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Dear Readers,

It is not news that the world is currently in a state of tremendous turmoil. For many of us it is a toxic world. Since our mission is to serve children, youth, families, communities, and school personnel from around the world, we do believe that you will find the Montenegrin Journal of Sports Science and Medicine to be fertile ground for offering assistance to others via the generation, dissemination, and preservation of findings from front-line research. On the other hand, the science is the fuel of progress, in the sports sciences, medicine, and much wider and we have to use this opportunity to spread out the best ideas and make this World better, mostly due to the reason the industrialization and technological advancement has adversely affected our environment and lifestyles that has manifested in new types of diseases and ailments, which poses a challenge not only to medical but also to sociological, psychological and more related fraternities. Hence one needs to do specialization and also acquire certain skills in advanced technologies, necessary to operate and use sophisticated equipment's, which not only help in exact diagnosis of the subjects in need but also provide options to use non-invasive methods of treatment and also increase healthy lifestyles dramatically. Maximum improvement of health and relief from suffering within available resources should be our main goal.

I would also remind again all the potential authors that Montenegrin Journal of Sports Science and Medicine also provides an ideal forum for exchange of information on aspects of sports science and medicine; all clinical aspects of exercise, health, and sport; exercise physiology and biophysical investigation of sports performance; sport biomechanics; sports nutrition; rehabilitation, physiotherapy; sports psychology; sport pedagogy, sport history, sport philosophy, sport sociology, sport management; and all aspects of scientific support of the sports coaches from the natural, social and humanistic side, in various formats: original papers, review papers, editorials, short reports, peer review - fair review, as well as invited papers and award papers.

In recent years, the Montenegrin Journal of Sports Science and Medicine has continued to show important advances in both the content and quality of its published articles, and the volume of submissions has increased substantially. Since the end of 2014, over 60 manuscripts have been processed (peer- and editorial-reviewed, and accepted or rejected). Now indexed in 29 databases, Montenegrin Journal of Sports Science and Medicine has kept recognition as one of Montenegrin leading scientific journals in the area of sports science and medicine. This is reflected in its MR4 status, as recognized by the University of Montenegro, the Department specialized for the classification of scientific publications. Additionally, Montenegrin Journal of Sports Science and Medicine has earned a current score of ICV 6.17, as reported in the IC Journals Master List 2013. As a consequence of these accomplishments, on behalf of our authors, journal board members and anonymous reviewers, all of people who have volunteered to contribute to the success of the journal, I have a pleasure to invite additional members to join us in an effort to make the Montenegrin Journal of Sports Science and Medicine widely recognized international publication.

Finally, we wish to encourage more contributions from the scientific community and industry practitioners to ensure a continued success of our journal. Authors, reviewers and guest editors are always welcome. We also welcome comments and suggestions that could improve the quality of our journal.

Thank you for reading us and we hope you will find this issue of MJSSM informative enough.

Editor-in-Chief
Prof. Duško Bjelica, PhD

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Original scientific paper
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Comparison of Fitness Levels between Croatian and Lithuanian Students

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A B S T R A C T

The aim of this study was to determine and compare the level of individual anthropological characteristics of children in Croatia and Lithuania. The study examined height, weight, BMI and flexibility, explosive power and muscle endurance. The study included a total of 11,258 participants from two different countries. Of the total sample, 8,289 participants were from Croatia between ages 11 and 14 (mean age 12,5±1.5), of which 4,032 were male and 4,157 were female students. The other 2,969 participants were from Lithuania, also in the age range of 11-14 years (mean age 12,4±1.6), of which 1,504 participants were male and 1,456 females. During the 2009-10 school year, reserachers conducted measurements on students at different schools across Croatia. The same battery of tests was conducted in Lithuania during the same year. The results showed that the Croatian students have a higher body-mass, have higher BMI values and score better on tests of flexibility. Lithuanian students achieved better results in the repetitive strength test. Boys are taller, heavier and had higher BMI values as well as achieved better results in tests of explosive power and muscle endurance, while girls were more flexibile. Boys from Lithuania scored highest in all tests except in flexibility compared to boys in Croatia. Girls from Lithuania are thinner, have lower BMI and achieve better results in repetitive test of strength than girls in Croatia. Age was shown as a significant factor in the increase in all tested variables.

Key words: *morphology, motor skills, gender.*

Introduction

According to World Health Organization's definition (WHO), health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity. Humans are built for movement, and, therefore, physical activity is crucial for their physical, cognitive and social development, as well as for the capacity to learn and develop fundamental motor skills and abilities that later enable an active lifestyle. Technological development and advances in technology may lead to increasing sedentary behaviour beginning at early childhood. This in turn can lead to increased risk of heart disease, malignant diseases, stroke, hypertension, diabetes; which are all leading causes of mortality among adults in developed countries.

Research on physical activity of children in the first grade of primary school show that 19.3% of boys and girls watch TV more than two hours per day. In addition, between 12% and 18% of pupils spend over two-hours per day playing computer games. 61.3% of boys and 57.4% of girls ride bicycles only once or less per week (for 30 minutes or more). 19.1% of boys and 28.9% of girls engage in walking or running once (or less) a week (Jureša, Musil, & Petrović, 2009). These data point to the current insufficient physical activity levels among children and to the need for organized forms of physical activity. It is important, for this reason, to monitor and check anthropological measures starting at early childhood.

Most commonly, when measuring the diversity of living between countries, data are associated with differences in dietary habits, access to sports facilities and possibilities for engaging in various physical activities, as well as in differences in education and training systems. Furthermore, there is very little research dealing with the cultural examination of anthropological characteristics of children in the countries of eastern and northern Europe.

Anthropological measures can be indicators of a person's health status and nutritional status of a population; therefore, studies of anthropological features are needed. Additionally, results from anthropological diagnostics can be used for forecasting anthropological features development, planning, programming and preparing all types of work in physical and medical fields, identifying talented children, monitoring body composition and physical fitness, signposting children toward appropriate anthropological activities and determining indicated lifelong physical exercise activities for children (Neljak, Novak, Sporiš, Višković, & Markuš, 2012).

Many studies have shown that the level of anthropological characteristics is affected by various factors including: environmental factors (Malina, Peña Reyes & Little, 2008), lifestyle, dietary habits (Hebbelinc, Clarys, & De Malsche, 1999), cultural differences, and socio-economic status (Freitas et al.,

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2007). Therefore, the objective of this research was to measure and determine the differences between anthropological characteristics among children in Croatia and Lithuania.

Methods

Participants

The study included a total of 11,258 participants from two countries. During the 2009-10 school year measurements were conducted on students at different schools across Croatia. The same protocol was done in Lithuania during the same school year. Of the total sample, 8,289 participants were from Croatia between ages 11 and 14 (mean age 12,5±1.5) of which 4,032 were male and 4,157 were female students. The distribution of participants was the folowing: 11yr-1994, 12yr-2103, 13yr-2200 and 14yr-1992. The other 2,969 participants were from Lithuania, also in the age range of 11-14 years (mean age 12,4±1.6) of which 1,504 participants were male and 1,456 females. The distribution of participants was the folowing: 11yr-760, 12yr-752, 13yr-725 and 14yr-732.

Measurements

During the research, the following data was collected: weight (kg), height (cm), body mass index (BMI), and three motor skills tests: 1) Sit and Reach test (SAR) for lower back flexibility; 2) Sit-up test (SUP) for abdominal muscles endurance; and 3) Standing Broad Jump (SBJ) test for explosive power.

Tests

SAR: The sit and reach test was used to assess flexibility of the spine and the posterior leg muscles. Each participant was asked to sit on the gymnasium floor, with knees straight and resting their bare feet vertically against a box 30 cm in height. To perform the test, the subject leaned forward with straightened arms and knees and reached over the top surface of the box. The distance between toes and finger was measured. Positive values were recorded if the participant was able to reach further than his/her toes, negative values were recorded if the participant was unable to reach his/her toes, and a zero value was given when participants just touched their toes.

Table 1. Descriptive statistics (mean±standard deviation) for Croatian and Lithunian students

	Mean ±SD	
Variables	Lithuania	Croatia
Height	160,09±10,12	159,79±9,83
Weight	48,04±10,46	52,38±12,76
BMI	18,6±3,28	20,86±3,65
SAR	-21,11±7,03	2,05±8,81
SBJ	165,97±27,71	166,79±26,05
SUP	24,22±4,65	20,19±4,97

Legend: BMI - mass index, SAR - Sit and Reach test, SUP - Sit-up test, SBJ - Standing Broad Jump.

SUP: The maximum number of sit-ups achieved in 60-seconds was recorded. The participants were instructed to keep their arms across their chest while curling up to a sitting position until their elbows touched their thighs. This test gave us insight in abdominal strength and endurance. One trial was given.

SBJ: The standing broad jump test defines the maximum horizontal distance attained by a jump, with feet together. The higher score of the two attempts was considered as the final score.

Table 2. Descriptive statistics (mean±standard deviation) within gender (not considering age and country)

	Mean ±SD	
Variables	Male	Female
Height	160,39±11,15	159,36±8,49
Weight	51,72±13,24	50,72±11,37
BMI	20,53±3,89	19,9±3,49
SAR	-6,61±12,63	-1,57±13,19
SBJ	175,44±27,19	157,85±22,7
SUP	22,55±5,23	20,13±4,75

Study design

The measurements conducted, were a part of the project: "Evaluation of anthropological characteristics of students in primary and secondary schools - Cro Fit Standards," under the leadership of the Agency for Education in Croatia. Measurers were trained physical education teachers, who were familiar with the methodology of measurements during workshops where they had learned about the details of the measurement. Anthropometric variables (weight and BMI) were obtained using the Omron BF 500 (Omron Medizintechnik, Mannheim, Germany) device that works on the principle of bioelectrical impedance. Height was measured with centimeter tape.

Statistical analysis

Descriptive statistics are expressed as mean and standard deviation for all variables. Two-way group ANOVA was used to examine the differences between Croatian and Lithuanian female participants and between Croatian and Lithuanian male participants. Three-way group ANOVA was used to examine the differences within age by country and sex. The alpha level was set at $p<.05$.

Results

When comparing Lithuanian and Croatian students as a whole, while not considering age and sex, we can see that two

groups are different. In particular, Croatian students are heavier, and have higher values of BMI, although, there is no significant difference in body height. Lithuanian students achieved better results in SUP, while Croatian students scored better in the flexibility of lower back and back thigh and explosive power (Table 1 and 7).

Table 3. Descriptive statistics (mean±standard deviation) within gender for Croatian and Lithunian Students

		Mean ±SD	
	Variables	Lithuania	Croatia
FEMALE	Height	159.45±8.71	159.33±8.41
	Weight	47.59±9.71	51.83±11.71
	BMI	18.59±2.82	20.39±3.58
	SAR	-19.13±6.8	4.66±8.43
	SBJ	153.7±21.19	159.39±23.04
	SUP	22.85±4.34	19.13±4.49
MALE	Height	160.71±11.29	160.27±11.09
	Weight	48.47±11.13	52.95±13.75
	BMI	18.61±3.68	21.49±3.64
	SAR	-23.03±6.7	-0.45±7.97
	SBJ	177.94±28.08	174.46±26.77
	SUP	25.56±4.55	21.38±5

Furthermore, as shown in Table 2 and 7, comparison of male and female students (not considering age and country) showed some statistically significant differences. Males were taller, heavier, with higher BMI and performed better in SUP and SBJ. Female students achieved higher results in SAR test.

When comparing Lithuanian and Croatian students while considering gender, results showed significantly significant difference for all motor variables: SAR ($p<.05$), SBJ ($p<.05$), SUP ($p<.05$) and BMI ($p<.05$). There was no significant difference in body height and body weight (Table 3 and 7).

Table 4. Descriptive statistics (mean±standard deviation) for total sample (not considering country and gender)

	Mean ±SD			
Variables	11	12	13	14
Height	151,09±7,59	157,59±7,64	163,12±7,71	167,72±8,15
Weight	43,59±10,46	49,37±11,2	53,82±11,52	58,15±11,29
BMI	19,37±3,65	20,13±3,67	20,37±3,57	20,79±3,74
SAR	-5,13±12,81	-4,82±13,51	-3,26±12,79	-3,06±13,4
SBJ	154,86±21,54	162,16±24,17	170,86±24,86	178,29±29,04
SUP	19,77±4,96	20,83±4,94	21,99±5,01	22,69±5,15

In order to examine whether there was a difference in observed variables according to age (not considering gender and country), the three-way analysis of variance was performed. As can be seen in Table 8, all variables obtained statistical significance at the level of .05. In all variables a progress with regard to age of participants can be observed (Table 4). The same occurs when age and gender were considered (Table 5).

