,00
	U12	54	12,4111	4,80097	,65333	1,40	25,30
	U13	48	14,3479	5,68016	,81986	6,60	28,30
	U14	62	10,8290	4,54722	,57750	4,60	25,60
	U16	27	8,0556	3,12463	,60134	2,70	16,00
	U18	24	5,7625	2,13110	,43501	2,10	9,20
	SENIORI	28	9,2929	2,12549	,40168	5,00	13,20
	Total	271	11,5812	5,44777	,33093	1,40	33,00

FATMASS	U10	28	7,2071	3,34420	,63199	3,00	17,70
	U12	54	5,2241	2,65422	,36119	,50	14,40
	U13	48	7,0063	3,63098	,52409	2,40	17,70
	U14	62	6,3597	3,63595	,46177	2,00	18,20
	U16	27	5,2037	2,51679	,48436	1,50	12,90
	U18	24	4,1792	1,66027	,33890	1,40	7,20
	SENIORI	28	7,4286	1,89734	,35856	3,70	11,80
	Total	271	6,1376	3,16540	,19228	,50	18,20
FFM	U10	28	32,2571	4,59214	,86783	26,20	45,60
	U12	54	35,4611	4,75995	,64775	28,70	48,00
	U13	48	40,0667	5,07993	,73322	30,80	51,30
	U14	62	49,4677	7,29956	,92704	36,10	73,00
	U16	27	57,3000	6,83453	1,31531	42,20	68,10
	U18	24	67,1500	5,32198	1,08634	57,50	76,60
	SENIORI	28	72,1036	6,00342	1,13454	59,90	85,30
	Total	271	47,9185	14,28010	,86745	26,20	85,30
TBW	U10	28	23,6179	3,36750	,63640	19,20	33,40
	U12	54	25,9611	3,47994	,47356	21,00	35,10
	U13	48	29,3354	3,71670	,53646	22,60	37,60
	U14	62	36,0758	5,65641	,71836	20,00	53,40
	U16	27	41,9444	5,00802	,96379	30,90	49,90
	U18	24	49,8208	3,65180	,74542	42,60	56,60
	SENIORI	28	52,8036	4,39937	,83140	43,90	62,40
	Total	271	35,1096	10,56327	,64167	19,20	62,40

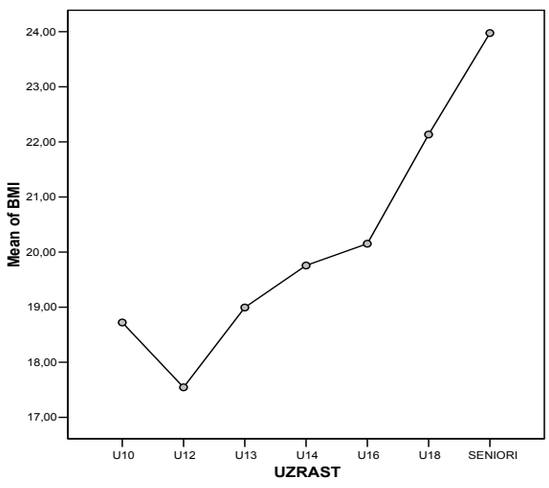
Graph 1.- Trend of growth of variable HEIGHT



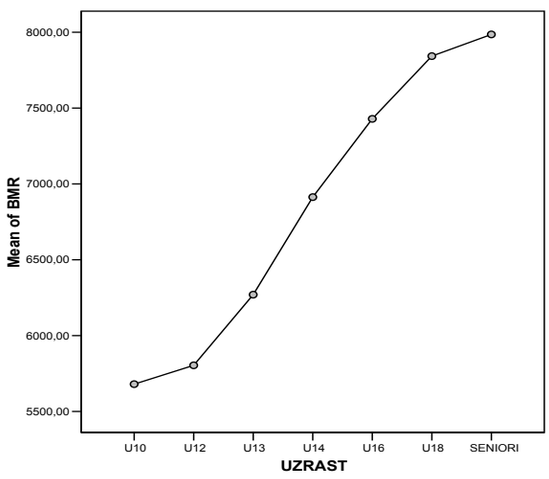
Graph 2.-Trend of growth of variable MASS



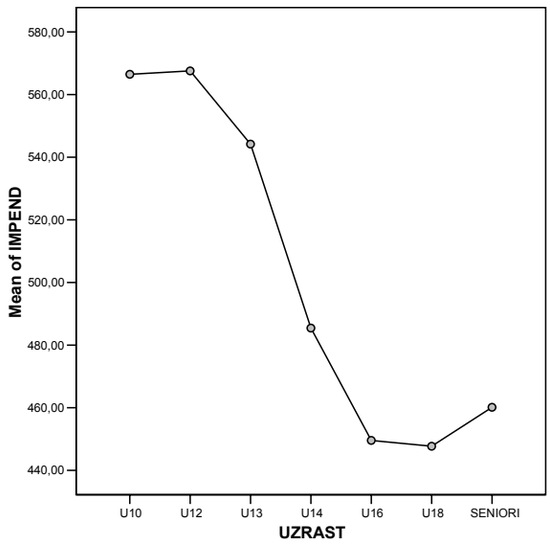
Graph 3.- Trend of growth of variable BMI



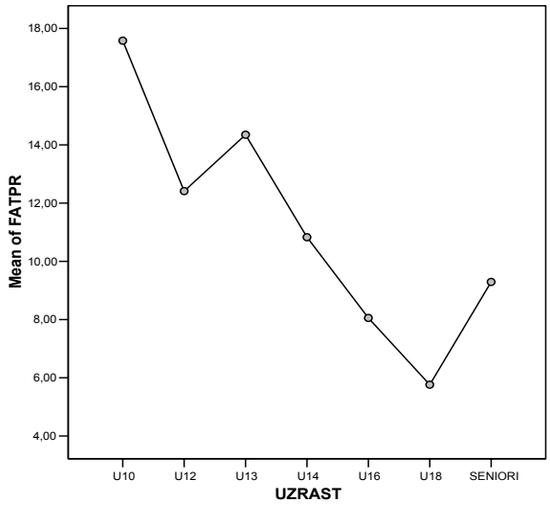
Graph 4.- Trend of growth of variable BMR



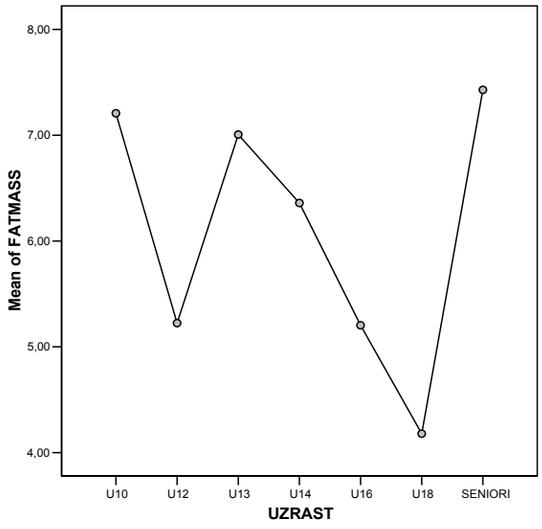
Graph 5.- Trend of growth of variable IMPENDANCE



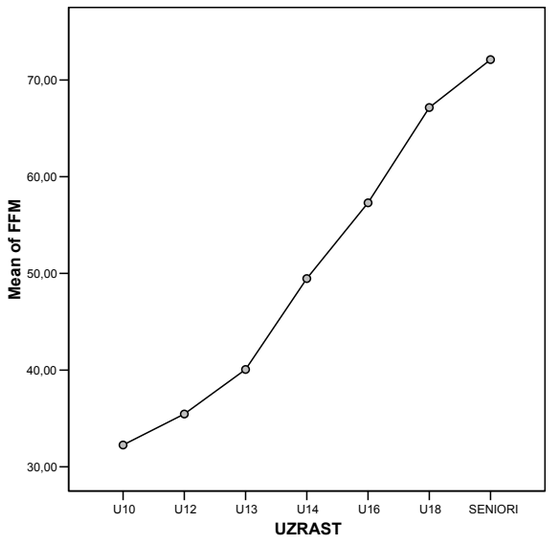
Graph 6.- Trend of the growth of variable FAT%



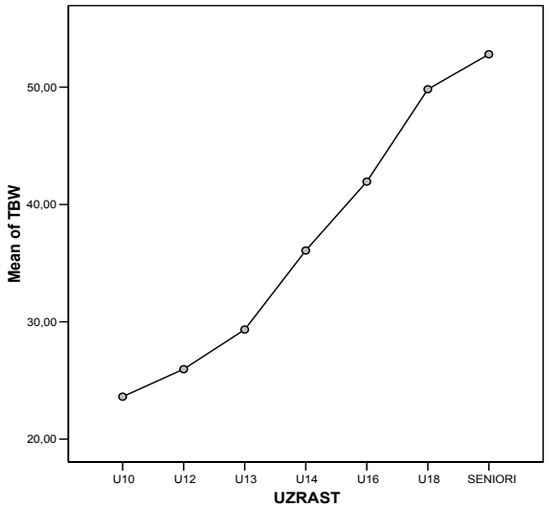
Graph 7.- Trend of growth of variable FATMASS



Graph 8.- Trend of the growth of variable FFM



Graph 9.- Trend of growth of variable TBW



Conclusion

The aim of this research was that through a cross – section view, determines the trend of changes among the indicators of body composition in soccer players in different age periods. On the studied sample of 271 subjects (respondents), distributed into 7 sub-samples, 7 variables were measured by Bioelectrical Impedance Analysis (BIA).For this purpose the electrical balance TANITA TBF-300 (Tanita corporation of America Inc.) was used. All obtained values were analyzed individually, and by basic descriptive data (central and dispersion parameters) it can be concluded that the distribution of results is within the normal distribution. On the basis of results determined by the analysis of variance (One way ANOVA) it can be concluded that there is a significant trend of changes in body composition in all variables on the level ($p<.01$). Analysis of inter-annual increases based on arithmetic means of variables, can be concluded that soccer players rapidly grow and develop, to grow and gain in weight (mass) slightly more in comparison to previous year. We can see the evident, changeable trend of changes in the percentage and

mass of fat (adipose) tissue where comes to decrease of the values during the age period of 10 to 12 years, when there is a growth of fat (adipose) tissue till the age of 13, and then comes to a sudden decrease of the value about the age of 16, which can be explained by the rapid growth and development, as well as the impact of training activities of the respondents followed by increased amount of muscular mass and decreased fat portion in body composition. The amount of fluid in body (Total Body Water) also has a continuous growth curve, but if we express it in percentages then we will notice that the amount of fluid in the body of players increases gradually (U10=69,56%; U12=63,8%; U13=62,3%; U14=64,67%; U16=67,05%; U18=69,56%) till the senior period when it starts to decrease slightly (SENIORI=66,39%). By the obtained results, a general conclusion can be drawn, and this conclusion is that soccer players in the period of the beginning of training process till the senior period have a rapid growth and development, followed by increase of muscular mass and decrease of the amount and the percentage fat portion in the body composition. To this dynamic trend of changes in body composition, beside the factors of growth and development, certainly a great influence has systematically planned and programmed training technology in soccer clubs.

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Differences in the course of result between the winning and losing teams in top handball

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Original scientific paper

Abstract

Starting from the assumption that there are some differences in the course of result in relation to the final result outcome, the aim of this research is to determine in what time segment of a match the partial result mostly makes a difference between winning and losing a match. The research was done on the sample of 101 matches of the World Championship for Men held in 2009 in Croatia, and included all of the matches which ended in a victory or a defeat. The variables are defined by the number of scored goals and the achieved score difference in six ten-minute time segments of a match. In the context of data processing, we calculated basic descriptive and distribution statistic parameters. The differences between the number of scored goals and the achieved score difference in six ten-minute periods of a match between the winning and the losing teams were determined by variance analysis. Variance analysis confirmed statistically significant differences in both groups of the variables. The winning teams score most goals in the penultimate segment of the game (40-50 min) and they achieve the biggest score difference in the second (10-20min) and the penultimate period (40-50min). The winning teams score least goals in the first ten minutes of the match, and they achieve the smallest score difference in the last ten minutes of the match. The losing teams score most goals in the last sixth and least goals in the first sixth of a match. Contrary to the winning teams, the losing teams achieve the biggest negative difference in the second and the fifth, and the smallest one in the last sixth of a match. The results of the research reveal the need to give special attention to tactical preparing and leading of the match in the training process, i.e. to those segments of the match which have special significance for the final result outcome.

Keywords: **differences, result, handball**

Sažetak

Polazeći od pretpostavke postojanja razlika u tijeku rezultata spram konačnog rezultatskog ishoda, cilj je ovog istraživanja utvrditi u kojem vremenskom razdoblju utakmice parcijalni rezultat najviše razlikuje pobjedu od poraza. Istraživanje je provedeno na uzorku od 101 utakmice Svjetskog prvenstva za muškarce koje je održano 2009. g. u Hrvatskoj, a obuhvaćene su sve utakmice tog prvenstva koje su završile pobjedom ili porazom. Varijable su definirane brojem postignutih golova i ostvarenom rezultatskom razlikom u 6 desetominutnih vremenskih segmenata utakmice. U okviru obrade podataka izračunati su osnovni deskriptivni i distribucijski statistički parametri. Razlike u broju postignutih golova i ostvarenoj rezultatskoj razlici u 6 desetominutnih razdoblja utakmice između pobjedničkih i poraženih ekipa utvrđene su analizom varijance. Analiza varijance potvrdila je statistički značajne razlike u obje grupe varijabli. Pobjedničke ekipe najviše pogodaka postižu u predzadnjem segmentu utakmice (40-50 min), a najveću rezultatsku razliku ostvaruju u drugom (10-20 min) i predzadnjem razdoblju (40-50 min). Najmanje pogodaka pobjedničke ekipe postižu u prvih deset minuta utakmice, a najmanju rezultatsku razliku ostvaruju u zadnjih deset minuta utakmice. Poražene ekipe najviše pogodaka postižu u posljednjoj, a najmanje u prvoj šestini utakmice. Suprotno od pobjedničkih, poražene ekipe najveću negativnu razliku ostvaruju u drugoj i petoj, a najmanju u posljednjoj šestini utakmice. Rezultati istraživanja ukazuju na potrebu da se u trenažnom procesu, taktičkoj pripremi i vođenju utakmice posebna pozornost posveti ovim segmentima utakmice koji su od posebnog značaja za konačni rezultatski uspjeh.

Ključne riječi: **razlike, rezultat, rukomet**

Introduction

Games, particularly sport games, participated by a great number of players who face each other on an individual, group and collective level in repeated moving, are methodologically demanding to analyse. Numerousness of objects, complexity of moving, variety of positions and an unlimited variability of tactical performances ask for a quality approach to the analysis of a sport game and its decomposition to smaller segments.

Handball game can be observed as a set of situation-related events partly determined by the structure of technical-tactical activity, by the influence of the opponents and external conditions, by dimensions of the athletes' system, but mostly by the managing network – the rules of the handball game. Events in a handball game present the interaction of various moves and they are determined by numerous factors (kinesiological, spatial, temporal and anthropological). However, they are not always linearly predictable since handball game has plenty of situations manifested in a random or chaotic manner. For instance, event "score" is determined by numerous activities of a defence player, an attack player and the goalkeeper, therefore this event cannot be predicted with certainty. Although physically a player scores in the moment when the ball is over the goal line by its major part, officially it becomes an event when the judge, based on his subjective assessment, confirms it with a whistle blow. At the same time, this is the only event presented by a numerical change of the result.

Each handball event has an outcome related to the aiming direction. The event outcome also leads to the consequence which may be determined by rules of the game or may be produced by situation-related circumstances. The consequence may also be positive, negative or neutral and presents the starting point for the next event. E.g. the outcome of the shot on goal can be positive or negative. If the aim is accomplished, i.e. if one scores, the consequence in unconditionally negative, i.e. the ball loss, for it belongs to the opponent according to the rules. However, if the outcome of this event is not positive, i.e. the goal is not scored because the goalkeeper has defended it or the ball hit the doorframe, the

outcome is negative, and the consequences of this outcome can be negative (after the rebound, the ball was won by one of the players from the opposed team) or positive (the ball was won by a player from the attacking team).

If we put aside the entropy of the result caused by unpredictable external factors which the participants cannot immediately influence, such as the judge's decisions, scoring a goal, being a resultant of cumulative situation-related activities of the confronted opponents, in addition to technical-tactical factors, is primarily determined by the level of players' anthropological potential (Kovač & Đukić, 1980; Czerwinski, 1995; Hianik, 2008).

A few researches have been published recently analysing the efficiency of the attack finalisation and the influence of different aspects of the attack finalisation on the final result of a match (Srhoj et al. 2001; Rogulj et al. 2004; Rogulj et al. 2009).

However, we lack in research analysing the course of the result and its influence on the final result outcome of a match.

Starting from the undoubted importance of the course of the result for the final result outcome (Rogulj, 2000; Rogulj et al. 2002), but also from the fact that this problem has not been studied enough, the aim of this research is to establish, on a relevant sample of top matches, in which time period of the match the partial result mostly makes a difference between the winning and the losing teams.

Methods

The research was done on the sample of 101 matches at the World Championship for Men held in Croatia in 2009. The sample involves all the matches of the championship which ended in a victory or a defeat. The variables are defined by the number of achieved goals, i.e. by the result increase and the achieved score difference in six 10-minute time segments of the match. In the aspect of data processing we calculated basic descriptive and distribution statistic parameters. The differences in the number of scored goals and the achieved score difference in six 10-minute periods of a match between the winning and the losing teams have been determined by variance analysis.

Results

Table 1 presents basic descriptive and distribution parameters of prediction variables. It is evident most scores were achieved in the last (4,82), and least in the first sixth of the match (4,16). Nearly the same number of scores is achieved between the twentieth and the fortieth minute. All the variables have satisfactory and balanced distribution parameters of symmetry and curvature. With the increase of the number of scores in relation to the time course of the match, the result dispersion is slightly increasing as well (standard deviation), therefore the greatest scoring dispersion is present in the last sixth as well as the greatest variability of score differences.

Table 1. Descriptive and distribution parameters (n=202)

VAR	MEAN	MIN	MAX	SD	SKE	KUR
INC/10	4,16	0,00	9,00	1,67	,18	-,18
INC/20	4,56	0,00	9,00	1,86	-,14	-,37
INC/30	4,55	0,00	9,00	1,70	-,11	-,33
INC/40	4,57	1,00	10,00	1,91	,37	-,40
INC/50	4,73	0,00	9,00	1,80	,20	-,23
INC/60	4,82	1,00	12,00	1,98	,28	,42
DIF/10	,00	-6,00	6,00	2,59	,00	-,50
DIF/20	,00	-7,00	7,00	2,92	,00	-,59
DIF/30	,00	-8,00	8,00	2,71	,00	-,02
DIF/40	,00	-9,00	9,00	2,93	,00	,18
DIF/50	,00	-8,00	8,00	2,86	,00	,75
DIF/60	,00	-8,00	8,00	3,00	,00	,03

Table 2 displays the results of the variance analysis of the variable for the number of scored goals in six 10-minute segments of the match between the winning and the losing teams. We established a statistically significant difference between result efficient and non-efficient teams in all the variables of the result increase. The winning teams score most goals in the penultimate segment of the match (40-50 min) and the least in the first ten minutes of the match. The losing teams score most goals in the last, and least in the first sixth of the match (graph 1).

Table 2. Variance analysis of result increase

VARIABLE	MEAN WINNING	MEAN LOSING	F	p
INC/10	4,80	3,54	30,22	,00*
INC/20	5,49	3,70	56,12	,00*
INC/30	5,21	3,88	32,07	,00*
INC/40	5,36	3,82	33,89	,00*
INC/50	5,58	3,88	51,08	,00*
INC/60	5,38	4,27	14,99	,00*

Table 3 displays results of the variance analysis for the variables of the score difference in six 10-minute segments of a match between the winning and the losing teams. We have established a statistically significant difference between result efficient and result non-efficient teams in all the variables of the score difference. The winning teams have the biggest score difference in the second (10-20 min.) and the penultimate period of the match (40-50 min.) and the smallest one in the last ten minutes of the match. Contrary to the winning teams, the losing teams have the greatest negative score difference in the second and the fifth, and the smallest one in the last sixth of the match.

