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UNIVERSITY OF SARAJEVO



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# **EFFECTS OF CHANGES OF BOXING RULES IN PERFORMANCES OF AMATEUR BOXERS BETWEEN TWO STATE CHAMPIONSHIPS OF BOSNIA AND HERZEGOVINA IN COMBATS OF DIFFERENT TIME FORMAT AND NUMBER OF ROUNDS**

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## **Abstract**

Rules in boxing are important because they provide the same conditions to boxers to show their best performances at competitions. World Boxing Federation (AIBA) changed rules in duration of combat. Therefore since 1997, year rules 3x3 minutes altered to 5x2 minutes and in 1999, year 5x2 minutes altered to 4x2 minutes and since 2009, 4x2 minutes returned to 3x3 minutes. The aim of this paper is to determine effects of changes of boxing rules on performances of amateur boxers between two state championships of Bosnia and Herzegovina in boxing in 2007, year and in 2016, years. Notation analysis of performances of amateur boxers was used on sample of 80 combats of State Championship of Bosnia and Herzegovina 2016, year which lasted 4x2 minutes and on sample of 48 combats of State Championship of Bosnia and Herzegovina 2007, year which lasted 3x3 minutes. Results of Chi-square test showed that statistically significant changes occurred in variables of punches, basic defenses, advanced defenses and way of winning, while variables of tactic elements of boxing didn't show statistically significant changes. International Boxing Association (AIBA) decision of returning rules on 3x3 minutes was good decision for boxing because boxers can show their best technical and tactical qualities for bigger efficiency and reduce of injuries and therefore boxing is more interesting to watch. Results of this research can be useful for referee organizations, coaches and competitors in function of more efficient planning and programming training process and especially for boxing scientific community.

Key words: **combat sport, transformation, efficiency, analysis, male competitors**

## **Introduction**

Organization of boxing competitions under AIBA presents sport duel which is performed based on set of boxing rules of sport in broader sense while in more specific sense referees use these rules to regulate this process. There are two components in boxing and those are: competition and training and that process is regulated by rules which main role is to provide boxers the same conditions for achieving results at competitions with maximal protection of boxers, increase of attractiveness, improvement of understanding of viewers of certain changes in boxing. Because of this, rules are used as fundamental means which help coaches and competitors to achieve their goals during the competition. International Boxing Association (AIBA) in order to bring innovations in boxing, changed rules of duration of rounds. So in period from 1997.-1999, year, duration of

combat and rounds was 5x2 minutes and from 1999.-2009, year, number of rounds and duration of was altered to 4x2 minutes. The last change happened in 2009, year when number of rounds and duration of combat returned to the old format 3x3 minutes. One of the important longitude researches which was conducted was research by Bianco et al. (2013) on amateur boxers in last 59 years in which impact of changes of rules on type of recorded decisions and implications on health of boxer was determined. Based on that research it was concluded that modern amateur boxing is much safer for boxers in formats 3x3 rather than 5x2 and 4x2 minutes formats. Elimination of boxing helmet and throwing out electronic ranking to the old system of referees' decisions also contributes to this. The contest format for elite and 'open' class amateur boxers has

been altered from 4 x 2 minute rounds to 3 x 3 minute rounds (AIBA, 2008), which is likely to have had an impact on the boxers' activity patterns within rounds and the accompanying physiological responses. Indeed, heart rates recorded during competitive situations and blood lactate values recorded post-contest consistently demonstrate differences between the 4 x 2 and 3 x 3 minute formats (Ghosh, 2010; Smith, 2006). Davis, Wittekind and Beneke (2013) in 16 boxers, peak post bout blood [La] was  $11.8 \pm 1.6$  mmol/L irrespective of winning or losing. Post bout blood [La] suggests that boxers must be able to tolerate a lactate production rate of  $1.8 \text{ mmol} \cdot \text{L}^{-1} \cdot \text{min}^{-1}$  and maintain skillful techniques at a sufficient activity rate. The activity profile of elite male amateur boxing has been discussed previously in the literature; each subsequent paper gives more insight and detail. Over the 4 x 2 minute format it was reported that Bosnian and Herzegovina male boxers used the lead straight punch and the lead hook to the head the most, representing 29% and 23%, respectively, of all attacking actions (Kapo et al., 2008).

Egyptian national level 3 x 3 minute male boxers threw 15 punches/min; winners had more lead- and rear-hand punches in round 3 and more straight, hook, and uppercut punches to the head in round 1 than the losers (unfortunately they do not specify lead or rear hand here) (Asker, 2011). It is suggested that for novice amateur male boxers to land punches in 3 x 3 minute bouts they must maintain a high frequency of lead-hand straight punches to the head, together with punching combinations (Davis, Wittekind, Beneke, 2013). However, that study found that regardless of landing punches, triple-punch combinations, even if they did not hit their target, had the highest probability of being scored by judges (Davis et al., 2015). The most recent study in this area reported that 3 x 3-minute male Olympic bouts consisted of  $\sim 1.3$  actions/s, comprising  $\sim 20$  punches,  $\sim 2.5$  defensive movements, and  $\sim 47$  vertical hip movements, all per minute, over 3 subsequent rounds lasting up to 252 seconds (Davis et al., 2015). At this level, unlike the novice boxers, rear-hand punches and the ability to increase punching accuracy over subsequent rounds were important for success. However, the study concluded that "technical discrimination between winners and losers at [the Olympic] level was difficult; outcome may be more dependent on which punch is 'lucky' enough to be scored by the judges or who 'appears' to be dominant on the day." (Davis et al., 2015, pg.56). The aim of this paper is to determine effects of changes of boxing rules on performances of amateur boxers between two state championships of Bosnia and Herzegovina in boxing in 2007.year where combat was performed in format 4x2 minutes and in 2016. year in format 3x3 minutes.

## Methods

### Sample subjects

Sample subjects of this research were  $n=80$  combats from State Championship of Bosnia and Herzegovina in

2007.year and  $n=48$  combats from State Championship of Bosnia and Herzegovina in 2016.year.

### Sample variables

Variables which were monitored as performances of amateur boxers at state championships of Bosnia and Herzegovina in boxing were:

Punches with hand: *Straight punch in head, straight punch to stomach, uppercut to head, uppercut to stomach, cross to head and cross to stomach.*

Basic defenses: *Blocking straight punch with hand, blocking uppercut, blocking cross with arm.*

Advanced defenses: *Avoidance, evasion and deflection*

Tactical elements of boxing: *offensive, defensive and combined*

Way of winning: *knock-out, referee's decision and injury*

### Procedures

All combats at National Championships of Bosnia and Herzegovina in 2007. & 2016.year, were recorded by video camera SONY HANDYCAM DCR- SR75. Two observers analyzed video records and they inserted all data into specially designed tables for registration performances of amateur boxers.

### Reliability

In order to determine the accuracy of the measurements, repeated measures (re-test) of intra-observers and inter-observers were used, who analysed all final fights from National Championships of Bosnia and Herzegovina in 2007. and 2016.year, under the same conditions and with the same equipment. After two weeks the same matches were reanalysed. Percentage error in measuring was calculated by comparing the data from the first measurement (V1) with the data from the second measurement taking into account all the three stages of analysed variables (V2) and using the equation (1) (Hughes, Cooper, & Nevill, 2004).  
Percentage error =  $(V1-V2) / (V\text{mean}) \times 100\%$  (1)  
Intra-observer percentage errors of reliability for National Championships of Bosnia and Herzegovina in 2007. and 2016.year ranged from 0.00% to 1.25%, and the inter-observers reliability for National Championships of Bosnia and Herzegovina in 2007. and 2016.year ranged from 0.00% to 3.18%, which is acceptable to 5%, which is the level of limiting error.

### Data analysis

Analyzed variables are shown in frequencies and percentage means. Chi-square test in the level of statistical significance of 0.01% and 0.05% was analyzed using SPSS 22.0 IBM Corporation, USA, is used for determination effects between two levels of competition with combats of different time format (Field, 2005). In order to determine the significance in the differences between the cells, standard residuals were calculated (*Std. Residual*).



## Results

Results of Chi-square test showed differences between performances of amateur boxers between two state championships in boxing in combats of different time formats. Differences in the level of statistical significance ( $p < .01$ ) occurred in variables of applied punches ( $\chi^2 = 343.7$ ,  $df = 5$ ,  $p < 0.00001$ ), basic defenses ( $\chi^2 = 291.9$ ,  $df = 2$ ,  $p < .00001$ ), advanced defenses ( $\chi^2 = 88.9$ ,  $df = 2$ ,  $p < .00001$ ). The way of winning is significant in level ( $p < .05$ ) of statistical significance ( $\chi^2 = 7.8$ ,  $df = 2$ ,  $p = .019$ ). Performances of amateur boxers in tactical elements didn't show existence of statistically significant differences ( $\chi^2 = 5.4$ ,  $df = 2$ ,  $p = .066$ ) between two state championships with different time format of combats.

Table 1. Performed punches at National championships of Bosnia and Herzegovina (NC B&H) in boxing

		NC B&H 2007. 4x2	NC B&H 2016. 3x3	Totals
Straight punch to the head	Frequency	2901	2629	5530
	%	44,4	53,5	48,3
	Std. Residual	-4.67	+5.41	
Straight punch to the stomach	Frequency	252	242	494
	%	3,9	4,9	4,3
	Std. Residual	-1.8	+2.08	
Uppercut to the head	Frequency	134	209	343
	%	2,0	4,3	3,0
	Std. Residual	-4.45	+5.14	
Uppercut to the stomach	Frequency	105	195	300
	%	1,6	4,0	2,6
	Std. Residual	-5.09	+5.89	
Cross to the head	Frequency	2791	1347	4138
	%	42,7	27,4	36,2
	Std. Residual	+8.69	-10.06	
Cross to the stomach	Frequency	354	292	646
	%	5,4	5,9	5,6
	Std. Residual	+4.6	+0.89	
Totals	Frequency	6537	4914	11451
	%	57,1	42,9	100,0

Table 2. Basic defenses

		NC B&H 2007. 4x2	NC B&H 2016.3x3	Totals
Blocking straight punch with the arm	Frequency	169	1170	1339
	%	27,1	65,1	55,3
	Std. Residual	-9.45	+5.57	
Blocking uppercut with arm	Frequency	24	80	104
	%	3,8	4,4	4,3
	Std. Residual	-0.44	+0.26	
Blocking cross with arm	Frequency	431	548	979
	%	69,1	30,5	40,4
	Std. Residual	+11.26	-6.63	
Totals	Frequency	624	1798	2422
	%	25,8	74,2	100,0

Table 3. Advanced defenses

		NC B&H 2007 4x2	NC B&H 2016 3x3	Totals
Avoidance	Frequency	412	176	588
	%	25,5	45,2	29,3
	Std. Residual	-2.82	+5.75	
Escapes	Frequency	909	118	1027
	%	56,2	30,3	51,2
	Std. Residual	+2.81	-5.72	
Deflection	Frequency	295	95	390
	%	18,3	24,5	19,5
	Std. Residual	-1.09	+2.22	
Totals	Frequency	1616	389	2005
	%	80,6	19,4	100,0

Table 4. Tactical elements of boxing

		NC B&H 2007 4x2	NC B&H 2016 3x3	Totals
Offensive	Frequency	10	12	22
	%	12,5	25,0	17,2
	Std. Residual	-0.88	+1.13	
Defensive	Frequency	15	12	27
	%	18,8	25,0	21,1
	Std. Residual	-0.33	+0.43	
Combined	Frequency	55	24	79
	%	68,7	50,0	61,7
	Std. Residual	+0.8	-1.03	
Totals	Frequency	80	48	128
	%	62,5	37,5	100,0

Table 5. Way of winning

		NC B&H 2007 4x2	NC B&H 2016 3x3	Totals
Knock-out	Frequency	3	8	11
	%	7,5	33,3	17,2
	Std. Residual	-1.29	+1.66	
Referee's decision	Frequency	35	16	51
	%	87,5	66,7	79,7
	Std. Residual	+0.46	-0.6	
Injury	Frequency	2	0	2
	%	5,0	0,0	3,1
	Std. Residual	+0.67	-0.87	
Totals	Frequency	40	24	64
	%	62,5	37,5	100,0