Table 5. Descriptive statistics (mean±standard deviation) within age for male and female students (not considering country)

		Mean ±SD			
	Variables	11	12	13	14
FEMALE	Height	151,75±7,72	158,09±6,94	162,44±6,59	164,89±6,31
	Weight	43,93±10,6	49,26±10,78	53,37±10,3	56,13±10,01
	BMI	19,07±3,62	19,66±3,56	20,22±3,37	20,6±3,21
	SAR	-3,67±13,15	-1,98±13,25	-0,7±12,6	-0,01±13,52
	SBJ	149,25±21,01	156,87±22,69	161,62±21,82	163,16±22,69
	SUP	18,77±4,62	19,81±4,54	20,76±4,58	21,07±4,92
MALE	Height	150,43±7,4	157,11±8,21	163,88±8,73	170,56±8,78
	Weight	43,25±10,3	49,47±11,59	54,33±12,73	60,18±12,12
	BMI	19,76±3,64	20,67±3,73	20,56±3,8	21,01±4,24
	SAR	-6,6±12,29	-7,51±13,2	-6,12±12,39	-6,14±12,55
	SBJ	160,47±20,58	167,09±24,48	181,43±23,9	193,55±26,66
	SUP	20,78±5,08	21,78±5,12	23,37±5,12	24,33±4,86

When age and countries were considered, the analysis showed statistically significant differences for whole morphological and motor battery of tests (Table 8). In all variables a progress with regard to age of participants can be observed in both countries (Table 6).

When examined whether there is a difference between Croatian and Lithuanian male and female participants when considering age results showed significantly difference for all mor-

phological variables (Height (p<.05); Weight (p<.05), and BMI (p<.05). There was no significant difference in SBJ and SUB (p<.05) between male and students from Croatia and Lithuania when considering age while in SAR we can notice statistically significant differences.

Table 6. Descriptive statistics (mean±standard deviation) within age for Croatian And Lithunian Students (not considering sex)

		Mean ±SD			
	Variables	11	12	13	14
CROATIA	Height	151.29±7.73	157.11±7.65	163.24±7.7	167.42±8
	Weight	45.05±10.98	50.18±11.77	55.14±11.94	59.07±11.9
	BMI	20.33±3.71	20.78±3.76	20.98±3.7	21.26±3.36
	SAR	1.46±7.7	1.73±8.35	2.39±8.64	3.01±9.51
	SBJ	155.63±21.82	162.73±23.69	170.34±24.89	178.16±27.99
	SUP	18.51±4.58	19.72±4.63	20.91±4.68	21.73±5.02
LITHUANIA	Height	150.57±7.2	158.91±7.44	162.77±7.72	168.52±8.49
	Weight	39.8±7.76	47.12±9.1	49.9±9.08	55.68±9.05
	BMI	17.47±2.64	18.59±2.95	18.74±2.58	19.65±4.3
	SAR	-22.14±5.78	-22.92±6.91	-20.02±7.16	-19.26±7.53
	SBJ	152.96±20.73	160.67±25.35	172.33±24.74	178.62±31.62
	SUP	22.91±4.44	23.75±4.53	25.09±4.65	25.21±4.6

Discussion and Conclusions

Numerous studies have shown that environmental factors (European Commission, 2013), cultural differences (Prskalo, Kraljević, & Kovačić, 2011), socio-economic circumstances (Jimenez Pavon et al., 2010a) and possibly differing physical education curricula, and the very availability of sporting facilities and venues largely influence children's physical fitness. With this in mind, the goal of this research was to measure physical fitness of children aged 11 to 14 years between two countries, Croatia and Lithuania. The results showed that the sample of children from Croatia significantly differed from the sample of children from Lithuania in almost all of the examined variables; only height was not significantly different. Croatian pupils are heavier and have a higher BMI, and achieve better results in the Sit and Reach (SAR) test, i.e. lower back flexibility test. Pupils in Lithuania achieve significantly results in the Sit-ups (SUP) test, i.e. abdominal muscles endurance test. There was a statistically significant difference in all of the examined variables between genders.

Table 7. Results of the analysis of variance (two-way ANOVA with interaction)

Variables	Source of Interaction	dF	MS	F	p
Height	Groups	1	171.91	1.75	0.18
	Gender	1	2621.56	26.76	0.00
	Group*gender	1	53.83	0.55	0.45
Weight	Groups	1	41311.17	278.46	0.00
	Gender	1	2160.96	14.57	0.00
	Group*gender	1	31.46	0.21	0.64
BMI	Groups	1	11289.02	914.91	0.00
	Gender	1	651.88	52.83	0.00
	Group*gender	1	599.45	48.58	0.00
SAR	Groups	1	1169091.54	19012.04	0.00
	Gender	1	44118.27	717.46	0.00
	Group*gender	1	794.577	12.92	0.00
SBJ	Groups	1	2613.94	4.20	0.04
	Gender	1	830255.96	1335.38	0.00
	Group*gender	1	45250.32	72.78	0.00
SUP	Groups	1	33573.70	1540.07	0.00
	Gender	1	13259.04	608.21	0.00
	Group*gender	1	110.13	5.05	0.02

Legend: dF - degrees of freedom; MS - mean square; F - MS factor/MS residual; p - statistical significance.

As already mentioned, there is a possibility that genetics, geographical area of living (Kovačević, Kvesić, & Kuna, 2011) and differing dietary habits (Strauss & Pollack, 2001) play a major role in morphological and motor abilities. Although previous studies have not yielded conclusive results, most of them have shown that the socio-economic circumstances of an individual's ecosystem are also related to the level of motor abilities as well as to some morphological characteristics (Jimenez Pavon et al., 2010a and 2010b). According to research conducted by Jimenez Pavon et al. (2010b), higher socio-economic status was negatively related to BMI; in other words, in more developed countries with better socio-economic status a lower prevalence of obesity was observed. This may be an explanation for the differences obtained in our research (better results of pupils from Lithuania in the weight and BMI values). These results are supported by research conducted by Janssen et al. (2005),

who observed that Lithuania is the country with the lowest prevalence of obesity (0.4 %) among 34 primarily European countries included in systematic review, while in Croatia the prevalence of obesity amounts to 3.8% (Antonić Degač, Kaić Rak, Mesaroš Kanjski, Petrović, & Capak, 2004).

Table 8. Results of the analysis of variance (three-way ANOVA with interaction)

Variables	Source of Interaction	dF	MS	F	p
Height	Groups	1	759.94	13.13	0.00
	Gender	1	17422.34	301.03	0.00
	Age	3	56219.10	971.39	0.00
	Group*gender	1	3.38	0.06	0.80
	Age*gender	3	5670.38	97.98	0.00
	Group*age	3	230.48	3.98	0.00
	Age*Group*gender	3	204.44	3.53	0.01
Weight	Groups	1	5938.92	49.90	0.00
	Gender	1	8388.16	70.48	0.00
	Age	3	42227.93	354.79	0.00
	Group*gender	1	4.73	0.04	0.84
	Age*gender	3	2157.34	18.13	0.00
	Group*age	3	476.14	4.00	0.00
	Age*Group*gender	3	479.68	4.03	0.00
BMI	Groups	1	1372.21	113.69	0.00
	Gender	1	66.47	5.51	0.01
	Age	3	486.89	40.34	0.00
	Group*gender	1	19.10	1.58	0.20
	Age*gender	3	105.79	8.77	0.00
	Group*age	3	158.69	13.15	0.00
	Age*Group*gender	3	28.62	2.37	0.05
SAR	Groups	1	265352.04	4405.72	0.00
	Gender	1	17378.93	288.55	0.00
	Age	3	2420.88	40.19	0.00
	Group*gender	1	1068.67	17.74	0.00
	Age*gender	3	522.86	8.68	0.00
	Group*age	3	454.28	7.54	0.00
	Age*Group*gender	3	229.88	3.82	0.00
SBJ	Groups	1	524.21	1.00	0.00
	Gender	1	584918.66	1112.30	0.00
	Age	3	127074.46	241.65	0.00
	Group*gender	1	22427.41	42.65	0.00
	Age*gender	3	51531.62	97.99	0.00
	Group*age	3	2185.39	4.16	0.00
	Age*Group*gender	3	775.01	1.47	0.21
SUP	Groups	1	6571.93	322.13	0.00
	Gender	1	5929.55	290.65	0.00
	Age	3	1684.98	82.59	0.00
	Group*gender	1	7.25	0.36	0.55
	Age*gender	3	249.81	12.25	0.00
	Group*age	3	56.61	2.77	0.03
	Age*Group*gender	3	6.40	0.31	0.81

The observed differences in motor abilities between children from Lithuania and children from Croatia may be due differing curricula. Namely, according to the European Commission's research, there are differences in teaching plans and programmes between European countries. About one third of the educational systems in Europe have two levels of physical education teaching programme: mandatory and elective teaching programme. (European Commission, 2013). According to the same research, Lithuania has a lot more mandatory teaching units in its mandatory teaching programme, as well as a wider selection of elective sports activities than Croatia, which may result in the obtained motor ability differences.

The difference noted in terms of flexibility (at the level of the entire sample and subgroups; boys and girls) favouring Croatian pupils is also supported by research conducted in Lithuania (Volbekiene, & Griciute, 2007). In their research with children from Lithuania aged 12-16, Volbekiene and Griciute found a trend of a significant reduction in flexibility, which they interpreted as a consequence of lower physical activity on a daily basis. In addition, they noted a mild increase in the repetitive strength of the torso.

Further, by making a comparison between boys and girls it was observed that boys had a higher body mass, were taller, had a higher BMI, and that they achieved better results in the SUP and SBJ tests, while girls displayed better results only in the SAR test. During the entire period of growth, with the exception of early adolescence growth momentum when girls surpass boys in height, girls are shorter on average (Mišigoj-Duraković, 2008). By making comparisons with results obtained through similar studies, it can be concluded that the results of

this research are very similar and that the subsamples differ in the same anthropological characteristics and motor abilities. Past research has obtained similar results (Boye et al., 2002; Malina & Katzmarzyk, 1999; Mraković, Findak, Metikoš, & Neljak, 1996; Prskalo et al., 2011) where boys have better results in tests examining explosive power and muscle endurance, while girls achieve higher values in motor tests that assess flexibility. The obtained differences in motor abilities among respondents may be a consequence of sexual dimorphism which results in differences in body proportions and composition, greater muscle mass and better functional and motor abilities in favour of men compared to women (Šegregur, Kuhar, & Paradžik, 2010). If we take into account the fact that boys have greater muscle mass than girls, this muscle mass will also have a higher percentage of different muscle fibres responsible for performance of high-speed movements, which can lead to a better SBJ test result (Kovačević et al., 2011). Mraković et al. (1996) state that lower motor ability values in girls should not be attributed only to the specificities of their morphological characteristics, but also to lower levels of usual physical activity and especially to lower participation in organized recreational or sports activities.

According to Currie et al., (2012), 81% of girls and 69% of eleven-year old boys are insufficiently active, and among thirteen-year-olds it is 85% for girls and 69% for boys, showing that the prevalence of insufficient activity is higher among girls than among boys. Longitudinal research (McHale, Crouter, & Tucker, 2001) carried out over a three-year period showed that girls spend much more time in sedentary recreational activites, i.e. they much more commonly engage in a hobby or reading, while boys typically spend their free time on sports or various kinds of games.

As for the differences in the examined variables with regard to age, it was observed that, regardless of gender or country, there was a statistically significant difference in all of the test variables. With age, an increase in all test scores was observed among boys and girls, as well as among Croatian and Lithuanian students. The body height and mass results are in line with the usual dynamics of growth and development, although rising values in the BMI variable are a cause for concern, which can point to the possibility of growing obesity issue.

With regard to the obtained motor variable results, Mišigoj-Duraković (2008) states that it is normal during school age for motor abilities to improve with adolescent growth in young boys, while girls' motor abilities development is slowed down at the ages of 14 or 15. According to our results, boys and girls improve their results in tests that assess all of the observed motor abilities.

The obtained gender differences between boys and girls may be a consequence of sexual dimorphism which results in differences in body proportions and composition, greater muscle mass and better functional and motor abilities in favour of men. Hence, future research should examine the effects of genetic, environmental, geographic area, cultural differences, socio-economic-status, different eating habits as well as various PE education since it is possible they could influence morphological and motor skills. In order to facilitate comparisons of results in different countries as well as tracking trends in students we should emphasize the importance of continuous monitoring of physical activity, both at the global and national level, as well as assimilating the methodology of measuring the level of physical activity. High prevalence of insufficient physical activity in children and adolescents indicates the importance of taking urgent action aimed at changing habits of physical exercise.

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Age-Related Patterns of Physical and Physiological Characteristics in Adolescent Wrestlers

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A B S T R A C T

The aim of the study was to examine the physical and physiological differences as dependent on age of young wrestlers. One hundred and twenty-six 15 – 17 year old wrestlers volunteered as subjects in the present study. The physical and physiological profiles included body weight, height, body mass index, flexibility, anaerobic power, aerobic endurance, strength, speed, and body composition. The statistically significant ($p<0.05$) results are as follows: Age group 17 (AG 17) had significantly higher leg and arm anaerobic power and capacity (leg power: 952±216 Watt (W); arm power: 684±194 W and leg capacity: 489±101 W; arm capacity: 354±88 respectively) as compared to the AG15 with (leg power: 718±279 Watt (W); arm power: 458±149 W and leg capacity: 376±132 W; arm capacity: 247±86 W respectively). AG17 wrestlers were significantly faster than AG 15 (4.29±.25 second - 4.53±.30 second respectively). AG 15 wrestlers had significantly lower right and left hand grip strength (right: 36.4±10.7 kg, left: 34.9±10 kg) than AG 16 (right: 43.9±8.4kg, left: 42.5±7.8 kg) and AG17 wrestlers (right: 46.6±8.7kg, left: 46.4±8.3 kg). In conclusion The results of this study suggest that height, body weight, fat free mass, arms – legs anaerobic power and capacity, speeds and hand grip strengths were increased both in one age range and in two ages range together with age progression, but it was clearly seen statistical differences in two ages range.