Table 3. Variance analysis of score result

VARIABLE	MEAN WINNING	MEAN LOSING	F	p
DIF/10	1,26	-1,26	58,64	,00*
DIF/20	1,80	-1,80	106,72	,00*
DIF/30	1,34	-1,34	56,02	,00*
DIF/40	1,54	-1,54	66,50	,00*
DIF/50	1,71	-1,71	97,96	,00*
DIF/60	1,11	-1,11	28,14	,00*

Discussion

A smaller number of scored goals at the opening of a match in the first ten minutes may be explained by the fact that at the beginning, regardless of the relation between the quality of two teams, most frequently there is an appropriate caution and respect for the opponent, which results in long organised attacks based on the basic principles of the game with the aim of creating a favourable opportunity for a certain realisation of the attack finalisation from close range (Rogulj, 2003). On the other hand, both teams are primarily focused on defence which is played with maximum engagement and motivation at the beginning of the match, trying to show the opponent they will not allow an easy realisation. Evidently, in these conditions of organised, engaged and most frequently aggressive defence with a stressed motivation and gradual, long-lasting and careful attack, we cannot expect a large number of scores (Czerwinski, 1998). A high level of energy potential possessed by the players at the beginning of the match is certainly favourable to this situation and it also enables them to play actively and aggressively in defence, while on the other hand, it decreases a possibility to make technical fouls and lose the ball in attack both of which are the starting point for the realisation of fast attacks to a disorganised defence and for "easy scoring" (Brčić et al. 1997; Talović et al. 2007).

From the tenth minute of a match on, a number of scored goals slightly increases and this increase is kept on the same level during the next half an hour of the game. It is evident that the middle part of the match is marked by a stable result increase which is primarily caused by an equal influence of both teams. A more noticeable increase in the number of scored goals is observed in the penultimate sixth of a match in winning teams, and particularly in the last sixth of the match in the losing teams (graph 1).

It is known for a fact that in the conditions of a greater score difference in the finalisation of the match, which is quite common in the matches between the teams of different qualities, the teams with an extremely positive result most frequently lacks in motivation (Hergeirrson, 2008). The fact that in a large number of cases a team has already won or lost the match before the last sixth, makes the "winning" team play with less engagement in defence which enables the opposed team of creating a more favourable situation for an unobstructed realisation. Disorganised and disengaged defence also enables to shorten positioning attack and enables a larger number of shots for the opposed team by the end of the match. A larger number of shots is also enabled by decreased energy potential producing a large number of technical fouls and balls losses in attack, and they are a starting point for the realisation of fast counterattacks characterised by a high level of realisation efficiency (Thorlund et al. 2008).

The winning teams score less goals in the last sixth than in the penultimate sixth partly for the reason they play in this phase of the game with young players or substitutes or, in the conditions of result uncertainty, they test certain innovative tactical variants (graph 1).

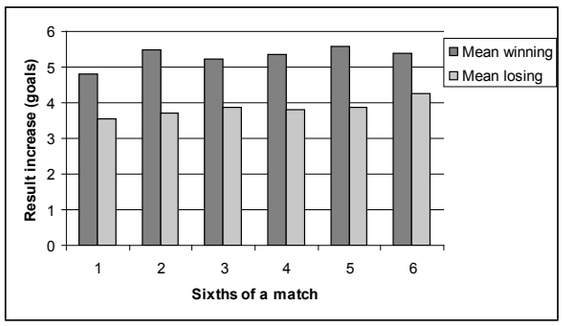
Variance analysis of score differences achieved in certain time segments of a match showed that the winning teams differ from the losing teams mostly in the score difference achieved between the tenth and the twentieth minute and the one achieved between the fortieth and the fiftieth minute of the match. For the final result success, it is important to increase the result difference all the time during the match, but primarily in the second and the fifth sixth of the match. Therefore, the victory is primarily "ensured" after the first ten minutes mainly spent in getting to know each other and in cautious and careful playing. With this kind of playing, technical and tactical features much less influence the result, and not even the condition component is of a great significance.

However, after the opening phase of the match, according to the research results, it is important to put in maximum efforts and engagement with the purpose of playing as efficiently as possible and to achieve as favourable result as possible in the following ten minutes. During this period of the match, the playing becomes fully competitive and both of the teams play openly, most frequently without any tactical calculations and with the equal engagement in all phases of playing (attack, defence and transition), therefore it is crucial to make as great score difference as possible in such conditions. In the next half an hour, i.e. from the twentieth to the fortieth minute, the teams achieve somewhat less, but rather an equal contribution of score differences which are achieved in certain segments of a match and for the final result success.

In addition to the second, the score difference achieved in the penultimate sixth of the match, from the fortieth to the fiftieth minute, is of extreme importance for the final victory. A signifi-

cant contribution of this phase of the match to the result success has been confirmed in some previous researches (Rogulj et al. 2002; Rogulj et al. 2004; Vuleta et al. 2005). This is evidently an extremely important, perhaps even a crucial segment which accumulates all the previous struggling and the activeness of both opposed teams in which they put in use the total maximum anthropological potential of their players. Due to given reasons, this phase of a match usually leads to the "break" of the score and results in a greater result sparating of one of the teams which is crucial for winning (graph 1). The smallest score differences between the winning and the losing teams are present in both the starting and the finishing phase of the match. Namely, due to already stated reasons, at the beginning of a match, the difference in the quality between the teams is less obvious, as well as in the finalisation of the match since the more quality team has probably already ensured the victory and is therefore playing with less engagement.

Graph 1. Display of result increase by individual segments of a match



Conclusion

By subliming the research results we can conclude that, quite expectedly, the achieved result increase and the achieved score difference in all ten-minute time segments of the match on the level of statistical significance is what makes a difference between the winning and the losing teams. However, in some parts of the match, it is extremely important to score as much as possible and to achieve as big result difference as possible, since it ensures the highest probability for the final result success. Therefore, knowledge obtained by this research can have a useful practical application in terms of giving special attention, both in tactical preparing and while leading the team in a competition, to those time segments of the match which are most crucial for winning. Further on, the research results may also be applied in a training process in a way that in the temporal distribution of weight loading and contents within a certain training unit, the intensity and extensity of weight loading is dosed and increased in the parts of training which match the time segments of a match most important for winning.

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Differences between specific motor skills of water polo players classified by different positions in the game

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Original scientific paper

Abstract
The goal of the research was to establish hierarchy of water polo players classified by their position who are Adriatic league juniors of which many participate in senior games. This league is one of the strongest in the world. This paper could be used to prove some rules important for modeling, selection and therefore using top notch water polo training for this population (possibly reducing number of injuries during more adequate and useful training sessions) This can be done by revealing hierarchy of water polo players motor skills and getting those facts partly responsible for success , together with coordinated work of relevant individuals (all water polo coaches, fitness coaches, scientists in the field etc). Testing was done on Adriatic league junior water polo players. 15 players per club from seven clubs were tested , all together 104 water polo players. Testing was carried out in pools and gyms in Dubrovnik (W.C "Jug"), Split (W.C. "Mornar"), Rijeka (W.C. "Primorje"), Sibenik (W.C. „Sibenik"), Zagreb (W.C. „Medvescak" and „Mladost"), Herceg Novi (W.C "Jadran"). The above mentioned players are registered in their home clubs and therefore eligible to compete in the league. Of all the tested players only the result of those players that are healthy with no morphological, psychological or other aberrations were taken into the account. Results clearly indicate differences between different positions (outside wingers, centers, defense and goalies) established after testing candidates with 10 motor skills variables specific for water polo players.

Keywords: **water polo players, specific motor skills, differences, positions in the game**

Sažetak
Cilj istraživanja je bio da se utvrdi hijerarhijski model vaterpolista, razvrstanih po pozicijama u igri, juniora Jadranske lige, od kojih su mnogi uključeni u igre seniora, u ligi koja je jedna od najjačih na svijetu. Otkrivanjem hijerarhijske strukture specifično motoričkih sposobnosti vaterpolista, i dobivanjem onih faktora koji su dijelom odgovorni za uspjeh u vaterpolu, uz koordinativno djelovanje mnogih relevantnih faktora (svih trenera vaterpolista, kao i kondicijskih trenera, naučnika iz ove oblasti i dr.), ovaj rad bi mogao poslužiti za dokazivanje nekih zakonitosti, koji su od važnosti za modeliranje, selekcioniranje, a samim tim i određivanje vrhunskih treninga u vaterpolu na ovoj populaciji (vjerojatno i smanjenje broja povređivanja uslijed adekvatnijih i svrsishodnijih trenažnih procesa). Ispitivanje se izvršilo na juniorima, vaterpolo igračima učesnicima Jadranske lige. Testirali su se igrači sedam klubova, njih 15 po svakom klubu, što u konačnici iznosi 104 vaterpolista. Ispitivanje se realizovalo u bazenima i dvoranama, u Dubrovniku („V.K.Jug"), Splitu („V.K.Mornar"), Rijeci („V.K.Primorje"), Šibeniku („V.K.Šibenik"), Zagrebu („V.K.Medveščak" i „V.K.Mladost"), Herceg Novom („V.K.Jadran"). Navedeni ispitanici su uredno registrovani u svojim matičnim klubovima te su stekli pravo nastupa u ligaškom takmičenju Jadranske lige za navedeni uzrast. U konačnu obradu su se uzeli samo rezultati ispitanika koji su zdravi, na kojima nisu zapažene morfološke, psihološke i druge aberacije i koji su pristupili testiranju. Rezultati jasno pokazuju razlike između pozicija u igri (vanjski-krila, centri, bekovi i golmani) koje su nastale nakon testiranja ispitanika sa 10 postavljenih specifično motoričkih varijabli za vaterpoliste.

Ključne riječi: **vaterpolisti, specifično motoričke sposobnosti, razlike, pozicije u igri**

Introduction

Water polo, being exceptionally dynamic and fast group sport belongs to poly structural group of sports. High level of competitiveness in water polo is based on good knowledge of elements based on specific morphological, motor skills an other characteristics. Good knowledge of hierarchical structure of the factors influencing results in a modern water polo game is a basic criteria for selection water polo talents and efficient planning and program making of daily training sessions. The issue of finding effective means and methods in training of young water polo players is an important topic in the world. Top results in water polo can only be achieved by programmed training session but also by serious, high quality selection process which can be achieved by molding of players. From these reasons stems that it is necessary to take care of extensiveness, intensity and quality of work in modern training, this specially refers to work with youth. It is therefore necessary to establish those factors which more or less lead to success in water polo through systematic training. It is known that specific motor skills are important in water polo, specially leg work. This has been confirmed by many writers: Feltner and Taylor (1997), Ball (2005), McCluskey, L. i sar. (2009), Lozovina (1983), Gladden and Colacino, 1978; Šimenc, 1989; Sanders, 1999; Dopsaj, 1999, Kontić 2007, Smith 1998, Sanders, 2005, 2008.). Unfortunately there is still not enough relevant scientific data that would enable greater effects with the goal of achieving top results in the sport, therefore this research is a contribution. The aim of this research is to show clear motor skill differences among players according to their position in the game. Subjects were Adriatic league junior water polo players.

Methods

This research is a transversal study aiming to establish motor skills dimensional differences of Adriatic league junior water polo players according to their position in the game. Total sample of respondents (104) was made up of members of seven clubs within Adriatic water polo league at the same level of competition in Croatia and Monte Negro. Research included 10 variables of specific motor area that clearly showed water polo players condition depending on their position

in the team. Positions were split on offense (wingers and outside players), centers, defense and finally goal keepers. Tests were given with explicitly clear measurements in pools and gyms of 7 participating clubs, with the goal of monitoring players for whom specific motor area skills are very important and they show true fitness levels.

Variables for assessment of specific motor skills in the water

Foot Crawl . . .	SMNOKR
Leg scissors . . .	SMNOŠK
Legs bicycle . . .	SMNOBI
Endurance with 10 kg bar . .	SMIZŠI
Lateral jump . . .	SMISBO
Vertical jump . . .	SMISKO
Shoot speed 7 m . . .	SMBRŠ7
Dynamometric force pulling bicycle foot .	SMFVNB
Dynamometric force pulling scissor foot .	SMFVNŠ
Dynamometric force pulling hand stroke .	SMFVRZ

Statistic programs Spss 15,0 and Statistical 8,0 were used to analyze the data. Determining measures of central and dispersion parameters were carried out with sub program Descriptive Statistics-Spss 15,0. Global differences were checked by using multivariate discriminant analysis (Discriminant Analysis - SPSS 15,0) attempting to establish importance of treated specific motor skills of water polo players classified by their position in the team. At invariant level analysis of variance was applied as well as LSD test. (Analysis of Variance; LSD test - SPSS 15,0).

Results and Discussion

Analysis of variance (ANOVA) is procedure of differentiating already defined entity groups described by a variable. Variables that are singled out in our case belong to the area of specific motor skills and they are: SMIZŠI, SMISKO, SMBRŠ7 and SMFVRZ.

Table 1. Anova

Meas.	Sum of Sq.	Df	Mean Sq.	F	Sig.
SMNOKR	35,755	3	11,918	2,124	,102
SMNOŠK	12,672	3	4,224	2,154	,098
SMNOBI	19,869	3	6,623	2,326	,079
SMIZŠI	464,811	3	154,937	3,838	**,012**
SMISBO	3,521	3	1,174	,254	,858
SMISKO	612,194	3	204,065	5,012	**,003**
SMBRŠ7	2873,800	3	957,933	29,032	**,000**
SMFVNB	176,009	3	58,670	1,270	,289
SMFVNŠ	189,032	3	63,011	2,375	,075
SMFVRZ	487,869	3	162,623	2,650	**,053**

Review of the results of LST test, measure SMNOKR statistically significantly distinguishes group of players in offence positions from goal keeper group at the statistical importance level (table2). Measure SMNOSK significantly distinguishes group of players at central positions and goalkeepers. Further analyses of LSD test show that SMNOBI measurement clearly discriminates offense positions and goal keepers as well as defense and goal keepers. For measure SMIZSI statistically significant differences are being noticed for offence players and goal keepers. For measure SMISKO statistically important differences are shown of three positions with goal keeper position which is logical considering their role in the game. Further analysis of LSD test showed statistical importance of differences for variable SMBRS7 for position of offence, center and quarterback with goal keeper position where significantly lower values for shot speed are noticed. Measure SMFVNS distinguishes offence from mid field. The last measurement in this chapter of specific motor skills in water polo players referring to LSD test results is inspection of measure SMFVRZ where statistical importance of difference between offence vs center, centers vs defense as well as centers vs goalkeepers. It can be stated that indicators of specific motor skills in Adriatic league junior water polo players mostly give information on statistically important differences between positions in water polo game for almost all positions. Details an analyses were mentioned earlier in the paper.

Table 2. LSD test

G(I)	G(J)	Differences between the groups	Sig.
Measurement SMNOKR			
1	4	-1,62699(*)	**,013**
Measurement SMNOŠK			
2	4	1,13117(*)	**,016**
Measurement SMNOBI			
1	4	1,06463(*)	**,023**
3	4	1,27551(*)	**,019**
Measurement SMIZŠI			
1	4	-5,57842(*)	**,002**
Measurement SMISKO			
1	4	-6,16934(*)	**,001**
2	4	-6,64035(*)	**,002**
3	4	-6,14035(*)	**,003**
Measurement SMBRŠ7			
1	4	13,45080(*)	**,000**
2	4	12,61988(*)	**,000**
3	4	14,46115(*)	**,000**
Measurement SMFVNŠ			
1	2	-3,51932(*)	**,016**
Measurement SMFVRZ			
1	2	-5,95169(*)	**,007**
2	3	5,30159(*)	**,038**
2	4	5,44620(*)	**,037**

Table three shows results of discriminant analysis in area of specific motor skills. Result was significant discriminative functions that have statistically medium important at the level (Sig + ,02, (Canonical Correlation = 80 and 46 while the third singled out function has statistically low value at the level (Sig.= ,41) (Canonical Correlation= 28). Value of Wilkes lambda used as a criteria for discriminative strenght of used variable system (table 4) is showin low value for the first and medium for second (first function, 25; second 72) and very high value (92) for third isolated function wich shows high and medium high as well as low discrimination between groups specially for the third isolated function. First isolated function explains 83,5% of total variance, second isolated function 12,5% of total variance and third isolated function explains 4% of total variance.

Table 3. Discriminative analyses

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	1,850(a)	**83,5**	83,5	**,806**
2	,276(a)	12,5	96,0	,465
3	,090(a)	4,0	100,0	,287

Table 4. Wilks Lambda

Test of Function(s)	Wilks' Lambda	Chi-square	Df	Sig.
1 through 3	,252	132,202	30	**,000**
2 through 3	,719	31,643	18	**,024**
3	,918	8,244	8	,410

From structure of discriminative function (table 5) it is obvious that variable SMBRS7 contributed to greatest global differences between the players playing different positions. It represents the shot speed from 7 maters. Other variables which contribute to statisticaly important differences are SMISKO, SMNOBI and SMNOKR and they represent vertical jump, foot crawl and leg bicycle. Regarding other function, greatest statistical differences between different team positions were variables SMFVRZ, SMNOŠK i SMFVNŠ which represent dynamometric force of hand stroke, speed of leg scissors and dynamometric force of leg scissors. It is easily noticeable from the above mentioned that two statistically important functions were isolated where shot speed variable dominates which is indicating importance of this segment for top notch junior water polo players. Quarterbacks were singled out, they have fastest shots because they sent the biggest number of devastating shots at the goal, specially in the part of the game when offence is finishing up. Other two positions (wing and center) have pretty high values for this measurement while goal keeper's values are below average which is not surprising because they do not participate in the offense at least not in the segment where speed of shot at the goal is dominant.

Table 5. Structure of discriminative functions

	Function		
	1	2	3
SMBRŠ7	**-,676(*)**	,277	,240
SMISKO	**,272(*)**	-,218	,023
SMNOBI	**-,188(*)**	,079	,164
SMNOKR	**,181(*)**	,021	,181
SMFVRZ	,013	**,535(*)**	-,015
SMNOŠK	-,073	**,437(*)**	-,146
SMFVNŠ	,114	**,401(*)**	,181
SMIZŠI	,221	,217	,355(*)
SMFVNB	-,070	,269	-,320(*)
SMISBO	-,055	,016	,148(*)

Position of group centroid clearly shows differences in measurements of morphological characteristics between groups of players classified according to the position in the pool, confirmed by discriminative analyses. Centroids of the group offense (,81) and goal keepers (2,75) are furthest apart which states that they differ the most as for specific motor skills of junior water polo players in Atlantic league and that they are different form other groups. Other group centroids, centers and defense players are the least different.

Table 6. Function of group centroids

Groups	Function		
	1	2	3
1,00	-,814	-,285	-,224
2,00	,025	1,117	-,081
3,00	-,725	-,110	,558
4,00	2,748	-,246	,003

Because variable SMBRS7 was showed as most responsible in this analysis it is good to emphasize some research in this context. There are two types of shots at the goal. The most widely used is upper technique where the ball is being dropped from a high spot above the head using medial shoulder rotation for speed and sweep in which the ball is moving horizontally over the surface of the water (Feltner i Taylor, 1997.). Technique described here is upper technique and is usually used. Authors are suggesting that the muscle strength main factor responsible for 5 meter shots in water polo. It has been established that stronger respondents better used upper technique of shooting at the goal in water polo (Feltner i Taylor, 1997.). Ball (2005.) is saying that the speed of a ball in water polo can develop up to 22 m/s which is close to 80 km/h. It is important to emphasize SMISKO variable because is showed statistical importance regarding different position in the game. Performance of vertical jump is basic technical skill in many team sports including water polo where the player very often must raise the body vertically above the water in order to shoot at the goal or to prevent the opposing player to pass the ball (Gladden and Colacino, 1978; Šimenc, 1989; Sanders, 1999; Dopsaj, 1999.). According to research (Lozovina 1983.) partial conclusions can be made that leg strength is dominantly important for successful task solving in water polo. Footwork is responsible for speed of swimming, different type of water polo walking, endurance during the game, jumping out and starting, and mainly for all the elements enabling to come into an optimal position for shooting and ultimately scoring. Adding to this of high level of distance swimming (100 and 400 m) which indirectly indicates functioning at the high level of stress as well as sprint swimming at 25 m and water polo crawl at 15 m the logical conclusion can be made that the water polo player who can function well at high level of stress and who uses footwork for speed development while swimming, good jumping out, start and different endurance tests has good predispositions to be successful water polo player. Based on many analyses and results and also research of this paper it is good to mention the importance of footwork during water polo players training.
(Kontic 2007.).