## Discussion

Application of rules changes demands of general, basic and specific abilities and features which are necessary for successful training and competitive activities and therefore changes in planning and programming complete training process of an athlete, which gets more demanding every day. Correct application of rules and competitor's knowledge of them contribute to efficiency of training process and saves precious time on disputable situations which

became normal phenomenon in sport. Analyzing results of performed punches from two state championships in boxing (Table 1.) and based on results of standard residuals it is evident that there were positive changes in performed punches (straight punches and uppercuts) during the application of rule 3x3 minute format as oppose to 4x2 time format rule. However, application of cross to the head didn't lead to positive transformations and they stayed dominant in combats of 4x2 minute format. This points to the fact that competitors who fought by rules of 4x2 time format had bigger frequency of cross punches because of its technical features which were emphasized with bigger dynamics during the combat and shortening the distance which at the end resulted with this score of applied punches. Competitors who fought by 3x3 time format rules had dominant, fast, easy and précised straight punches with low energy consumption of a boxer. It is interesting that uppercuts had significant application in 3x3 time format rule than in 4x2 time format rule. This is most probably because they had enough room for adequate preparation of performance and the fact that uppercut is technically and tactically most demanding punch in boxing and based on these indicators it can be concluded that analyzed boxers of state championships of Bosnia and Herzegovina were technically very well prepared. There were no significant changes in application of cross to the stomach and the reason for this is that these punches are performed as feinting punches to the head and as punch in series of attacks on semi-distance. Apart from this, cross to the body is applied when boxer is certain that he will hit the aim and that he will finish the action to the opponent's body without consequences. Obtained results in this research are confirmed by research of El-Ashker (2011) which analyzed technical and tactical aspects of boxing matches which differentiate winners and losers and came to the conclusion that winners have better offensive technique of straight punch to the head or body, punches with lead or rear hand, combination of punches and defensive way of fighting in 3x3 time format. Effects of change of rules reflected positively on basic defense in boxing in two segments NC BI&H when applying 3x3 rule (NC B&H, 2016) in relation to 4x2 rule (NC B&H, 2007) (Table 2). The biggest application had defense, blocking straight punch with hand (Std.Rezidual. +5.57) which is part of basic defense.

Also, positive effects reflected on application of blocking uppercut with hand (Std.Rezidual. +0.26). However, change by rules 3x3 didn't occur in blocking cross with hand. They stayed dominant at competition in 2007. where combat lasted 4x2 minutes (Std.Rezidual. +11.26). These data concur with data form Table 1. which tells us that defenses were applied situationally and depending on punches which were dominant and which was caused by change of 3x3 minute rule. It contributed to the fact that dominant defenses were: blocking straight punch with the hand and blocking uppercut with the hand, and number of straight punches and uppercuts was bigger in 3x3 rule than in 4x2 rule (Std. Rezidual). In 4x2 rule there was big-

ger number of (Std. Rezidual) of performed cross punches which was caused by rule of decreasing time limit from 4x2 minutes where intensity of combat in semi-distance and close fight and punch and defense had better application of performance.

Results of change of rules in boxing reflected positively to the advanced defense in boxing in two segments of NC BI&H when applying 3x3 minute rule (NC B&H 2016) in relation to 4x2 minute rule (NC B&H 2007, Table 3.). Avoidance (Std.Rezidual. +5.75) and deflection (Std.Rezidual. +2.22) had more significant application in combats of 3x3 minutes format while escapes (Std.Rezidual. +2.81) stayed dominant in combats of 4x2 minute format. Application of avoidance in 3x3 minute format, from tactical aspect, were directed to forcing attack at semi-distance in terms of more active attack in contact with the opponent, by using technical segments of avoidance, which are useful for blocking cross punches, where boxers put themselves in good position and perform contra attack with their free arm.

Dominance of application of defense by deflection in 3x3 minute format was used by boxers in combats against straight punches to the head because defense is performed timely and correctly by deflection which enables boxers to put themselves in advantageous exit position to perform contra attack with return punch which occurred with application of 3x3 minute rule and forcing combats with straight punches. Dominance of defense by reflection (bending to the back) by the rule of 4x2 minute format, is shown because of the fact that return punches can be performed during the short-distance and semi-distance combats. All indicators from different segments of boxing combats, according to different rules, reflected on the final result and that is the way of winning (Table 5). In 3x3 minute combats there is bigger number of winnings by knock-out (Std.Rezidual. +1.66). Quality of boxing technique is emphasized through application of 3x3 minute rule because boxers can have quality preparation for attack from a distance by using straight punches and punches in series by using other technique elements which resulted with ending before regular end of combat. This also creates opportunity for efficient combat. Type of winning in which referees made final decisions in combats dominated in competitions of 4x2 format (Std.Rezidual. +0.46). Because of high intensity of exchange of punches in semi-distance and in short-distance where boxers couldn't use their most efficient technical-tactical advantages because of shortness of time, referees had dominant role in deciding the winner. Rules are important because they protect health of boxers. By applying the 3x3 rule there were no injuries of boxers in combats (Std.Rezidual - 0.87). This happened probably because fighters had better control during the combat which caused less injuries and better efficiency. Abandoning the combat because of injury happened in two cases, by application of the rule 4x2 minute format (Std. Rezidual. +0.67) because of bigger frequency of punches at semi-distance and clinching where fighters have con-

stant activity of higher intensity which resulted with uncontrolled punches and weaker defense due to tiredness. Obtained results of two state championships of Bosnia and Herzegovina with different time duration of combats point to justification of AIBA decision to change rules of duration and number of rounds in boxing. Results of this research are similar to the results of research of Kruszewski et al. (2016) who analyzed final combats of Olympic games in 2012. in London. Straight punches are most commonly used punches in relation to uppercuts and crosses while the most common way of defense is application of contra punches, which points to the conclusion that avoidance and deflection give opportunity of efficient contra attack. El-Ashker (2011) analyzed technical and tactical aspects of boxing matches which differentiate winners and losers and found out that winners have more developed offensive technique of straight punch to the head or body, punches with front and rear hand, combination of punches and defensive way of fighting in 3x3 minute matches in 33 rounds and that winning in boxing demands great effort of boxer to apply more efficient punches of than the opponent. Obtained results of this research are the same as the results of research of Hickey (2006); Blower, (2007) who determined that straight punch is the most efficient punch in boxing.

Davis, Wittekind and Beneke (2013) winners landed  $18 \pm 11$  more punches than losers by applying more lead-hand punches in round 1, total punches to the head ( $121.3 \pm 10.2$  vs  $96.0 \pm 9.8$ ), and block and counterpunch combinations ( $2.8 \pm 1.1$  vs.  $0.1 \pm 0.2$ ) over all 3 rounds and punching combinations ( $44.3 \pm 6.4$  vs  $28.8 \pm 6.7$ ) in rounds 1 and 3 (all  $P < .05$ ). The results suggest that landing punches requires the ability to maintain a high frequency of attacking movements, in particular the lead-hand straight punch to the head together with punching combinations. Defensive movements must initiate a counterattack.

All these indicators from state championships of B&H and from researchers which researched boxing by applying different rules, point to the fact that it is necessary to, according to 3x3 minute rule, develop straight punches and crosses of advanced defense, avoidance and deflection and improve application of uppercuts, basic defenses and advanced defenses of avoidance at training. Significance of this research is reflected in opportunity that coaches can apply obtained results in their work with younger boxers and to create quality assumptions for creation of complete boxers of senior rank.

## Conclusion

Obtained results of two National championships of Bosnia and Herzegovina in 2007.year and in 2016.year with different time duration of combats point to the justification of the decision of International Boxing Association (AIBA) to change rules of duration of combat and number

of rounds in boxing. Matches that lasted 4x2 minutes at National Championship of Bosnia and Herzegovina caused increase of intensity of combat through increased frequency of punches and reduce of quality of performances of technical-tactical elements with potential injuries and less attractive boxing for viewers. International Boxing Association (AIBA) returned to the old rule of 3x3 minute format, making good decision for boxing because boxers can show their best technical-tactical qualities with bigger efficiency and reduce of injuries and therefore boxing is more interesting to watch. Results of this research can be useful for referees' organizations, coaches and competitors at all levels of competition in function of more efficient planning and programming training process and especially for boxing scientific community, which has an obligation to help in creation of quality boxers.

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# ASSESSMENT OF HEALTH BEHAVIOUR AMONG SCHOOL AGE CHILDREN REGARDING THEIR PHYSICAL ACTIVITY AND EATING HABITS

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## Abstract

Proper eating habits and physical activity are important part of healthy lifestyle, therefore they should be adopted in younger age. This study aims to determine representation of physical activity and assesment of eating habits of the school age children regarding their age and therefore suggest proper health improvement measures of the school age children. The instrument of the study was questionnaire specifically designed for the research purposes, predicted for AutoFill. Retrospective cross sectional study was carried out on the sample of 150 respondents divided in three groups based on their school age, of which 82 (54,7%) were girls and 68 (45,3%) were boys. Number of students actively involved in sport significantly decreases with older school age ( $p=0,0001$ ). Furthermore, time spent in walk or bicycle riding is also decreasing with older school age ( $p=0,006$ ). On the contrary, time spent in front of a TV or computer is significantly increasing with age ( $p=0,0001$ ). There is obvious problem of overweight and obese children and adolescents, affected more than 1/5 of the 3rd grade High school children. Educational and health institutions should be more engaged in resolving this problems, in order to promote health and prevent later diseases and/or complications.

Key words: **dietary pattern, overweight children, adolescents, junk food, sedentary behaviour**

## Introduction

School children are representing one third of the population. Population this large, which represents future, requires special attention, especially in the terms of health. With life conditions improvement, raising level of health culture, numerous diseases are vanished. Among this population, age interval from 15 till 18 years is especially critical. There is clear connection between obesity in child age and obesity in later in the adulthood. Even 77% children with body mass index (BMI) equal or higher from 95th percentile has BMI equal or higher than 30 kg/m<sup>2</sup> in the adulthood, although only 7% of children with normal BMI in childhood become obese in the adulthood (Freedman et al., 2001).

There are many convincing evidences that children and adolescents spend majority of the day physically inactive (sedentary lifestyle). However, physical inactivity differs among young people regarding their interpersonal skills, personal characteristics and enviromental factors as well (Gomes et al.,2015). Physical inactivity represent main/leading risk factor for development of coronary disease, it increases risk of cerebrovascular stroke/incident and other

major cardiovascular risk factors, such as obesity, high blood pressure, low level of HDL and diabetes.

Proper eating habits are important part of healthy lifestyle, and they should be adopted in younger age as such. Balanced diet of youngsters is a foundation for healthy growth, preservation and promotion of health, on the one hand, and could be cause of illness or its complications, on the other hand (Nelms, 2001). Eating habits are mostly adopted in childhood, within circle of family and friends, and they affect „junk food“ consumption frequency in the adulthood (French et al., 2001).

Significant connection is proved between health behaviour in the youth with lifestyle and health behaviour in the adulthood. Prevention of negative health behaviour pattern establishment in the early age is considered to be simpler and more effective rather than attempts of alteration already established patterns in the older age/adulthood.

This study aims to assess health behaviour among school age children regarding their physical activity and eating habits, and, furthermore, to suggest proper health improvement measures of the school age children.

## Methods

### Participants

This study represents retrospective cross sectional study carried out on the sample of 150 respondents divided in three groups based on their age, who don't suffer from severe chronic disease and voluntarily participated in this study. The first group is consisted of the fifth grade elementary school pupils; the second group is consistent of ninth grade elementary school pupils; the third group is consisted of the third grade high school pupils (50 respondents each group). Interviewed pupils were from Elementary School „Musa Ćazim Ćatić“ in Sarajevo, and Catholic High School-Medical School department in Sarajevo.