Key words: *Aerobic, Anaerobic, Body composition, Strength, Wrestlers.*

Introduction

Wrestling is one the first sports included in the ancient Olympic Games. It is characterized as a discipline which makes great demands on athletes in terms of physical preparation (Sterkowicz-Przybycień et al., 2011). Anaerobic and aerobic capacity, upper and lower body strength, power, agility, and flexibility are important factors needed to achieve good results in wrestling competitions (Bloomfield, 1994, Horswill, 1989, Horswill, 1992, Yoon, 2002, Mirzaei et al., 2009). The results of the study (Horswill, 1992) summarizes that the general physiological profile of the successful wrestler as one having high anaerobic power (mean ranging from 6.1 to 7.5 Wkg^{-1} for arms and from 11.5 to 19.9 Wkg^{-1} for legs); high anaerobic capacity (range for arms from 4.8 to 5.2 Wkg^{-1} and for legs from 7.4 to 8.2 Wkg^{-1}); high muscular endurance; average to above average aerobic power (range from 52 to 63 ml/kg/min); average pulmonary function (range from 1.90 to 2.02 *l/kg/min* for maximal minute ventilation ($\dot{V}_{Emax}$)); normal flexibility; a high degree of leanness (3.7–13% fat), excluding heavyweights; and a somatotype that emphasizes mesomorph. To achieve the better performance, the wrestling training has to be formulated according to these components.

Wrestling is a sport that applied based on the specific age categories. In other words, in wrestling there are many age categories, including schoolboys (14-15 years (from 13 with medical and parental certificate), cadet (16-17 years (from 15 with medical and parental certificate), junior (18-20 years (from 17 with medical and parental certificate), senior (20 years and older) and veterans (older than 35 years) (FILA, 2014). However, there is no enough information available in the literature about age – related characteristics of physical and physiological on wrestlers struggling in a category. Therefore, in the current study, we asked whether the differences of are physical and physiological based on ages in the category of cadet struggling wrestlers. It was hypothesized that depending on the age and training experience in wrestlers, physical and physiological differences occur and this promotes advantage in favor of older wrestlers.

Methods

Subjects

One hundred and twenty-six young wrestlers (age: 16.5 ± 0.7 year (yr); Height (HT): 170.2 ± 8.0 cm; body weight (BW): 67.7 ± 15.2 kg) volunteered as subjects in the present study. The wrestlers were divided into three independent age groups according to obtained personal informative form: age group 15 (AG15): n = 25; AG16: n = 41; AG17: n = 60.

Procedures

Before participating, subjects' parents (all under the age of 18) read and signed an informed consent form. It was asked for the athletes not to participate daily training program within 24 hours prior to testing. Testing was completed for all wrestlers in the same laboratory and field facilities on three consecutive days. However, all participants completed a personal information form that included their age (day/month/year), training background. The subjects and coaches were informed in detail about the experimental procedures and the possible risks and benefits of the project. The study, which complied with the Declaration of Helsinki, was approved by the Bioethics Commission of the University of Ankara.

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Physical Tests

Height and Body Weight

Body height (HT) and weight (BW) measurements were made using a digital scale (Seca gmbh & co.kg Germany) in bare feet and wearing only shorts.

Body Composition

Body composition analysis was determined by measurement of skinfold thickness and was measured at 3 sites (subscapular, triceps, abdominal) with a Holtain caliper. Body fat percent was calculated from the formula developed by Lohman (1992). Fat free mass (FFM) was calculated by subtracting the fat tissue mass (in kg) from the total body mass.

Physiological Tests

Anaerobic test

The Wingate (WAnT) tests were used for the arms and legs during separate tests (Inbar et al., 1996). The leg Wingate test consisted of a 30-s supramaximal cycling against a resistance load. Each test was performed on a Monark cycle ergometer (Model 894-E) and the load was calculated as 0.075 kg $x.kg^{-1}$ body mass for each participant (Hübner-Woźniak et al., 2004). Arm cranking was performed at standing body posture using ergometer (Monark 894E). Resistance of 0.055 $kp.kg^{-1}$ body mass was used for the athletes (Hübner-Woźniak et al., 2004).

Sprint running test (10 – 30 m)

After a standardized 15-min warm-up period (low-intensity running, several acceleration runs, and stretching exercises), the subjects undertook a sprint running test consisting of two maximal sprints of 30 m, with a 3 min rest period between each sprint. Maximal sprints of 10 m were measured during 30 m sprint running test. The better of two measurements were recorded. The running speed of the wrestlers was evaluated using dual-beam electronic timing gates (Sport Expert MPS 501 Model). Speed was measured to the nearest 0.01 s.

Maximal hand grip and back strength tests

Hand grip strength was measured for right and left hands with a Dynamometer (Takei A5001 Hand Grip Dynamometer Tokyo, Japan). Maximal back and leg strength (BS) were measured using a back and leg muscle dynamometer (Takei A5002 Back and Leg Dynamometer, Tokyo, Japan). The average of two trials was recorded.

Flexibility test

Flexibility of the trunk was determined from a sit and reach test using a standard sit and reach box. Two trials were performed for this test. The better of two measurements were recorded

Aerobic endurance test

Aerobic endurance was determined by using shuttle run (20 meter) test. The wrestlers started running back and forth a 20 m course and touched the 20 m line. The initial speed was 8.0 km/h which got progressively faster (0.5 km/h. every minute), in accordance with a pace dictated by a sound signal on an audiotape. The wrestlers were instructed to keep pace with the signal for as long as possible. When the subjects could no longer follow the pace, the last stage recorded was used to predict VO2max. A predicted VO2max was obtained using the equation of Leger and Gadoury (1989).

Statistical Analysis

General characteristics of the participants were presented as means and standard deviations. Standard statistical methods were used for the calculation of the mean and standard deviations (SD). The differences between the three age groups (AG: 15, AG: 16, and AG: 17) were determined using the one-way analysis of variance (ANOVA). Post hoc comparisons were made using the tukey procedure. Additionally, Pearson correlation was calculated to examine the relationships between variables. The level of significance for all statistics was set at $p<0.05$.

Results

According to age groups, characteristics, body composition (Fat%, FFM), hand grip, leg, and back strength, speed, flexibility, aerobic endurance, arms and legs anaerobic power and capacity values are presented in the tables below.

Table 1. The Characteristics of Wrestlers

	A M±SD	B M±SD	C M±SD	p	Post Hoc Significant Result
Height(cm)	163.3±9.0	169.8±8.0	171.6±7.3	0.00	A-B, A-C
Weight (kg)	55.9±15.1	66.4±15.6	70.4±14.1	0.01	A-B, A-C
Fat %	6.5±3.6	8.6±5.6	9.5±5.8	0.20	
FFM (kg)	51.9±11.8	60.0±10.3	63.2±9.1	0.00	A-B, A-C
BMI	20.7±3.2	22.8±3.7	23.7±3.3	0.02	A-C
Training Experiences	4.5±1.3	5.4±1.5	5.8±1.6	0.02	A-C

Legend: A - AG 15, B - AG 16, C - AG 17, FFM - fat free mass, BMI - body mass index

According to age groups, there was significant difference in height variable between AG 15 and AG 16; and between AG 15 and AG 17 ($p<0,05$). There was significant difference in weight variable between AG 15 and AG 16; and between AG 15 and AG 17 ($p<0.05$). There was significant difference in FFM variable between AG 15 and AG 16; and between AG 15 and AG 17 ($p<0.05$). There were significant differences in BMI and sport experiences variables between AG 15 and AG 17 ($p<0.05$) Table 1.

According to aerobic and anaerobic performance values, there was significant difference in leg anaerobic peak power (W) between AG 15 and AG 17 ($p<0.05$). There was significant difference in leg anaerobic average power (W) between AG 15 and AG 16; and between AG 15 and AG 17 ($p<0.05$). There was significant difference in arm anaerobic peak power (W) between AG 15 and AG 16; and between AG 15 and AG 17 ($p<0.05$). There was significant difference in relative arm peak

power (W/kg), arm average power (W) and relative arm average power (W/kg) between AG 15 and AG 17 ($p<0.05$). There was no significant difference in aerobic endurance (V02 Max) among all age groups ($p>0.05$) Table 2.

Table 2. Aerobic and leg and arm anaerobic performance values of wrestlers

	A M±SD	B M±SD	C M±SD	p	Post Hoc Significant Result
LPP (W)	718±279	868±204	952±216	0.00	A-C
RLPP (W/kg)	12.6±1.8	13.2±1.9	13.5±1.8	0.20	
LAP (W)	376±132	462±102	489±101	0.00	A-B, A-C
RLAP (W/kg)	6.6±0.7	7.0±0.8	7.0±0.7	0.25	
APP (W)	458±149	616±193	684±194	0.00	A-B, A-C
RAPP (W/kg)	8.2±1.2	9.3±2.2	9.7±2.0	0.05	A-C
AAP (W)	247±86	315±96	354±88	0.00	A-C
RAAP (W/kg)	4.4±0.6	4.7±0.9	5.0±0.8	0.02	A-C
Aerobic (V02 Max)	51.9±4.6	49.6±5.7	50.8±5.9	0.38	

Legend: LPP - Leg peak power, RLPP - Relative leg peak power, LAP - Leg average power, RLAP - Relative Leg average power, APP - Arm peak power, RAPP - Relative arm peak power, AAP - Arm average power.

Table 3. Speed, strength and flexibility values of wrestlers

	A M±SD	B M±SD	C M±SD	p	Post Hoc Significant Result
10 meter (s)	1.82±.10	1.78±.12	1.80±.11	0.55	
30 meter (s)	4.53±.30	4.36±.21	4.29±.25	0.01	A-C
Right hand grip (kg)	36.4±10.7	43.9±8.4	46.6±8.7	0.00	A-B, A-C
Left hand grip (kg)	34.9±10	42.5±7.8	46.4±8.3	0.00	A-B, A-C, B-C
Back strength (kg)	135±32	150±32	153±35	0.23	
Leg strength (kg)	176±36	189±40	194±38	0.30	
Flexibility (cm)	30.6±6.3	32.0±7.5	33.6±5.9	0.21	

According to speed, Strength and flexibility values, there was significant difference in 30 meter (m) between AG 15 and AG 17 ($p<0.05$). There was significant difference in right hand grip strength between AG 15 and AG 16; and between AG 15 and AG 17 ($p<0.05$). There was significant difference in left hand grip strength among all age groups ($p<0.05$). There was no significant difference in back strength, leg strength and flexibility among age groups ($p>0.05$) Table 3.

Table 4. The correlation of selected physical and physiological parameters

N=126 (r)	LPP	LAP	APP	AAP	RHS	LHS	BS	LS
Height	.74**	.77**	.65**	.75**	.70**	.69**	.67**	.56**
Weight	.82**	.89**	.71**	.82**	.75**	.74**	.77**	.61**
BMI	.76**	.84**	.65**	.77**	.70**	.69**	.73**	.56**
FFM	.85**	.92**	.77**	.87**	.80**	.81**	.77**	.62**

Legend: RHS - right hand strength, LHS - left hand strength, BS - back strength, LS - leg strength, **p=0.01.

It was identified high level correlation between height, weight, BMI, FFM and arms-legs anaerobic performance values (power and capacity) (Table 4).

Discusion

The primary findings of this investigation indicate that AG 15 wrestlers were shorter than AG 16 and AG 17 wrestlers (3.8 and 4.8 % respectively) significantly. AG 17 wrestlers were significantly heavier than AG 15 wrestlers (21 %). AG 15 wrestlers had significantly lower FFM than AG 16 and AG 17 wrestlers (13.5 and 17.9 % respectively). AG 15 wrestlers had significantly lower BMI than AG 17 wrestlers (12.7 %). However, AG 17 had more training experience (22 %) than AG 15 wrestlers according to Table 1. When the results for the three elite groups (AG 15, AG16, and AG 17) were compared, some anthropometric variables such as height (HT), body weight (BW), body mass index (BMI), and fat free mass (FFM) seem to be related to age differences. Camic et al. (2009) confirmed that in young wrestlers the increase of BW, HT, and FFM were related to age in a similar pattern to that in non-trained adolescents. Housh et al. (1993) who compared age-related changes in HT and BW in a sample of 477 high school wrestlers with those of a national sample of 14- to 18-yr-old males. They reported average yearly increases of 2.1 cm in HT and 2.6 kg in BW. Whereas Camic et al. (2009) found yearly increases of 5.7 cm in HT and 4.3 kg in BW (8–13 yr). Housh et al. (1997) reported yearly increases of 2.1 cm in HT and 4.0 kg in BW in a sample of 67 high school wrestlers in a longitudinal investigation. These differences in yearly increases in HT and BW for the young wrestlers likely reflected the growth spurt associated with adolescence in the young wrestlers. In addition, the increase of FFM with age may be as a result of both more training experience and age related.