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Discriminative analyses in area of specific motor skills shows that there is a statistically important difference between groups of respondents representing different positions in the team at the same level of competitiveness. Differences are surely made by selection of children, different approach and training methods. It is assumed that training method alone is responsible for all mentioned factors as well as education and expertise of coaches working with this age group.

Conclusion

With junior water polo players methods of determining their hierarchical model were conducted, specifically motor skills, divided by positions in the game consisting of offense, center, defense and goal players. Sample players were junior water polo players active in Adriatic league, currently registered with their clubs. There were 104 respondents from 7 clubs in Croatia and Monte Negro. It can be concluded that water polo players have different specific motor skills according to their positions on the team. Differences are surely made by selection of children and demands in the game. It is assumed that training method alone is responsible for all mentioned factors as well as education and expertise of coaches working with this age group. Specific motor

skills in water polo players, as a segment of anthropological area is very important for success in this sport, specially bicycle foot work so the coaches are advised to pay attention to its development.

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Effects of drop jumps on gymnastics basic jump

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Abbreviations: CMJ, countermovement jump; CMJ-fa,countermovement jump with the free arms; DJ, drop jump; SJ, squat jump; BJ, bunny jump.

Abstract
The aim of this study was to investigate the relationship and effect between mechanical output in maxmium vertical and horizontal jumping students 3 year of Faculty of PE and Sport, University of Tuzla. On the sample consisted of female (n=30) and male students (n=37). Sample of depenedent variables were drop jumps from 20, 40, 60, 80, 100 cm. A sample of independent variables included only one variable bunny jump. All data was analyzed using Tanita TBF-300A, Optojump, Brower Timing Systems and SPSS 17.0. With regression analysis explained (R Square) 34% of the common variables with criteria. Analyzing the effect of individual variables one can see that the only statistically significant effect on the criterion variable is a variable drop jump from 80 cm (Beta: 0.611, $p<0.05$).

Keywords: **Drop Jumps, Bunny Jumps, Optojump, Explosive power of lower limbs**

Sažetak
Cilj ovog rada bio je ispitati donose bi uticaj između ispoljavanja maksimalne vertikalne i horizontalne komponentne odrazna, kod studenata 3 godine Fakulteta za tjelesini odgoja bi sporit, Univerziteta u Tuzli. Uzorak ispitanika sastojalo se od (n = 30) studentima i (n = 37) studenata. Kao uzorak zavisnih varijabli uzeti su dubinski skokovi sa visina od 20, 40, 60, 80, 100 cm. Za uzorak nezavisnih varijabli uzeta je samo jedna varijabla zečji uskok naprijed. Svi podaci analizirani su uz pomoću elektronske vage Tanita TBF-300A, Optojump-a, laserskim elektronskim sistemom mjerenja vremena i statističkim paketom SPSS 17.0. Sa regresionom analizom objašneno je 92% varijabiliteta sa kriterijem. Analizirajući učinak pojedinih varijabli može se vidjeti da je jedini statistički značajan uticaj na kriterijske varijable imala varijabla dubinski skok sa 80 cm (Beta: 0,611, $p<0,05$).

Introduction

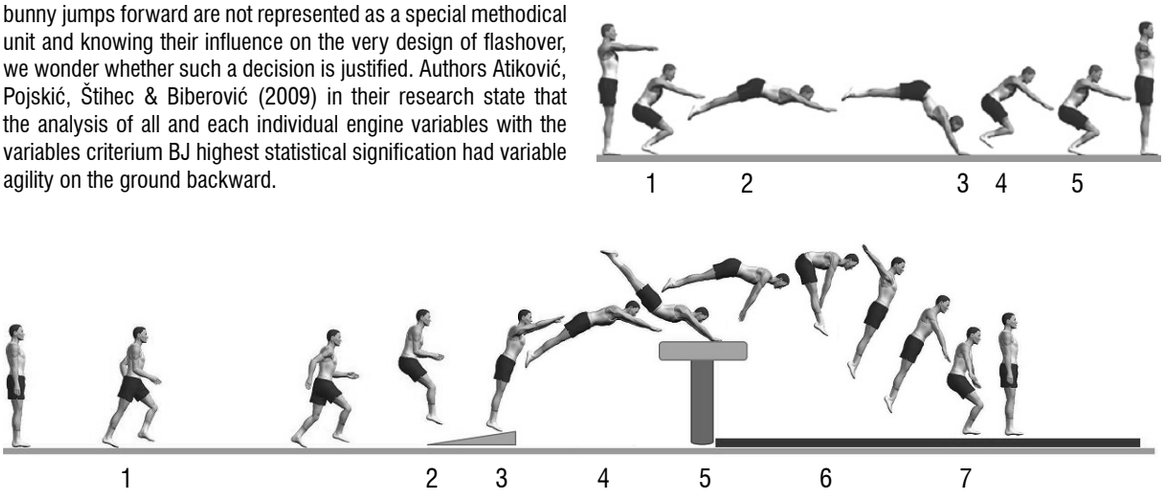
Arms and legs muscle power in general, and vertical jump performance in particular, are considered as critical elements for successful athletic jumps and bunny jumps performance. In scientific literature results of human muscle power testing are usually reported either in absolute (watts; W) or in per-body mass ratio standards (W/Kg) values. Action of muscles can be presented in three main ways of muscle activity: concentric contraction (C), ecscentric (E) and isometric (I), where the distance is constant, only changes muscle tone Hay and Reid (1982).

The importance of gymnastics elements bunny jump (BJ) forward (Picture 1) is reflected in the fact that this jump which is performed on the ground in its structure *has five stages* (taking off, first flight phase, taking weight on hands, second flight phase, two-footed landing), that is 1/7 (Picture 2) of the element on gymnastics valut. Out of seven stages of valut jump (Prassas, 2002; Čuk & Karácsony, 2004, Ferkolj, 2009, Begatović, Čuk & Atiković, 2011), the BJ we can use it as a warm up and easier way of learning elements of jump in an analytical method which is most commonly used while learning gymnastics elements like these. The first phase is a sprint towards the vault. This is an important phase because the following phases are dependent on it Čuk, Bricelj, Bučar, Turšič, & Atiković (2007). The jump on the springboard must be completed with minimum loss of sprint speed. Good and fast run-up allows a good reflection, and good reflection the good performance of flashover Ferkolj (2010). Antonov (1975) and Semenov (1987) measured the distance between the spring at springboard between 2.3-2.8 m. Flight time is depended on the speed of running and force of the reflection. When analyzing the data used in this work, most of the gymnasts had the time 0.24 to 0.30 s. Čuk & Karácsony (2004) found that top gymnasts spent only 0.24 s to complete the take-off phase on the springboard following the sprint approach. The time of the first flight phase depends on the relationship between horizontal and vertical velocity (Prassas, 2002). Analysis of the results in the example by Ferkolj (2007) showed that all the components of velocity in (x, y, xyz) axis differ in percentage. Velocity component in x-axis is reduced by 31.33%, the y-axis increased by 76.09% while the overall velocity component in xyz axis decreased by 10.60%. Analyzing this stage of flashover, the authors found the following usage of the time with the jump. Semonov (1987) usage of the time is generally 0.13 to 0.15 s. Čuk & Karácsony (1995) have established 0.08 s for a simple jump type stoop. In his research the author Ferkolj (2010) found that at the first hand contact with the table, overall speed (xyz) is 5.724 m/s. Atiković (2011) analyzes that the time of the second flight phase for easy jumping types stoop and hecht ranges from 0.70 to 1.20 s heavy jump type Dragulescu piked. Landing is the last, where in a very short time, stopping the gymnast must produce a force to stop the movement and rotation.

BJ forward are one of the most important elements in gymnastics on the vault. They require eccentric reflection, the head is not too obscure in the phase of flight. Landing is in use on the hands. The

impact on the development of motor skills is important and that especially relates to the coordination and strength Begatović, Čuk, & Atiković (2010). It is interesting that in the school curriculum, bunny jumps forward are not represented as a special methodical unit and knowing their influence on the very design of flashover, we wonder whether such a decision is justified. Authors Atiković, Pojskić, Štihec & Biberović (2009) in their research state that the analysis of all and each individual engine variables with the variables criterium BJ highest statistical signification had variable agility on the ground backward.

Picture 1. *Changes the body positions in the important bunny jump phases (1-5)*



Methods

Sample of the examines

The sample consisted of female (n=30) and male students (n=37) 3 years for the Faculty of PE and Sport University of Tuzla, which are regularly attended classes in the Artistic Gymnastics twice a week by 60 minutes.

Sample of the variables

Anthropometry and body composition Height and body mass were measured before all tests physical fitness abilities. Body height was measured using Martin's anthropometer with precision of 0.1 cm. Harpenden skinfold caliper are used in the measurement of skinfold thickness and the estimation of total body fat. body type (standard), weight (kg), body mass index (kg/m^2), basal metabolic rate (kJ), basal metabolic rate (kcal), impedance (Ω), Fat%, fat mass (kg), fat free mass (kg) total body water (kg), was measured using a Tanita TBF-300A Pro Body Composition analyzers scales with precision of 0.1 kg. The components of the body composition were estimated based on the reactance and resistance measured by bioelectrical impedance. Students and students were barefooted during measurements.

Physical fitness tests Physical fitness was measured using the EUROFIT test battery. This battery consists of several tests which measure the basic motor capacity of the subjects. All tests were performed in the under standardized conditions. To measure the characteristics of drop jumps (DJ) we used the laser system Optojump length of 2 m. Optojump has high values of reliability, time series are measured in 1/1000 s. Optojump we measure the following variables: total time (mm:ss), specific energy (J/Kg) total energy (J), specific power (W/Kg), time of contact (s), time of flight (s), height (cm), power (W/Kg), frequency (stride/s), number of jumps (freq.).

Data analyzes methods

For measuring bunny jumps distance (cm) and speed passage at 3, 6, 9 m we used Brower Timing Systems - Wireless Sprint System. Times accurate to 1/100th of a second. Measured variables of BJ were: time of hand support time (s), legs support time (s), total time flight phase (s). All jumps was recorded with two SVHS cameras and in frquency of 60 frame per second. The cameras were positioned so as to capture all important phases. Data book was made in several parts: transfer of video records of movement quantitaive data, edit that made data into Excell 2007. Data obtained in this study were analyzed using a software system for multivariate and univariate data analysis SPSS 17.0 (Statistical Package for the Social Sciences) data processing was performed at the Faculty of PE and Sport of Tuzla, University of Tuzla. We used standard statistical procedures to determine the following basic parameters descriptive variables. Applying the analysis of the intercorrelation matrix of variables (Correlations) determined the contents and value of the matrix of correlation coefficients. We use Kolmogorov-Smirnov test to determine the normality of distribution of the results for further multivariate analysis. By regression analysis we try to determine whether the BJ is dependent on some drop jumps and what are the types of those jumps.

Results and Discusion

In (Tables 1-4) of the final value of anthropometry, body composition and physical fitness tests, BJ with mean values, SD, minimum and maximum results and the percentage difference between male and female students, Kolgmogorov – Smirnov test normality of distribution of the results. Mutual comparative results in the mentioned tables can find that the reason for the lower score because of female motor abilities and morphologic characteristics all values are usually lower Čuk & Bučar (2000). Drop jump is of high importance in order to achieve sporting performance in both team and individual sports. In (Table 2), in all the jumps men reached higher values than female students. The biggest difference is in the drop jump 80 cm and the percentage of that is 25% in favor of the students, while the smallest difference is the drop jump 20 cm and the percentage is 9% higher value for the benefit of students. In (Table 3), students compared to female students had a greater jump distance of 37 cm, the smaller number of jumps to 9 m, the shorter the time spent during the phase of the rearward leg and arms and for 0.047 s longer resided in the flight phase.

Table 1. *Descriptive statistics Anthropometry, Body composition and Physical fitness tests*

Variables	Female (n=30)				Male (n=37)			
	Mean	SD	Min	Max	Mean	SD	Min	Max
Body type (Standard & Athlete)	Standard				Standard			
Height (mm)	1640	60.827	1600	1710	1817.567	61.617	1720	1980
Weight (kg)	61.033	6.153	55	67,3	80.359	9.117	69.1	113
Age (Year)	22	0.733	20	24	21.81	0.844	21	24
Body mass index (kg/m^2)	22.666	1.04	21,5	23,5	24.329	2.484	20	32
Basal metabolic rate (kJ)	6050.666	291.376	5777	6357	8105.108	587.104	7305	10142
Basal metabolic rate (kcal)	1446	69.346	1381	1519	1937.189	140.278	1746	2424
Impedance (Ω)	531.666	47.437	477	562	485.702	50.798	372	598
Fat %	25.1	4.479	21,8	30.2	16.194	3.915	8.9	25
Fat mass (kg)	15.5	4.3	12	20.3	13.259	4.474	6.5	28,3
Fat free mass (kg)	45.533	2.203	43	47	67.1	5.739	57	84.7
Total body water (kg)	33.333	1.594	31.5	34.4	49.124	4.2	41.7	62
Skinfold - triceps (mm)	17	4	13	21	8.837	4.079	4	22
Skinfold - biceps (mm)	14	7.549	7	22	6.378	2.67	3	17
Skinfold - subskapular (mm)	17.666	5.131	12	22	16.459	8.674	8	54
Skinfold - abdominal (mm)	27.333	3,785	23	30	19.702	9.231	7	40
Skinfold - quadriceps f. (mm)	29	6	23	35	22.243	8.712	7	47
Skinfold - triceps (mm)	19.666	4.509	15	24	12	7.568	4	42
Plate tapping in 20 s (freq.)	43.333	4.163	40	48	47.729	4.432	39	57
Leg tapping in 15 s (freq.)	23.333	1.527	22	25	22.918	1.861	19	28
Test sit and reach (cm)	31.666	8.504	23	40	32.567	6.99	12	47
Flamingo balance test (freq.)	9.333	1.154	8	10	9.864	4.54	3	22
Shoulder flexibility (cm)	99.666	13.012	87	113	86.27	10.918	62	110
Sit-ups in 60 sec.(freq.)	35.666	8.962	30	46	33.324	8.086	15	48
Lifting a torso from l. p. max rep. (freq.)	25.333	11.718	12	34	25.081	7.342	14	47
Agility on the ground – bac. (s)	12.91	1.77	11.26	14.78	10.201	1.784	6.71	14.12
Standing jump - Sargent vertical jump (cm)	34	4.582	29	38	50.567	6.304	34	62
Standing broad jump (cm)	168	7.211	160	174	211.108	24.179	177	272
Bent arm hang (s)	10.07	5.837	6.65	16.81	33.996	15.092	8.89	67.24
Medicine ball throwing (3 kg) (cm)	340	10	330	350	566.945	61.726	430	710

Table 2. *Descriptive statistics dropa jumps from 20, 40, 60, 80, 100 cm*

Variables	Female (n=30)				Male (n=37)				F-M
	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean %
Drop jump 100 cm	1				1				
Total time (mm:ss)	0.357	0.018	0.337	0.373	0.459	0.6	0.356	0.557	-22.222
Specific energy (J/Kg)	1.54	0.158	1.365	1.672	2.582	0.658	1.523	3.729	-40.356
Total energy (J)	94.588	18.568	75.086	112.055	206.697	52.853	109.661	294.629	-54.238
Drop jump 80 cm	1				1				
Total time (mm:ss)	0.351	0.019	0.338	0.374	0.469	0.06	0.265	0.559	-25.159
Specific energy (J/Kg)	1.489	0.167	1.373	1.681	2.693	0.649	0.844	3.756	-44.708
Total energy (J)	91.404	18.646	77.784	112.656	214.474	49.646	71.754	315.477	57.382
Drop jump 60 cm	1				1				
Total time (mm:ss)	0.378	0.028	0.349	0.405	0.477	0.054	0.361	0.569	-20.754
Specific energy (J/Kg)	1.724	0.254	1.464	1.972	2.775	0.614	1.567	3,892	-37.873
Total energy (J)	106.173	25.789	80.529	132.106	221.384	47.897	133.159	342.924	-52.041
Drop jump 40 cm	1				1				
Total time (mm:ss)	0.378	0.009	0.367	0.386	0.471	0.054	0.336	0.57	-19.745
Specific energy (J/Kg)	1.718	0.089	1.619	1.791	2.705	0.605	1.357	3.906	-36.488
Total energy (J)	104.728	10.552	98.509	116.913	215.718	48.004	124.427	344.143	-51.451
Drop jump 20 cm	1				1				
Total time (mm:ss)	0.418	0.04	0.392	0.465	0.463	0.051	0.344	0.557	-9.719
Specific energy (J/Kg)	2.116	0.418	1.847	2.599	2.61	0.578	1.423	3.729	-18.927
Total energy (J)	130.518	37.992	104.729	174.148	208.442	46.247	122.193	329.654	-37.384

Table 3. *Descriptive statistics of bunny jumps*

Variables	Female (n=30)				Male (n=37)				F-M
	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean %
Bunny jump (distance - cm)	104.333	3.511	101	108	141.432	25.182	92	206	-26.231
Bunny jumps - 9m (freq.)	6.333	1.154	5	7	4.945	0.704	4	7	28.068
Bunny jumps - 3m (s)	0.896	0.092	0.82	1	0.788	0.235	0.59	1.9	13.705
Bunny jumps - 6m (s)	2.573	0.136	2.45	2.72	2.024	0.402	1.42	3.8	27.124
Bunny jumps - 9m (s)	3.91	0.174	3.79	4.11	3.18	0.555	2.45	5.42	22.955
Bunny jumps - hand support time (s)	0.36	0.08	0.28	0.44	0.302	0.054	0.24	0.48	19.205
Bunny jumps - legs support time (s)	0.453	0.1	0.36	0.56	0.365	0.098	0.24	0.6	24.109
Bunny jumps - total time flight phase (s)	0.066	0.046	0.04	0.12	0.113	0.094	0.04	0.4	-41.592

Table 4. *Kolmogorov-Smirnov Test*

N=37		DJ100	DJ80	DJ60	DJ40	DJ20	BJD
Normal Parameters[a]	Mean	.459	.469	.477	.471	.463	141.432
	Std. Deviation	.060	.060	.054	.054	.051	25.182
Most Extreme Differences	Absolute	.092	.093	.091	.130	.102	.120
	Positive	.083	.071	.058	.091	.102	.120
	Negative	-.092	-.093	-.091	-.130	-.086	-.072
Kolmogorov-Smirnov Z		.557	.567	.551	.791	.619	.731
Asymp. Sig. (2-tailed)		.916	.905	.922	.558	.838	.659

a. Test distribution is Normal; n=37 male students.
Legend: BJDIS-bunny jump distance, DJ-drop jump.

Table 5. *Pearson's matrix of intercorrelation drop jumps and bunny jump*

Variables	BJDIS	DJ100	DJ80	DJ60	DJ40	DJ20
Bunny Jumps (cm)	1.000	.499	.354	.389	.538	.388
Drop Jump 20 cm		1.000	.719	.776	.750	.715
Drop Jump 40 cm			1.000	.920	.792	.797
Drop Jump 60 cm				1.000	.837	.833
Drop Jump 80 cm					1.000	.790
Drop Jump 100 cm						1.000

Correlation is significant for all at level p <0.01; n=37 male students.
Legend: BJDIS-bunny jump distance, DJ-drop jump.