### Variables sample

The instruments of the study was Questionnaire designed for this research purposes, with required measurements by medical professional. Questionnaire is designed and adapted by the Department of Public Health and Preventive Medicine, Faculty of Medicine, University of Sarajevo, based on standardized Food and Frequency Questionnaire „FFQ“ (Johansson et al. 2002), Physical Activity Questionnaire for Children „PAQ-C“ (Kowalski et al., 1997) and Physical Activity Questionnaire for Adolescents „PAQ-A“ (Kowalski et al., 1997).

Questionnaire is consisted of general informations (school age, sex) and chapters related to the eating habits (number of meals, eating speed, frequency of eating breakfast, sweets right after waking up, type of snacks and beverages in schools, frequency of eating fruits, vegetables, fish, meat, candies, milk and dairy products, type of beverages in general) and physical activity/inactivity (time spent in sport activities, walk, bicycle riding, in front of a TV or computer). Body weight and height were measured and BMI calculated on site by medical professionals.

### Statistical analysis

Statistical analysis was performed using SPSS software (version 23.02., SPSS Inc, Chicago, Illinois, USA). Values were expressed as frequency and percentages. Analysis of associations of the outcome and risk factors was performed by Pearson Chi-square test for independent samples. Results of the analysis were considered statistically significant with p-value less than 0.05 %.

## Results

The study included 150 patients, of which 82 (54,7%) were girls and 68 (45,3%) were boys. According to our research activity plan, respondents are divided in 3 groups, based on a school age. The first group is consisted of the fifth grade elementary school pupils, the second group is consistent of ninth grade elementary school pupils, the third group is consisted of the third grade high school pupils.

Gender distribution analysis shows that in the 5<sup>th</sup> grade Elementary school ( ES) there was 56% of boys and 44% of girls. In the 9<sup>th</sup> grade of Elementary School ( ES), boys and girls were equally represented (50%), and in the 3<sup>rd</sup> grade of High School (HS), girls were dominant (70%) over boys ( 30%).

Number of students actively involved in sport significantly decreases with older school age ( $p=.0001$ ), with 84% pupils in the 5<sup>th</sup> grade ES, 56% pupils in the 9<sup>th</sup> grade ES and 28% pupils in the 3<sup>rd</sup> grade HS (Table 1).

Table 1. Distribution of the respondents in relation to school age and sport activity

		Class			Total	
		5th ES	9th ES	3rd HS		
Actively involved in sport	Yes	N	42	28	14	84
		%	84,0	56,0	28,0	56,0
	No	N	8	22	36	66
		%	16,0	44,0	72,0	44,0
Total		N	50	50	50	150
		%	33,3	33,3	33,3	100,0

$\chi^2=31,818$ ;  $df=2$ ,  $p=.0001$

Furthermore, time spent in walk or bicycle riding is also statistically significantly decreasing with older school age ( $p=.006$ ) ( Table 2).

Table 2. Distribution of the respondents in relation to school age and time spent in walk or bicycle riding

		Class			Total	
		5th ES	9th ES	3rd HS		
Time spent walking or riding bicycle (daily)	Less than an hour	N	9	16	26	51
		%	18,0	32,0	52,0	34,0
	1-3 hours	N	35	26	21	82
		%	70,0	52,0	42,0	54,7
	More than 3 hours	N	6	8	3	17
		%	12,0	16,0	6,0	11,3
Total		N	50	50	50	150
		%	33,3	33,3	33,3	100,0

$\chi^2=14,506$ ;  $df=4$ ,  $p=.006$

On the contrary, time spent in front of a TV or computer is significantly increasing with age ( $p=.0001$ ) ( Table 3).

Table 3. Distribution of the respondents in relation to the school age and time spent in front of a TV or computer

		Class	Class			Total
			5th ES	9th ES	3rd HS	
Time spent in front of a TV or computer (daily)	Less than an hour	N	27	7	11	45
		%	54,0	14,0	22,0	30,0
	1-3 hours	N	19	24	24	67
		%	38,0	48,0	48,0	44,7
	3-5 hours	N	4	14	14	32
		%	8,0	28,0	28,0	21,3
More than 5 hours	N	0	5	1	6	
	%	0,0	10,0	2,0	4,0	
Total	N	50	50	50	150	
	%	33,3	33,3	33,3	100,0	

$\chi^2=28,930$ ;  $df= 6$ ,  $p=.0001$

Analysis of the number of the meals shows that most of respondents consume 3 or 4 meals per day in all interviewed groups, with non-significantly decrease in older age ( $p=.094$ ). Most of the respondents in all 3 groups eat with moderate speed, although it's observed that speed of eating is significantly increased with older school age with 6% in the 5th class of ES, 18% in the 9th class of ES and up to 30 % in the 3rd grade of HS, with statistically significant difference ( $p=.003$ ). All of the 5th graders in our study eat breakfast (100%), while 88% of the 9th grade ES pupils and 80% of the 3rd grade HS pupils do so. This difference is statistically significant ( $p=.005$ ). Even though percentage of the respondents who eat sweets right after awakening increases with older age, from 4% in the 5th grade up to 14 % in the 3rd grade, this is not statistically significant ( $p=.211$ ). The 5th grade ES pupils mostly eat sandwich or fruit as a snack, 9th grade ES pupils pastry and sandwich, the 3rd grade HS pupils mostly pastry or nothing at all, which shows statistical significance ( $p=.0001$ ). Mostly drunk beverage with snack is water in all grades, although there is significant difference when it comes to percentage of those who drink water with older school age, which decreases in older grades, and, respectively, percentage of those who drink sodas, juices and yogurt increases with older school age ( $p=.023$ ).

Furthermore, frequency of vegetable consumption decreases with aging with statistically significant difference in relation of school age, therefore, 58% of 5th grade ES pupils, 46% of the 9th grade pupils and 26% of the 3rd grade pupils eat vegetable every day ( $p=.001$ ). Even though frequency of fish consumption decreases with older age, this differences are not statistically different ( $p=.667$ ). Most of the 5th and the 9th grade ES pupils eat fish once a week, and 3rd grade HS pupils mostly once in two weeks.

Frequency of meat consumption is mildly increasing with age; most of the respondents in all 3 groups eat meat every other day. Those results are without statistical significance ( $p=.388$ ). Frequency of consumption of the sweets increases with school age, without statistical significance ( $p=.233$ ). Frequency of the milk and dairy products consumption significantly decreases with age ( $p=.001$ ), in a way that daily consumption of milk and dairy products was in 80%, 54% and 42% of the 5th, 9th and 3rd grade pupils, respectively. Water is shown as main beverage during the day in all groups, but statistically significant difference is reported in a way that percentage of those who drink mainly water decreases, and, respectively, number of those who consume juices and milk as main beverage during the day increases with older school age ( $p=.018$ ).

## Discussion

Some of the major factors which affect increase of mortality and morbidity rate in the general population and which could be influenced upon are irregular eating habits, physical inactivity, smoking, sleeping habits. Reduction of exposition to those factors is one of the principle assignments of Primary Health Carte and society, as well.

Obesity is predisposing factor for appearance and development of many chronic non-contagious diseases, for example: cardiovascular diseases, hypertension, early atherosclerosis, diabetes mellitus type 2, endocrinological, orthopedic, psychosocial disorders etc. representation of obesity among school age children is steady growth. (Džubur et al., 2012). Children's body weight is affected with numerous factors, such as: high calorie diet, excessive food intake, lack of physical activity, increased time spent in sedentary activities. (Džubur et al., 2009).

In our study, there was 15, 3% overweight and obese respondents, 83, 3% of normal weight respondents, and 1, 3% of underweight respondents. In the 5<sup>th</sup> grade of elementary school, 92% of children had normal weight, 2% were underweight and 6% were overweight and obese. In the 9<sup>th</sup> grade of elementary school, there was 80% of normal weight pupils, percentage of the underweight pupils remain the same (2%), and 18% of the respondents were overweight or obese. In the 3<sup>rd</sup> grade of high school, there were no underweight respondents, 78% had normal weight and 22% were overweight or obese children. These results clearly show that number of overweight children is increasing with their age.

Available assessments for time period of 1980's and 1990's point out increase of obesity in the developed countries even two to five times more ( e.g. from 11% up to over 30% in boys in Canada) and almost four times in the developing countries (e.g. from 4% up to 14%) in Brazil (Flynn et al., 2006). Study carried out in the Australia demonstrates a „plateau“ or just mild increase in the percentage of the boys and girls classified as obese, almost without any change during last 10 years.

Prevalence is 21-25% for both overweight and obese boys and girls, respectively 5-6% for obese boys and girls itself. (Olds et al., 2010). Top two countries with the highest prevalence of overweight and obese youth are Malta (25,4% and 7,9%) and United States of America (25,1% and 6,8%), while two countries at the bottom of the list, with the least prevalence are Lithuania (5,1% and 0,4%) and Latvia (5,9% and 0,5%). Prevalence of overweight and obesity is significantly high in the North America, United Kingdom and southwest Europe (Janssen et al., 2005). Prevalence of obesity among our respondents increases with age. It is also confirmed with other studies, such as study of Kyungwon et al. (2008) carried out in Korea, and study of Cynthia et al. (2012) carried out in the USA.

Results of our study points that 56% of the respondents are actively involved in some sport. However, data showed that among them, there is very small part of the 3rd grade high school pupils, which is quite disturbing. Videlicet, in the 5th grade of elementary school even 84% of pupils were actively involved in sport, in the 9th grade 56%, and just 28% in the 3rd grade high school pupils. Similar results are reported in Sherar L. et al. research carried out in 194 boys and 207 girls. Their results demonstrate that physical activity rapidly decreases during childhood and adolescence (Sherar et al., 2007). Decrease of the physical activity with age was also a conclusion of study carried out in youth sample of 238 boys and 265 girls from age 6 till 18 years old divided in 4 groups based on age (Lopes et al., 2007), and study from 2011. year carried out among pupils from 10 till 19 years old. (Dumith et al., 2011). Children and adolescents should be engaged in one or more hours daily. Physical activity should be adjusted according to the age, pleasant and versatile. (Landry et al., 2012). According to the results of our study, the most pupils from the 5th grade of the elementary school (70%), spends 1-3h engaged in moderate, which includes walking, riding a bicycle, and 18% of them spends less than one hour to do so. With age, number of children spending less and less time in moderate physical activities is increasing, therefore, most of the 3rd grade high school pupils spend less than an hour in moderate physical activities (52%). Studies conducted in Canada indicates that 9% boys and 4% girls spend 60 minutes of moderate to intense physical activity at least 6 times a week, with boys being more active than the girls. Canadian children spent 8,6h per day (62% of their wake hours) accustomed to their sedentary activities. Based on results of that study it's shown that level of physical activities of Canadian children is very low (Colley et al., 2011). *National Health and Nutrition Examination Survey* show that children aged 6-11, 12-15, and 16-19 spend sitting approximately 6.1, 7.5 and 8.0 hours, respectively. It implies that there is higher level of physical inactivity in older age, which is complementary with results in our study (Pate et al., 2011).

In our opinion, reason for decreased level of physical activity in older age is multifactorial. It is noticeable that in past decades with rise of digital era, media is targeting children

and adolescents, providing variety of interesting content. Children and adolescents are spending most of their time on line, watching TV, playing games, social networking, and numerous other digital stimuli which are very available and accessible. Older children are more submissive to those trends, but it is general concern that age limit for the virtual experiences is dropping low.

On the other hand, there is lack of infrastructure for the variety of sport activities that school aged children would find interesting. Even those who enjoy sport activities, face other obstacles, since active involvement requires a lot of expenditures, starting from the memberships and mandatory equipment to the travel costs, and even time for their parents to drive them back and forth to the practice, which is not always possible, in terms of parent's working hours or even possession of the vehicle. In the socio-economic matter of speaking, online activities and screen time are affordable alternative for the sports in the parent's eyes.