The comparison of anaerobic performance indicates that

AG 17 had significantly higher leg peak power than AG15 (25 %). AG 15 wrestlers had significantly lower leg average power than AG 16 and AG 17 wrestlers (18.6 and 23 % respectively). AG 15 had significantly lower arm peak power than AG 16 and AG 17 wrestlers (26 and 33 % respectively). However, AG 15 had significantly lower relative arm peak power and relative arm average power than AG 17 wrestlers (15 and 12 % respectively). In addition, AG 15 had significantly lower arm average power than AG 17 wrestlers (30 %) (Table 2). In the available literature, there are little reports of studies of legs and arms anaerobic peak and mean power in the same group of different age wrestlers or any other combat sport discipline (Terbizan and Selievold, 1996). Terbizan and Selievold (1996) while studying 15, 16, and 17 year-old wrestlers, established that arm and leg anaerobic mean power increased with age, but statistically significant differences were only observed between the youngest group and both older groups. Laskowski and Smaruj (2008) monitored the changes in anaerobic capacity influenced by during three years of judo training of 14–16 year-old boys. They found that maximal anaerobic power 801.12 W and relative maximal anaerobic power 12.29 W/kg after 3 years process training of 16.6 year-old boys. The results of our study compared with the study, it is seen that similar age and body weight of the wrestlers have more anaerobic power values than judo athletes. The reason may be different training experiences. In our study, statistically significant differences were only leg anaerobic peak and average power, arm anaerobic peak and average power, relative arm anaerobic peak and average power observed between AG15 and AG17 wrestlers. However significant differences were observed leg anaerobic peak power, arm peak power between AG16 and AG17. It was shown that the anaerobic performance values in adolescent wrestlers increased with age according to Table 2. The study results are seen to being similar to Terbizan and Selievold (1996) found no statistical differences in one age range, but it was clearly seen statistical the differences in two ages range. Age-related increases in average anaerobic power and peak power during adolescence have been shown to coincide with increases in BW, FFM and HT. We suggest that both body composition (especially the increase of FFM rate) and HT have considerable importance for sports that have predominately anaerobic aspects in high level performance. The numerous studies are generally about differences between successful and less successful wrestlers or between male and female wrestlers (Roemmich and Frappier, 1993; Hübner-Woźniak et al., 2004; Vardar et al., 2007; Pallares et al., 2011; Pallares et al., 2012). The studies that compared different competitive level judoists (elite and amateur) have found that elite judoists had higher anaerobic power and capacity values than amateur judoists (Franchini et al., 2011). The average power and peak power capabilities of wrestlers are associated with explosive maneuvers (Lansky, 1999) and can differentiate between successful and less successful wrestlers (Horswill et al., 1989). For example, Horswill (1989) reported that the anaerobic capabilities of elite junior wrestlers were as much as 13% greater than the average power and peak power of non-elite junior wrestlers. Kim et al. (2011) found that peak and mean power of legs was correlated with fat free mass while studying South Korean judokas. Vardar et al. (2007) established that peak power was positively correlated with FFM in male wrestlers aged from 15 to 19 years. It suggested that FFM rather than %FM may be a predictor of anaerobic performance in wrestlers (Vardar et al., 2007; Demirkan et al., 2013).

The comparison of speed, strength values of cadet wrestlers indicate that AG17 wrestlers were significantly faster than AG 15 (5.6 %). AG 15 wrestlers had significantly lower right hand grip strength than AG 16 and AG17 wrestlers (17.1 – 22 % respectively) to Table 3. And also AG 15 wrestlers had significantly lower left hand grip strength than AG 16 and AG17 wrestlers (18 and 25 % respectively). AG16 wrestlers had significantly lower left hand grip strength than AG 17 wrestlers (8.4 %). Although there was no significant differences back and leg strength values among age groups, AG 15 wrestlers had relatively lower back strength than AG 16 and AG17 wrestlers (10 and 12 % respectively). Also, AG15 wrestlers had lower leg strength than AG17 wrestlers (9.3%). The development of absolute strength during childhood and adolescence has been shown to be highly related to chronological age (De Ste Croix et al., 2003). Previous studies have reported moderate to high correlations (r = 0.36–0.96) for muscular strength versus HT, BW, or FFM (Housh et al., 1995; Housh et al., 1996; Almuzaini, 2007). In our study, it was seen that moderate to high correlations (r = 0.61- 0.81) between the HT, BW, FFM and muscular strength which obtained from hand grip and leg- back strengths to Table 4.

Conclusion

The present study demonstrated that HT, BW, FFM, and arms – legs anaerobic power and capacity, speeds and hand grip strengths were increased both in one age range and in two ages range together with age progression, but it was clearly seen statistical differences in two ages range. In addition this, it was seen that older wrestlers have more training experiences compared with the youngest wrestlers. Therefore, the youngest wrestlers appear to be at a disadvantage due to lower values for HT, BW, FFM, arms – legs anaerobic power and capacity, speed, strength and training experiences. However, these findings indicate that height and fat free mass are considerable factors to achieve the better anaerobic power and capacity. The paper presents also age-related normative data of young wrestlers.

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The Importance of Loosely Systematized Game Phases in Sports: The Case of Attack Coverage Systems in High-Level Women's Volleyball

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A B S T R A C T

Change is ubiquitous, but its degree and rate often affords detection of emerging patterns and establishing behavioral dynamics based on expected regularities. Match analysis capitalizes on such regularities, capturing information relevant for enhancing structure and reducing improvisation to a minimum. However, what if a game phase is only loosely regular, defying pattern systematization? Is it still possible to unfold principles of behavior capable of abstracting over-arching patterns? Our research focused on analysis of complex IV (KIV) or attack coverage in volleyball. Fourteen matches from the 2013 Volleyball Women's World Grand Champions Cup were analyzed. Results showed the occurrence of KIV corresponded to fewer than 5% of the total number of actions, and plays where a team successfully conquered a point after attack coverage was circa 1%, meaning this game complex will only make a difference in balanced matches. Overall, twenty-nine attack coverage structures emerged, denoting very high organizational variability. Attack coverage therefore provides an example of principle-based and not structured-based game phase. Associative analysis showed that quick attack tempos constrain the emergence of more complex attack coverage structures. The search for principle-based instead of structure-based game phases may provide useful insights for comprehension of game dynamics and for informing training processes.

Key words: *structured improvisation, principle-based systemic organization, volleyball.*

Introduction

Although change is the most ubiquitous fact of reality, its degree and rate are often reduced enough making it possible to detect emerging patterns and establish expected behavioral regularities (McGarry, Anderson, Wallace, Hughes, & Franks, 2002). Match analysis capitalizes on such regularities (Garganta, 2009; Lames & McGarry, 2007), attempting to understand the game logic and the relationships within a team and between teams (Ciuffarella et al., 2013). Resulting information aids in the optimization of training processes (Lames & McGarry, 2007; McGarry, 2009). Therefore, researchers and practitioners search for game regularities with the expectancy that performance will benefit from them (Dutt-Mazumder, Button, Robins, & Bartlett, 2011). In this context, Dynamic Systems Theory has brought about a deeper theoretical framework, presenting a set of elements in dynamic interaction according to a common goal (Walter, Lames, & McGarry, 2007).

Often, dynamic systems are complex enough as to possess subsystems, which, despite being slave to the overall system, exhibit partial independence (Thelen, 2005). This partial autonomy of subsystems may promote the occurrence of disturbances from within the system, causing the system to enter a transition period marked by instability until the system returns to its previous state or achieves a new stable state (McGarry et al., 2002). This is achieved through self-organization in response to non-linear constraints (McGarry, 2009), and often generates *novel patterns* (Walter et al., 2007). This effect of novelty should advise researchers to exert caution when generalizing results or when extrapolating conclusions into future competitions (Walter et al., 2007).

Team sports have been characterized as dynamic systems (Walter et al., 2007), with relationships between teammates, opponents, and the environment over time, in the search to score a point and simultaneously to prevent the opponent from scoring (Lames & McGarry, 2007). Such complex and often antagonist interactions generate self-organized patterns, and the emergent structures allow researchers and practitioners to capture the regularities and hopefully diminish the role of randomness (Bergeles & Nikolaidou, 2011; Peña, Rodríguez-Guerra, & Serra, 2013). Hence, the degree of structure is enhanced, whereas the degree of improvisation is left to a minimum (Bergeles & Nikolaidou, 2011; Miskin, Fellingham, & Florence, 2010). However, what ensues when a system is only loosely regular, when its patterns are so diversified that defy systematization? Indeed, randomness occurring at various levels and time scales is deemed to create disturbances in the system, ultimately creating uncertainty regarding the outcome (Aicinena, 2013;

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García, Ibáñez, Cañadas, & Antúnez, 2013). Could we still find emerging *principles* of behavior capable of abstracting overarching patterns? Instead of having a set of predetermined structures for each game scenario, could we instead find some general, loosely systematized principles that could then be easily applied to a wide number of game scenarios and their variations?

This possibility will be explored providing the example of volleyball. Research systematized the game logic and its subsystems, the most relevant being game complexes (K's), which have their own inner logic, despite integrating the broader system that is the game of volleyball. Complex I (KI) or side-out consists of service reception, setting and attack, while complex II (KII, counter-attack or side-out transition) consists of serve, blocking, defense and counter-attack (Costa, Afonso, Brant, & Mesquita, 2012; Costa, Ferreira, Junqueira, Afonso, & Mesquita, 2011; Rodriguez-Ruiz et al., 2011). Some authors also highlight the K0 (autonomizing the serve), KIII (transition or counter-attack to a previous counter-attack), KIV (attack coverage) and KV (freeball and downball), all having their own internal logic and, therefore, being considered separately in research and in training (Hileno & Buscà, 2012).

One such complex, KIV, consists in recovering the ball and restructuring the offensive phase after the ball touches the block and returning to the attacking team's court (Hileno & Buscà, 2012). The literature is outdated and highly simplistic when approaching this game complex, bringing about two main structures: *a)* the 3//2 system, consisting of three players near the attacker (first line of coverage) and two far from the attacker (second line of coverage); and *b)* the 2//3 system, which is the opposite of the 3//2, having two players near the attacker and three further back in the court (e.g. Asher, 1998; Selinger & Ackermann-Blount, 1986). Despite this apparent simplicity, what would happen if the game constraints became so complex or diversified so as to challenge the structuration of rigid attack coverage systems? Indeed, research has been showing that volleyball attack systems are increasingly fast and complex (Afonso, Mesquita, & Marcelino, 2008; Castro & Mesquita, 2008; Ciuffarella et al., 2013; Costa et al., 2012), and this is expected to impact upon the possibilities of KIV structuring, as has been hinted by Hileno and Buscà (2012). Relevant to our case, this was the only scientific paper we found concerning KIV. This might be particularly relevant in female volleyball, since a stronger weight of KII induces longer rallies and, therefore, more opportunities for playing in KIV (Bergeles, Barzouka, & Nikolaidou, 2009; Costa et al., 2012).

Therefore, our purpose was to examine attack coverage in high-level women's volleyball and to verify whether structured systematization is possible or if a loose-principled approach is more suitable. We hypothesize that attack coverage will likely require a loosely systematized approach; hence we expect a rigidly structured approach not to be suitable in this game phase. The implications of this specific case might be broadened into research questioning similar themes and inform about the degree of structuring that a given phenomenon concedes.

Methods

Sample

Fourteen matches from the 2013 Volleyball Women's World Grand Champions Cup were analyzed, including twelve of the highest ranked National Teams. A total of 52 sets were analyzed, including 6815 ball possessions, 2042 of which occurred in KI and 4773 in KII. The Ethics Committee at the Centre of Research, Education, Innovation and Intervention in Sport of University of Porto provided institutional approval for this study.

Instrument

The matches were filmed with a video camera positioned circa 9 meters from the side of court and at a height of circa 3 meters (Sony® Handycam HDR-CX240, 1080p, USA). Data were registered in a worksheet created with IBM® SPSS® Statistics Version 21. Total actions of the teams, occurrence of KIV, the complex that the team was in the moment of KIV (KI or KII), final effect after of KIV, KIV structure (i.e., player distribution in the court), number of coverage lines, quality of first contact, attack zone and tempo were analyzed.

Variables

Game complex previous to the attack coverage considered the KI (attack after serve-reception) and the KII (counter-attack) (Castro, Souza, & Mesquita, 2011; Silva, Lacerca, & João, 2013).

Setting zone was evaluated by the number of attack options afforded to the setter, following a model similar to that of Esteves and Mesquita (2007), according to which we divided the court in three different functional zones (Figure 1). In zone A the setter had all attack options available; this zone is defined as the region from the center line to 2 meters away and spaced 1 meter from the right line and 3 meters from the left line. Zone B still allows quick attacks, but limits the number of attack combinations available, and is located 2 meters to 4 meters from the centerline and laterally 1 meter from the right line and 4 meters from left line. Zone C comprises the remainder of the court, affording only the realization of high sets to the extremities or to the back row.

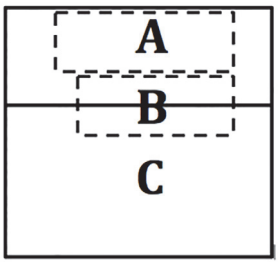

Figure 1. Setting zones

The attack zones were defined according to the FIVB rules, with the court divided into six zones (numbered 1 to 6). For our purposes, zones 5, 6 and 1 were grouped into the category of second line attacks.

Attack tempo denotes the relationship between the attacker and the setter in the play, implying the notion of timing and not

corresponding to a specific time length. We defined three attack tempos, based on Afonso and Mesquita (2007): 1 (the attacker will be in the air, during or shortly after the set); 2 (after the set, the attacker takes two steps); and 3 (three or more steps taken after the set).