Table 6. *The regressive analysis of the criteria variable bunny jump*

					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.590[a]	.348	.243	21.910	.348	3.310	5	31	.016

a. Predictors: (Constant), DJ-drop jumps from 20, 40, 60, 80, 100 cm.

Reviewing the results (Table 4) of the Kolmogorov-Smirnovog test normality of distribution, it is shown in all variables that distribution of the results does not deviate from the normal distribution of results, which brought to fulfillment of the conditions for further multivariate analysis.

Having inspected and analyzed Pearson's matrix of intercorrelation which is applied on measuring of BJ and DJ (Table 5), it can be observed that the matrix includes coefficients of correlation which have statistically high values on the statistically significant level of ($p<0.01$). High values can be observed in all inter-correlations of the results. Criterion varaible bunny jump achieved a statistically significant relationship with five variables: drop jump (DJ) from 40 cm (r: 0.538, $p<0.01$), DJ from 100 cm (r: 0.499, $p<0.01$), DJ from 60 cm (r: 0.398, $p<0.01$), DJ 20 cm from (r: 0.388, $p<0.01$), and DJ from 80 cm (r: 0.354, $p<0.01$). The bigest correlation is expressed in the drop jump from 40 cm.

Table 7. *Univalent analysis of the variance (ANOVA)*

	Model	Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7946.259	5	1589.252	3.310	.016[a]
	Residual	14882.822	31	480.091		
	Total	22829.081	36			

a. Predictors: (Constant), DJ-drop jumps from 20, 40, 60, 80, 100 cm.
b. Dependent Variable: BJ-bunny jump – distance (cm).

Regression analysis of the criterion variable bunny jump (BJ) manifest in the area of selected variables (Table 6), does not provide enough information about the effects of the appropriateness of the variables on the success of the performance jump. Common of variance is 59% with the criterion is explained (R Sguare) with the predictor system of variables, while the correlation of the entire system, the predictor variables with the criterion, the coefficient of multiple correlation amounts to 0.34 (RO).

Table 8. *The impact of individual variables on the criteria variable bunny jump*

Model		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B	
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
1	(Constant)	28.933	35.063		.825	.416	-42.578	100.444
	Drop jump 20 cm	146.505	101.465	.350	1.444	.159	-60.434	353.445
	Drop jump 40 cm	-49.740	155.028	-.120	-,.21	.750	-36.921	266.441
	Drop jump 60 cm	-115.088	207.540	-.248	-.555	.583	-538.368	308.192
	Drop jump 80 cm	282.267	132.867	.611	2.124	.042	11.284	553.250
	Drop jump 100 cm	-20.613	136.200	-.042	-.151	.881	-298.395	257.168

Dependent Variable: BJ-bunny jump – distance (cm).

After the insight into the applied univalent analysis of the variance on the sample of (n=37) male students examinees in (Table 7), (ANOVA), we ascertained that the value of the univalent test (F-test; 3.310) so that the contribution of the applied variables is of great significance. However, some important differences between the items were noticed, namely the arithmetic mean and variability. Also, there are significance relations on the statistically important level of the treated variable, (Sig.; .016)

Analyzing the impact of individual variables (Table 8), one can see that the only statistically significant effect on the criterion variable is a variable: DJ from 80 cm which is significant at the level of (Beta: 0.611, sig.<0.05). Significant prediction is just within this variable and this means that the increase in the length of the jump phase of flight time is best defined with this variable. It can be established that it would be best to develop the drop jumps during the training phase of the eccentric reflection of bunny jump forward. From the analysis of the results, no explanation for the phase of flight is found, how long does the motors on the legs last, the angular values during the phase of flight, body weight and height, swing arms in the direction towards engaging to hands in front and these parameters are not included in 66% variance. In future work, it would be required to also take other biomechanical parameters which detremine successful performance. Some authors have conducted similar studies relating to horizonatlne and vertical jumps. Marković (2007) in his research provides training plyometric drop jumps with a statistically significant and practically relevant improvement in vertical jump height with the mean effect ranging from 4.7% (SJ and DJ), over 7.5% (CMJ-fa) to 8.7% (CMJ) a statistically significant and practically relevant improvement in vertical jump height with the mean effect ranging from 4.7% (SJ and DJ), over 7.5% (CMJ-fa) to 8.7% (CMJ). Kyselovičová & Zemková (2010) study of 5 junior gymnasts compares power in the active phase of take off and height of the jump in maximal and during a modified aerobic gymnastics routine. Results showed that subject achieved the highest value in maximal jump (MJ) test, but in combination of high impact aerobics and aerobic jumps (AG II) the examined subjects were able to perform maximal power during the test with only slight decrease about 2%. A group authors Kollias, Panoutsakopoulos, & Papaiakovou (2004) have studied 6 different sports performed DJ from 60 cm on a force plate. Results revealed that volleyball players jumped higher ($p<0.001$) than other athletes because of the fact that they conduct more drop jumps on their practice. However, track and field athletes produced higher peak force and higher power output using a shorter upward phase ($p<0.001$).

Conclusion

Based on the findings of the present study, the following conclusions are drawn. The aim of this study was to investigate the relationship and effect between mechanical output in maxmium vertical and horizontal jumping students 3 year of Faculty of PE and Sport, University of Tuzla. In all drop jumps male students reached higher values than female students. The biggest difference is in the drop jump 80 cm and the percentage of that is 25% in favor of the students, while the smallest difference is the drop jump 20 cm and the percentage is 9% higher value for the benefit of students. Criterion varaible bunny jump achieved the bigest statistically significant relationship with drop jump from 40 cm (r: 0.538, $p<0.01$). The low value of (R Square; 0.34) indicates that the strength of the legs is one of the most important parts of the jump. Strong movement in the direction of movement of the hands forward as part of the kinetic chain certainly is as important in the design and length of the jumps which would be analyzed in future work. Also, the angle of the knee joint and body posture are important in the performance of the bunny jump, but in this work are analyzed and we propose to take into next consideration.

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Quantitative differences of different impact on the development of basic motor status of children before puberty age

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Original scientific paper

Abstract

The main objective of this study was to determine the level of quantitative changes brought by the influence of different training of integrated nature. The programs were introduced in the educational process and thy integrate the training of dynamic and static muscular endurance program with elementary stylized movement structures in Latin American and standard dances. Sample of subjects consists 32 students before puberty age 12 years old. Randomly divided into two subsamples, the 16 subjects who were treated in two differently structured programs. The experimental training of program lasted 6 weeks.

The first experimental group practiced the program consisted of Latin American dances (Samba, Cha - cha - cha and jive) and dynamic exercises to develop muscularendurance.

The second experimental group practiced the program consisted of the standarddances (English Waltz, Tango, Quickstep) and standardized exercise design. Monitoring changes was determined by testing the initial and final measurements. The results of discriminant analysis of initial and final measurements lead to the realization that both programs produced different quantitative effects in the variablesthat determine the basic motoric profile of boys and girls aged 12 years old.

Keywords: **integrated training, dynamic and static muscular endurance, body shaping exercises, Latin American dances, standard dances, children**

Introduction

"Dance can be defined as a form of musical experience through the rhythmicmovements of certain developments and contributes to the artistic expression of the spiritual state of man. In dance man expresses his body in motion and the motion which spatially, temporal and dynamic forms " (Kostić, 2001).

It is proven that the successful performance of dance structures of all the essential motor skills to some degree (Bilić, 2005; Jocic, 1991; Kostic, 1994; Uzunović, 2004; Srhoj, Katic & Kaliterna, 2006; Hmjelovjec,I., Hmjelovjec,D., Redžic,200). Demonstrated a significant effect of cognitive abilities and musical abilities to performthe dance structure and conative characteristics (Bonacin, 2004; Jocic, 1991; Kostic 1994, Kostic, Jocic & Uzunović, 1999). Also, the results of these studies indicate that certain skills and characteristics significantly affect the performance of dance structures (Blašković, 1979), as well as the success of the competitions in sport dance (Kostic, Zagorec, & Uzunović, 2004; Uzunović & Kostic, 2005). It is undisputed that the specific way to train certain dance disciplines can contribute tosuccess in dancing, and the fact that it is necessary to develop motor skills in order toachieve the success of the dance.

This information confirms research in the field of dance training of (Kostic, 1997; Volgar, Kovaĉ and Deţman, 2002; Šebić,2008). Following the trends on the one hand when it comes to access multidiscilinarni Research deficit problem and the results of the effects of residency training in character the author addressed the problem of this kind of research. This research is certainly connected to the unexplored area transformational effects ofthe various integrated programs (motor exercises + stylized movements) for the development basic motor performance in younger age categories of children.In line with with these issues in this paper will test the hypothesis that was set to examine the effects of two different programs in a quantitative form. The expectations of the authors of this research are leaning on earlier findings from space efkata transformationon the one hand and studying the impact of dance structures on the other hand (Zagorc and Jarc-Šifrar,2000). Zagorc and Jarc-Šifrar,2003).The emphasis has been placed in the assumptions is certainly the first program thatintegrates exercise for the development of dynamic and static muscular endurance withthe potential elements of Latin American relation to another program. According to former debate is clearly visible Hypothesis: exercise program thatintegrates the repetitive nature and stylized movement structures of Latin Americandances will cause much great-

er quantitative change in basic motor profile of the respondents. Since the programs are integrated nature where a good percentage are occupied byexercise stylized movement structures Latino-American and standard dance made a small section of the introductory notes understand the difference between these dances. For example, to perform the standard dances are typical steady movements,which have to be fused, liquefied, which is one of the characteristics of cold-blooded English temperament. The basis of the standard dances is a dynamic movement. In these dances there is no pronounced hip movements. Basic features of the standard dances: swing, dynamicsand ease, form and beauty. The most attention in the standard dances are addressedto: the position of the foot (feet positions), the dance direction (alignment), the amount of turn (amount of turn), lifting and lowering (rise and fall) and against the bodily movement (contra body movement). Developments must have a line, form and aestheticexpression.

While on the other hand, in contrast to the standard Latin American dances, dances from the competition program are by nature wild, fast and temperamental. The characterand temperament of Latin American dances fit the specifics of the people who createdthem. Dynamic and "alive" rhythms provide a wide range of dance expression which the English dance teachers formed in exactly prescribed movements and movements to the rhythm of a particular time, place and thus laid the foundations for today applicabletechniques. Technique of Latin American dances includes 23 basic positions from which begins andends with dancing figures. For all the Latin dances is characterized by movement in thepelvic area, a greater amplitude of movement to the position of the foot where the toesturn "box" or van.

Methods

This research was conducted on a sample of 32 students, and then the sample was divided randomly into two equal groups of 16 students aged 12 years. For the purposes of this study used the following tests of basic motor skills profile:

1. For assessment of the level coordination skills were used:
- Steps to the side (MKOKUS)
- Polygon backward (MKOPLN)
- Bend, body twist, touch (MKOPZD)
- Coordination with bat (MKOPL)

2. For assessment of the potential of muscular endurance:
- Push-ups (MRSSKL)
- Righting the body and back (MRSIST)
- Raising the tbody (MRSPTL)
- The deep squat (MRSDC)

3. For assessment of the level of balance and functional joint stability, the following varjable was used:
- Standing on one leg transversely on the bench with eyes closed (MRRAV) Standing on the bench for balance crosswise into two legs with eyes open (MRS2PN)
- Flaningo-test (MRKFL)

4. Variables for assessment of stylized movement structures (Selected Dances)
- Samba
- Cha – cha – cha
- Jive
- English Waltz
- Tango
- Quickstep

The measurement was carried out in terms that are predetermined for the test in the morning, under the optimal temperature, but that is always carried out with the same timekeepers. Subjects were for research purposes divided into 3 groups of 70-10 students for effective testing. The sequence of measurements in conducting moror tasksis organized in a way that was almost eliminated the influence of fatigue arising aftersevere physical tests on the results of other tests. Timekeepers werw previously familiar with the technique of performing the tests and themanner of recording the results using a oneday training. For tracking results are especially designed measurement list containing personal data of subjects. The study lasted six weeks. Three weeks have been reserved for the initial, control and final test.

The period in which is tested the transformation of muscle endurance training programlasted six weeks. Was applied to an experimental group.

The program has met the principle of progressive increase of the load and he's met through the increased volume of work. Differences in size of the volume of work was realized through differences in the first three in relation to the other three weeks (see Table 1).

Table 1. Basic parameters of six week training program the first experimental group

Basic parameters of the program	**1-3 weeks**	**4-6 weeks**
weekly frequency of training	3	4
Training volume	45 min	45 min
Number of exercises	3	4
Number of series	2-3	4-5
Number of repetitions	12-16	16-20
Retention time of contraction	10-12 sec	12-14sec
break between the series	45-60 sec	30-45 sec

Selection of content / exercise program is conducted with the principle of reciprocity and symmetry representation of exercises for all muscle regions. More specifically, the following exercises were selected for the development of dynamic muscular endurance: back squat, push-ups, abs and exercis for back, and for the development of static endurance were used strongholds such as: motors on the elbows, the back of theshoulder, and right and left side motors in the elbows.

Table 2. Structure of training (class) compared to the weekly frequency

Structure of training	1-3 Weeks	4-6 Weeks
Introductory-preparatory part	Warming up (cardio)-5min Preparatory exercises: Exercises for development of static muscular endurance (Table 2) 10 min	Warming up (cardio)-5min Preparatory exercises: Exercises for development of static muscular endurance (Table 2) and (Tabel 1-4-6 weeks) 10 min
Main part	Dances (Tabel 4)	Part A: Dances Part B: Exercises for development of dynamic endurance character (Table 2) and (Table 1-4-6 weeks) -15 min
Final part	Exercises to develop strength of dynamic-character (Table 2) 10 min Relaxation exercises 3 min	stretching exercises (static)

The structure of training (Table 2) is different from one hand the load and volume of work, and the other by the distribution of exercise for developing muscular endurance of the dynamic and static characters within parts of the training, specifically within the ntroductory-preparatory, main and final part of an hour. The clearest difference is seen in the last three weeks where the distribution of fitness exercises is incorporated in main part of the class and it takes time a lot of space in apart of the set. By all parameters, the program is significantly different between control and experimental groups (see Tables 3 and 4)

Table 3. Elements of an integrated program of Latin American dances in the first experimental group

SAMBA	CHA-CHA-CHA	JIVE
Samba Whisks L and R	Chasse to L,Chasse to R	Basic in place
Samba walk(side)	Fan	Basic in fallaway
Stacionary samba walk	Hand to hand	American spin
Traveling Botafogo	Hockey stick	Change to hands behind back
Volta actions	Spot turn to L,spot turn to R	Change of place LtoR ,Change of place RtoL

Table 4. Fundamental parameters of six week training program other experimentalgroup

The main parameters of the program	1-3 weeks	4-6 weeks
Weekly frequency of training	3	4
Training volume	45 min	45min

Table 5. Structure of training (class) compared to the weekly frequency

Structure of training	1-3 Weeks	4-6 Weeks
Introductory-preparatory part	Warming up (cardio)-5min Preparatory exercises: shaping exercise, static character. 7-8 exercises, 10-12 min	Warming up (cardio)-5min Preparatory exercises: shaping exercise, static character. 7-8 exercises, 10-12 min
Main part	Dances (Tabel7)-20 min	Dances (Tabel7)-20 min
Main part	stretching exercises-5min (static)	stretching exercises-5min (static)

Table 6. Elements of an integrated program of standard dances with other eksperimentane grup

ENGLISH VALCER	TANGO	QUICKSTEP
Chase from promenade pisition	Close promenade	Foward lock step
Natural turn	Open promenade	Natural spin turn
Natural spin turn	Progresiv link	Natural pivot turn
Reverse turn	Progressive side step	Progressiv chase
Whisk	Progressive side step reverse turn	Quarter turn to right

In this study the results obtained were analyzed in univariate level. More specifically, to test the hypothesis of normal distribution after analyzing the differences in the variables (effects of) between two time points (initial - final), was applied discriminant analysis (under the model differences). By applying discriminant analysis to determine more clearly the quantitative changes in the multivariate level.

Results

For interpretation of the results were used significant variables discriminate those explain particular percentage of variability. In order to interpret the differences, it is necessary to define any significant discriminant variable. The criterion for discriminant strength of the variables used was called. Wilks Lambda. variable, that is. given the structure of discriminant variables (functions). The obtained results of this paper are:

c) results of the discriminatory function of the first experimental group and separate for boys and girls
d) results of discriminant function in control groups and to separate for boys and girls

First experimental group - Boys

Table 7. Eigenvalues

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	38,321	100,0	100,0	,987

Table 8. Wilks's Lambda

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1	,025	31,210	11	,001

Table 9. Discriminative function structure matrix

	Function
	1
mkopl	-,373
mkopzd	,341
mrs2pn	,329
mrrav	,290
mkopln	-,267
mkokus	-,259
mrkfl	-,203
mrsskl	,081
mrsdc	,069
mrsptl	,065
mrsist	,062

Table 10. Functions at Group Centroids

Group	Function
	1
1	-5,791
2	5,791

Tables 7.8, 9 and 10: The basic parameters of the discriminant function and its structure between initial and final measurements of motor variables

In the 7 and 8 tables we can see that there is an isolated canonical function, Static significant. In the entire system in the variables between the initial and final testing of the experimental group of subjects, clearly shows that there is a statistically significant difference Sig .=. 001, which indicates that the integrated training program affected the changing levels of coordination, balance and repetitive potential. Isolated discriminant-function was significant and high, and is explained with 98% of the total variability. The discriminative power .31 indicates a difference of results between two tests. This concluded that there was a quantitative difference between the initial and final testing of the applied variables in the subjects of the first experimental group. The displayed values represent the arithmetic mean of the initial and finalmeasurements of variables that have contributed to significant changes in thecoordination with the bat (MKOPL) -.373, Bend, body twist, touch (MKOPZD) .341, Standing on two legs crosswise on a bench with your eyes open (MRS2PN) .329, Standing on one leg crosswise on a bench with eyes closed (MRRAV) .290, Polygon backward (MKOPLN) .- 267, steps to the side (MOKUS) -. 259, Flamingo test (Merkel) -. 203rd.

First experimental group - Girls

Table 11. Eigenvalues

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	43,292	100,0	100,0	,989

Table 12. Wilks's Lambda

Test of Function(s)	Wilks' Lambda	Chi-square	Df	Sig.
1	,023	32,222	11	,001

Table 13. Discriminative function structure matrix

	Function
	1
mkopl	,372
mkopzd	-,361
mrs2pn	-,271
mkokus	,240
mrrav	-,210
mrsdc	-,131
mkopln	,121
mrsskl	-,108
mrkfl	,107
mrsptl	-,098
mrsist	-,091

Table 14. Functions at Group Centroids

Group	Function
	1
1,000	6,155
2,000	-6,155

Tables 11.12 13 and 14 are basic parameters of the discriminant function and its structure between initial and final measurements of motor variables

From a canonical discriminant function we can see that in the entire system applied variables between the initial and final testing subjects of the experimental group, there was a statistically significant difference Sig .=. 001, which indicates that the integrated program influenced the changes levels of of coordination, balance and repetitive potential. High value of variability and coefficient quantitative difference between the two measurements clearly point to the statement that there was a quantitative change in the motor profile of subjects under the influence of an integrated training program. The variables that contributed to significant changes in the Polygon backward (MIKOPL), Bend, body twist, touch (MKOPZD), Standing on two legs crosswise on a bench with your eyes open (MRS2PN), Steps to the side (MKOKUS), standing on one leg crosswise on the bench with eyes closed (MRRAV).