Children and adolescent are subjected to various social factors-socioeconomical status, culture, tradition, industrialization itself; thus, that group of population spends more and more hours in sedentary conditions (TV, videogames, and computer). In terms of spending time watching TV, 30% of the commercials shown are about food and other alimentary products, and 80% of those commercials is about unhealthy „junk food“. Regarding unawareness' and lack of self-consciousness of this particular group of population about what this food does, there is bigger chance and probability that they will buy the food that was suggested via commercials on TV (Crowle and Turner, 2010). Boys and girls who are spending less time in front of a TV or at the computer has less chance to be obese, regardless the level of physical activity (Eisenmann et al., 2008). Time respondents spent in front of the TV or computer is statistically significantly bigger in relation to the age, according to the results of our study. Results of the study conducted in Romania on children aged 11-18 years show that high school pupils spend over 3h daily in front of their computers. Furthermore, the study among the young aged 2-18 years indicates that they spend 2-4h daily watching TV or at the computer, and even 5-10h sedentarily (Chiriță, et al. 2006). Ethnicity, sociodemographics, parental behavior, whether they have TV or computer in the room, it all affects time period spent on watching TV (Salmon et al., 2011).

Our study analysis of number of the meals per day have shown that most of the respondents in all three groups consume 3 (40%) or 4 (40%) meals per day. Study carried out by Andre et al. (2005) resulted with similar percentage (43, 4%) of the respondents who had 4 meals per day, although the percentage of the respondents who had 5 meals per day (39%) was bigger than in our study (16%). Prevalence of the overweight and obese respondents increases with decrease of the number of the meals, which was also a result of the previously mentioned study (André



et al. 2005). Maruyama et al. (2008) affirms significant relation between eating speed and obesity, in order that persons who eat faster has increasingly higher chances to become overweight (Maruyama et al., 2008). Our study had shown that most of the respondents in all age categories eat with moderate speed, although it is notable that with older age, eating speed rises, from 6% in the 5th grade ES up until 30% in the 3rd grade HS, with statistical significance. Breakfast is the most important meal in the day, which has positive effect to the children's health. Skipping breakfast is common practice in the USA and Europe (even 30%) regarding age and population. Our research showed that all children in the 5th grade ES eat breakfast, and with older age percentage of the children who are skipping it increases (12% in the 9th grade ES and 20% in the 3rd grade HS). Similar results were found in the Netherlands study, with 3-16% of children skipped breakfast at age 4-11 years and 16-20% at the age 12-18 (Vingerhoeds, 2015).

In the study carried out in the USA, 20% of children skipped breakfast at age 9-13 years and 31, 5% at the age 14-18 years (Deshmukh-Taskar et al., 2010). Increased body mass in older grade students can be attributed to the type of food they eat for snack. Results of the our study show that majority of the 5th grade ES students takes fruit as a snack, which isn't the case in the older grades, who mainly eat pastry. Children in the higher grades eat more and unhealthier conducted in the USA (Finkelstein et al., 2008). Mostly used beverage with snack was water in all age groups, with significant difference in relation to the increase of the number of those who also consume sodas. Refreshing drinks with added sugar became a trend and desirable habit among children. Study carried out on 3098 respondents had also pointed out increase usage of the sugar sodas among adolescents regarding the children of younger age (Wang et al., 2009). Results of our study match results of the showing frequency of the fruit and vegetable consumption among children and adolescents decreases with age (Rasmussen et al., 2006). Our research indicates that consumption of meat increases, and consumption of fish decreases with older age, both non-significant. Similar results are acquired in Serbia (Šarčević et al., 2015). Candies were consumed everyday by 28% of the 5th graders up to the 50% of the 3rd grade High School students. German research conducted upon 7186 boys and 6919 girls showed that 16% of the respondents eat chocolate everyday and almost 20% eat other candies as well (Mensink et al., 2007). Everyday milk and dairy products consumption significantly differed among the school age, with total of 58, 7%. Therefore, in the 5th grade ES 80% of the students consumed milk and dairy products everyday, 54% in the 9th grade ES and 42% in the 3rd grade HS. Research conducted in the USA among children and adolescents showed that 77% of boys and 67, 4% of girls daily consume milk and dairy products (Kit et al., 2011). Main beverage during the day was water, in our study, even though part of the students who consumed sodas rises with age, at the expense of the water consumption.

## Conclusion.

Based on the result analyses, we conclude that there is obvious problem of overweight and obese children and adolescents, affected more than 1/5 of the 3rd grade High school children. Younger school age children tend to eat healthier and be more physically active then the older ones. Time spent in front of a TV or computer considerably increases with older school age.

Center for disease control (CDC) recommends 30 minutes of moderate physical activity at least 5 times a week, for adults, and daily 60 minutes during whole week for the adolescents. (Buelow and Ngo, 2012). Two hours is a daily maximum for time spent in front of the TV or computer. (August et al., 2008). Eating breakfast gives you smaller chance to become overweight or obese, on the contrary, some studies have shown that skipping breakfast can be related to the body mass increase (Rampersaud et al., 2005). American Heart Association recommends at least two portion of fish per week in order to achieve cardio-protective effect. (Smith and Sahyoun, 2005). Educational and health institutions should be more engaged in resolving this problems, in order to promote health and prevent later diseases and/or complications.

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# COMPARISON OF BODY COMPOSITION AND FUNCTIONAL PROFILE OF FEMALE BASKETBALL PLAYERS

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*Original scientific paper*  
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## Abstract

In many countries, basketball has established itself as one of the most popular sports. The aim of this study was to examine and analyze body composition and functional profile of cadet basketball players. The sample subjects were 20 female basketball players of KK Zeljeznicar (age =  $15:30 \pm 0.82$ ; height =  $172.0 \pm 5.94$ ), whose composition of the body (height, weight, BMI, FatP) and parameters of spirometry (FVC, FEV 1, FEV / FVC, PEF) were examined. The results showed that basketball players from KK Zeljeznicar are lower than their peers but they are much heavier and that the percentage of fat is a lot higher than in previous studies. Also all variables of spirometry indicate significantly lower means in relation to previous studies. These results indicate importance of further work on the physical preparation of a basketball player, because creation of adequate base directly affects better sports results.

Key words: **spirometry, BMI, Tannita, basketball profile, training, coach**

## Introduction

Basketball season requires from basketball players a high level of readiness and therefore involves a high level of cardio-respiratory function. Basketball is a sport that combines cyclic and acyclic types of movement with or without a ball (Erčulj, 2010). Based on the rules of FIBA basketball game is consisted of four quarters that last 10 minutes and a break of 1.5 minutes, after two quarters followed by half with a break of 15 minutes. During a period of 40 minutes female players run across 5553 and 6231 meters using various types of movement, such as jogging, sprints with or without the ball, jumping, etc., which is considerably less than the male players who run across  $7558 \pm 575$  m (Scanlan et al., 2012).

Although basketball is considered that it is not primarily a sport of endurance, it involves high level of cardio-respiratory function, which is inevitable to withstand high intensity in basketball game. Tests for the assessment of lung capacity that provide qualitative and quantitative information about the function of the lungs are one of the most important tests to assess physical fitness of athletes. Breathing process involves exchange of oxygen from the atmosphere to the cells (respiration) and vice versa (expiration) (Ikonomi et al., 2016). Exchange of oxygen and carbon dioxide between body cells and the atmosphere is changeable in relation to physical activity, and together with the ability of circulatory system. it sig-

nificantly enables physical activity. Such exchanges are tested by the method of spirometry which measures static and dynamic lung volumes. As it is very well-known, developments of lung capacity and volumes are directly influenced by duration, type and intensity of sports activity. Aerobic trainings have the biggest impact on the increase in vital capacity, however ventilation values in pre-pubertal and pubescent age are changing along with the anthropometrical characteristics (Hraste et al., 2009). Examination of lung functions is one of the most important diagnostic procedures in sports, and as possible reasons for poor lung function stands out the type of sport and intensity of physical activity (Mazic et al., 2015), gender (Malina et al., 2004), age (Cotes, Chinn, & Reed, 2001), anthropometrical characteristics of which body weight and percentage of body fat is one of the key elements of success in basketball (Nunes et al., 2009; Tan et al., 2013). Physical abilities of athletes, in any sport, are among the most important predictors of achieving higher levels and top results. Until present day, there are very few researches which determine the body composition and functional profile of basketball players in Bosnia and Herzegovina, and based on that the question is what the real state of basketball players at the cadet level in Bosnia and Herzegovina is. The primary objective of this study was to examine and analyze body composition and functional profile of cadet basketball player.

## Methods

### The sample

The sample subjects of this research are 20 healthy basketball players, non-smokers (age  $15.30 \pm 0.82$ ), representing the basketball club "Željeznica" season 2014/2015. These players are second on the table Bosnia and Herzegovina state championship aforementioned season and most of them were invited to the cadet national team. Since these basketball players are minors, parents of all respondents have signed approval for implementation of the research.

### The sample of variables

The variables used in this study, in addition to the number of years and height (cm) include variable body composition, body weight (kg), percentage of body fat - FatP (%), body mass index – BMI ( $\text{kg}/\text{m}^2$ ). Also variables spirometry forced vital capacity – FCV (l), forced expiratory volume in the first second – FEV<sub>1</sub> (l), ratio of exhaled in the first second of the entire amount that you can exhale - FEV<sub>1</sub>/FCV (%), peak air flow on the exhale – PEF ( $\text{l} \times \text{s}^{-1}$ ) are included.

### Testing protocol

All subjects, before testing procedure, have informed about the nature of testing. Testing began at 9: 00h, and all players had identical and optimal conditions for testing. Body composition was tested on a bioelectrical impedance scale

TANITA BC 420 SMA (TANITA Europe GmbH, Sindelfingen, Germany) where the basketball players wore only underwear. Spirometry parameters were tested in sitting position, with the nose clip, and test was repeated three times for every subject, and the one with the best technique is taken into account. Spirometry was performed by Spiro-M PC (Ultrasound Spirometer PC with 3D Ultrasound Wavefront Technology).

### Statistical analysis

In order to interpret and discuss the results of this study, descriptive statistics (mean and standard deviation) was calculated. Data analysis was performed by the SPSS statistical package 21. in Windows operating system.

## Results

Results of descriptive parameters: age, height, weight, percentage of body fat, BMI and spirometry variables of basketball players are shown in Table 1. Considering the results of research Delextrat, Bernard, & Bieuzen, 2014 ( $15.1 \pm 0.4$  years old,  $176.9 \pm 11.2$  cm,  $65.7 \pm 10.9$  kg) it is noticeable that the players of this study are approximately the same age ( $15:30 \pm 0.82$ ) but they have much lower Height =  $172.0 \pm 5.94$  cm and weight weight =  $71.41 \pm 4.77$  kg. BMI ( $24.24 \pm 2:46$ ) and Fat percentage ( $29.91 \pm 3.87$ ) which showed significantly higher values in relation to the research Erčulj et al., 2010 Variables spirometry FCV =  $4.06 \pm 0.50$ , FEV<sub>1</sub> =  $3.22 \pm 0.51$  FEV / FCV =  $79.08 \pm 5:44$ , PEF =  $4.66 \pm 0.95$  compared to the results Myrianthefs et al., 2014 point to a lower means in all treated variables.