Concerning the *attack coverage structure*, a field format was used, thereby not making use of pre-established categories, as our goal was to list all the structures emerging from the plays. As there are, to our knowledge, no references defining what an effective attack coverage is, we considered that to participate effectively in attack coverage the player must be facing the attacker or the blockers, and be in the medium to low body position described by Selinger and Ackermann-Blount (1986), ready to engage. The *number of attack coverage lines* was measured counting from the net to the end line (Table 1).

Attack coverage effectiveness was characterized by the effect of the play following it: the team terminated the play by scoring, terminated the play by losing the point or the rally continued.

Variables and Testing Procedures

Descriptive statistics were used to register the events. We first attempted constructing of three distinct predictive models, using Multinomial Logistic Regression: *a)* a model predicting the efficacy of attack coverage based on game complex, setting zone, attack zone, attack tempo, attack coverage structure, and attack coverage lines; *b)* a model predicting the attack coverage structure, based on game complex, setting zone, attack zone, and attack tempo; and *c)* a model predicting the number of attack coverage lines, also based on game complex, setting zone, attack zone, and attack tempo. No significant model could be achieved, as very strong data dispersion inhibited detection of repetitive game patterns.

As a second step, a more modest associative analysis was performed to examine relationships between the several variables under analysis, even if a more global and comprehensive model could not be achieved. A Chi-square testing with Monte Carlo correction was conducted. Where p was ≤0.05, cells containing adjusted residuals above |2.0| were analyzed. Cramer's V was calculated to evaluate the Effect Sizes. Results of this second analysis somewhat support those obtained through the first analysis, and its implications will be discussed in detail.

Reliability analysis

Intra-observer reliability analysis was conducted circa one month after the original observations, and achieved a Cohen's Kappa between 0.81 and 0.89. Inter-observer reliability analysis was conducted by an experienced volleyball coach and researcher and achieved a Cohen's Kappa between 0.75 and 0.84.

Results

Descriptive analysis

Attack coverage occurred in 277 occasions, corresponding to 4.1% of the plays. Of these, 128 (46.2%) occurred after KI and 149 (53.8%) after KII. Twenty-nine different KIV structures appeared, under four groups: one-line formations, two-line formations, three-line formations and four-line (see Table 1).

Table 1. Attack Coverage Formations

No. lines	No. structures	Frequency of occurrence	Percentage
1	5 (1, 2, 3, 4, 5)	13	4.8
2	10 (1//1, 1//2, 1//3, 1//4, 2//1, 2//2, 2//3, 3//1, 3//2, 4//1)	167	60.1
3	10 (1//1//1, 1//1//2, 1//1//3, 1//2//1, 1//2//2, 1//3//1, 2//1//1, 2//1//2, 2//2//1, 3//1//1)	93	33.5
4	4 (1//1//1//1, 1//1//2//1, 1//2//1//1, 2//1//1//1)	4	1.6

Overall, 4.7% of attack coverage scenarios presented a system with one line of coverage (*n*=13), 60.3% a two-line system (*n*=167), 33.6% a three-line system (*n*=93), and 1.4% comprised a four-line system (*n*=4).

Concerning the quality of first contact, 48.7% of attack coverage occurred after setting in zone A (*n*=135), 38.6% after setting in zone B (*n*=107), and 12.6% after setting in zone C (*n*=35). Attack coverage followed attacks in zone 2 in 28.9% of occasions (*n*=80), zone 3 in 12.3% (*n*=34), zone 4 in 47.3% (*n*=131), and second line in 11.5% (*n*=32). With regard to attack tempo, tempo 1 occurred in 9.0% of the plays preceding attack coverage (*n*=25), tempo 2 in 41.5% of the plays (*n*=115), and tempo 3 in 49.5% (*n*=137).

Finally, 22.9% (*n*=61) of the counter-attacks following attack coverage resulted in attack error (i.e., they ended up being ineffective), 54.5% (*n*=151) offered continuity in play, and only 23.5% (*n*=65) resulted in scoring a point.

Associative analysis

Attack coverage formations presented a significant association with attack tempo (χ^2=99.416, p≤0.001, V=0.424). Several attack coverage formations associated positively with tempo 1: 1//2 (2.2), 1//4 (5.6), 3//1 (2.5), 5 (3.2). No cell revealed significant associations with tempo 2. Tempo 3 associated negatively with the 1//4 structure (-2.2).

There was also a significant association between attack coverage formation and attack zone (χ^2=124.123, p≤0.030, V=0.386). Three formations associated with attacks in zone 2: 1//1//2 (2.2), 2//1 (-2.6), 2//3 (2.2). Four formations associated with attacks in zone 3: 1 (2.9), 1//4 (4.7), 2//3 (-2.4), 3//1 (3.4). One formation associated negatively with attacks in zone 4 (1//4; -2.1) and one positively with second line attacks: 2//1//1 (2.4).

Finally, there was association with quality of first contact (χ^2=76.615, p≤0.035, V=0.372). The following cells associated with balls passed into setting zone A: 1//3//1 (-2.3), 1//4 (2.3), 2//2 (2.6), 2//3 (-2.7). Balls set in zone B associated with 2//2 (-3.3) and 2//3 (3.0). Associations emerged in the following cells for balls set in zone C: 1//1//1//1 (2.6) and 1//2//1//1 (2.6), 1//3//1 (2.2). No significant association was found with game complex (p=0.538, V=0.310) and attack coverage effect (p=0.101, V=0.355).

Considering the number of attack coverage lines, there was an association between the number of lines and game complex (χ^2=9.554, p=0.023, V=0.186). KI associated positively with the emergence of two-line systems (2.4) and negatively with three-line systems (-2.3). The inverse relationships were observed for KII.

No association was found between number of coverage lines and quality of first contact (p=0.203, V=0.124), attack zone (p=0.145, V=0.127), attack tempo (p=0.117, V=0.136), and effect of attack coverage (p=0.179, V=0.127).

Discusion

Science has aimed at revealing hidden but meaningful patterns that improve our ability to anticipate and better cope with expected constraints. Systemic approaches attempt to understand the relationships within the subsystems and how such interactions influence the evolution of the system's behavior over time (McGarry et al., 2002). Armed with these conceptual lenses, researchers in match analysis try to capture meaningful game patterns in an effort to better systematize its understanding and hopefully translate that knowledge into better practices (Dutt-Mazumder et al., 2011). Using the example of the attack coverage (complex IV) in volleyball, we posed the question of what would happen when a system's behavior refused rigid structuring. Our aim was to verify is there were such scenarios in high-level sport and, if so, if it was still possible to find a principle-based organization to inform practice.

Results showed that the occurrence of KIV corresponded to fewer than 5% of the total number of actions, suggesting that it may not be as relevant to the outcome as other game complexes analyzed by the literature, such as complexes I (Laios & Kountouris, 2005; Zetou, Moustakidis, Tsigilis, & Komninakidou, 2007) and II (Marcelino, Mesquita, Sampaio, & Moraes, 2010). Furthermore, the overall percentage of plays where a team successfully conquers a point after attack coverage is around 1%. However, performance at the highest level often depends on the little details that produce all the difference (Marcelino et al., 2010).

Additionally, we highlight the emergence of 29 different attack coverage formations, each occurring with low frequency. Indeed, only two out of the 29 structures presented a rate of occurrence greater than 10%, namely the 2//2 structure with 11.9%, and the 2//3 structure with 13%. This denotes a considerable structural variability under this game complex. The 3//2 structure, one of the systems depicted in dedicated volleyball manuals (e.g., Asher, 1998; Selinger & Ackermann-Blount, 1986), occurs in only 7.2% of the situations. Consequently, a highly structured approach to KIV is not warranted, thereby confirming our hypothesis. Instead, a principle-based view may be more suitable (e.g., 'if you are near the attacker and not involved in other actions, try to cover the attack').

Acting upon general principles instead of rigid, predetermined structures is consistent with accepting the role and weight of change in most phenomena. And although some game phases in different sports may be prone to detailed structuring (Garganta, 2009; Lames & McGarry, 2007; McGarry et al., 2002), others may resist such pretensions and increase the challenge of guiding good practices, meaning a dynamic system can be so complex and the interactions between its subsystems so diversified (Thelen, 2005) that self-organizing behavior will generate a number of different outcomes. Notwithstanding, our data suggests that some principle-based guidelines are possible. The association between attack tempo and attack coverage structure revealed an effect size of V=0.424, meaning an extremely good relationship between the two variables. Thus, attack tempo seems to highly constraint the type of organizations possible in each attack coverage sequence. Specifically, tempo 1 is associated with a number of two-line structures and with a one-line structure. No three- or four-line structures were associated with tempo 1. Therefore, despite the quickest attack tempo promoting more feeble opposition from the blockers and defenders due sheer game velocity (Ciuffarella et al., 2013; Costa et al., 2012), it also impairs the attacking team's chances of structuring solid attack coverage.

The very strong effect size verified for the association between attack coverage systems and attack zone (V=0.386) is, we believe, a side effect of attack tempo, since quicker attack tempos usually associated with zone 3, and slower attack tempos with zones 2, 4, and 2nd line (Palao, Santos, & Ureña, 2007). We extend this reasoning to the setting zone (V=0.372), as this variable severely constraints the options that are available for developing quicker attacks (Marcelino, César, Afonso, & Mesquita, 2009; Palao et al., 2007).

Providing a very specific example from volleyball, we hope to shed improved comprehension of what our results suggest. When a team attacks by position 6, for example, a number of different scenarios could have preceded that attack. In a highly systematized attack coverage approach, each such scenario would warrant a very specific structure, defining which players would cover each location of the court depending on a number of variables besides attack zone, such as: zone of first contact, zone of second contact, involvement of attackers in quick attacks and/or in combination plays, and so on. Conversely, a loosely systematized approach would merely require defining one broad action principle (e.g., cover near the attacker if you are close to him/her, cover the backcourt if you are further away), which would then be applied plastically to each emerging game scenario. This would afford a more natural response to emerging game constraints, besides imposing a much smaller load to the players' memory.

Conclusion

In summary, the volleyball game promotes few occurrences of complex IV. Two major factors may contribute to this: *a)* when the attacker faces the block, he might miss the attack, score a point, or put the ball into the opponent's court, with or without a touch on the block; situations in which the ball deflects on the block and returns to the attacking team's court is reduced; and *b)* when the ball does return to the attacking team's court after being deflected by the block, it often results in a point by the blocking team; on fewer occasions, the team is able to defend the ball, but not allowing the construction of an organized attack; on very few occasions, the team will be able to counter-attack and score a point. Nonetheless, those few occasions may be highly relevant for balanced matches, as most are expected to be at the highest levels of practice.

The associations between the emerging attack coverage structures and game variables such as attack tempo, game complex, and others were scarce, with considerable variation and no clear patterns emerging. Therefore, a principle-based approach may be more rational than more strictly structured approaches. Notwithstanding, we suggest that much research is warranted to better understand the actual role of complex IV in high-level women's volleyball and similar game phases in other sports.

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The Determination of Physical Activity Levels of Trainers in Kastamonu, Turkey

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A B S T R A C T

This study was carried out with the aim of determining the PA levels of the trainers working in Kastamonu in terms of gender and marital status variables. This study was applied to trainers from 15 different branches in the competitions organized by Kastamonu Directorate of Youth and Sports and Kastamonu Directorate of National Education. A total of 51 trainers participated in the study voluntarily; 19 of them were female; their mean age was 26.53±9.08 years, their mean height was 167.37±5.37 m and their mean weight was 60.37±7.30 kg. 32 of the trainers were male; their mean age was 35.41±8.10, their mean height was 179.69±6.25 m and their mean weight was 83.94±12.11 kg. Since the PA levels of the trainers working in the city center of Kastamonu were studied, the number of subjects was 51. In this study, in order to determine the physical activity level of the trainers, Physical Activity Evaluation Survey (PAAQ) has been used. SPSS 15.0 was used to analyze the data in the dual comparisons, the nonparametric Mann-Whitney U Test has been applied. According to gender, there was no significant difference in met/week values of all indexes (p>0.05); also according to marital status, there was significant difference in met/week value of work index (p<0.05, U=183,500). As a result, according to gender, while it was found that PA levels of male trainers were higher in work (p>0.05, U=230,500) and sport indexes (p>0.05, U=282,000), PA levels of female trainers were found higher in home index. On the other hand, it was also determined that according to marital status, PA levels of single trainers were higher than married trainers in work index.

Key words: *Physical Activity, trainer, Physical Activity Assessment Questionnaire (PAAQ).*

Introduction

Human body constantly needs to move due to its innate nature. However, through the facilities and the opportunities provided by civilization, people are becoming less mobile each passing day (Zorba and Saygin, 2009). As a result, health problems related to less movement have begun to appear and immobility has become a factor which threatens people and puts life under risk (Zorba and Saygin, 2009). With these changes, people's physical activity levels are also constantly decreasing. Today, physical activity deficiency is commonly seen in adult and old population. There are many psychological, behavioral and physiological reasons as to why people do not perform physical activity or perform limitedly (Bulut, 2013).