The control group – Boys

Table 15. Eigenvalues

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	64,194	100,0	100,0	,992

Table 16. Wilks's Lambda

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1	,015	43,862	7	**,000**

Table 17. Discriminative function structure matrix

	Function
	1
Mrs2pn	,533
Mkopzd	,275
Mkokus	-,140
Mkopln	-,126
Mrrav	,096
Mrkfl	-,087
Mkopl	-,077

Table 18. Functions at Group Centroids

grupa	Function
	1
1,000	-7,495
2,000	7,495

Table 15, 16, 17 and 18 are Basic parameters obtained with the discriminant function and its structure between initial and final measurements of motor variables

The table above shows that the isolated one discriminative function was statistically significant. Very similar, as in the previously presented results of the first experimental group this isolated Discriminative function was significant and high, and is explained with 99%. Discriminative power (.43) indicates that the difference found between the two tests. With this we can rightfully concluded that there was a quantitative difference between the initial and final testing of the variables used in subjects other experimental groups. The variables that contributed the most significant quantifiable changes are Standing on two legs crosswise on a bench with your eyes open (MRS2PN) .533, and a variablebend, zasuk, touch (MKOPZD) .275.

The control group – Girls

Table 19. Eigenvalues

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	39,105	100,0	100,0	,987

Table 20. Wilks's Lambda

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1	,025	38,761	7	,000

Table 21. Discriminative function structure matrix

	Function
	1
Mrs2pn	,507
Mkopzd	,493
Mkopl	-,306
Mrrav	,300
Mkokus	-,189
Mkopln	-,165
Mrkfl	-,095

Table 22. Functions at Group Centroids

grupa	Function
	1
1,000	-5,850
2,000	5,850

Table 19,20,21and 22 are Basic parameters of the discriminant function and its structure between initial and final measurements of motor variables

The presented results ar explaining a canonical function which shows that the entire system in the variables between the initial and final testing subjects second experimental groups, there is a statistically significant difference Sig .=. 000, This fact justifies the applied integral program that is obviously influenced on changes inthe level of coordination and balance. The variables that contributed the most to the explanation of isolated canonical functions are: Standing on two legs crosswise on a bench with your eyes open (MRS2PN) .507,(MKOPZD) .493, (MKOPL) -. 306, and standing on one leg crosswise on the bench with-eyes closed (MRRAV) .300.

Discussion

The results of discriminant analysis applied in order to verify set hypothesis that was supposed to establish clear differences between the two applied programs of integral nature programs, more precisely, a very small percentage confirms the hypothesis only with boys. That percentage in terms of basic motor profiles it can be defined only for variables that estimate the basic coordination and balance performance in subjects. The results obtained with this analysis justify the programs and exercises selected because they meet the main goal in improving the quality of motor output in childrenbefore the puberty. However, the deeper answers to this outcome in the results certainly hiding in a very vulnerable period of development of the child, in the age of 12 years. During this period, boys and girls are entering in the sensitive stages of growth, and between them there is no great imbalance in motor output, especially in the exercise of muscular force in the way of quality and longevity of performance . What is very interesting and dominant value is that this research is fully justified an integrated approach to designing the progam for the development of motor performance. This means specifically that the program to develop basic performance can be justified and often can be inserted in programs of stylized movements from a variety of dances. In this paper, these programs of were included in the movements selected from Latin American dances and sandard dances. The structure of movements through the dances obviously in one hand motility and psychological well works on anthropological development of children satusa of this age.

The basic conclusion of this discussion would certainly need to go in the direction of the open support of integrated programs and teaching activities which are combinations of specific basic and stylized movements. This research, methodology, shaping of the programs , selection and monitoring of the program is a fundamental proof of these allegations. Using a stylized dance movements-certainly opens up new directions in integral planning and programming of kinesiology Operators, especially in children befor epuberty period of growth and development of the organism.

Coordination and equilibrium capacities are certainly the foundation of the motor profile of younger ages. All received canonical fiction isolated and their structures the best way to support this discussion. The results contained in the structure matrix shows the determination of variables that ar explaining transformational effects of these integrated programs. In all groups ofvariables from the areas of coordination and balance ar explaining and justify the application of such a shaped programs.

Conclusion

The Goal of this study was to test the practical application programs two of integral nature, their impact and the difference of the impact on the transformation and motor profiles of children before the puberty. Whether and in what extent the goal met? The answers to this questions are multiple. Results indicate following facts:

- integrated programs have their foundation and it is more contained in motivating children of this ages to develop their basic motor output and the development of their stylized movement through dance
- integrated programs have a universal character of the application, regardless of gender of children
- An integrated programs develops team spirit of teachers in the sensitive stages of child growth and development of the organism.

This research has not guaranteed to give answers to all questions, but the set of assumptions, display of the programs, check the hypothesis, the evidence who did notconfirm the hypothesis, clearly with applicable results in practice, one can create new trendy issues of shapingquestions, program of integral character, checking the existing curriculum, training, testing andmotor profiles for each age class.

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The efficacy of classic and direct methodical practice partial differences analysis in alpine skiing learning

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Original scientific paper

Abstract
The problem of research in this scientific paper is based on determining which method of teaching the elements of alpine skiing, with students from 19 to 21 years of age, is more efficient on grounds of two different approaches to the methodology of ski beginners training.

The "classic approach" or the "traditional method" of learning how to ski presents the manner of skiing through particular phases. Such manner of training has a long-standing history and it proved as an efficient manner for bringing the skiing closer to beginners. A "direct approach" to the alpine ski training can refer to any training not including plough or V- position of ski technique.

Based on presented results of arithmetic means of sub-samples from the set of variables with grades of skiing techniques of the group that was taught alpine skiing using the „classic" method, and the set of variables referring to the grades of the group taught by "direct" method, based on the significance of differences tested under the T-test, significant partial differences can be identified for the given parameters contributing to set hypotheses on qualitative differences expressed through medium values of single assessed ski techniques. Research results have contributed to the thesis that a "direct" methodical approach is more efficient in alpine skiing teaching students than the „classic" methodical sequence in the ski training.

Keywords: **alpine skiing, direct approach**

Introduction

Skiing is one of the most useful activities for the man's health. Spending time on snow is a continuous movement. In addition to effects of the winter itself, the influence of winter activities on organism is especially highlighted. Cold, wind and other characteristics have a useful impact on organism and its resilience. Spending time at skiing resorts opens the possibility that one encounters various situations, when he/she must react quickly, think and cope with space and time and to protect oneself or to learn in motor manner (Nurković, N. 2003.).

The "classic approach" or the "traditional method" of learning how to ski presents the manner of skiing through different phases. Such manner of training has a long-standing history and it proved as efficient manner for bringing the skiing closer to beginners. From the first use of skies as a transport until today, there were different ways of using skies that are referred to as skiing techniques. Skiing techniques themselves are closely related to the equipment for alpine skiing whose changes enabled a continuous growth of new and improvement of the existing skiing techniques. One of skiing techniques that was present throughout the history of alpine skiing, from the very beginnings until today, is the plough skiing technique or the V-shape technique. That skiing technique is often used today in alpine skiing by beginners, who are only making a balanced position on skies (Matković, B. and others). In addition to skiing techniques and it is also used by touring skiers who are descending using skies outside arranged ski terrains, whereby they encounter obstacles such as rocks, plants or cracks in the snow and ice. Therefore, in order to have a safe descending from the mountain, they use elements of the plough technique of alpine skiing. Similar to that, plough or V-shape skiing technique is also used by Mountain Rescue Services who are descending the hill under load when transporting injured skiers. Plough position of skies enables a safe balanced position and the control of speed in which the front part of skies (tips) is put together and the back part (tails) is spread.

Such position of skies with a continuous and instant pressure of both knees forward and inside causes skies into position of edging which enables the skier a safe and controlled descending down the slope. Due to aforementioned characteristics, such skiing technique is traditionally applied during the beginning phases of ski teaching. The lack of plough skiing technique is the fact that a long-term position in the plough position for the skiers presents the pressure for ankles and muscles of lower body extremities. Moreover, using that skiing technique, it is not possible to dynamically overcome the ski trail, and after learning how to ski in such manner, beginners still have the remains of the plough position in parallel curves.

By going to a winter skiing resort outside the place of residence and by doing various physical activities in a group, it is unavoidable to meet new people, and thereby, to make mutual bonding which influences the sociological component. Great number of recreational skiers and the growing interest for the alpine skiing today had a definite impact on organization and manner of teaching. The life tempo and growing obligations of the present lifestyle led to a decreasing amount of free time, and as a consequence, there is a need for more efficient utilisation of each free day. Alpine skiing schools or their programmes had to adjust to such trend, which are today mostly organized for 6 or 7 days, within which beginners learn new and motor activities. Ski schools today mostly create their offer on the basis of seven-day students' winter trip, and skiing resorts themselves, offering various activities and programmes and the possibility of renting the equipment, mostly organize their offer to the period of seven days. Such lifestyle and the very offer affected changes in the present manner of ski training. A "direct" approach of alpine ski training can be considered any training which does not include plough or "V- position" skiing techniques.

The main aim of research in this scientific paper is based on determining which method of teaching the elements of alpine skiing with students from 19 to 21 years of age, is more efficient on the basis of two different approaches to the methodology of ski beginners training.

The research was based on the research of the following authors: Žvan, M., Agrež, E., Berčić, H., Dvoršak, M., Lešnik, B. and others. (1998), in the book "*Alpsko smučanje, staudijsko gradivo"* state that the lack of plough skiing technique is that a long-term position in a plough position represents difficulty for the skier for ankles and muscles of lower extremities. Moreover, using that skiing technique, it is not possible to dynamically ski down the hill.

Cigrovski, V. (2007) in his paper "*Effectiveness of different methods in the process of learning the skiing knowledge",* shows the research that was done on the sample of 126 beginners which indicate how a more efficient manner of teaching alpine skiing is the one which uses elements of plough technique of alpine skiing in its programme. Namely, after performed research with skiing beginners, it was determined how the programme of learning alpine skiing in which elements of the plough alpine skiing techniques are left out presents a deficiency and not advantage in the end. Different programmes of teaching alpine skiing should enable recreative skiers up to the level that they can use more advanced elements of the skiing technique, but in the beginning phases of learning, plough skiing technique elements are in the function of better improvement and it is not the phase that should be left out. Moreover, it is not necessary to force elements of plough alpine skiing technique, but ski trainers, after their students acquired the elements of aforementioned technique during their training, should continue with more advanced elements of the skiing school, that is, elements belonging to a parallel skiing technique.

Sekulić, D., Rausavljević, N. (2006), in their research "*Analysis of methodical procedure of specific visualisation in the ski training*" , state researches who studied the alpine skiing learning process from different aspects which were also organized on the principle of six-day or seven-day alpine ski learning process. Authors concluded that in the perspective of developing the school of alpine skiing, it is necessary to take good care on the client's desire for a more efficient alpine ski school and desire of the teacher to transfer as much knowledge on alpine skiing as possible in scheduled period.

Murovec, S. (2006), in his book "*Na kanto!:UPS-učenje s podaljševanjem smuči*", indicates one model of approaching the learning which during the process of teaching beginners, each several days, it demands the change of skies length on which beginners are being taught. In that manner, first steps on the snow are acquired on extremely short skies of 90 centimetres length, then the skiers take skies of 125 centimetres length, and at the end of the teaching process, they choose skies for their morphological characteristics or desires of skiers themselves. Such approach of teaching completely leaves out the elements of the plough or V-shape skiing technique.

Lešnik, B., Murovec, S., Gašperšić, B. (2002), in the book „*Opredelitev oblik drsenja in Smučanja*", state that the so-called V-shape skies position is often used today as a transfer phase between the elements of the plough and parallel skiing technique where the frontal part of skies is put significantly closer in relation to the plough position. By using the "V" skies position in the learning process, whether as a methodical exercise or as the element of the skiing technique, the preparation for making the turn completely using the parallel skiing techniques is done gradually.

Methods

Methods in research are based on quantification of learning process phenomena in alpine skiing. This scientific paper is based on determining which method of teaching the elements of alpine skiing is better, with students from 19 to 21 years of age a 55 of them in same academic year of study at the Faculty of Sport and Physical Education in Sarajevo.

Research variables used in this paper are: KLIND ("V" position skis turns, direct way of learning), OSZAVD (basic alpine skiing turn, direct way of learning), ZAKBRD (parallel turning in hill way, direct way of learning) , SIPAVD (parallel turnings in wide course, direct way of learning), KLINKL ("V" position skis turns, classic way of learning), OSZAVKL(basic alpine skiing turn, classic way of learning), ZAKBRKL(parallel turning in hill way, classic way of learning), SIPAVKL(parallel turnings in wide course, classic way of learning).

Data processing methods

In this paper, data processing method is on invariant level with basic statistical parameters obtained from created matrixes.

Descriptive statistics offers basic data on the phenomenon of valorised result in terms of grades describing the quality of performing alpine skiing techniques. Data in tables of basic statistical parameters are presented separately for the two groups of examinees, that is, their results. By comparing and controlling obtained parameters, previously set assumptions were explained with analysed differences in assessed segments.

T-test method shall provide data on statistical significance of partial differences based on assessed alpine skiing techniques.

Results and Discussion

After processing results and creating matrixes with data on assessed alpine skiing techniques, basic statistical parameters referring to studies phenomenon in the research were calculated.

Table 1. Descriptive statistical data

	val. N	Mean	Median	Sum	Minimum	Maximum	Std.Dev.	Standard Error	Skew.	Kurtosis
KLIND	55	6,37272	6,00000	350,500	5,500000	10,00000	0,77709	0,104783	2,377845	8,119726
OSZAVD	55	6,38181	6,00000	351,000	5,000000	10,00000	0,94752	0,127765	1,980118	3,916598
ZAKBRD	55	6,77272	6,50000	372,500	5,500000	10,00000	1,01296	0,136588	1,137987	1,188519
SIPAVD	55	7,10000	7,00000	390,500	5,500000	10,00000	0,89958	0,121300	0,777668	1,720879
KLINKL	55	6,66363	6,50000	366,500	5,500000	8,50000	0,70088	0,094508	0,682972	-0,349322
OSZAVK	55	6,65454	6,50000	366,000	6,000000	8,00000	0,71279	0,096114	0,780109	-0,637894
ZAKBRK	55	6,20909	6,00000	341,500	6,000000	8,00000	0,41601	0,056095	2,271521	5,645072
SIPAVKL	55	6,29090	6,00000	346,000	5,500000	8,00000	0,60622	0,081743	1,580762	1,396536

Table 1 provides data on the medium value of grades for the two groups of examinees with supporting parameters which include: Median, Sum, Min and Max, Stand. Deviation and errors, and Skew and Kurtosis of results distribution. Differences in medium values of variables referring to grades for the group which learned to ski according to "direct" method in relation to the group who learned to ski according to "classic" methodical procedures of alpine ski training, are visible, and their values go in favour of expectations in this paper.

Medium values of the results describing grades from technical elements show visible differences in the level of grades for the variables describing skiing elements where V-position techniques and ploughing are used. Variables KLIND and OSZAVD have less values than KLINKL and OSZAVKL variables, therefore, variables with grades of a direct approach of skiers' training where skiing elements of plough and V-position turnings were not applied, had weaker results for aforementioned techniques.

Medium values of results assessing skiing techniques with parallel set skies, such as the curve towards the hill (ZAKBRD) and broad parallel wriggling (SIPAVD), trained according to direct approach with medium grades 6.772 and 7.100, show even better results in relation to variables ZAKBRKL and SIPAVKL describing the grades for the group of students who learned to ski according to the classic manner of training for beginners. If it is taken into consideration that students were divided into relatively heterogeneous groups according to the level of alpine skiing knowledge, then given results go more in favour of the hypothesis which states: It is expected that skiers who used a "direct" methodical sequence highlighting the technique curve towards the hill and broad parallel wriggling, would adopt the target technique in faster and efficient manner and have better results when making parallel skiing techniques. When the total value of grades is summed up for the group that was trained according to direct approach, the sum of 1.465.50 is obtained and it is bigger in relation to the sum of grades for the group using the "classic" approach (1.420.00) and methodical procedures for training beginners with phases of ploughing or V-position curves or turnings. Such result goes in favour of the hypothesis claiming that it is expected that the group who did the training using "direct approach" achieves better results in the final testing than the group who did the training using the "classic approach".

The analysis of partial quantitative differences in the level of students' grades, T-test

In order to determine partial quantitative differences of medium value of grades achieved by the students from the group that was taught alpine skiing using the "classic" method and the group that was taught by "direct" method, the analysis of results using the T-test was applied.

Based on presented results of arithmetic means of sub-samples from the set of variables with grades of skiing techniques of the group that was taught alpine skiing using the "classic" method and the set of variables referring to grades of the group that was taught using "direct" method, based on the significance of differences (Sig) tested under the T-test, it can be determined that there are partial differences for the given parameters going in favour of set hypotheses on qualitative differences expressed through medium values of especially assessed skiing techniques. Values of the T-test were significant on the level (Sig $p=$ or < 0.05).

By examining Table 2 with results of analyses of partial quantified differences based on the T-test, it is noticeable that there are statistically significant differences of medium values of assessed techniques for two differently trained groups of students.

In relation to the variable KLINKL, variable KLIND has less value expressed in the difference of -0.2909 which goes in favour of the hypothesis which states: It is expected that skiers who used a "classic" methodical sequence, including the ploughing and basic curve, would have better results when using ploughing techniques in alpine skiing. Of course, V-shaped curve in its root has a plough position that was avoided in a direct manner of learning to ski from the reason that "remains" of ploughing are preferred to be avoided in target skiing techniques represented by parallel curves with different speed, rhythm and their radius.

Curve towards the hill was assessed also as one of important elements in training of beginners. Values of given techniques are expressed with variables ZAKBRD and ZAKBRKL. Since this is the case of parallel technique, medium values of grades are higher for the variable ZAKBRD and they amount 6.772 in relation to the lower value of variable ZAKBRKL with the value 6.209. Such result of the T-test indicates statistically significant difference with

the coefficient value p= 0.000. The following hypotheses can be concluded from the aforementioned: It is expected that skiers who used a "direct" methodical sequence highlighting the technique curve towards the hill and broad parallel wriggling, would adopt the target technique in faster and efficient manner and have better results when making parallel skiing techniques.

Relations between quantitative and partial differences, which are relevant for this paper, were extracted from Table 2 in medium values of variable SIPAVD (broad parallel wriggling trained by "direct" approach) and SIPAVKL (broad parallel wriggling trained by "classic" approach). There is a significant difference in the value of aforementioned medium grades with the value of 0.809 and coefficient of p= 0.000. Such big difference that goes in favour of the grade expressed by variable SIPAVD confirms assumptions of the general hypothesis presuming that it is expected that the group who did the training using "direct" approach would have better results on the final testing than the group who did the training using "classic" approach, or hypothesis which states: It is expected that skiers who used the "classic" methodical sequence including the ploughing and basic curve will have worse final results when performing parallel ski turning techniques.