Table 1. Results of descriptive parameters

	Tannita and spirometry							
	KK Željeznica		Delextrat, et al., 2014		Myrianthefs, et al., 2014		Erčulj et al., 2010	
	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation
Age	15.10	0.82	15.10	0.40	16.7	0.20	14.58	0.52
Height (cm)	172.0	5.94	176.90	11.20	169.9	1.50	174.29	7.95
Weight (kg)	71.41	4.77	65.70	10.90	61.3	1.50	63.70	8.20
Fat procentage (%)	29.91	3.87	/	/	/	/	22.05	4.21
BMI ( $\text{kg}/\text{m}^2$ )	24.24	2.46	20.96	0.77	21.28	1.5	20.90	1.80
FCV (L)	4.06	0.50	/	/	4.34	1.20	/	/
FEV <sub>1</sub> (L)	3.22	0.51	/	/	3.81	0.98	/	/
FEV/FCV (%)	79.08	5.44	/	/	87.2	0.85	/	/
PEF (L/s)	4.66	0.95	/	/	/	/	/	/

## Discussion

The aim of this study was to examine and analyze body composition and functional profile of cadet basketball players. Comparing results of this research with results of previous research it can be concluded that players of KK Željeznica are shorter in average than their peers but they are heavier and their fat percentage is much higher in relation to the subjects of above-mentioned research. Significant differences in these variables can be attributed to the training process, better selection and more quality diet. However, since this research was performed on female basketball players aged  $15.10 \pm 0.82$  this difference can be subjected to the different changes due to puberty. These results also reflected the parameters of spirometry, because lung volumes depend on the height which means that taller athletes have better results (Mazic et al., 2015). In addition to height and weight, BMI and Fat percentage can also be taken as predictors of lung volumes which ultimately can predict differences in lung capacity (Cotes et al., 2001). Differences in FCV are partly caused by height and weight of players but also by physiological adaptation of children in basketball training. Forced expiratory volume in first second - FEV1, which is directly related to the FCV is a better indicator of physiological adaptation of subjects when it comes to low and submaximal intensity (Radovanovi et al., 2009). Forced expiratory volume in the first second - FEV1 and peak flow of air in the exhale - PEF parameters were significantly correlated (0.69) (Prakash Meshram, & Ramtekkar, 2007), but also significantly changed under the influence of the training. Therefore it is very important to work on improvement of these parameters. Basketball is a sport which depends on the function of the respiratory system and sufficient functional state of the external respiration system which reflects on ability of the body for prolonged intense muscular work (Grechishkina et al., 2015). The effectiveness of the basketball courts depends on the quality of the respiratory system and, according to author's recommendations, (Degens et al., 2013), a high-intensity aerobic endurance training is the best for its improvement. An additional cause of these differences is the quality of the league that teams come from, because the quality of the league dictates the quality of fitness condition of the clubs which participate (Moreno et al., 2013).

## Conclusion

When reviewing the results of this study and comparing them with the results of previous studies there can be noted that players of basketball club "Željeznica" on average have bigger weight and that their percentage of body fat is higher. Also their BMI is higher and they are shorter. All variables of spirometry are lower than in previous studies. The performance of vital lung capacity are directly related to the composition of the body or body structure, gender and age, and it is important to emphasize that they are measurable and that their improvement can be influenced. In the meantime, the increase

in pulmonary volume and capacity increases the passing movement of  $O_2$  from the lungs to the blood (Marangoz et al., 2016). These results indicate that it is necessary to work more on physical preparation of female basketball players in order to create adequate base and to achieve better results. In future studies, it would be desirable to include a larger number of basketball players and use Ergospirometry in order to get better view of the current state of the basketball player.

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# SOMATOTYPE OF TOP SERBIAN JUDOKAS

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## Abstract

Judo is a dynamic and demanding martial art which can contribute to a physical and psychological development of a person. Research into the performance requirements of judokas has suggested the existence of the correlation between anthropometric and physical attributes and the demands of this sport. The purpose of the present investigation was to assess the somatotype characteristics of top male judokas in Serbia. The study of elite athletes (judokas, in this case) may provide valuable information on the morphological requirements for achieving success in this sport. Present research of somatotype characteristics in 20 top Serbian male judokas (12 juniors and 8 seniors) aged  $19.32 \pm 4.02$  years was measured. Anthropometric variables included height, mass, selected diameters, girths and skinfolds, and a Health-Carter anthropometric somatotype. All the anthropometric data were collected following the International Biological Programme and then processed by the Somatotype 1.2 programme. The obtained results show a similar profile and endomesomorphic mean somatotype (3.29-5.23-2.88), as in many previous studies.

Key words: judo, selection, constitution, body composition

## Introduction

In selection of athletes for a particular sport discipline, the focus should be on those traits and abilities which have the most significant influence on the performance, and on those which are predominantly genetically determined. One of the most important genetically determined factors, which is taken into account when evaluating a person's readiness to undergo certain physical and mental strain, is their physique. Human physique, that is somatotype, is a particular set of structural and morphological, physiological and functional, psychological cognitive and conative factors of an individual, which are under the influence of hereditary traits and some exogenous factors as well (Tucker & Lessa, 1940), such as diet, socio-economic conditions, physical activity and sport.

In elite judo competitors physique is an important factor affecting performance, exhibit the greatest similarity in morphological traits and motor abilities. Those traits of athletes, achieving highest results in a particular sport, create a somatic and physical "model" for that discipline. Determining a somatotype in judo as a martial art is a useful procedure in selecting sportsmen who have the propensity to become successful and achieve top results. Most authors (Gualdi-Russo & Graziani, 1993; Romero et al., 1996; Romero Colazos et al., 1996; Benavent et al., 2004; Lewandowska et al., 2011; Sterkowicz-Przybycień et al., 2012) have come to one, the most prominent somatotype model of judokas: endomesomorphic (with mesomorphy being more domi-

nant and endomorphy less). This can also be viewed as a different distribution of three somatotype components depending on the weight category: the higher the weight category, the more dominant endomorphy becomes (Claessens et al., 1987; Grosso et al., 2007; Lewandowska et al., 2011); when it comes to the level of competition, the value of mesomorphy increases with the increase in the levels of competitors, while the value of endomorphy decreases (Kuźmicki & Charzewski, 1987; Fagerlund & Häkkinen, 1991); and when it comes to the age category, the higher the age category, the higher the values of the meso and endo components become (Benavent et al., 2004).

In spite of the fact that judo has gained popularity all over the world, there is a lack of data on somatotype studies of Serbian judokas, even though there is a large number of them in this country. Consequently, the purpose of the present investigation was to assess the somatotype characteristics of top male judokas in Serbia.

## Methods

### Subjects

Twenty male judokas (age  $19.32 \pm 4.02$  years, body height  $177.27 \pm 5.07$  cm, body mass  $71.38 \pm 11.13$  kg) volunteered to participate in the study and were members of judo club 'Kinezis' (Niš, Srbija), competing at national and



international level. They were national team members, regularly participating and winning medals in age categories at World and European tournaments (championships), universiades and European cups. Commonly, subjects were placed in top three at Balkan Championship.

Table 1. Baseline characteristics of top Serbian judokas (N=20)

Variable	Mean±SD	Median	Range
Age	19.32±4.02	17.94	13.71 – 26.51
Height	177.27±5.07	178.45	169.4 – 185.2
Weight	71.38±11.13	70.35	54.7 – 91.6

Legend:SD – standard deviation.

### Set of measuring instruments

The measurements were taken during the peak of the competition season, just before the national competition. All the examinees underwent identical research protocol, which they had been introduced to and which they had agreed to beforehand. An anthropometric method was used for obtaining the judokas' somatotype. Anthropometry included 10 following variables: body height (in cm), body weight (in kg), four skinfolds (over triceps, subscapular, suprailliac, medial-calf; in mm), biceps girth (flexed 90° and tensed; in cm), standing calf girth (in cm), bicondylar humerus and femur breadth (in cm).

The testing was done before noon, in the room with optimal microclimatic conditions (temperature values from 21°C to 23°C, humidity 55-60%) with participants in underwear, by the same investigator according to the methods proposed by the International Biological Programme (Weiner and Lourie, 1969). Body mass was measured with Omron BF 511.

### Statistical data analysis

For the research purposes we used descriptive statistics. Descriptive statistics deals with the measures of central tendency (mean, median and mode), measures of variability (range, standard deviation, variance and average deviation), as well as graphical and tabular presentation of basic statistical values.

The somatotype was determined according to the methodology of Heath-Carter (Carter & Heath, 1990) which implied carrying out the statistical analysis of data using the computer programme Somatotype 1.2. During the investigation we carried out the measurements according to The Heath-Carter Anthropometric Somatotype – Instructional Manual, published by Department of Exercise and Nutritional Sciences San Diego State University San Diego, CA. 92182-7251. U.S.A Carter, J.E.L., (2002). Somatotype is most commonly measured using the Heath-Carter measurement system, in which ratings for endomorphy, mesomorphy and ectomorphy are calculated using various anthropometrical measurements and also sometimes in conjunction with standardized photos (photoscopic method). There are three ways of obtaining the somatotype. The anthropometric method, in which anthropometry is used – to estimate the criterion somatotype. The photoscopic method, in which ratings are made from – a standardized

photograph. The anthropometric plus photoscopic method, which combines – anthropometry and ratings from a photograph – it is the criterion method.

A somatotype is evaluated on the basis of three numbers – the first number indicates the endomorphic, the second number the mesomorphic and the third the ectomorphic component. If a component is lower than 2.5 it is considered to be low, from 3.0 to 5.0 medium and from 5.5 to 7.0 as high. Values higher than 7.5 are considered as extreme. The calculated triplenumbers are applied to a spherical triangle (a somatograph) on which the peaks are like the marginal types, the centre the balanced types and inside the medium types.

## Results

The sample of 20 top Serbian judokas showed the following mean somatotype: 3.29-5.23-2.88 (values for endomorphy, mesomorphy and ectomorphy, respectively; Figure 1.) Descriptive statistics of all measurements are presented in Table 2.

Table 2. Descriptive statistics of measured anthropometric parameters

Variable	Mean±SD	Median	Range
Triceps SF	11.89±4.13	11.3	5.8 – 2.4
Subscapular SF	13.09±2.77	12.6	9 – 19.4
Suprailliac SF	8.64±1.97	8.6	4.8 – 13.2
Calf SF	7.09±1.88	6.5	4 – 10.4
Flexed arm G	33.92±3.98	34.15	25.5 – 42.1
Calf G	36.9±2.4	37.3	32 – 40.4
Humerus B	7.13±0.43	7.05	6.5 – 7.9
Femur B	9.74±0.42	9.74	9.2 – 11.1
HWR	42.93±2.02	42.93	39.53 – 47.39
SAD	1.8±1.08	1.56	0.56 – 4.24
Endomorphy	3.29±0.69	3.2	2 – 5.1
Mesomorphy	5.23±1.41	5.2	2.7 – 7.8
Ectomorphy	2.88±1.44	2.7	0.7 – 6.1

Legend: SF – skinfold, G – girth, B – breadth, HWR – height-weight ratio, SAD – somatotype attitudinal distance, SD – standard deviation.

## Discussion

Apart from talent, the adequate body constitution is a prerequisite for achieving success in sports. Physique is to a large extent determined by the human genotype, but within the defined limits it is also subject to environmental influence. The extent of sensitivity to external environment is also hereditary conditioned.