Physical activity (PA), which has been produced as a result of flexing skeletal muscles, is corporal movements requiring energy consumption over basal level (Özer, 2006). PA involves activities which is a part of daily life. Regular PA has positive effect on the function of quite a few systems (F. Soyuer, and Soyuer, 2008). It is a well known fact that regular physical activity reduces the risk of developing cardiovascular diseases; helps control blood pressure in cases of hypertension; preserves ideal body weight; reduces the frequency of depression and stress and helps the formation of healthy bone and muscle ligament structure (Arikan, Metintaş, and Kalyoncu, 2008). Various sports, Cronbach alpha value was 0,926 by Karaca, Ergen, and Koruç (2000) dance, exercise, game and daily activities, which involve all or a part of basic body movements, such as walking, running, jumping, cycling, arm-leg and head-neck movements are accepted as physical activity (Baltaci, Irmak, Kesici, Çelikcan, and Çakir, 2008).

PA of a person or a group is classified according to how it is performed. Common classifications are as follows: occupational activities, housework, spare time activities and transportation. Spare time activities might be sub-classified as recreational activities (walking, cycling) and exercise training (Özer, 2006).

It is an important problem that physical activity is not performed regularly and insufficiently in many countries. Therefore, increasing active life-style constitutes an important component of national and international public health suggestions (Savci, Öztürk, Arikan, Inal, and Tokgözoğlu, 2006). According to Driskell, Kim, and Goebel (2005), with reference to the guidebook of The American College of Sports Medicine (ACSM) and American Overseas Dietetic Association (AODA), it is necessary for adults to perform sub-maximal activity, which is a minimum of 30 minutes every day or several days a week.

Although people have more spare time now, they still do not allocate sufficient time for physical activity (Heyward, 2006). An immobile life-style and gaining weight are a common problem observed among trainers, as a result of terminating their active sports life. This condition brings along health

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problems as well. Regular physical activity has a significant role in increasing the self-esteem, work productivity and performance of the trainer. In addition, psychological benefits of physical activity, such as positive thinking and dealing with stress, have the effect of coping with psychological stress the trainers are subject to, due to the expectation of winning and being successful.

This study was performed with the aim of determining the PA levels of the trainers working in Kastamonu with regards to gender and marital status variables.

Methods

This study was applied to the trainers from 15 different branches in the competitions organized by Kastamonu Directorate of Youth and Sports and Kastamonu Directorate of National Education. A total of 51 trainers participated in the study voluntarily. 19 of them were female; their mean age was 26.53±9.08 years, their mean height was167.37±5.37 m and their mean weight was 60.37±7.30 kg. 32 of them were male; their mean age was 35.41±8.10, their mean height was 179.69±6.25 m and their mean weight was 83.94±12.11 kg. Since PA levels of the trainers working in the city center of Kastamonu were studied, the number of subjects was 51. Physical Activity Assessment Questionnaire (PAAQ) on the validity and reliability of the study was performed (Karaca et al., 2000) and was used in order to determine PA levels of the trainers. For each activity, MET value provided by Ainsworth et al. (2000) as Metabolic Equivalent (MET) was used. According to this, all activities are assigned an intensity level based on the rate of energy expenditure expressed as METs.

Physical Activity Assessment Questionnaire (PAAQ) is composed of a total of 6 parts as descriptive information (age, height, weight etc.): activities related with work, activities related with transportation, stair climbing, activities related with housework and activities related with sports. Using this questionnaire, individuals' MET/week (kcal/kg/week), kcal/ week, MET/hour values can be calculated. In calculating these data, (frequency x time x intensity) is used. Frequency refers to how many times the activity is done per week; time refers to how much time it takes to do the activity (hour or minute); intensity refers to the MET value spent for the activity in 1 hour. The formula below is used in order to calculate MET/ week values.

MET/week (kcal/kg/week) = the frequency of activity x the time of activity x the intensity of the activity (Karaca et al., 2000).

MET Value: MET (Metabolic Equivalent) is predetermined for each activity and is referred to as kcal/kg (Ainsworth et al., 1993).

For the analysis given place to in the study, the SPSS 15.0 package program has been used and has been interpreted in 0.05 meaning level. In the dual comparisons, the nonparametric Mann-Whitney U Test has been applied.

Results

According to gender, there was no significant difference in MET/week values of all indexes ($p>0.05$); however, according to marital status, there was significant difference in MET/week value of work index ($p<0.05$, U= 183,500).

Table 1. The Comparison of Met/Week Values According to the Gender and Marital Status Variables

Variables	Indexes	N		Mean Rank	Sum of Ranks	U	p
GENDER	Work Index	Female	19	22.13	420.50	230.500	0.152
		Male	32	28.30	905.50		
	Transportation Index	Female	19	29.08	552.50	245.500	0.254
		Male	32	24.17	773.50		
	Home Index	Female	19	30.82	585.50	212.500	0.075
		Male	32	23.14	740.50		
	Hobby Index	Female	19	24.50	465.50	275.500	0.490
		Male	32	26.89	860.50		
	Stair Climbing Index	Female	19	24.13	458.50	268.500	0.484
		Male	32	27.11	867.50		
	Sport Index	Female	19	24.84	472.00	282.000	0.668
		Male	32	26.69	854.00		
	Total İndex	Female	19	27.37	520.00	278.000	0.612
		Male	32	25.19	806.00		
MARITAL STATUS	Work Index	Single	24	31.85	764.50	183.500	0.008
		Married	27	20.80	561.50		
	Transportation Index	Single	24	24.63	591.00	291.000	0.533
		Married	27	27.22	735.00		
	Home Index	Single	24	23.83	572.00	272.000	0.326
		Married	27	27.93	754.00		
	Hobby Index	Single	24	25.50	612.00	312.000	0.779
		Married	27	26.44	714.00		
	Stair Climbing Index	Single	24	29.02	696.50	251.500	0.166
		Married	27	23.31	629.50		
	Sport Index	Single	24	21.79	523.00	223.000	0.057
		Married	27	29.74	803.00		
	Total Index	Single	24	25.38	609.00	309.000	0.777
		Married	27	26.56	717.00		

Legend: U - Mann-Whitney U Test

In terms of gender, PA levels of male trainers were found to be higher in work index ($p>0.05$, U=230,500) and sport index ($p>0.05$, U=282,000), while PA levels of female trainers were found to be higher in home index. On the other hand, it was also determined that in terms of marital status, PA levels of single trainers were found to be higher than married trainers in work index.

Discussion

In this study, which was carried out in order to determine physical activity levels of trainers serving in Kastamonu province in terms of their gender and marital status, there is no significant difference in the MET/week values of all the indexes of participating trainers' with reference to gender and marital status ($p>0.05$). However, it was determined that in the case of home index, female trainers' physical activity levels are higher than males'. Thomas, Costa, Silva, and Hallal (2010) suggest as a result of their study that females are more active in housework. In addition, the study Bicalho et al. (2010) carried out in Brazil suggest that men are more active in their work and spare times, while women are more active in housework. Akandere et al. (2008) suggest in their study which they carried out on kick box trainers, that the time that is spend at work and at home differs according to gender and women spend less time at work. The reason behind this is considered to be primarily arising from the fact that women have to deal with house work (Arslan, Koz, Gür, and Mendeş, 2003) or that women spend more time at home compared to men (Akandere, Arslan, and Taşkin, 2008).

In our research, we have found out that male trainers' physical activity levels are higher than women's in work and sports indexes in terms of the gender variable. Richardson, Ainsworth, Wu, Jacobs, and Leon (1995) carried out a study on men and women, whose ages range between 20 and 59 and found out that men's sports index averages are higher than women's. The results of our study are similar to those of Richardson et al.'s. (1995) Physical Activity Assessment Questionnaire (PAAQ) Reliability and Validity Study carried out by Karaca et al. (2000) indicates that that men are less active than women in terms of home index.

According to the marital status variable, a statistically significant difference was found in MET/week value in work index ($p<0.05$). This study also shows parallelisms with the results of Burton and Turrell (2000) and Hallal's studies (Hallal, Victora, Wells, Lima, 2003). In the work index, it can be seen that single trainers have higher physical activity levels than married trainers. Nevertheless, Hull et al.(2010) in their study, where they examine the effect of marriage and having children on physical activity, stated that marriage does not have any effect on physical activity for young adults. Likewise, the difference on total index between married and single trainers determined in our study shows similarity with the study carried out by Hull et al. (2010).

Conclusion

In conclusion, it can be seen that female trainers are more active in home index, while male trainers are more active in work index. Moreover, we have found out that PA levels of single trainers in work index are higher than those of married trainers. The time that women spend on sports activities are less than men's. Therefore, the awareness of male coaches in terms of encouraging their spouses to do sports activities and informing them about the benefits of physical activities should be raised. In addition, male coaches can hire help for their spouses for house work or help them themselves and thus allow female coaches to allocate time for physical activities. By reducing the usage of technological devices which facilitate life but steer people towards inactivity, people can be allowed to be physically more active. Married couples who are both coaches choosing sports activities which they can do together may help them to acquire the habit of doing sports regularly. Therefore, it is considered that acquiring the habit of regular physical activity and adopting exercises as a part of daily life will be quite efficient in protecting human health and reducing health risks to be faced in future life.

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Body Height and Its Estimation Utilizing Arm Span Measurements in Bosnian and Herzegovinian Adults

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A B S T R A C T

Anthropologists recognized the tallness of nations in the Dinaric Alps long time ago. As the modern Bosnian and Herzegovinian fall more into the Dinaric racial classification, the purpose of this study was to examine the body height in Bosnian and Herzegovinian adults as well as the relationship between arm span as an alternative to estimating the body height and body height, which vary in different ethnic and racial groups. The nature and scope of this study analyzes 212 students (178 men, aged 22.42±2.79 and 34 women, aged 21.56±2.06) from the University of Banjaluka to be subjects. The anthropometric measurements were taken according to the protocol of the ISAK. Means and standard deviations were obtained. A comparison of means of body heights and arm spans within each gender group and between genders were carried out using a t-test. The relationships between body height and arm span were determined using simple correlation coefficients and their 95% confidence interval. Then a linear regression analysis was performed to examine the extent to which the arm span can reliably predict body height. The results have shown that male Bosnian and Herzegovinians are 183.87±7.11 cm tall and have an arm span of 184.50±8.28 cm, while female Bosnian and Herzegovinians are 171.82±6.56 cm tall and have an arm span of 169.85±8.01 cm. Compared to other studies, the results of this one have shown that both genders make Bosnian and Herzegovinian population one of the tallest nations on the earth, maybe the tallest one. Moreover, the arm span reliably predicts body height in both genders. However, the estimation equations, which were obtained in Bosnian and Herzegovinians, are substantially different alike in other populations, since arm span was close to body heights: in men 0.73±1.17 cm more than the body height and in women 1.97±1.45 centimeters less than the body height. This confirms the necessity for developing separate height models for each population.

Key words: *Prediction; Standing Height; Stature; Armspan; Bosnia and Herzegovina.*

Introduction

The Republic of Bosnia and Herzegovina is an independent, democratic state with a multiparty parliamentary system. The governmental system is based on the division of power into legislative, executive and judiciary and it has a bicameral legislature and a three-member Presidency composed of a member of each major ethnic group (Bosniaks, Serbs and Croats). However, the central government's power is highly limited, as the country is largely decentralized and comprises two autonomous entities: the Federation of Bosnia and Herzegovina and Republic of Srpska, with a third region, the Brčko District, governed under local government. This country is one of the successor states of the former Yugoslavia, from which it declared independence in 1992. Although it is one of the youngest modern countries in the World, this is a region that traces permanent human settlement back to the Neolithic age, during and after which it was populated by several Illyrian and Celtic civilizations. Culturally, politically, and socially, the country has one of the richest histories in the region, having been first settled by the Slavic peoples that populate the area today from the 6th through to the 9th centuries AD. From mid-15th to the late 19th centuries, this area was under the Ottoman Empire that was followed by annexation into the Austro-Hungarian Empire on 1908, which lasted up until the World War I. In the interwar period, Bosnia and Herzegovina was a part of the Kingdom of Serbs, Croats and Slovenes (Kingdom of Yugoslavia from 1929 onward) and after World War II, the country was granted full republic status in a newly formed Socialist Federal Republic of Yugoslavia. Hence, it is not hard to conclude the area of this country was under pressure of all strongest empires and represent the largest crossroads in the World.

Today, the Republic of Bosnia and Herzegovina covers the area of 51,197 sq. kilometers (Central Intelligence Agency, 2014). It is located in Southeastern Europe, on the Balkan Peninsula and it is bordered by Croatia to the north, west and south, Serbia to the east, and Montenegro to the southeast and it is almost landlocked, except for the 20 kilometers of coastline on the Adriatic Sea, around the town of Neum in the Herzegovina-Neretva Canton. Although the city is surrounded by Croatian peninsulas, by the international law, Bosnia and Herzegovina has a right of passage to the outer sea. In the central and southern interior of the country, the geography is mountainous, in the northwest, it is moderately hilly, and the northeast is predominantly flatland. The country's name comes from two regions: Bosnia and Herzegovina, which have an unclear defined border between them. Bosnia occupies the northern areas, which are roughly four-fifths of the entire country, while Herzegovina occupies the rest in the southern part of the country. The country is mostly mountainous, encompassing the central Dinaric Alps. The northeastern parts reach into the Pannonian basin, while in the south it borders the Adriatic Sea. Dinaric

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Alps generally run in east-west direction, and get higher towards the south. Overall, close to 50% of Bosnia and Herzegovina is forested, while less than 1% is covered by water. Most forest areas are in Central, Eastern and Western parts of Bosnia, while Herzegovina has drier Mediterranean climate. Northern Bosnia (Posavina) contains very fertile agricultural land along the river Sava and the corresponding area is heavily farmed. This farmland is a part of the Parapannonian Plain stretching into neighboring Croatia and Serbia.