Table 2. *T-test for Dependent Samples*

	Mean	Std.Dv.	N	Diff.	Std.Dv. - Diff.	t	df	p
KLIND	6,372727	0,777092						
KLINKL	6,663636	0,700889	55	-0,290909	1,061493	-2,03246	54	0,047038
KLIND	6,372727	0,777092						
OSZAVKL	6,654545	0,712798	55	-0,281818	1,096136	-1,90671	54	0,061884
KLIND	6,372727	0,777092						
ZAKBRKL	6,209091	0,416010	55	0,163636	0,908063	1,33643	54	0,187014
KLIND	6,372727	0,777092						
SIPAVKL	6,290909	0,606225	55	0,081818	1,017275	0,59648	54	0,553350
OSZAVD	6,381818	0,947529						
KLINKL	6,663636	0,700889	55	-0,281818	1,246341	-1,67692	54	0,099338
OSZAVD	6,381818	0,947529						
OSZAVKL	6,654545	0,712798	55	-0,272727	1,165945	-1,73473	54	0,088494
OSZAVD	6,381818	0,947529						
ZAKBRKL	6,209091	0,416010	55	0,172727	1,110631	1,15338	54	0,253834
OSZAVD	6,381818	0,947529						
SIPAVKL	6,290909	0,606225	55	0,090909	1,142977	0,58986	54	0,557743
ZAKBRD	6,772727	1,012963						
KLINKL	6,663636	0,700889	55	0,109091	1,311244	0,61700	54	0,539826
ZAKBRD	6,772727	1,012963						
OSZAVKL	6,654545	0,712798	55	0,118182	1,228382	0,71351	54	0,478604
ZAKBRD	6,772727	1,012963						
ZAKBRKL	6,209091	0,416010	55	0,563636	1,130612	3,69715	54	0,000511
ZAKBRD	6,772727	1,012963						
SIPAVKL	6,290909	0,606225	55	0,481818	1,197852	2,98306	54	0,004277
SIPAVD	7,100000	0,899588						
KLINKL	6,663636	0,700889	55	0,436364	1,190450	2,71843	54	0,008800
SIPAVD	7,100000	0,899588						
OSZAVKL	6,654545	0,712798	55	0,445455	1,165367	2,83480	54	0,006439
SIPAVD	7,100000	0,899588						
ZAKBRKL	6,209091	0,416010	55	0,890909	1,034994	6,38377	54	0,000000
SIPAVD	7,100000	0,899588						
SIPAVKL	6,290909	0,606225	55	0,809091	1,132397	5,29883	54	0,000002

Analysis of partial quantitative differences ***(T-test)***

In general, top competitors or technical innovative individuals, wanting to have a more efficient manner of skiing, anticipated changes in the history of alpine skiing. In case of technique on "structured" skies with decreased lateral radius, there were changes in terms of innovation in the skies development and production. No individual or competitor but the professional expert team has dominantly changed the «skiing environment»! (Žvan,M. and others 1998) It was necessary to find the new, efficient and functional manner of skiing or the new technique. Ever since then up to the present, there were attempts in finding an efficient, quality technique acceptable for the skier, as well as method of ski training.

The responsibility of ski instructors was never significant and sensitive in such manner before. Good knowledge of the technique and method of skiing by present ski instructors demands a sensitive and responsible application in the education process. It is highly important to know and to feel where the student's position in terms of skiing knowledge, what is his/her knowledge, what he/she does not know and how he/she can use it further.

The basic idea of research in this paper is based on determining which method of teaching the elements of alpine skiing with students of the second year of the Faculty of Sport is more efficient on the basis of two different approaches to the methodology of training ski beginners.

Conclusion

Based on obtained results, the relevant conclusions were also obtained contributing to set hypotheses in this sci. paper.

Differences in medium values of variables indicating the grades for the group who learned how to ski using "direct" method in relation to the group who learned how to ski using "classic" methodical procedures of alpine skiing training, are visible, and its values also go in favour of set hypothetic assumptions.

When the total value of grades is summed up for the group that was taught using the direct approach, we get the sum of 1,465.50 which is higher than the sum of grades for the group that used the "classic" approach (1.420.00) and methodical procedures of ski training of beginners with phases of ploughing or V-position of skies curves, the result goes in favour of the hypothesis claiming that it is expected that the group who did the training using "direct approach" achieves much better results on the final testing than the group who did the training using "classic approach".

Relations of quantitative, partial differences that are relevant in this paper with medium values of variables SIPAVD (broad, parallel wriggling trained with "direct" approach) and SIPAVKL (broad, parallel wriggling trained with "classic" approach) indicate a significant difference of aforementioned medium grades with value of 0,809 and coefficient p= 0.000. Such important difference in favour of assessment expressed with the variable SIPAVD confirms hypothetic assumptions which presupposes that it is expected that the group who did the training using "direct" approach achieves better results on the final testing than the group who did the training using "classic" approach or the hypothesis which reads: It is expected that skiers who used the "classic" methodical sequence including the ploughing and basic curve will have worse final results when making parallel skiing turn techniques.

Medium values of results who assess ski techniques with parallel set skies, such as curve towards the hill (ZAKBRD) and broad parallel wriggling (SIPAVD), trained according to direct approach with medium grades 6.772 and 7.100, show better results in relation to variables ZAKBRKL and SIPAVKL describing grades for the group of students who learned how to ski according to the classic approach f training ski beginners. If you take into consideration that students were divided in relatively heterogeneous groups according to the knowledge level of alpine skiing, then given results go in favour of the hypothesis which states: it is expected that skiers who used a "direct" methodical sequence highlighting the technique curve towards the hill and broad parallel wriggling, would adopt the target technique in faster and efficient manner and have better results when making parallel skiing techniques.

Variable KLIND, in relation to the KLINKL variable, has less value expressed in the difference of -0.2909 which goes in favour of the hypothesis stating: It is expected that skiers who used the "classic" methodical sequence including the ploughing and basic curve will have better final results when performing plough techniques in alpine skiing. Of course, V-position of skies curve in its root has a plough position that was avoided in a direct manner of learning to ski from the reason that "remains" of ploughing are preferred to be avoided in target skiing techniques represented by parallel curves with different speed, rhythm and their radius. The present researches indicate that skiers who learned how to ski using the "classic" method of skiing schools often show "remains" of ploughing or V-position of skies in some parts of skiing turns which should be completely parallel. (Kovač, S. 2003.) At the end of the research, it must be indicated that according to obtained total results, it is applicable to use a "direct" manner of training beginners, if there are conditions or suitable area for such method in the skiing resort where the training is held.

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Effects of unilateral isokinetic training on maximum strength of dynamic knee stabilizers

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Original scientific paper

Abstract
This research aims to define effects of unilateral isokinetic training of a dominant leg on development of peak torque of knee extensor and flexor of physically active female population.
Respondents who participated in the research were 30 female students from Faculty of Sport and Physical Education in Sarajevo. They were divided into two groups, an experimental and a control group. Maximum strength of dynamic knee stabilizers was tested on an isokinetic apparatus (Biodex 3) with angular speed of 60°/s and 180°/s. The experimental group conducted additional isokinetic trainings of a dominant leg with angular speed of 60°/s three times a week in the period of four weeks. Obtained results lead to the conclusion that a concentric isokinetic training with angular speed of 60°/s produced significant effects on development of maximum strength of dynamic knee stabilizers of a trained leg and that those results are statistically significally diferent from results of the control group which condusted regular classes.

Keywords: **isokinetic training, strength, dynamic knee stabilizers**

Sažetak
Cilj ovog istraživanja je utvrditi efekate unilateralnog izokinetičkog treninga dominantne noge na razvoj vršnog momenta sile ekstenzora i fleksora koljena,tjelesno aktivne ženske populacije. Ispitanice koje su sudjelovali u ovom istraživanju su studentce Fakulteta sporta i tjelesnog odgoja u Sarajevu njih 30,koj su podjeljene u dvije grupe, esperimentalnu i kontrolnu. Maksimalna jačina dinamičkih stabilizatora koljena testirana je na izokinetičkom aparatu (Biodex 3) na ugaonim brzinama veličine 60°/s i 180°/s. Eksperimentalna grupa je provodila dodatni izokinetički trening dominantne noge, 3 puta sedmično, pri ugaonoj brzini od 60°/s, u trajanju od četri sedmice. Dobijeni rezultati upućuju na zaključak da je koncentrični izokinetički trening na ugaonoj brzini od 60°/s proizveo značajne efekte na razvoj maksimalne sange dinamičkih stabilizatora koljena trenirane noge, te da se ti rezultati statistički značajno razlikuju od rezultata kontrolne grupe koja je provodila redovnu nastavu.

Ključne riječi: **izokinetički trening, snaga, dinamički stabilizatori koljena**

Introduction

Term "isokinetic training" and its advantages in regard to other types of trainings from previous researches (Thistle et al, 1967) has been used in literature for a long period of time.

However, only a small number of researches dealt in additional isokinetic training of physically active persons. If there are such researches they were mainly conducted with male population.

In his research Kazazović (2009**)** defined influence of individually formed training programs on increase of maximum strength of dynamic knee stabilizers of students from Faculty of Sport and Physical Education. In this research the experimental group (which conducted concentric isokinetic training) showed significant quantitative changes influenced by a treatment.

A transformation process was dominantly directed towards changes of maximum strength of dynamic knee stabilizers.

According to previously published researches, the purpose of this study is to define effects of unilateral isokinetic training of a dominant leg on development of peak torque of knee extensor and flexor of physically active female population. The conducted research represented only results and effects of a dominant leg. The reason for this is the fact that the isokinetic training has an unilateral character and that it is first performed on a dominant leg and the author had an intention to avoid contra-lateral effects of the unilateral training. In literature this phenomenon is called "cross education" effect. The "cross education" phenomenon has been famous for more than a hundred years (Zhou, 2000, Lee and Carol, 2007). It has been proven that unilateral strength training together with the "cross education" phenomenon cause an increase of strength of untrained limb, which could produce a wrong picture of effects on a leg which is not dominant. These results are found in researches (Munn, Herbert and Gandevia 2004, Adamsona et al. 2008)

Methods

Respondents sample:
Population of physically active women, 30 female students of the Faculty of Sport and Physical Education in Sarajevo, was divided into two groups with a random selection method:an experimental group (n = 15) and a control group (n = 15). The population included physically active women between the age of 19 and 25. None of the selected respondents could have a history of injuries of lower limbs in the last two years.

Morphologic characteristic of the sample include the average height of 168 cm, weight of 60, 9 kg and percentage of adipose tissue in total body mass of 26, 3 %.

Variables sample:
Variables for an assessment of the knee extensor and flexor strength with an isokinetic dynamometer:
1. KE60PT - Knee – extension – 60°/s – peak torque

2. KF60PT - Knee – flexion – 60°/s – peak torque
3. KE180PT - Knee – extension – 180°/s – peak torque
4. KF180PT - Knee – flexion – 180°/s – peak torque

A protocol for an isokinetic evaluation of the dynamic knee stabilizers strength

1. Skeletal muscle screening
2. General warming up and body stretching
3. Setting the respondents in an optimal stabilization
4. Alignment between the joint and dynamometer rotation axis
5. Verbal introduction to the concept of isokinetic exercise
6. Correction of gravity.-
7. Warming up (3 sub-maximum, 1 maximum repetition).
8. Maximum test at test speed of 60°/s (5 repetitions).
9. Maximum test at test speed of 180°/s (5 repetitions).
10. Testing extremities.

Experimental procedure description

During this training period both groups performed physical activities related to a program of regular classes at the Faculty of Sport and Physical Education, but the experimental group also performed an additional isokinetic training of a dominant leg.

The experimental group performed knee trainings on a Biodex isokinetic dynamometer with angular speed of 60°/s 3 times weekly. A number of repetitions in series and a number of series are set in a way that work performed (total work) increases progressively from week to week.

The control group acted according to a regular curriculum and a practical training program of a year of study regularly attended by students.

Data processing methods

Basic central and dispersion parameters were calculated with descriptive statistics for both groups in initial and final measuring.

Statistical significance of effects achieved between the initial and the final measuring for groups is defined on a basis of significance of differences between arithmetic means .Testing of significance of differences between arithmetic means was done with a t-test for small dependable samples.

The level of statistical significance was set to $p < 0.05$.
Data processing was done with statistical packages IBM SPSS 19, 0 for Windows and STATISTICA 9.0.

Results and Discussion

Analyzing central and dispersion parameters of all respondents in the initial and final measuring represented in tables 1 to 4 we can conclude that the results are distributed normally both in the initial and in the final measuring. An observation and analysis of average results in both measuring clearly indicate that mean values of variables applied for the experimental group (Table 1 and 2) show higher numerical characteristics in the final then in the initial measuring. Even in the first analysis these characteristics of the control group show a decrease of mean values between two time points of measurement.

Table 1. Descriptive statistics (Experimental group – initial measuring)

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Skewness	Kurtosis
EX60IN	15	125.1	86.9	212.0	143.260	35.8311	.253	-.686
FLEX60IN	15	71.50	40.50	112.00	76.9400	17.97052	-.084	.475
EX180IN	15	67.90	66.10	134.00	94.9200	20.58339	.300	-.775
FLEX180IN	15	46.60	33.80	80.40	55.9667	12.94586	.065	-.205
Valid N (listwise)	15							

Table 2. Descriptive statistics (Experimental group - final measuring)

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Skewness	Kurtosis
EX60FIN	15	124.0	120.0	244.0	169.267	31.2444	.821	.970
FLEX60FIN	15	60.00	71.00	131.00	92.1133	16.64168	.914	.739
EX180FIN	15	60.60	88.40	149.00	114.5667	17.05234	.637	-.280
FLEX180FIN	15	38.90	49.40	88.30	70.0067	12.13192	.056	-.868
Valid N (listwise)	15							

Tabela3. Descriptive statistics (Control group – initial measuring)

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Skewness	Kurtosis
EX60IN	15	122.50	90.50	213.00	148.0333	29.04459	.077	1.521
FLEX60IN	15	65.50	47.50	113.00	80.5733	20.50775	-.324	-.876
EX180IN	15	65.90	65.10	131.00	99.2333	19.58603	-.140	-.798
FLEX180IN	15	41.20	40.80	82.00	61.5467	11.54747	.159	-.370
Valid N (listwise)	15							

Table 4. Descriptive statistics (Control group – final measuring)

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Skewness	Kurtosis
EX60FIN	15	109.00	105.00	214.00	143.6000	26.08722	1.163	3.188
FLEX60FIN	15	56.30	50.70	107.00	78.2400	16.77812	-.001	-.870
EX180FIN	15	64.30	67.70	132.00	97.1333	17.91295	.152	-.650
FLEX180FIN	15	32.20	39.60	71.80	57.9200	9.53634	-.291	-.320
Valid N (listwise)	15							

According to results of previous researches (Costill, Coyle, Fink, Lesmes, Witzmann, 1979; Peterson, 1990; Kazazović et al. 2007), a concentric isokinetic training of lower limbs most probably should influence improvement of various dimensions of strength of physically active women. An analysis of results obtained from an additional four-week isokinetic training leads us to the conclusion that there are statistically significant differences between results of the experimental group in the initial and final measuring (Table 5). Namely, all pairs of variables between the initial and final measuring indicate statistical significance of differences, which practically means that the additional concentric isokinetic training at angular speed of 60°/s caused a significant increase of all parametres of maximum strength of dynamic knee stabilizers.

Analyzing differences between arithmetic means of the experimental group from the initial and final measuring at angular speed of 60°/s we realize that an average result of knee extensors in the final measuring is higher for 25,9 Nm∼ 18 %, while that result is 15,2 Nm∼ 20 % higher for flexors (*Table 6.)*. Such results and sizes of effects of the implemented isokinetic training of the experimental group measured at angular speed of 60°/s can be explained with a phenomenon of specificity of the implemented isokinetic training. The fact that effects of a training are the strongest in an exercise that is used as a training asset and as a test for evaluation of effects of so-called "training specificity " is well known (Sale and MacDougal, 1981).

Table 5. Results of T-test for experimental group between initial and final measuring

Paired Samples Statistics									
		Paired Differences					T	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	EX60IN	-26.0067	19.3273	4.9903	-36.7098	-15.3036	-5.211	14	**.000**
	EX60FIN								
Pair 2	FLEX60IN	-15.17333	10.58175	2.73220	-21.03331	-9.31335	-5.554	14	**.000**
	FLEX60FIN								
Pair 3	EX180IN	-19.64667	16.13266	4.16543	-28.58064	-10.71270	-4.717	14	**.000**
	EX180FIN								
Pair 4	FLEX180IN	-14.04000	9.93290	2.56466	-19.54066	-8.53934	-5.474	14	**.000**
	FLEX180FIN								

Table 6. Results of T-test for control group between initial and final measuring

Paired Samples Statistics									
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	EX60IN	4.43333	12.83531	3.31406	-2.67463	11.54129	1.338	14	.202
	EX60FIN								
Pair 2	FLEX60IN	2.33333	8.19753	2.11659	-2.20631	6.87298	1.102	14	.289
	FLEX60FIN								
Pair 3	EX180IN	2.10000	5.93103	1.53139	-1.18450	5.38450	1.371	14	.192
	EX180FIN								
Pair 4	FLEX180IN	3.62667	5.28900	1.36561	.69772	6.55562	2.656	14	.019
	FLEX180FIN								

Variables for evaluation of strength of the knee flexor and extensor measured at angular speed higher than 180°/s indicate that an average result for the knee extensor strength in the final measuring is higher for 19,6 Nm∼ 21%, while for the knee flexor strength that result is higher for 14,1 Nm∼ 25 %. These results can be explained in the way that a concentric isokinetic training at lower angular speed – in our case 60°/s- is so unspecific that it caused a significant increase of maximum knee extensor strength measured at angular speed higher than 180°/s (Kovačević, 2009).

The control group indicates that results of peak torque of the knee extensor measured at angular speed of 60°/ s are decreased for 4,2 Nm or ∼ 3% in the final measuring in regard to the initial measuring. Quantitatively expressed, the control group records a decrease of maximum strength of the knee flexor measured at the same angular speed of 2,4 Nm or ∼ 3%. Measuring peak torque of the knee extensor at angular speed of 180°/s indicates that the control group records a decrease of results of 2, 1 Nm or ∼ 2% in the applied period of time. We see similar results of the control group regarding maximum knee flexor strength measured at the same angular speed and a decrease of result of 3, 6 Nm or ∼ 6% during duration of the study.

An analysis of differences between the groups clearly shows that the additional isokinetic training produced very significant transformation effects on development of maximum strength of dynamic knee stabilizers measured at the isokinetic dynamometer at both test angular speed. If we consider the fact that the control group achieved negative results in all of the applied tests of maximum strength of dynamic knee stabilizers, then we can talk about net effects of the implemented isokinetic training.

Conclusion

According to the obtained results we can conclude that the unilateral isokinetic training of a dominant leg at angular speed of 60°/s produced positive transformation effects on maximum strength of the knee extensor and flexor expressed through peak torque measured at angular speed of 60°/s and 180°/s in the range from 18% to 21%. An additional training program at isokinetic apparatus enables development of maximum strength of dynamic knee stabilizers and confirms results of previous researches. Furthermore, we can conclude that angular speed of 60°/s is very favorable for application in isokinetic trainigs because it is unspecific and develops maximum strength of the knee extensor and flexor measured at significantly higher angular speed. These conclusions are based on differences between the experimental and control group. Namely, the control group achieved negative results in all of the applied tests of maximum strength of dynamic knee stabilizers – the strength decreased in the movement of extension and flexion of the knee joint of a dominant leg. On a basis of these facts, we can conclude that all of the achieved effects arose as a consequence of the additional isokinetic training and that they represent net effects of the implemented experimental treatment.

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Qualitative changes in the basic motor and specific throwing abilities under the influence of explosive strength training for students of the university of sports

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Original scientific paper

Abstract
Research was conducted on a sample of (n: 120) students of the I year from the University of Sports and Physical Education. The program of explosive strength lasting three months with a frequency of two trainings per week was applied to the experimental group (subsample of 60 examinees). In addition to the three-month long program, the experimental group had hours of physical education classes of Judo, Anthropomotorics, and Athletics as school subjects, with frequency of two hours per week. Second subsample (n: 60) of examinees belonging to the control group only had the class of physical education according to the Faculty curriculum. The three-month long program of explosive strength led to radical, structural changes regarding the space in specific throwing abilities in the experimental group, while in the control group those changes are of very low intensity. The differences in effects of the experimental program and the class of physical education regarding scoring efficiency in shot put were comparatively determined. A higher level of scoring efficiency in shot put - back technique was determined in the experimental group.

Keywords: **explosive strength, specific throwing abilities, shot put, experimental program, regular class**

Introduction

Reliable and relevant information regarding the subject's state are only possible by applying scientific methods in research. The intention of this work is the analysis of qualitative effects of a modeled explosive strength-based program, as well of the class of physical education in scope of basic motor and specific throwing abilities in care of students of the University of Sports and Physical Education.

Atletic throws belong to group of ballistic motion in which the space catapulting the athletic throwing devices in order to achievethe greatest possible range *(Milanović, Harasin 2003)*.