The somatotype analysis of Serbian judokas proved the domination of the endomesomorphic type (3.29-5.23-2.88), which is generally the predominant type in other countries as well. A study which examined the somatotype of top athletes of a variety of sports, among which were judokas at that time the future contestants in the 2000 Olympics in Athens, placed them into the group of athletes with the highest values of the mesomorphic component

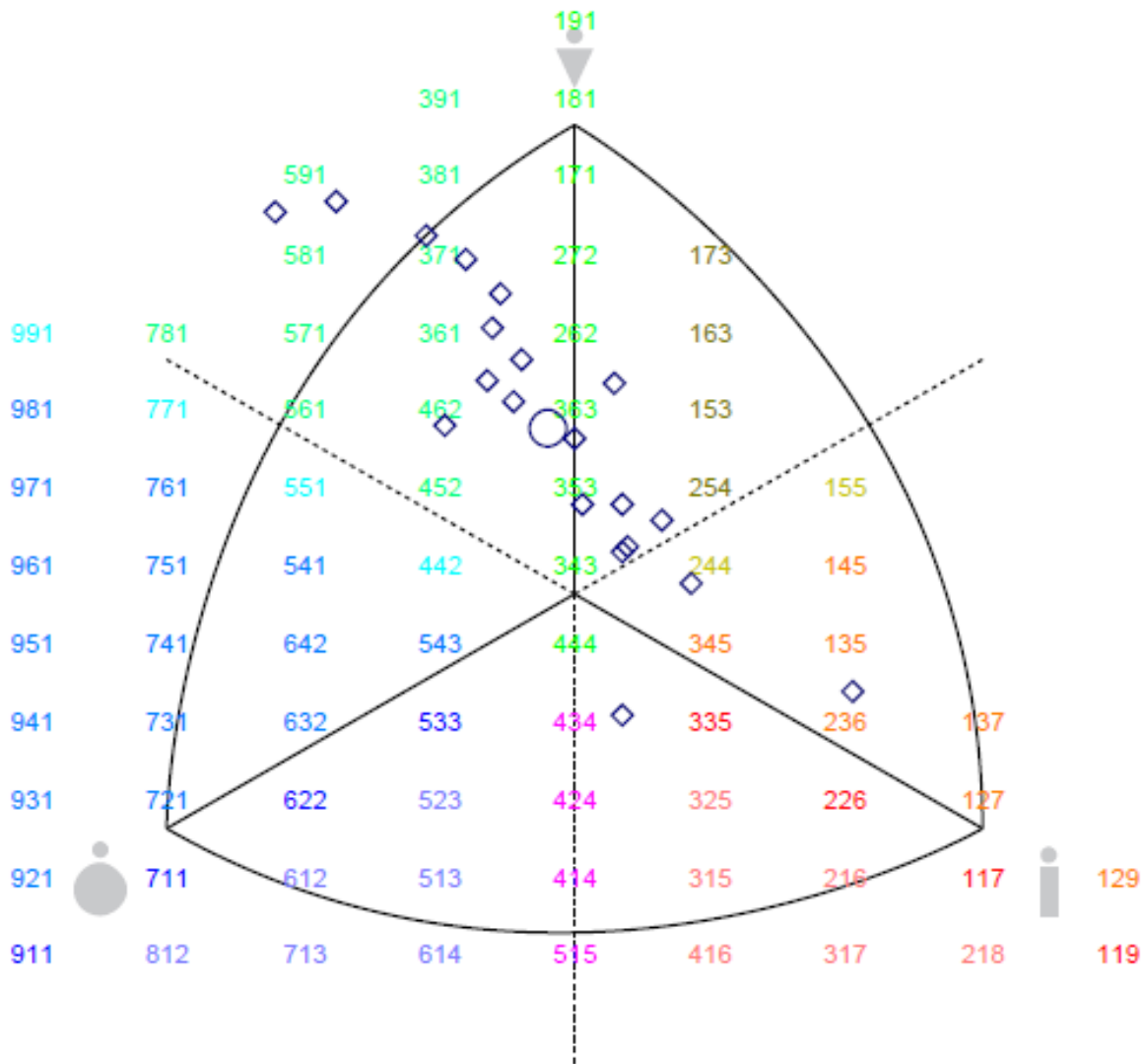


Figure 1. Somatoplot of Serbian judokas (N=20). The squares are the individual somatotypes, and the circle is the mean profile

and the significantly lower values of the ectomorphic one (2.84-5.72-1.51) (Krawczyk et al., 1997). The same thing was mirrored in our sample.

A typical somatotype of Polish junior judokas is endomesomorphic as well (3.0-5.5-2.1), and so is the one of the senior members of the Polish national team (2.6-6.4-1.8) (Sterkowicz-Przybycien et al., 2012). The higher values of the mesomorphic and the lower values of the endomorphic components can be justified by a more representative set of examinees. Our set included some competitors of the national league together with the standard ones. The national league competitors influenced the mean results of the tested group. In the sample of 13 Polish judokas aged  $18.4 \pm 3.1$  (cadets and juniors) the mean value of the somatotype was 3.5-5.9-1.8 (Lewandowska et al., 2011). The endomesomorphic type was confirmed, with slightly lower values of the third component. The identical case was with the Kuźmicki&Charzewski (1987) study (2.7-6.3-1.7), and the one conducted among the members of the Hungarian team members (3.61-6.97-1.56) (Farnos, 1980), which was characterized by the extremely high values of the mesomorphic component and the low values of the ectomor-

phic one. The results of our judokas bear striking similarity to the results of Nigerian judokas: 3.6-5.1-2.6 (Mathur et al., 1985). 18 junior and senior representatives took part in that research. Their average body mass was  $67.4 \pm 3.8$ kg, which means that there were no examinees belonging to the heavy weight categories, which, in turn, resulted in ectomorphic values being higher than in other studies.

Although, there are differences in the values of various components among the compared groups, the mesomorphic factor clearly dominated in all of them. All of these results indicate massive (mesomorphic) physique of judokas, characterized by large circumferences of muscles and developed (robust) bone bases, adapted to heavy loads. The training process leads to the transformation of the selected individuals into the aforementioned somatotype. With strength being one of the most dominant motor abilities in this sport and being prevalent in various forms (maximum, repetitive, explosive and static), the domination of the mesomorphic type then does not surprise: all the training process focused on the development of strength consequently leads to the enlargement of the muscular mass, which directly places these athletes into the mesomorphic type.

## Conclusion

Serbian judokas can be described as the athletes of the endomesomorphic type, which is consistent with the somatotype of the judokas from other countries. That can point to physical equality between Serbian and other judokas in the sports arena. However, taking into account the fact that sports results do not depend solely on athlete's physical characteristics (they are just a small piece of a jigsaw), the study in itself can be said to be flawed for not having included some other important influences on any athlete's performance, such as motor ability, psychological readiness, functional ability. Apart from this, another issue is a small, appropriate and age differing sample of examinees. Therefore, the authors feel that the status of Serbian judokas should receive a more interdisciplinary attention and that further research should be conducted on a larger and more representative sample.

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# EFFECTS OF CIRCUIT TRAINING ON BODY COMPOSITION OF WOMEN

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## Abstract

Body composition and fat components of the human body are of great significance in modern diagnostics and assessment of a training process when compared to other benchmarks. The basic goal of this research is to evaluate the effects of circuit training on body composition changes in female population. The sample for this research consisted of 45 female test subjects of 35 years of age in average. Eight variables were applied for body composition assessment measured through a unique and advanced double frequency technology of TANITA TBF-300 A monitor electronic scales, and the BIA technique (Bio Impedance Analysis = measuring bioelectric impedance). The test subjects had taken part in a two month long program of circuit training sessions three times a week (24 training sessions in total). Based on partial differences (t-test for dependent samples) between the initial and final testing, the results have indicated that statistically significant changes have occurred in the following variables: body weight (BW), body fat percentage (FAT%), fat tissue mass (FTM), metabolic age of a body (MTA) and body mass index (BMI). Circuit training was demonstrated to be a very efficient mean of exercise with the goal of reducing body fat in women.

Key words: **group fitness, transformation processes, body composition, recreationists**

## Introduction

Modern civilization causes primarily a sedentary (sitting) way of life, and in today's modern society Homo Sapiens became Homo Sedens which has significantly deteriorated his health. Numerous studies, from around the world, indicate that a large percentage of the population is insufficiently physically active, the consequence of which is that in the majority of the developed countries, over 50% of the adult population is overweight (Ostojić, 2007; Hajmer, 2010; Hollmann & Hettinger, 2000). It is estimated that, in Europe, the lack of physical activity is responsible for over 600,000 deaths annually. Two thirds of adults in the European Union (persons over 15 years of age) fail to reach the recommended level of physical activity (WHO - Regional Office for Europe, 2006).

Hypokinesia (reduced movement, reduced physical activity) is a factor which contributes to development of many chronic diseases and imbalances, and also leads to an increase in risk factors of cardiovascular and other chronic diseases such as diabetes, obesity, hypertension, bone and joint diseases, etc. (Warburton, Gledhill, & Quinney, 2001). Physical activity is any type of movement performed through activation of skeletal muscles demanding energy consumption (Caspersen, Powell and Christenson, 1985), and it helps in achieving an optimum state of health thus reducing the risk of developing many chronic diseases (Blair, Cheng and Holder, 2001).

In 1989. year, the American Alliance for Health, Physical Education, Recreation and Dance (AAHPERD) had listed the so called components of physical fitness; body composition being one of them. Body composition implies the percentages of fat, muscular and bone tissue in the overall body mass. It is important that the percentage of body fat does not cross a specific limit that jeopardises the health of an individual.

One of the most basic measurements when assessing body compositions is the Body Mass Index – BMI. The calculation of a body mass index determines a desirable body mass of a human being (Table 1). According the World Health Organization (WHO, 1998) BMI lower than 18.5 is considered to indicate insufficient weight and a state of undernourishment, eating disorder or other health problem, while BMI higher than 25 is considered to indicate obesity. These ranges in the values of BMI are only valid as statistics categories for adults.

*Table 1. Categories of human body in reference to BMI (according to: Federation International of Sports Aerobics and Fitness & Belgrade Aerobic and Fitness Association, 2006)*

BMI range	Weight categories
19 do < 25	Normal weight
25 do < 30	Overweight
30 do < 35	Obesity
35	Morbid obesity

Any kinesiological activity which can effectively influence recreationists' morphological characteristics and lifestyle is of great significance for social community. Group fitness program, as a form of circuit training, represents an efficient combination of resistance exercises and high intensity aerobic exercises. It unifies the basic principles of aerobic, interval training, and strengthening exercises, which intensifies calorie consumption, improves cardiovascular system function and strengthens the entire body (Perez and Greenwood-Robinson, 2009). This concept of an approach to modern fitness exercising satisfies the goals of harmonious body shaping, improvement of body posture, strengthening bone, joint, tendon and ligament segments of the locomotive system and improves general health (Furjan-Mandić, Kosalec and Vlašić, 2011). Application of various fitness programs has produced significant effects in the improvement of functional and motor abilities (Mandarić et al., 2011; Oreb et al., 2007; Park et al., 2003; Šebić et al., 2012), as well as changes in the body composition of women (Donges et al., 2010; Stasiulis et al., 2014). For most female recreationists the motive to take part in group exercising programs is shaping of their body into a generally harmonious form, with a specific accent on the reduction of the subcutaneous fat tissue (Šebić and Podrug–Arapović, 2008). The basic goal of this research was to evaluate the effects of circuit training for the duration of two months (24 training sessions) on changes in body composition in female population.

### Sample of test subjects

The sample of test subjects for this research was composed out of 45 (forty five) attendees of the Aerobics Club LN1 from Sarajevo of 35 years of age on average (age group ranging from 25 to 45 years of age).

### Sample of variables

Eight variables were used for body composition assessment: body weight (BW), body fat percentage (FAT%), fat tissue mass (FTM), fat free mass (FFM), muscle mass (MUS), bone mass (BON), metabolic age of a body (MTA) and body mass index (BMI).

### Circuit training description

Circuit training created for the purpose of this research was designed to be simple, and also to improve stamina and muscle endurance. The goal of the training program was to provide for an adequate and healthy way of regulating body weight in female population. Circuit training, the overall duration of which was 60 minutes, consisted of introductory warm-up (10 minutes), preparatory stretching (5 minutes), followed by exercise stations of eight exercises that activate the entire body (35 minutes), done in a fast tempo with the use of external weights (2 kilogram dumbbells). The circuits are repeated five times. Every exercise lasts for 45 seconds. During the circuit training there is no pause between the exercises, and one circuit lasts for 6 minutes. Between each new circuit, there is a 60 second break. After the completion of all circuits there are 10 minutes of static stretching.

Table 2. Time articulation of a single training session

Part of training session	Contents	Duration
I - Introductory part	Warm-up through basic steps of hi-low aerobics	10 minutes
II – preparatory part	Dynamic stretching of large muscle groups	5 minutes
III – Main part	8 exercise circuit training	35 minutes
IV – Concluding part	Static stretching (large muscle groups)	10 minutes

Table 3. Example of the types of exercises in one circuit training session

No.	Exercise	Dominant muscle activation	Duration
I	Squat press	legs and shoulders	45 sec
II	Stiff-leg deadlift	hamstrings and lower back	45 sec
III	Alternating front lunge + dumbbell lateral shoulder fly	legs and shoulders	45 sec
IV	Bent over two dumbbell row	back	45 sec
V	Sumo squat + dumbbell butterfly	chest and legs	45 sec
VI	Bicep curl with alternating knee raise	arms and abdomen	45 sec
VII	Sumo squat with overhead dumbbell triceps extension	arms and legs	45 sec
VIII	V-ups	abdomen	45 sec

### Data processing methods

The results were processed in the software package SPSS 22.0 for Windows. Central and dispersion parameters were calculated for each applied variable, and the normality of the distribution was examined based on skewness and kurtosis

coefficients. The differences in body composition between the initial and the final stage were determined based on the t-test for dependent samples. Eta-squared was used for calculating effect size in t-test for dependent samples.