Bosnia and Herzegovina is home to three ethnic "constituent peoples": Bosniaks, Serbs and Croats. According to the 1991 census, Bosnia and Herzegovina had a population of 4,377,000 inhabitants (Institute for Statistics of Federation of Bosnia and Herzegovina, 2014), while the 1996 UNHCR unofficial census showed a decrease to 3,920,000 inhabitants (Institute of International Cooperation of the German Adult Education Association, 2014). Large population migrations during the Yugoslav wars in the 1990s have caused demographic shifts in the country. No census has been taken during war time, and political disagreements have made it impossible to organize one later on. Nevertheless, a census has been planned for 2012., but that date has been delayed until 2014. The total population of the Republic of Bosnia and Herzegovina, according to the 2014 census, was 3,871,643 inhabitants (Central Intelligence Agency, 2014). Ethnically, according to data from 2014 cited by the Central Intelligence Agency (2014), Bosniaks constitute 52.5 percent of the population, Serbs 33.5 percent, Croats 14 percent, and others around 1 percent. According to the same resource, 40 percent of the population identifies religiously as Muslims, 31 percent as Orthodox Christians, 15 percent as Roman Catholics, and 14 percent other (mostly atheists, Jews, and others). From the reason the ethnicity mostly corresponds to the religious affiliations, the authors of this study assumed the ethnical differences are based mostly on religious backgrounds and it is not realistically based on biological facts.

The tallness of the nations in the Dinaric Alps has been recognized by European anthropologists more than 100 years ago (Pineau, Delamarche, & Božinović, 2005). As the modern Bosnian and Herzegovinians, like the rest of the nations from Former Yugoslavia, fall more into the Dinaric racial classification than any other, it is assumed by the authors of this study that Bosnian and Herzegovinian adults might be equally tall or a bit taller than the tallest nations in the Europe (Bjelica et al., 2012; Popović, Bjelica, Molnar, Jakšić, & Akpinar, 2013): Dutch (male: 183.8 centimeters; female: 170.7 centimeters), Montenegrins (male: 183.21 centimeters; female: 168.37 centimeters) and Serbians (male: 182 centimeters; female: 166.8 centimeters). The authors of this study believed Bosnian and Herzegovinian population might be the tallest in the World, mostly due to the reason most of previous studies investigated all the nations that has been contained in Pineau and collaborators' sample (Bjelica et al., 2012; Popović et al., 2013, Popović, Bjelica, Geogiev, Hadžić and Akpinar, in press), excluding the Bosnians and Herzegovinians. However, any of previously investigated nations didn't reach the tallness that Pineu and his collaborators confirmed. From this reason, the population from Bosnia and Herzegovina might be the key population that increased the average body height of Dinaric Alps population measured by Pineu and his collaborators (2005). However, unlike the most other countries through Western Europe, Bosnia and Herzegovina keeps poor records and an update of average body heights among its populations is beneficial as well as its estimation utilizing arm span measurements, mostly due to the reason that measurement of body height is important in many settings (Bjelica et al., 2012).

It is already well known in scientific literature that the measurement of body height is important in many settings: it is an important measure of body size and gives an assessment of nutritional status (cited in Datta Banik, 2011), as well as an important measure of determination of basic energy requirements, standardization of measures of physical capacity and adjusting drug dosage, and evaluation of children's growth, prediction and standardization of physiological variables such as lung volumes, muscle strength, glomerular filtration and metabolic rate etc. (Golshan, Amra & Hoghoghi, 2003; M. Golshan, Crapo, Amra, Jensen & R. Golshan, 2007; Mohanty, Babu & Nair, 2001; Ter Goon, Toriola, Musa & Akusu, 2011). However, the exact body height cannot always be determined the usual way because of various deformities of the extremities or in patients who have undergone amputations or similar injuries. In such circumstances, an estimate of body height has to be derived from other reliable anthropometric indicators such as hand and foot lengths (A.K Agnihotri, S. Agnihotri, Jeebun & Googoolye, 2008; A.K. Agnihotri, Purwar, Googoolybe, S. Agnihotri & Jeebun, 2007; Kanchan et al., 2008; Rastogi, Nagesh & Yoganarasimha, 2008; Sanli et al., 2005), knee height (Fatmah, 2005; Hickson & Frost, 2003; Karadag, Ozturk, Sener & Altuntas, 2012), length of the forearm (Ilayperuma, Nanayakkara & Palahepitiya, 2010), length of the sternum (Menezes et al., 2009; Menezes et al., 2011), vertebral column length (Nagesh & Pradeep, 2006), sitting height (Fatmah, 2005), length of scapula (Campobasso, Di-Vella & Introna, 1998), arm span (Aggrawal, Gupta, Ezekiel & Jindal, 2000; Bjelica et al., 2012; Datta Banik, 2011; Fatmah, 2005; Hickson & Frost, 2003; Jalzem & Gledhill, 1993; Mohanty, et al., 2001; Ter Goon et al., 2011) as well as cranial sutures (Rao et al., 2009), skull (Bidmos, 2006; Bidmos & Asala, 2005), facial measurements (Sahni et al., 2010) et cetera. Therefore, all these anthropometric indicators which are used as an alternative to estimate body height are very important in predicting age-related loss in body height. Also in identifying individuals with disproportionate growth abnormalities and skeletal dysplasia or body height loss during surgical procedures on the spine (Mohanty et al., 2001), as well as predicting body height in many older people as it is very difficult to measure it precisely, and sometimes impossible because of mobility problems and kyphosis (Hickson & Frost, 2003).

According to all mentioned above, the authors believed it would be reasonable to find the effectiveness of using various body indicators in estimating body height in the Bosnian and Herzegovinian population. Furthermore, several studies have reported the effectiveness of using various body parameters in predicting body height and arm span was found to be the most reliable one (Hickson & Frost, 2003; Jalzem & Gledhill, 1993; Mohanty et al., 2001; Ter Goon et al., 2011). However, the associations of arm span and body height was found to vary in different ethnic and racial groups (Bjelica et al., 2012; Brown, Feng & Knapp, 2002; Popović et al., 2013, Popović et al., in press; Reeves, Varakamin & Henry, 1996; Steele & Chenier, 1990). Even though several studies of this nature are available on western populations, very limited data is available on Bosnian and Herzegovinian subjects. In the light of rather scarce recent scientific literature, the purpose of this study was to examine the body height in both genders of Bosnian and Herzegovinian adults and the relationship between arm span and body height.

Methods

The nature and scope of this study qualifies 212 students (178 men and 34 women) from the University of Banjaluka to be subjects. This group was chosen because the growth of an individual ceases by this age and there is no age-related loss in body height at this age. The authors have also believed this

sample might fairly represent the whole population of Bosnia and Herzegovina as students were admitted into the University of Banjaluka regardless of geographical residence and socio-economic status, as well as ethnicity. The average age of the male subject was 22.42±2.79 years old (range 19-32 yrs.), while the average age of the female subject was 21.56±2.06 years old (range 19-26 yrs.). It is also important to emphasize that the authors could not accept students with physical deformities that could affect body height or arm span, and without informed consent were excluded from the study. The exclusion criterion was also being non-Bosnian and Herzegovinian (twelve participants, five male and seven female were excluded from the data pool). Accordingly, the authors have purposely selected (deliberate sampling) the students from the Faculty of Sport and Physical Education at University of Banjaluka as they believed that most of them could be eligible to participate in the study, as well as this is one of the highly ranked Faculty of Sport and Physical Education in Bosnia and Herzegovina which brings together students from all parts of Bosnia and Herzegovina.

According to Marfell-Jones, Olds, Stew & Carter (2006), the anthropometric measurements, including body height and arm span were taken according to the protocol of the International Society for the Advancement of Kinanthropometry (ISAK). The trained anthropometrist (the same one for each measure) whose quality of performance was evaluated against prescribed "ISAK Manual" prior to the study performed these measurements. The age of the individuals was determined directly from their reported date of birth.

The body height presents the perpendicular distance between the top of the head (the vertex) and the bottom of the feet. It was measured using stadiometer to the nearest 0.1 centimeters in bare feet with the participants standing upright against a stadiometer. The respondents had to put their feet together and move back until their heels touched the bottom of the stadiometer upright. Their buttocks and upper part of their back have also been touching the stadiometer upright while their head did not have to touch the stadiometer. The respondent's head had to be in the Frankfort horizontal plane. This was achieved when the lower edge of the eye socket (the orbitale) is horizontal with the tragion. The vertex was the highest point on their head, otherwise the respondents had to raise or lower their chin until it was in the Frankfort horizontal plane to align their head properly.

The arm span is the anthropometric measurement of the length from the tip of the middle fingers of the left and right hands when raised parallel to the ground at shoulder height at a one-hundred eighty degree angle. It was measured using a calibrated steel tape to the nearest 0.1 centimeters in bare feet on a level concrete floor with their upper backs, buttocks and heels against the wall, which provide support. The participant's head was also in the Frankfort horizontal plane and the arms were outstretched at right angles to the body with palms facing forwards. The measurement were taken from one middle fingertip to the other middle fingertip, with the tape passing in front of the clavicles while two field workers supported the elbows. The measurements were taken twice, and an average of the two readings was calculated. When the two measurements agreed within 0.4 centimeters, their average was taken as the best estimate for the true value. When the two initial measures did not satisfy the 0.4 centimeters criterion, two additional determinations were made and the mean of the closest records was used as the best score.

The analysis was carried out using Statistical Package for Social Sciences (SPSS) version 20.0. Means and standard deviations (SD) were obtained for both anthropometric variables. A comparison of means of body heights and arm spans within each gender group and between genders was carried out using a t-test. The relationships between body height and arm span were determined using simple correlation coefficients and their 95% confidence interval. Then a linear regression analysis was performed to examine the extent to which arm span can reliably predict body height. Finally, these relationships were plotted as scatter diagrams. Statistical significance was set at $p<0.05$.

Results

A summary of the anthropometric measurements in both genders is shown in Table 1. The mean of the arm span for male subjects was 184.50±8.27 centimeters, which was 0.73±1.17 centimeters more than the body height and statistically insignificant (t=0.776, p=0.438), and for female subjects it was 169.85±8.01 centimeters, which was 1.97±1.45 centimeters less than the body height and statistically insignificant (t=1.110, p=0.271). The gender difference between body height and arm span measurements was statistically significant (body height: t=9.715; p<.000, and arm span: t=9.68; p<.000).

Table 1. Anthropometric Measurements of the Study Subjects

Subjects	Body Height Range (Mean±SD)	Arm span Range (Mean±SD)
Male	164.2-206.3 (183.87±7.11)	165.4-211.1 (184.50±8.27)
Female	159.3-187.4 (171.82±6.56)	152.1-190.1 (169.85±8.01)

The simple correlation coefficient and their 95% confidence interval analysis between the anthropometric measurements are presented in Table 2. The relationships between body height and arm span was high and significant in the sample, regardless of gender.

Table 2. Correlation between Body Height and Arm Span of the Study Subjects

Subjects	Correlation Coefficient	95% confidence interval	Significance p-value
Male	0.876	0.691–0.814	<0.000
Female	0.887	0.590–0.862	<0.000

The results of the linear regression analysis are shown in Table 3. The first of all models were derived by including age as a covariate. However, it was found that the contribution of age was insignificant and therefore the age was dropped and

estimates were derived as univariate analysis. The high values of the regression coefficient signify that arm span significantly predicts body height in both Serbian genders.

Table 3. Results of Linear Regression Analysis Where the Arm Span Predicts the Body Height

Subjects	Regression Coefficient	Standard Error (SE)	R-square (%)	t-value	p-value
Male	0.876	3.445	76.7	24.064	0.000
Female	0.887	3.072	78.7	10.877	0.000

The relationships between arm span measurements and body height among the above models is plotted as a scatter diagram.