In the shot put training, accentuation (strength is trained the most in the moves which are dominant in the competing structure), has a significant place in the phase of planning and programming the training it self (*Zaciorski and Kremer 2009).* In the training cycle, proper distribution and the ratio of general and specific operator, through time periods of one year - training cycle has big significance regarding scoring efficiency.
Research done testify the efficiency specific movements in the training process have on scoring efficiency (*Kyriazis, Terzis, Boudolos, Konstantinos, Georgiadis, 2009*) who studied the performances in shot put – rotational technique, during the preseason and the competing period. The results indicate that the result in shot put – rotational technique, during the competing period, is more dependent on the initial speed and explosive power of lower extremities, than on the absolute muscle strength (1RM from deep squat). Moreover, researchers (*Terzis, G., Spengos, K., Karampatsos, G., Manta, P., Georgiadis, G. (2009).),* on a sample of eight men and eight women, studied the acute effect of deep jumps on throwing performances regarding the shot. The results were measured after the examinees completed five consecutive deep jumps from a 40-cm high bench. Higher results in shot put were achieved from men after completing deep jumps done just before throwing ($8.94\pm$ 1m vs. 9.60 ± 0.9m, $p<$), unlike from the women examinees ($7.56\pm$ 1m vs. 7.67 ± 0.9m, $p<$).
For a quality eccentric-concentric contraction, three significant conditions must be fulfilled (*according to Komi and Gollhofer, 1997*):

- Timeliness of muscle activation just before the eccentric contractions,
- A short-lasting eccentric contraction,
- Actual changes between phases of stretching and shortening,

Plyometric exercises such as jumps, deep jumps, plyometry of upper extremities with medicine balls, and sprinter exercises were mostly represented in the program of explosive strength.

Research of what effect methods of training have on the development of explosive strength in the examinees of the experimental group was achieved in addition to six hours per week in regular classes based on the curriculum for I year undergraduates (Judo, Anthropomotorics, and Athletics – 2 hours of exercises per week), with two additional hours of experimental training, within 26 training hours for the students of the University of Sports and Physical Education in Sarajevo, in duration of 13 weeks.

The examinees of the control group had only their regular classes with six hours per week, which was achieved based on the determined University curriculum of practical exercises (Athletics, Judo, and Anthropomotorics). Initial (before the treatment started) and final measurement (after treatment) of specific motor abilities and results in shot put – back technique were carried out for both groups, in the same time period.

Methods

Sample examinee

Research was conducted on a sample of 120 regular students who attend first year of the University of Sports and Physical Education in Sarajevo, male gender, of age between 20 and 25 years, in second semester of school year 2007/2008. From such a defined population, *two* following *subsamples* are formed:

1. Subsample of 60 examinees who in addition to their motor exercises in classes of practical exercise, within regular classes have an organized training program with two additional hours per week for the development of explosive strength (*experimental group),*
2. Subsample of 60 examinees who are involved only in motor exercises achieved during hours in practical exercises within regular class based on a determined university curriculum (control group).

All examinees passed the shot put – back technique before the start of the experiment. A total of twenty three (23) variables were applied. To assess the state of entities in the area of basic motor-skills a total of fifteen (15) variables were applied, in the area of specific throwing abilities a total of seven (7) and a criterion variable of scoring efficiency in the shot put – back technique.

Sample of measuring instruments

1. Tests of basic motor abilities,
2. Tests of specific motor abilities,
3. Scoring efficiency in the athletic discipline of shot put – back technique.

Measuring instruments for the assessment of basic motor abilities

(1) Segmentary speed:	
1. Foot taping	MTAN
2. Hand taping	MTAR
3. Feet taping the wall	MTAZ
(2) Repetitive strength:	
4. Raising body on the Swedish bench	MDTK
5. Chins	MZGN
6. Squats with a 30% load	MCUO
(3) Explosive strength:	
7. Long jump	MSDM
8. Triple jump	MTRS
9. Five long jump	MTPS
(4) Flexibility:	
10. Deep bend on the bench	MDPK
11. String	MSPA
12. Flex with a rod	MISP
(5) Agility:	
13. Envelope test	MKOT
14. Side steps	MKUS
15. Eight with flexion	MOSS

Applied set of motor variable was taken from *Kurelić, Momirović, Stojanović, Šturm and Viskić-Štalec, 1975.* research

Measuring instruments for the assessment of specific motor abilities

Chest shot put – half squat	SMPP
Overhead backwards shot put – half squat	SMKUN
Forward shot put – half squat	SMKUI
Medicine ball throw from sitting position	SMMES
Clap pushups in 10 seconds	SMSKL
Long jump from half squat	SMDOS
Long jump after the first jump	SMDOSS

Measuring instruments for estimating results in shot put – back technique

1. Shot put – back technique	REZK

By using factorial analysis under the model of congruence, structural changes of basic motor and specific throwing abilities at students were determined. Differences that have arisen through two points in time in criterion variable of scoring efficiency in shot put – back technique, were tested by T tests for independent samples.

Results and discussion

Quality changes in the initial and final measurement of the control group members

Quality changes in the scope of basic motor ability of the control group in the initial and final measurement

In the initial measurement of the control group, a system of fifteen (15) manifested basic motor measures contains about 67% common variance (Table 3). Thus, five latent dimensions were extracted which defined the given space.

The first factor carries the most information because it extracted around 22% common variance of the analyzed measures. It is determined by high projections by measurements of the triple jump (.91 MTRS), long jump (.89 MSDM), and five jump (.88 MTPS).

Considering the presence of explosive strength variables enabled the definition of independent factors, which is how we interpreted it, as a ***factor of explosive strength of lower extremities*** (initial measurement).

In the final measurement (Table 4) of the control group, a system of fifteen (15) manifested basic motor measurements contains around 73% common variance. Thus, six latent dimensions were extracted which defined the given space.

The first factor carries the most information because it extracted around 25% common variance of the analyzed measures. It is determined by high projections by measurements of the long jump (.93 MTRS), and the five long jump (.91 MTPS). An Eigenval value of 3.86 is an indicator of a middle factorial saturation caused by extracted measurements.

As in the initial measurement, the explosive strength variables defined this factor, thus we can name it ***the factor of explosive strength of lower extremities*** (final measurement), and it is under the auspices of energetic regulation (the mechanism of excitation intensity).

The second factor of the initial measurement is defined by flexibility variables and by one variable of segmented movement speed of Deep bend on the bench (.75 MDPK), foot taping (.68 MTAPN), flex with a rod (.67 MISP), and string (.65 MSPA). This factor drained around 17% of common variance of the system with Eigen value. (2.56), which is greater than zero and keeps the rights of its extraction.

This second extracted factor is interpreted as a latent dimension responsible for the ***flexibility and segmentary speed of lower extremities*** (initial measurement)…

The second factor of the final measurement is defined by agility variables and by one flexibility variable Deep bend on the bench (.76 MDPK), envelope test (.70 MKOT), Eight with flexion (.69 MOS), and side steps (.60 MKUS). This factor drained around 13% of common variance of the system with the Eigen vector value of (1.98).

This second extracted factor is interpreted as a latent dimension responsible for the ***agility and flexibility of lower extremities*** (final measurement).

The third latent dimension of the initial measurement is defined by motor variables: side steps (MKUS =.74) and feet taping the wall (MTAZ .66). Statistically significant projections of the variables explain around 11% of common variance of the system whereby the own value greater than zero (Eigen. =1.66) is maintained. Communalities of the extracted variables are of middle projections about .67 for side steps and .47 for the feet taping the wall variable. The third latent dimension can be defined as a ***factor of agility and segmentary speed of lower extremities.***

The third latent dimension of the final measurement is defined by a motor variable: string (MSPA=.86). Statistically significant projections of the variables explain about 10% of common variances of the system, whereby the own value greater than zero (Eigen. =1.56) is maintained. The communality of the extracted variable is of middle projections around .51. The third latent dimension can be defined as a ***factor of flexibility of lower extremities.***

The initial measurement extracted 67% variability with five main components, while the final measurement extracted 73% variability with six main components (Tables 2 and 3). There was a slight change in the structure of the control group when it comes to motorics, because the contents of a standard class program affected so one coefficient of an explained variability factor increased. In the first factor, there are stronger saturations of the long jump (.94 MSDM), triple jump (.93 MTRS), and five long jump (.91 MTPS). The first and second factor on the final measurement gain on intensity of the projections. There is not a meaningful answer for the changes regarding the third factor.

There were slight structural changes of basic motor abilities in the control group between two time periods, as a consequence of a standard program of the I year of the University of Sports in the second semester of the academic 2007/8 year.

Table 1. and 2. *The communalities of basic motor abilities of the initial and final measurement of the control group*

INITIAL			FINAL		
	Initial	Extraction		Initial	Extraction
mtan	1.00	.73	mtan	1.00	.58
mtar	1.00	.68	mtar	1.00	.49
mtaz	1.00	.47	mtaz	1.00	.81
mdtk	1.00	.76	mdtk	1.00	.80
mzgn	1.00	.42	mzgn	1.00	.53
mcuo	1.00	.77	mcuo	1.00	.72
msdm	1.00	.81	msdm	1.00	.88
mtrs	1.00	.85	mtrs	1.00	.87
mtps	1.00	.79	mtps	1.00	.83
mdpk	1.00	.64	mdpk	1.00	.71
mspa	1.00	.51	mspa	1.00	.84
misp	1.00	.51	misp	1.00	.75
mkot	1.00	.72	mkot	1.00	.67
mkus	1.00	.67	mkus	1.00	.81
moss	1.00	.70	moss	1.00	.71

Table 3. and 4. *A matrix of isolated characterized roots and explained parts of common variance in basic motor abilities of the control group's initial and final measurement*

INITIAL				FINAL			
	Initial Eigenvalues				Initial Eigenvalues		
	Total	% of Variance	Cumulative %		Total	% of Variance	Cumulative %
1	3.44	22.92	22.92	1	3.86	25.76	25.76
2	2.56	17.08	39.10	2	1.99	13.26	39.02
3	1.67	11.11	51.10	3	1.56	10.41	49.44
4	1.32	8.77	59.87	4	1.36	9.06	58.50
5	1.07	7.16	67.03	5	1.20	7.97	66.47
				6	1.03	6.87	73.34

Table 5. and 6. *Structure matrices of basic motor abilities of the control group's initial and final measurement*

	INITIAL						FINAL					
	Component						Component					
	1	2	3	4	5		1	2	3	4	5	6
mtrs	.91	-.09	-.04	-.06	-.13	msdm	.94	.18	-.08	.12	.10	-.00
msdm	.89	.08	-.04	.06	-.21	mtrs	.93	.11	-.08	.10	.15	-.03
mtps	.88	-.06	-.17	-.07	-.19	mtps	.91	.21	-.07	.22	.12	.04
mdpk	-.15	.75	-.26	.08	.03	mkus	.56	.53	-.49	-.17	.21	.29
mtan	.05	.68	-.43	.43	-.10	mtan	.14	.76	-.12	.08	-.04	.10
misp	.06	.67	.14	-.01	.09	mdpk	.05	.70	.32	.01	-.20	.21
mspa	-.14	.65	.07	.30	.05	mkot	.32	.69	-.14	.27	.32	-.12
moss	.34	.59	-.29	-.26	-.45	moss	.40	.60	-.59	.17	.01	-.06
mkus	.38	-.00	-.74	-.15	-.32	mspa	.06	.21	.86	.08	-.05	.15
mtaz	-.03	.10	-.66	.03	.04	mdtk	.04	.06	-.04	.88	.12	.08
mtar	.04	.10	.03	.81	-.15	mzgn	.38	.14	.06	.65	-.05	.03
mkot	.48	.24	-.43	-.49	-.43	misp	-.06	.25	-.05	.04	-.80	.25
mzgn	.37	.25	-.26	.44	-.08	mcuo	.17	.29	-.17	.12	.73	.32
mdtk	.18	.09	.18	.17	-.78	mtaz	.01	.29	-.07	.38	-.13	.78
mcuo	.04	-.24	-.47	-.11	-.73	mtar	-.03	-.27	.32	-.18	.08	.54

Quality changes in the space of the control group's specific throwing abilities in the initial and final measurement

In the control group's initial measurement, a system of seven (7) manifested specific throwing measurements contains around 71% common variance (Table 9). By that means the two latent dimensions that defined the given space were extracted. In the final measurement (Table 10) of the control group, the system explained, with a negligible increase, regarding the initial measurement 73% common variance, and the two factors were extracted. Essentially, expect for this minor change, there were not significant differences in the space of specific throwing abilities.

Standardized curriculum in the experimental period of thirteen (13) weeks did not cause structural changes on specific throwing space of measurements for the control group examinees.

Table 7. and 8. *The communalities of control group's specific throwing abilities of the initial and final measurement*

INITIAL			FINAL		
	Initial	Extraction		Initial	Extraction
smpp	1.00	.69	smpp	1.00	.76
smkun	1.00	.77	smkun	1.00	.83
smkui	1.00	.81	smkui	1.00	.87
smmes	1.00	.67	smmes	1.00	.60
smskl	1.00	.28	smskl	1.00	.43
smdos	1.00	.88	smdos	1.00	.86
smdoss	1.00	.89	smdoss	1.00	.76

Table 9. and 10. *A matrix of isolated characterized roots and explained parts of common variance in specific throwing abilities of the control group's initial and final measurement*

INITIAL				FINAL			
	Initial Eigenvalues				Initial Eigenvalues		
	Total	% of Variance	Cumulative %		Total	% of Variance	Cumulative %
1	3.72	53.17	53.17	1	3.98	56.91	56.91
2	1.26	18.04	71.21	2	1.13	16.21	73.12

Table 11. and 12. *Structure matrices of specific throwing abilities of the control group's initial and final measurement*

INITIAL			FINAL		
	Component			Component	
	1	2		1	2
smkui	.90	.46	smkui	.93	.42
smkun	.87	.33	smkun	.91	.38
smpp	.82	.50	smpp	.87	.44
smmes	.81	.32	smmes	.77	.45
smdoss	.44	.94	smdos	.51	.92
smdos	.42	.94	smdoss	.52	.86
smskl	.25	.53	smskl	.23	.65

Quality changed in the experimental group's initial and final measurement

Quality changes in the area of basic motor abilities of the experimental group's initial and final measurement

Based on the communality analysis (Table 13 and 14) in the initial and final measurement of the experimental group's basic motor abilities, it can be observed that all the variable significantly contribute to the explanation of the given variability and represent those variance parts of every variable which can be interpreted (explained) through isolated system of latent dimensions. All variables have high and middle-high projections.

In the initial measurement of the experimental group, a system of fifteen (15) manifested basic motor measurements contains about 68% common variance (Table 15). By that means five latent dimensions which defined the given space were extracted.

The first latent dimension is defined by the participation and extraction of explosive strength variables which with their coefficient sizes and positions on the coordinate system enabled an independent extraction. The main carrier of this extracted factor is the five long jump variable (.91 MTPS), long jump (.86 MSDM), and triple jump (.86 MTRS). Eigenval value of 4.39 is an indicator of a middle factor saturation caused by the extracted measurements.

Considering the presence of explosive strength variables enabled the definition of independent factors, which is how we interpreted it, as a ***factor of explosive strength of lower extremities*** (initial measurement).

In the final measurement of the experimental group, a system of fifteen (15) manifested basic motor measurements contains about 66% common variance. Thus, five latent dimensions which defined the given space were extracted.

The first latent dimension was defined by the participation and extraction of explosive strength variables which with their coefficient sizes and positions in the coordinate system enabled an independent extraction. The main carrier of this extracted factor is the triple jump variable (.87 MTRS), five jump (.85 MTPS), and long jump (.77 MSDM). Eigenval value of 4.39 is an indicator of a middle factor saturation caused by the extracted measurements. This factor drained around 29% of the total motor system.

Considering the presence of explosive strength variables enabled the definition of independent factors, which is how we interpreted it, as a ***factor of explosive strength of lower extremities*** (final measurement).

The first factor in the initial measurement was dominant in terms of motorics; however under the influence of the experimental program, it lost on its intensity. There were structural changes, and that fact mostly explains the structure of the first factor.

In the initial measurement, 68% of the variability was extracted from five main components, while in the final measurements 66% variability was extracted with the same number of five main components (Table 15 and 16). There was a slight change in the structure of the experimental group when it comes to motorics, because the contents of the plyometric program affected in a way which changed the intensity of the bonds. In the first factor, there is a stronger saturation in the measurement of five jump (.91 MTPS), long jump (.86 MSDM), and triple jump (.86 MTRS). There is not a meaningful answer for the changes regarding the third factor. The first and second factors explain 51% of the variability in the initial measurement, while 48% of the variability is explained in the final measurement. The contents of the plyometric program for the basic motor abilities caused slight structural changes within the experimental group.

Table 13. and 14. *The communalities of the experimental group's basic motor abilities in the initial and final measurement*

INITIAL			FINAL		
	Initial	Extraction		Initial	Extraction
mtan	1.00	.64	mtan	1.00	.52
mtar	1.00	.74	mtar	1.00	.76
mtaz	1.00	.56	mtaz	1.00	.29
mdtk	1.00	.45	mdtk	1.00	.41
mzgn	1.00	.75	mzgn	1.00	.72
mcuo	1.00	.65	mcuo	1.00	.68
msdm	1.00	.81	msdm	1.00	.74
mtrs	1.00	.80	mtrs	1.00	.78
misp	1.00	.65	mtps	1.00	.85
mkot	1.00	.70	mdpk	1.00	.75
mkus	1.00	.62	mspa	1.00	.67
moss	1.00	.71	misp	1.00	.57
mdpk	1.00	.63	mkot	1.00	.85
mspa	1.00	.66	mkus	1.00	.57
mtps	1.00	.86	moss	1.00	.76

Table 15. and 16. *A matrix of isolated characterized roots and explained parts of common variance in basic motor abilities of the experimental group's initial and final measurement*

INITIAL				FINAL			
	Initial Eigenvalues				Initial Eigenvalues		
	Total	% of Variance	Cumulative %		Total	% of Variance	Cumulative %
1	4.39	29.26	29.26	1	4.36	29.08	29.08
2	2.12	14.15	43.41	2	1.78	11.84	40.92
3	1.38	9.21	52.62	3	1.52	10.14	51.05
4	1.27	8.44	61.06	4	1.22	8.14	59.20
5	1.06	7.10	68.16	5	1.04	6.91	66.11

Table 17. and 18. *Structure matrices of basic motor abilities of the experimental group's initial and final measurement.*

INITIAL						FINAL					
	Component						Component				
	1	2	3	4	5		1	2	3	4	5
mtps	.91	.28	.14	.30	-.18	mtrs	.87	.04	.22	-.15	.13
msdm	.86	.35	.03	.25	-.11	mtps	.85	.00	.42	-.21	.27
mtrs	.86	.22	-.00	.27	-.27	msdm	.77	-.02	.47	-.26	.05
mspa	.61	-.07	.50	.06	.12	mspa	.68	.41	.08	.23	-.02
mtaz	.48	.23	.44	.33	-.43	mkus	.66	.19	-.16	-.12	.17
mzgn	.41	.80	.10	.12	-.13	mtaz	.48	.14	.32	-.05	.05
mcuo	.17	.79	.25	.16	.00	mdpk	.30	.81	.25	-.13	.00
moss	-.04	.59	.58	.42	.10	misp	-.04	.71	-.08	-.11	.25
mdpk	.04	.35	.74	.20	.05	mzgn	.23	.16	.83	-.02	.17
misp	.11	.03	.73	-.22	-.09	mcuo	.37	.21	.77	-.10	-.03
mtan	-.10	.27	.55	.45	-.38	mdtk	.05	-.14	.59	-.14	.18
mkus	.31	-.06	.13	.71	-.15	mkot	.34	.12	.12	-.87	.02
mdtk	.12	.19	-.11	.63	-.15	moss	.06	.51	.24	-.67	.40
mkot	.27	.43	.17	.61	.39	mtar	.28	.07	.25	.24	.75
mtar	.24	.09	.04	.18	-.84	mtan	.10	.23	.05	-.35	.66

Factorial analysis of specific throwing abilities of the experimental group in the initial and final measurement

Based on the communality analysis (Table 19 and 20) in the intial and final measurement of the specific throwing abilities of the experimental group, all variables can be observed expect push ups with claps within 10 seconds (SMSKL .21) in initial and (SMSKL .16) in the final, which significantly contribute to the exaplanation of the given variability. All variables have high and middle-high projections.