## Results

Central and dispersion parameters for the set of body composition variables treated in the initial testing relates to condition of the test subjects prior to the application of the circuit training program (Table 4). With the majority of

the applied variables, it is clear that the results are placed within the normal distribution range and that a satisfactory homogeneity of the results is visible. Variables such as fat free mass (FFM), muscle tissue (MUS), bone weight (BON) show somewhat increased result elongation values which was to be expected due to the range of test subjects' age.

Table 4. Descriptive statistics (initial) - minimum results (Minimum), maximum results (maximum), Arithmetic middle (Mean), standard deviation (Std. Deviation), skewness coefficient (Skewness), kurtosis coefficient (Kurtosis)

	N	Rang	Min.	Max.	Mean	Std. Devi.	Skewness	Kurtosis
BW	45	70.00	44.80	114.80	76.08	14.55	.522	.549
FAT%	45	42.60	7.10	49.70	33.86	7.57	-.959	2.451
MMT	45	53.90	3.20	57.10	26.67	10.21	.605	1.393
FFM	45	28.50	40.90	69.40	49.41	5.47	1.190	<b>2.701</b>
MUS	45	27.10	38.80	65.90	46.91	5.20	1.192	<b>2.694</b>
BON	45	1.40	2.10	3.50	2.49	.272	1.136	<b>2.764</b>
MTA	45	56.00	13.00	69.00	41.33	14.53	-.211	-.673
BMI	45	24.70	17.50	42.20	26.39	4.99	.926	1.419

Central and dispersion parameters for the set of body composition variables treated in the final testing, after the completion of the of the training content application process, shows to what extent the goals of the test subjects' transformation have been met (Table 5). Unlike in the initial measurements, greater result homogeneity is noticeable in the final measurements, and there are no significant deviations, other than in the body fat percentage (FAT%) variable where there is a somewhat increased kurtosis value; yet

as the body fat percentage is directly dependant on height and weight of the test subject's body, these results were to be expected. Pertaining to the basic descriptive data, it can be concluded that the distribution of the results is set within the normal distribution, that the body composition of the test subjects during their final measuring is satisfactory and that it falls within the reference values consistent with healthy individuals (according to Egger, Champion and Bolton 1999).

Table 5. Descriptive statistics (final) - minimum results (Minimum), maximum results (maximum), Arithmetic middle (Mean), standard deviation (Std. Deviation), skewness coefficient (Skewness), kurtosis coefficient (Kurtosis)

	N	Range	Minimum	Maximum	Mean	Std. Dev.	Skewness	Kurtosis
BW	45	62.50	43.90	106.40	72.368	12.232	.462	.609
FAT%	45	39.80	5.70	45.50	31.335	7.439	-.888	<b>2.077</b>
FTM	45	45.10	2.50	47.60	23.471	8.863	.417	.700
FFM	45	17.40	41.40	58.80	48.897	4.078	.348	-.362
MUS	45	16.50	39.30	55.80	46.417	3.868	.346	-.362
BON	45	.90	2.10	3.00	2.480	.211	.380	-.356
MTA	45	51.00	12.00	63.00	37.222	14.111	-.096	-.960
BMI	45	20.60	17.60	38.20	25.104	4.119	.960	1.408

With regard to the basic descriptive data, it can be concluded that the test subjects' body composition during their final measurement was statistically significantly better compared to their initial state. The arithmetic middle of the body fat percentage value for the test subjects at the beginning of the testing was 33.86, which meant that the test subjects were in the overweight category. The result of the final testing of the arithmetic middle was 31.33 which speaks for the effects of circuit training, because the test subjects are now in the moderate body weight category.

During the initial measurement, the average body mass index (BMI) of the test subjects was 26.39, which indicates increased body weight or obesity, while, during the final measurement, the average value of the BMI was 25.104 which places them in the upper line of normal weight category.

The insight into values of t-test for dependent samples of the body composition arithmetic means between the initial and the final measurements, shows that there have occurred statistically significant changes in variables of

body weight (BW), body fat percentage (FAT%), fat tissue mass (FTM), metabolic age of the body (MTA), and body mass index (BMI) where statistical significance is  $P=0.00$  (Table 6). The eta-squared results have indicated that the

effect size is big in all variables where statistically significant changes have occurred between the initial and final measurements.

Table 6. T-Test for dependent samples

		Paired Differences		t	df	Sig. (2-tailed)	ETA SQUARED
		Mean	Std. Deviation				
Pair 1	BW-BW2	3.720	3.121	7.996	44	<b>.000</b>	<b>0.59</b>
Pair 2	FAT%-FAT%2	2.528	3.545	4.784	44	<b>.000</b>	<b>0.34</b>
Pair 3	FTM-FTM2	3.206	3.673	5.855	44	<b>.000</b>	<b>0.44</b>
Pair 4	FFM-FFM2	.513	3.269	1.053	44	.298	0.02
Pair 5	MUS-MUS2	.497	3.108	1.074	44	.289	0.02
Pair 6	BON-BON2	.0155	.1650	.632	44	.531	0.00
Pair 7	MTA-MTA2	4.111	5.753	4.793	44	<b>.000</b>	<b>0.34</b>
Pair 8	BMI –BMI2	1.293	1.137	7.629	44	<b>.000</b>	<b>0.57</b>

## Discussion

It is possible to make an insight into a current state of a body as well as to monitor changes and evaluate the real effects of the applied training process through body composition analysis. It is apparent that the applied circuit training program has caused significant changes within the important women body composition parameters. Performing regular physical activity for the duration of two months (three times a week), has contributed to body weight reduction in test subjects. The applied circuit training form has activated their entire body in a quality way and in a short period of time, has led to acceleration of metabolism, increased calorie consumption and thus led to body weight reduction in women.

Circuit training is a form of interval training, where a body has to adapt to rapid alternation of exercises, and where heart rate rapidly increases, than reduces, than increases again. The intervals increase oxygen level in the body, which intensifies calorie consumption not just during training session but in the rest period after workout. With this type of workout, the results can be achieved much more quickly than with standard forms of workout.

With significant body weight reduction came a significant body fat percentage loss (FAT%). Egger, Champion and Bolton (1999) suggest a criteria for classifying obesity for general population according to the body fat percentage, where women with 17% of body fat fall into the category of lean individuals, with 17-27% to individuals with an acceptable level of body fat, 27-33% of body fat to obese, and over 33% to morbidly obese category. According to their body fat percentage at the beginning of the program, the body fat percentage of the test subjects placed them into the category of the obese. After the application of the circuit training, the test subjects are now in the category of individuals with moderate body weight, that is, healthy

individuals. It is well known that women must have certain percentage of body fat, primarily for normal birth function, as well as hormonal and other functions. However, it is important that their body fat percentage does not cross a specific line where the health of an individual is at risk. The upper limit of the body fat percentage for women is 30%, while the minimum values are between 5% and 17% (Mišigoj-Duraković, 2008). Assessing body composition according to the body mass index – BMI, demonstrates significant transformation under the influence of circuit training. The test subjects' BMI at the beginning of the program was an indicator of an increased body weight or obesity, while at the final stages it was a clear indicator of normal body weight.

Such changes in body composition of female recreationists (reduction of body weight, body fat percentage and body mass index), due to application of group fitness exercise program have been confirmed in similar research by Cugusi et al. (2016); Ljubojević et al. (2014); Barene et al., (2013); Donges, Duffield and Drinkwater (2010) and Stasiulis et al., (2010).

The fat free mass (FFM) of the body, also referred to as functional tissue, is composed of muscles, bones, internal organs and water. The term can refer to any type of tissue which does not contain fat. A high level of fat free mass implies a lean and healthy body. The correction of body composition is often equated with the reduction of body mass, which is wrong. Reduction of body mass does not simultaneously imply the reduction of body fat percentage, because the reduction can happen due to loss of muscle tissue, which is not good. Drastic low calorie diets, without regular exercise, have as a consequence the illusion of weight loss, while in reality the body creates the energy it needs by burning muscle mass which slows down the

metabolism because there are no muscles to burn the ingested energy. After the completion of a diet, the kilograms lost usually come back quickly and on a larger scale (the so called yo-yo effect). The essence of the applied circuit program was the improvement of body composition, that is, reduction of fat tissue with preservation or increase of muscle tissue.

With the application of the circuit training program, the final measurements showed no increase, and no reduction either, in fat free mass (FFM) and muscle tissue (MUS). It is important that no loss of muscle mass occurred during the circuit training program, and that the muscle mass was preserved. For increase in muscle mass it would have been necessary to use bigger weights and do lower number of repetitions which would make pauses between the exercises last longer.

Metabolic age (MTA) refers to measuring the real metabolic state of the body. With individuals who are not physically active and have excess fat tissue, their metabolic age is commonly much higher than their biological age. Exercise program applied in this research has contributed to reduction of metabolic age of the test subjects, to acceleration of their metabolism, and it can be said that it has rejuvenated the body of the test subjects. The bone weight (BON) variable suffered no transformation because of the test subjects represented a mature population of women whose body growth and development has been completed. The interest of future group program effects research should be aimed towards the programs that will, along with the loss of fat tissue, simultaneously influence the increase of muscle mass in those who exercise. This research has proven positive transformation effects of circuit training, and that increased physical activity leads towards improving the health of female population. Circuit training is one of the possibilities for resolving a problem for mature age women, because it provides all assumptions necessary in the fight against fat tissue and all negative consequences of sedentary way of life.

## Conclusion

Circuit training program with the duration of two months and iteration of three training sessions a week, has led to statistically significant changes in body composition of a female population. No statistically significant increase in muscle mass has occurred. In comparison with initial measurements, body weight, body fat percentage, overall fat tissue mass, body weight index and metabolic age were reduced. It is possible that the increase of muscle mass would have been achieved with prolonging the training protocol and individual choice of weights. Research results are applicable to female population. It would be good to compare the effects of the program among the male population of similar characteristics.

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# RELATIONS WITH STUDENTS IN THE PROCESS OF TEACHING AND END USERS SATISFACTION MEASURING

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## Abstract

The aim of paper was to determine satisfaction of the relations between students and professors and assistants in the communication channel, their teaching process satisfaction, equipment, student exchange programs, practice and value elements of the education institution which are considered to be important by the end users – students. Aspect of measuring the teaching process quality and communication relations is significant because of the overall satisfaction of students which has direct reflection on the value of the Higher Education Institution (HEI). The significance of getting information from users for HEI represents meeting the needs and demands of their end users and other target groups, as much as generating the conditions for improving all teaching processes. Main outcome of the study was that the idea of marketing communication based on key information about advantages and disadvantages within the teaching process, it is possible to set up a value platform improvement in two-way communication channel and promote market value.

Keywords: **marketing communication, target groups, communication channels, teaching processes, market value**

## Introduction

Entering the sphere of marketing communication for any kind of institution or organization represents one important ongoing process which has an aim of improving relations both with real and those potential target groups. That improving part can be seen as exchanging processes, products or services, feelings, thoughts and ideas, appreciating Kotler's idea that: „*Modern marketing calls for more than developing a good product, pricing it attractively, and making it available to target groups.*“ (Kotler and Armstrong, 2007). Marketing communication eventually aims to contribute to the improving satisfaction of end users. „*Marketing communication is a management process being used for communication between an organization and different audiences*“ (Brkić, 2003), and this is also the reflection of marketing function. Making a long-lasting good communication with target groups, as well as with stakeholders, provides the value which improves competitive advantage and helps the public to create the image of the institution. Word communicate comes from Latin *communicare* which means „*to share, transmit, make common*“ (Vukajlija, 2012). In one of the crucial aims of marketing communication, Solomon said: „*Informing real and potential consumers and building the consciousness about the firm and its products/brands*“ (Solomon, 2012). Making a decision on the target groups is being done on the basis of products i.e. services provided by the company, whether it refers to

products or services. For HEIs, primary target group are students mainly (Bonacin, 2011) judging the professors level of education (Mašala, 2013). To communicate with other institutions, private sector, non-governmental organizations and media is important as well. It impacts on the public information, creating the image, promotion and making a brand (Solomon, 2014). End users are primary group for the business orientation. According to online business dictionary, end user is a person or organization that actually uses a product, as opposed to the person or organization that authorizes, orders, procures, or pays for it.

Characteristics that affect the determination of the target groups are: location structures, demography, labor market, laws, technological achievements (Đurić, 2015).

HEI target groups according to their relevance can be classified in five major groups: students, partners, NGO sector, government institutions and media (Đurić, 2015; Rađo, 2010). Primary group, students ensure the existence of the institution. Depending on the study programs offered, universities show how their students are ready to meet the needs of the market, and how much of their knowledge can be used in practice and what kind of it. Common projects with NGO and openness towards local community provide promotion of the university and stimulate students to participate in some extracurricular

activities. Connection with government institutions in the process of implementing the strategy as well as it is communication with the media which are directly placing activities done by the HEI in public are important. Students satisfactions has been studied by several authors (Astin, 1977; Noel, 1978; Pascarella & Terenzini, 2005; Peters, 1988; Tinto, 1987). Study outcomes suggesting that students were very satisfied, folglich with a bigger probability of staying at university, graduate and participate in improving the values of HEI. They can improve the managing of quality by pointing out directly their attitude about teaching process if the gathered information are used for improving the overall teaching process and guarantees their satisfaction.

Investigation was designed in a way to assess satisfaction and relations between students and academic staff according to the quality in communication channel, their teaching process satisfaction, equipment, student exchange programs, practice and value elements of the education institution.

### Methods

Research was done during the 2015. Academic year. Students of the first and second cycle of studying were asked to fulfill the specific questionnaire made for this research. Categories of general satisfaction were assessed with obligatory data needed: (I) subject usage, curriculum information, communication with professors and assistants, amiability for consultation, cooperation with the local community, extracurricular activities, financial acceptability, recommendation, loyalty and elements that HEI should have, (II) realization of the activities of the contracts from international cooperation and (III) participating in projects and practice. Questionnaire had objective metric characteristics and reliability.

### Subjects

In overall there has been included 446 full-time, part-time and DL students (I and II cycle of studying) from 9 faculties in Sarajevo Canton and Central Bosnia Canton. Male share was 56 % follows. The biggest age group of respondents was 22 – 24 (30%), then 18 – 21 (28%), 28 – 37 (19%), and over 37 (12%). The smallest number of respondents was at the age 25 – 27 (11%).

### Statistical analysis

Data processing was done using software program SPSS 22.0 (IBM Corp). The data are presented as percentages, while frequencies were used for statistical analysis. Answer frequencies difference and their significance was performed using Chi-squared test ( $\chi^2$ ). Factorial analysis method of principal component was performed as well. Keiser Mayar Olkin test was used for determining sample adequacy, while Bartlett test assessed homogeneity of variance. Factor structure featured projections with eigenvalue higher than one. Oblimin rotation was used for projecting factor vectors in space to generate component matrix. A p value of  $p < 0.05$  was eligible as significant.

## Results

No structural differences were for gender, age, type of study, year of study, class presence of students, range of index marks and subject usage for students. Largest share of respondents were second year students 38,3%, fourth year 21,5%, first year 20,2%, third year 18,8% and fifth year 1,1%. More than 75% of the respondents were present at classes. The highest index mark of the respondents was 8 (37%), then 7 (30%), 9 (12,8%), 6 (13%). The number of respondents with the mark 10 (7,2 %) was the smallest. Out of all the respondents, 58,2% of students totally agree that subjects that are a part of their studies are useful for them, 27,1% mostly agree, 9,9% of students have no opinion about that, 2,7% partially agree and 2% totally disagree. Most of the students around 42% of the respondents totally agree with the promptness of maintaining records and documents, 31% mostly agree, 14% nor agree nor disagree, 8% partially agree and 5% disagree. The results for the following question „Students are regularly informed by the faculty about the timetable changes, exam schedule, and cancelled lectures. Out of all the respondents, more than 60% is totally satisfied which is 268 answers, 9% disagree which is 42. Out of all the respondents, 42% students think that professors and assistants are completely motivated for work, 35% mostly agrees, 15,2% nor agrees nor disagrees, 4% partially agrees and 2,7 % disagrees. Analyzing the satisfaction of accuracy, 49,3% students are totally satisfied, 23,5% mostly agree, 13,5% have no clear attitude on this, 7% partially agree, and 6,3% is not satisfied. On a cumulative basis, the percentage of satisfaction for accuracy is bigger with 72,8%. A 48% of students totally agree, 28,5% mostly agree, 12,8% nor agree nor disagree, 7% partially agree and 3,8% with the communication relations with assistants and atmosphere. 75,6% of respondents mostly or totally agree and 3,4% disagree with the statement that assistants have good communicational skills and that they create nice atmosphere during classes. Using the Chi-squared test, it was determined the level of satisfaction with the extracurricular activities according to the mode of studying and differentiations can be viewed. Out of all the respondents, primary research shows that on the cumulative basis 54% totally or mostly agree that studying is acceptable, 21% nor agree nor disagree, 15% partially agree, 9% disagree and 1%. Differences between study mode and extracurricular activities was significant ( $\chi^2 = 38,7$ ,  $p < 0,001$ ) for full-time students compared to associate and DL students.

Table 1. Chi squared Test of Study mode and extracurricular activities

Compared groups	$\chi^2$	df	P - value
Full time students*#	38,69	8	<0,001
Associate students#			
DL students			

\* - different compared to associate students

# - different compared to DL students

Table 2. Image elements important for students expressed in percentage by relevance

	Valid %	Cumulative %
Good knowledge	0,2	0,2
Good passing rate	12,7	12,9
Eminent professors	32,2	45,1
Student exchange	2,7	47,8
Better possibility for employment	13,2	61,0
Good student practice	9,3	70,2
Equipment and capacity	14,6	84,9
Curriculum quality	5,9	90,7
Types of Classes	6,8	97,6
Administration	1,7	99,3
Students' competitions	0,2	99,5
Other	0,5	100
Total	100	

Ranking first three elements in the frequency as elements of image, most frequent were: eminent professors, better possibility of employment and equipment and capacity. 5% of students disagree with the statement that faculty provides good practice and a chance to improve their knowledge by doing some projects. Factorial analysis was performed as valid. According to results of Keiser Mayar

Olkin test (score = 0,94) and Bartlett test ( $p < 0.001$ ) analysis meet presumptions. In overall, eight factors satisfied threshold of eigenvalue higher than 1, cumulatively explaining 67,08% of variance. Highest component loadings was on non-educational, administrative staff and communication with them.

Tabela 3. Keiser Mayar Olkin test

Kaiser-Meyer-Olkin		0,94
Bartlett's Test	$\chi^2$	9973,1
	df	666
	P	0,0002

Table 4. Factor score structure

	Total	% of Variance	Cumulative %
1	14,54	39,3	39,3
2	2,29	6,19	45,49
3	1,87	5,05	50,54
4	1,52	4,11	54,65
5	1,33	3,59	58,24
6	1,14	3,08	61,33
7	1,09	2,94	64,26
8	1,04	2,81	67,08

*Eigenvalue higher than one*

Table 5. Matrix of components – oblimin rotation

Selected elements:	Component		
	1	2	3
Professors and teachers motivate students to learn	0,77		
Motivation of professors and assistants	0,75		
Classroom equipment	0,75		
Raising the quality of teaching by professors and assistants	0,74		
Interest for practice work	0,73		0,30
Correct attitude of staff	0,73	0,30	
Performance of obligations on time by teachers and assistants	0,73		
Interest in practice	0,73	-0,38	
Classes on time	0,72		
Expressing knowledge of the matter	0,71		
Good communication skills of teachers and assistants	0,71		
Willingness administrative staff	0,71	0,46	
Satisfaction readiness assistants	0,70		
Good information for students	0,70	0,42	

## Discussion

Subliming the results, active students are satisfied within most of the categories. Most of the respondents were males 56%, most of the respondents were between the ages 22-24, according to the mode of studying most of the students are part-time students 43% and when it comes to their academic year most of the students are second year students, with the highest index mark 8 and 75% of presence at classes. This was important because the quality view and relations to the personnel are better acceptable with its credibility if it is analyzed by the students who are present at the most of classes and lectures. They are very satisfied with the administrative processes, support services and communication between them. If there are any variations or deviations, it is relatively small percentage 7% of disagreement for availability of administrative staff. The analysis shows that the learning results and acquired qualifications respond to the purpose in the great scope and that the usefulness for end users is satisfied. When it comes to the information about relevance in the process of education, they agree that they are visible, available, and accurate, more than 60%. Students are totally satisfied when it comes to the process of communication with professors and assistants during the teaching process. Students evaluated the satisfaction for motivation, communication, availability for consulting, understandable approach, use of modern aids for the process of improvement, etc. In all categories, complete satisfaction about these questions goes over 70%. The rest 30% have no clear opinion on this, are partially or not satisfied at all. When it comes to teaching personnel, students are inclined to the fact that one of the most important elements in the process of creat-

ing values for HEI. If we compare certain results of the research done in 2014 in which some students from this one were included, there can be seen some similarities in answers about teaching personnel. Tendencies in the dissatisfaction of the research and results that some faculties got, some elements can be seen: practice, extracurricular activities, participation in projects. If we compare the research results with those from the UK universities (Douglas et. al., 2006) that were done with the specimen of 864 respondents, the most important areas that were pointed out by students in the UK as the most valuable ones are about the services related to learning and teaching. Teaching quality, professors' approach and course books initially contribute to their satisfaction and classify them as important aspects of values of HEI. However, determination of service satisfaction depends on the mode of studying, whether students are full-time, part-time or DL students. According to the mentioned researches, to those students who do not spend much time at university (faculty), more important is satisfaction to get the service information on the website, communication with administrative offices, than quality of the lectures and teaching process. Which is not the case with those students who attend classes and lectures. These researches determined that the quality of practice and extracurricular activities can be seen with those full-time students. They are related to the learning motivation, teaching motivation, classroom equipment quality, amiability of professors and assistants, determination of complete communicational skills in the process of studying. From this can be seen that connection of relations of human capital with relational capital should be constant and regularly tested. From the primary

researches it is discovered that certain faculties are constantly testing the satisfaction of students, however some of them do it but without any clear and representative results, which is not a good message to students

## Conclusion

Measuring students' satisfaction through a survey is one of the ways for HEI to identify their needs, see dissatisfaction and use the results of the survey in order to improve the processes that made them dissatisfied. Institutional efficiency means constant monitoring and quality improvement in all segments of HEI business.

The most important segment in the communication chain with students is maintaining their satisfaction. By missing it, students leave universities. These University values as a „market institution“ were described by Bryant 2006.; Miller 2003. and Schertzer & Schertzer, 2004. Separation from competition is possible only by motivation of excellence through consistent receiving of key information in two-way communication chain. Universities exist for students as their end purpose with intense contribution to the scientific creation. Communication process with students is a reflection of marketing function, undersetting their needs, wants and continuous market monitoring. Using the inputs of the results is used for strategic quality planning of HEI providing important guidelines/instructions for operative goals and program planning. Finally, reputation and perception of image that HEI creates through internal and external communication chain. Students prefer the feeling of being connected to the HEI where they are studying and the reflection of their satisfaction represents fulfillment of socio-academic integration of students.

Two-way communication and separation of all the structures needed for the set goals represent big picture with a perspective if it is approached meticulously. To simplify, HEI should be thinking about the leaders who would lead them through a vision, prognosis, procedures and criteria, who would integrate employees and end users, who would make a positive communication by developing business network. Universal model does not exist, and if it existed than researches wouldn't be needed. Time and needs are changing. With them, study programs and market needs, too. Differentiation from competition and approaching target groups for HEI in the future won't be easy. The effects of end users satisfaction and employee satisfaction create the image of HEI in public.

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## Instruction for authors

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