Based on the differences in the communality values, which had only one value greater than 0.70 in the initial measurement, which is shot put Chest shot put – half squat (.72 SMPP), and five communality value's measurements higher than .70 in the final measurements: Forward shot put – half squat (.83 SMKUI), Long jump from half squat (.78 SMDOS), Overhead backwards shot put – half squat (.77 SMKUN), Chest shot put – half squat (.75 SMPP), and Long jump after the first jump (.70 SMDOSS), from which it can be observed that root changes occured in the experimental group's members which were applied to the plyometric program.

Forward shot put – half squat gained the most strength due to its change from the initial and final measurement, from .59 to .83.

In the initial measurement of the experimental group, a system of seven (7) manifested specific throwing mesurements contains about 56% of common variance (Table 21). Thus, one latent dimension which defined the given space was extracted. In the final measurement (Table 22) the experimental group explained this system much better with 63% of common variance and one extracted variable.

Based on the changes in the communality values, the percentagally explained variances in the initial and final measurement and the changes in the structure matrices, it can be observed that the plyometric program which lasted for thirteen (13) weeks and conducted on an experimental group of students, caused radical qualitative changes in the specific throwing abilities in the final measurement in regard to the initial measurement.

Table 19. and 20. *The communalities of the experimental group's specific throwing abilities in the initial and final measurement.*

INITIAL			FINAL		
	Initial	Extraction		Initial	Extraction
smpp	1.00	.72	smpp	1.00	.75
smkun	1.00	.68	smkun	1.00	.77
smkui	1.00	.59	smkui	1.00	.83
smmes	1.00	.39	smmes	1.00	.47
smskl	1.00	.21	smskl	1.00	.16
smdos	1.00	.68	smdos	1.00	.78
smdoss	1.00	.67	smdoss	1.00	.70

Table 21. and 22. *A matrix of isolated characterized roots and explained parts of common variance in specific throwing abilities of the experimental group's initial and final measurement*

INITIAL				FINAL			
	Initial Eigenvalues				Initial Eigenvalues		
	Total	% of Variance	Cumulative %		Total	% of Variance	Cumulative %
1	3.95	56.38	56.38	1	4.47	63.81	63.81

The differences between the initial and final measurement of scores in shot put in terms of the control group

Table 23. *The significance of the differencecs between arithmetic sorroundings in shot put – back technique in terms of the control group*

					Std.Dv.			
	Mean	**Std.Dv.**	**N**	**Diff.**	**Diff.**	**t**	**df**	**p**
REZKI	738,03	119,38						
REZKF	767,50	118,71	60	-29,46	50,77	-4,49	59	**,000**

Table 23. presents T-test results in shot put – back technique between the initial and final measurement in terms of the control group's examinees. It points out that with the analysis of the T-value coefficient (-4.49) and its significance (p=.000) it can be concluded that there is a statistically significant difference (p=.005) in the shot put test, in terms of the final measurement and the initial measurement. Considering the negative sign of the value (t), the values of the results in the final measurements gained slightly more value (better interpreted), and that indicates that there is a higher value of the results of the arithmetic sorrundings of the final in regard to the initial measurement of 29cm.

The differences between the initial and final measurements in shot put scores for the experimental group

Table 24. *The significance of the differencecs between arithmetic sorroundings in shot put – back technique in terms of the experimental group*

					Std.Dv.			
	Mean	**Std.Dv.**	**N**	**Diff.**	**Diff.**	**t**	**df**	**p**
REZKI	791,03	97,36						
REZKF	837,28	103,06	60	-46,25	49,60	-7,22	59	,000

Table 24. presents T-test results in shot put – back technique between the initial and final measurement in terms of the experimental group's examinees. It points out that with the analysis of the T-value coefficient (-7.22) and its significance (p=.000) it can be concluded that there is a statistically significant difference (p=.005) in the shot put test, in terms of the final measurement and the initial measurement. Considering the negative sign of the value (t), the values of the results in the final measurements gained slightly more value, and that indicates that there is a progress of the results of the arithmetic sorrundings of the final in regard to the initial measurement of 46c m.

Conclusion

The results of the factorial analysis (under the model of congruence), in the final compared to the initial measurement in the experimental group of examinees indicate, that under the influence of transformational processes, and the application of explosive strength modelated training in the space of basic motor abilities, it leads to slight differences in the space of specific throwing abilities which led to radical structural changes.

The results of the factorial analysis (under the model of congruence), in the final compared to the initial measurement in the control group of examinees indicate, that under the influence of a standard model of practical class in the space of basic motor abilities, there were slight changes and in the space of specific throwing abilities were no structural changes.

Progress in intensity the early stages is therefore not a result of increased muscle(hypertrophy), but the ability of central nervous system to activates or stimulates the muscles (Bompa, 1993, Sale, 1986).

Based on these results, it is obvious that the Program of explosive strength caused a higher level of changes compared to the control group which only performed regular class of physical education. Radical structural changes occured mostly in the area of specific throwing abilities.

In the shot put training, accentuation (strength is trained the most regarding the moves which are dominantin the competitive structure), has a significant place in the planning and programming phase of the training (*Zaciorski i Kremer 2009*).

Specialized strength training secures the athlete's great chance of improving his/her athletic achievements, and reduces the risk of getting injured *(Foran 2010)*.

In addition to determining the effects of the author's program and his adaptive potential in the development of basic and specific throwing ability, his effect on the scoring efficiency in the shot put discipline was determined. Thus, it should be clear that a higher level of achievement was not the primary goal. Range of improvement only measures the efficiency of the offered program content. The score improvement in the shot put of 46 cm, which was statistically more significant in the experimental group than within the control group that received a results shift from 29 cm, which is a 17 cm difference, could only be underestimated by people who do not understand this type of experiment. For those who understand this program, the improvement of 46 cm is a very significant jump, especially taking into account that the experiment lasted only for three months and with training frequency of two hours a week. Continued use of the content of this program throughout an one-year macrocycle, with higher weekly frequency, would certainly give results with even more significant effects.

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Effects of programmed training on motor abilities of persons with movement impairment in sitting volleyball

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Abstract
Results obtained through testing of 60 players were analyzed in order to determine the effects of programmed training on motor abilities of persons with movement impairment in a sports discipline – sitting volleyball. Programmed training was conducted through an intensive exercise of explosive strength, motion frequency, and agility for the duration of 60 days. Nine variables were applied for evaluation of motor abilities: side sliding, 20 meter sliding, throwing of a medicine ball while in lying position, hand tapping, foot tapping against wall, bend-stretch touch an "eight" with touch, sliding in a rectangle, and distance sliding. Qualitative changes were determined through application of factor analysis during and after the programmed treatment. Factor analysis confirmed that the expected changes in the tested motor abilities did take place as a result of the programmed training in such a way that 2 factors were singled out in during the initial measurement. Of those the first main component was composed of 4 variables. The greatest positive and orthogonal projections were recorded with the variables of distance sliding from still position, as well as throwing of a medicine ball while in lying position. Negative projections on this factor were recorded in variables 20 meter sliding and the "eight" with touch.
The records of initial measurement showed a domination of explosive force, whereby agility of the tested individual was projected negatively. In the final measurement, upon completion of the treatment, the greatest positive projections of an isolated main component were recorded with regard to the variables: foot tapping against a wall, bend-stretch touch, and hand tapping. The greatest negative projections were recorded with regard to: the "eight" with touch, sliding in a rectangle, and side sliding. The explosive force factor was reduced in a final measurement, while motor abilities were dominant.

Keywords: **motor abilities, programmed training**

Sažetak
U cilju utvrđivanja uticaja programiranog treninga kod osoba sa invaliditetom u sportskoj disciplini sjedeće odbojke na motoričke sposobnosti igrača, analizirani su rezultati dobijeni na uzorku od 60 igrača. Programirani trening se provodio intenzivnom vježbom eksplozivne snage, frekvencije pokreta i agilnosti u trajanju od 60 dana.
Za procjenu motoričkih sposobnosti, primjenjeno je 9 varijabli: klizanje u stranu, klizanje 20 metara, bacanje medicinke iz ležanja, taping rukom, taping nogom o zid, pretklon- zasuk-dodir, osmica sa dodirom, klizanje u pravokutniku i otklizavanje u dalj s mjesta. Kvalitativne promjene su determinirane primjenom faktorske analize, prije i poslije programskog tretmana. Faktorska analiza je potvrdila da je došlo do očekivanih kvalitativnih promjena ispitivanih motoričkih sposobnosti, pod utjecajem programiranog treninga, na način da se u inicijalnom mjerenju izolirala 2 faktora, od kojih je prva glavna komponenta sačinjavala 4 varijable. Najveće pozitivne paralelne i ortogonalne projekcije, imale su varijable otklizavanje u dalj s mjesta i bacanje medicinke iz ležanja. Negativne projekcije na ovaj faktor imale su varijable klizanje 20 metara i osmica sa dodirom. Uvidom u rezultate inicijalnog mjerenja konstatirana je dominacija eksplozivne snage, pri čemu se negativno projektovala agilnost ispitanika.
U finalnom mjerenju, nakon provedenog tretmana, najveće pozitivne projekcije na izoliranu glavnu komponentu, imale su varijable taping nogom o zid, pretklon- zasuk-dodir i taping rukom, a negativne projekcije: osmica sa dodirom, klizanje u pravokutniku i klizanje u stranu. U finalnom mjerenju, faktor eksplozivne snage je potisnut, a dominirale su motoričke sposobnosti.

Ključne riječi: **motoričke sposobnosti, programirani trening**

Introduction

It has been determined by previous research that motor abilities may be influenced by certain exercise processes. It has been established that a specific program within a training process of sports games results in positive effects and transformation[1,2,3,5,11]. As training frequency in sitting volleyball proves to be insufficient for reaching desired effects, it is necessary to examine methods, means, forms, operators and program whose application would have the same of better effects within shorter time. The questions that have to be answered are – how much does one need to exercise for those changes to take place, what is the level of adaptability of new motion structures and whether those changes may take place within shorter time?

It is possible to apply programmed training, structured in accordance with a given situation, in a sports discipline of sitting volleyball through a training process with an aim to more quickly and more extensively develop motor abilities, based on a premise that application of such program shall not have negative effects on other segments of anthropologic status of a player.

In the field of sports for athletes with movement impairment, adjusting program to the players and their abilities is necessary for psychological reasons, to enable the players to find by themselves the game elements, motivation, to involve spontaneity, independence, sensibility, creativity, expressiveness, challenge, risk and alike. In this way the players will by themselves establish harmony in the perception, motor, cognitive, and conative area which will enable them to move to a higher level of motor abilities.

In order for the player to be interested and motivated to adopt and excel the contents of training, it should consist of a number of games that make training more interesting and special. Tangible and recognizable transformation represents a special motivation for the player as it caused his conscious engagement and acceptance of exercises. Due to the aforementioned, there is a need to evaluate effects of programmed contents in the training procedure and possibility of their application.

Sitting volleyball training programs have to meet emotional, social, and intellectual needs as a condition for maximum involvement and effort of players and their motivation for transformation through sports games. The aim of this research is to determine the effects of programmed training on motor abilities of persons with movement impairment in a sports discipline – sitting volleyball through factor analysis.

Methods

Analysis of latent space of applied variables on motor abilities of sitting volleyball players was used in this paper.

The sample

The sample is represented by 60 players with movement impairment, subjected to experimental training program in sitting volleyball.

Sample variables

The following variables were used to determine explosive strength of examinees: distance sliding from still position (MESODOM), 20 meter sliding (MESK20) and throwing of a medicine ball while in lying position (MESBML). The following variables were used to determine motion frequency: hand tapping (MFPTAR), foot tapping against wall (MFPTNZ) and bend - stretch-touch (MFPPZD). The following variables were used to determine agility: side sliding (MAGKUS), sliding in a rectangle (MAGKUP) and an eight with touch (MAGOSD).

Results and discussion

An evaluation of variables' representativeness was conducted on the examinee sample in order to determined justifiability of application of factor analysis in this particular research. Kaiser-Meyer-Olkin coefficient of representativeness was calculated, amounting to 0.81. Its significance was tested through Bartlett Test through H2 amounting to 257,20, with level of statistical significance $p = 0.000$. Factorization of variability in both initial and final measurement was done whereby two factors were isolated in both cases. Percentage of total variability amounted to 60% of common variance in the first main component at two measurement levels

Table 1 shows contribution of variables to individual factors, and it may be observed that the first factor defines four variables of which MESODM, MESK20 and MESBML has the greatest contribution, i.e. those defining explosive force of examinees so that this factor is titled **Explosive Strength Factor.**

The variables MFPTNZ, MFPTAR, MFPPZD, defining frequency of motion, have the greatest positive parallel and orthogonal projections onto the second factor onto which the variables of agility MAGKUS, MAGKUP and MFPPZD are negatively projected so that this factor is called **Motion Frequency Factor**.

Table 1. Parallel and orthogonal projection of variables on factors (the pattern matrix and structure)

VARIABLES	F 1	F 1	F 2	F 2
	PAP	ORP	PAP	ORP
MESODM	0,92	0,96		
MESK20	- 0,86	- 0,82		
MESBML	0,86	0,90		
MAGOSD	- 0,68	- 0,54		
MFPTNZ			0,80	0,91
MFPTAR			0,79	0,74
MAGKUS			- 0,74	- 0,53
MAGKUP			- 0,70	- 0,55
MFPPZD			0,56	0,46

Table 2 shows the contribution of individual variables, factors, and can be noted that the first factor defines the six variables of which 3 variables are positive, which define the frequency of movement, and 3 negative projections of the variables that define a player's agility. This points to the fact that measuring area of motor skills is defined by multidimensional characteristics, which are affected by motor skills.

There are negative correlations between the variables: MAGKUS, MAGKUP and MAGOSD, which are related to agility, which can be explained by the fact that the program improves the speed of movement and thus reduces the time required for the agility of players.

There are positive projections with variable MFPTNZ, MFPTAR and MFPPZD that define the frequency of movement, and this factor might be called the **frequency of movement and agility factor.**

The best parallel and orthogonal projection on the second factor have the variables: MESODM, MESBML and MESK20 that define the area of explosive strength and this factor is called the **factor of explosive strength.**

By factor analysis of qualitative changes we can see that under the influence of the program, as the first principal component with the largest percentage of variability, frequency of movement is being isolated, which indicates that the specific program developed in participants the ability which precedes motor skills, and it can be concluded that specific training process influenced the development of motor skills in subjects, as indicated by the communality of variables in measurement of subjects.

Table 2. Parallel and orthogonal projection of variables on factors (the pattern matrix and structure)

VARIABLES	**F 1**	**F 1**	**F 2**	**F 2**
	PAP	**ORP**	**PAP**	**ORP**
MAGKUS	- 0,82	- 0,67		
MFPTNZ	0,77	0,92		
MAGKUP	- 0,76	- 0,67		
MAGOSD	- 0,70	- 0,55		
MFPTAR	0,61	0,51		
MFPPZD	0,56	0,45		
MESODM			0,93	0,91
MESBML			0,86	0,87
MESK 20			- 0,76	- 0,69

Table 3 shows that the correlation coefficients of variables through their communalities are very high, pointing to the fact that all the variables in the measurement area have a significant stake in defining the area as part anthropological status of the subjects.

Table 3. Communality of variables

variables	**communality**
MESODM	0,86
MESK20	0,59
MESBML	0,74
MFPTAR	0,40
MFPTNZ	0,69
MFPPZD	0,37
MAGKUS	0,75
MAGKUP	0,61
MAGOSD	0,59

From the table 4 it is evident that the factors have a relatively good correlation indicating the existence of a connection between frequency of movement, agility and explosive strength in the training procedure.

Table 4. Correlation factors

Factors	1	2
1	1,00	0,45
2	0,45	1,00

Conclusion

In the area of motor abilities of subjects, the final measurement have isolated a factor of frequency of movement and agility, with the highest power of variability and explosive strength factor as the second principal component. Given that in the initial measurement the opposite occurred, where **factor of explosive strength** was isolated, as the first principal component and **frequency of movements and agility factor** as well as other major component, it can be concluded that the program has developed skills in subjects that precede motor skills, and can conclude that the training procedure in the final measurement affect the logical sequence of development of motor skills. Factor analysis confirmed that, under the influence of the program, there has been a qualitative change in the expected motor abilities. Choosing variables for measuring the subject has well covered the whole area of measurement and showed a significant change in variability on the variables: MESODM, MESK20, MFPTAR, MFPPZD and MAGKUS.

These variables describe the abilities that can be improved with applied training procedure, and noted changes can be explained as the changes that have occurred under the influence of programmed workouts.

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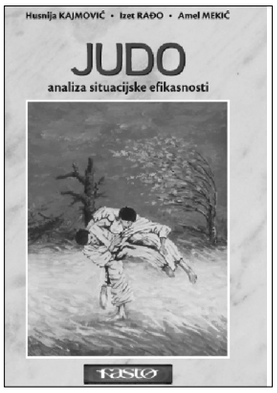

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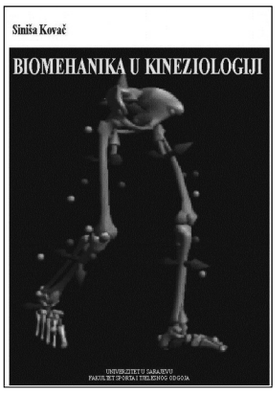

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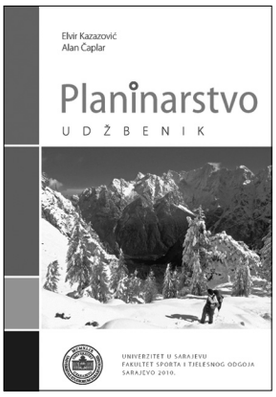

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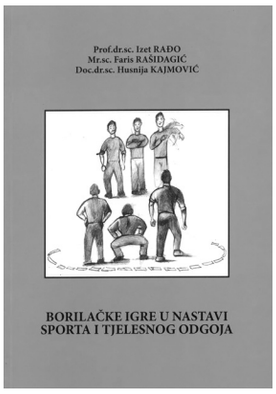

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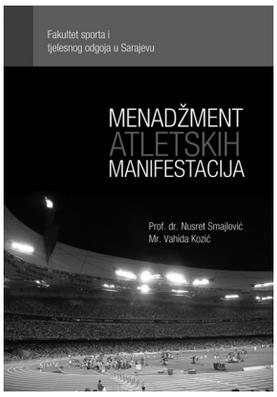

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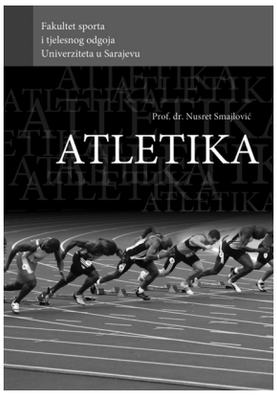

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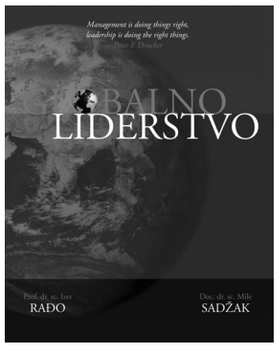

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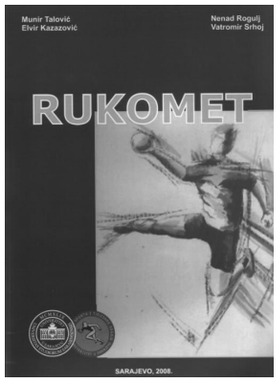

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