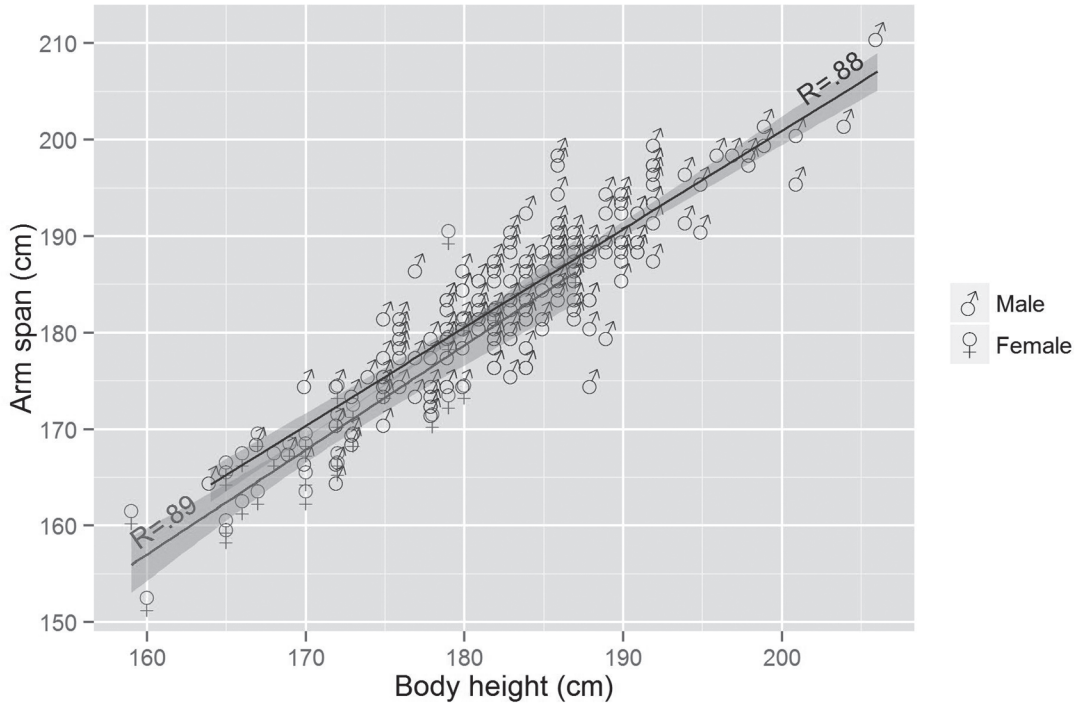

Figure 1. Scatter Diagram and Relationship between Arm Span Measurements and Body Height among Both Genders

Discusion

This study contributes to a very important update of average body heights among Bosnian and Herzegovinian males and females. The results proved that Bosnian and Herzegovinian males are very tall with an average of 183.87 centimeters and it is a little bit more comparing to the tallest nations in the Europe: 183.8 centimeters of the Dutch male population measured in the last nationwide survey in 2010 (TNO, 2010), 183.74 centimeters of the Montenegrin male population measured in 2013 (Popović, Bjelica & Hadžić, 2014) and 182 centimeters of the Serbian male population measured in 2012 (Popović et al., 2013). Consequently, the average height of Bosnian and Herzegovinian men is also taller than 181.3 centimeters of the Lithuanians (Tutkuviene, 2005), 180.6 centimeters of the Icelanders (Dagbjartsson, Thornórsson, Pálsson & Arnórsson, 2000), 180.5 centimeters of the Croats (Juresa, Musil & Tiljak, 2012), 180.4 centimeters of the Swedes (Werner & Bodin, 2006), 180.3 centimeters of the Slovenes (Starc & Strel, 2011), Danes (Statistics Denmark, 2011) and Czechs (Vignerová, Brabec & Bláha, 2006) and 141.7 centimeters of the shortest ethnic group in the whole World, Mbuti Pygmies (cited in Froment, 1993), which made Bosnian and Herzegovinian males the tallest nation on the earth. On the other hand, the average body height of Bosnian and Herzegovinian females was 171.8 centimeters on average and this result proved that Bosnian and Herzegovinian females are much taller than the tallest nations that were measured so far, such as the Netherlands with 170.7 centimeters (TNO, 2010), Montenegrins with 169.5 centimeters (Popović et al., 2014), Lithuanians with 167.5 centimeters (Tutkuviene, 2005), the Slovenes with 167.4 centimeters (Starc & Strel, 2011), the Icelanders and Czechs with 167.2 centimeters (Dagbjartsson et al., 2000; Vignerová at al. 2006), the Letts with 167.1 centimeters (Gerhards, 2005), and the Swedes with 167 centimeters (Werner & Bodin, 2006). However, there is a hypothesis that both genders of Bosnian and Herzegovinians did not reach their full genetic potential yet, since they have been influenced by various environmental factors (wars, poor economic situation, etc.) in the last few decades. Therefore, the authors believe that these circumstances had a negative bearing on the secular trend in Bosnia and Herzegovina as well as surrounding countries such as Serbia, Montenegro and Macedonia (Bjelica et al., 2012; Popović et al., 2013, Popović et al., in press;), while it is expected that the secular changes affecting height will go up in the following two decades, comparing it to developed countries where this trend has already completed.

For better viewing of the tallest nations around the World,

the authors have prepared Table 4 to present an overview of the top 10 tallest male populations on the earth, while the overview of the data from the female population is sorted in Table 5 (the most of them are data from the national surveys).

Table 4. Top 10 Tallest Male Nations on the Earth

#	Country	Average Body Height	Source
1	Bosnia and Herzegovina	183.9	Current study
2	Netherland	183.8	TNO, 2010
3	Montenegro	183.7	Popović et al., 2014
4	Serbia	182.0	Popović et al., 2013
5	Lithuania	181.3	Tutkuviene, 2005
6	Iceland	180.6	Dagbjartsson et al., 2000
7	Croatia	180.5	Juresa et al., 2012
8	Sweden	180.4	Werner & Bodin, 2006
9	Slovenia	180.3	Starc & Strel, 2011
10	Denmark	180.3	Statistics Denmark, 2011

Table 5. Top 10 Tallest Female Nations on the Earth

#	Country	Average Body Height	Source
1	Bosnia and Herzegovina	171.8	Current study
2	Netherland	170.7	TNO, 2010
3	Montenegro	169.5	Popović et al., 2014
4	Lithuania	167.5	Tutkuviene, 2005
5	Slovenia	167.4	Starc & Strel, 2011
6	Iceland	167.2	Dagbjartsson et al., 2000
7	Czech Republic	167.2	Vignerová et al., 2006
8	Latvia	167.1	Gerhards 2005
9	Sweden	167.0	Werner & Bodin, 2006
10	Serbia	166.8	Popović et al., 2013

It is also interesting to mention that the density of very tall subjects appears to be characteristic of the Bosnian and Herzegovinian males, since 20.2% measured 190 centimeters or more in body height. If 20.2% in Bosnia and Herzegovina would be compared to 28% in Dinaric Alps (Pineau et al., 2005), 20% in the Netherlands (Pineau et al., 2005), 14% in Serbia (Popović et al., 2012), 13% in Montenegro (Bjelica et al., 2012) and only 1.5% in France (Pineau et al., 2005), it would imply that the density of very tall subjects in Bosnian and Herzegovinian males appears, but not frequently like in the Dinaric Alps in general that reached in Pineu and collaborator's study. On the other hand, the density of very tall subjects also appear to be characteristic of the Bosnian and Herzegovinian females, since mora than 14% measured 180 centimeters or more in body height.

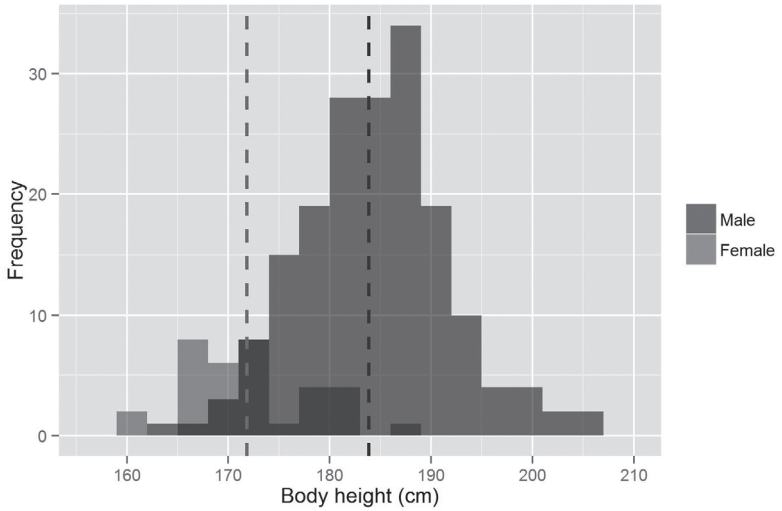

Figure 2. Density of Body Height among Both Genders

The estimation of body height using various anthropometric measurements are quite the age-old investigations over the past centuries and it has been attempted by many authors. As it is already mentioned, all of them estimated body height from vario-

us anthropometric measurements, but it is important to emphasize that the arm span has been derived the most reliable body indicator for predicting body height of an individual (Mohanty et al., 2001; Ter Goon et al., 2011). However, it must be underlined that the individual and ethnic variations in respect of body height and its relation with arm span were already observed in European (Reeves et al., 1996) and African populations (De Lucia et al., 2002), while Mohanty et al. (2001) have stated that the estimating equation varies from race to race, and ethnic group to ethnic group. In Steele and Chenier's study (1990), the arm span was nearly 8.3 centimeters more than the body height for black population (105.36% body height), whereas for white population this difference was only 3.3 centimeters (102.04% body height). Mohanty et al. (2001) have noted in their study that the arm span was nearly 2.5 centimeters more than the body height in South Indian females (101.4% body height), which is similar to that noted in the white population. In Ter Goon et al.'s study (2011), arm span was 5.8 centimeters more than body height for Nigerian males (103.3% body height), whereas for Nigerian females this difference was only 4 centimeters (102.5% body height) which is similar to that noted in the white population, although they are black. The most recent studies conducted by Bjelica et al. (2012) that showed that arm span was 2.5 centimeters more than body height for Montenegrin males (101.4% body height), whereas for Montenegrin females this difference was only 0.24 centimeters but in favor of body height (99.9% body height) and Popovic at al. (2013) that showed that arm span was 2.8 centimeters more than body height for Serbian males (101.5% body height), whereas for Serbians females this difference was only 0.15 centimeters but in favor of body height (98.7% body height), while Quanjere et al. (2014) have highlighted the body height estimated from the predicted arm span/height ratio may differ by up to 10% from actual stature. All mentioned have confirmed again the necessity for developing separate height models for each population on account of ethnic differences. Therefore, the main goal of the current study was to find out if these facts are true for the Bosnian and Herzegovinian population, since it is known that the estimating equation varies from race to race, and ethnic group to ethnic group (Mohanty et al., 2001). Hence, in the present study it is observed that the arm span was 0.73 centimeters more than the body height in males (100.3% body height), while it was 1.97 centimeters less than the body height in female population (98.9% body height). The arm span/height ratio in Bosnian and Herzegovinian males is extremely low when compared with other Europeans but it is quite close to the data that were reached in the measurement of Montenegrin and Serbian population (Bjelica et al., 2012; Popović et al., 2013), while the arm span/height ratio in Bosnian and Herzegovinian females is corresponding to Montenegrin and Serbian population as well as other Europeans.

The results of the above mentioned studies are also very similar to the correlation obtained in the present study (men: r=0.876; women: r=0.887). For example, Mohanty et al. (2001) reported that the correlation was r=0.82, while in Hickson and Frost's study (2003) correlation was r=0.86, in Zverev's study (2003) correlation was r=0.87 for males and r=0.81 for the female population. In the most recent studies, Ter Goon et at. (2011) reported that correlation was r=0.83, while Bjelica et al. (2012) reported that the correlation was r=0.861 for males and r=0.809 for female population and Popović et al. (2013) reported that the correlation was r=0.814 for males and r=0.822 for female population. As the correlation between arm span and body height was so high and significant in both Bosnian and Herzegovinian genders, the arm span measure therefore seems to be a reliable indirect anthropometric measurement for estimating body height in Bosnian and Herzegovinian adults.

Even though these relations are similar, the estimation equations which are obtained in Bosnian and Herzegovinian population, if the authors exclude Montenegrin and Serbian population, are substantially different from other populations, especially in Bosnian and Herzegovinian female population. Although this confirms the necessity for developing separate height models for each population on account of ethnic differences, it must be emphasized that further researches has to use larger samples for the prediction of body height utilizing arm span measurement, mostly due to the reason this study as well as some other studies that has been attempted in the past (Aggrawal et al., 2000; Bjelica et al., 2012; Hickson & Frost, 2003; Kwok & Whitelaw, 1991; Popović et al., 2013; Steele & Chenier, 1990; Ter Goon et al., 2011; Zverev 2003) used quite small samples. A more precise estimation of the average body height and its prediction utilizing arm span measurements in Bosnian and Herzegovinian adults would require a large sample with sufficient geographical and social heterogeneity or a national survey that measures the whole population. Moreover, next to the small sample, especially in female population (n=34), the obvious limitation of this research study was the composition of the measured sample that consisted of university students. Since university-educated persons, according to Bjelica et al. (2012) have been taller than the general population in Poland (Kułaga et al., 2011; Wronka & Pawliñska-Chmara, 2009), and Hungary (Bodzsár & Zsákai, 2008; Eiben & Tóth, 2000; Szöllősi, 1998), the authors cannot exclude the possibility that the body height of the students somewhat overestimates the average body height of contemporary Bosnian and Herzegovinians. On the other hand, this fact wasn't the case in Montenegro and might not be the case in Bosnia in Herzegovina too, mostly due to the reason the results from the study (sample that consisted of university students) conducted by Bjelica et al. (2012) correspond with the results reached in the national survey (Popović, et al., 2014).

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Revised September 2014

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Original Scientific Paper

Transfer of learning on a spatial memory task

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Word count: 2,980

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Conference paper:

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Ethnology. (2005, July). In *The Columbia encyclopedia* (6th ed.). New York: Columbia University Press. Retrieved November 21, 2005, from http://www.bartleby.com/65/et/ethnolog.html

Thesis and dissertation:

Pyun, D. Y. (2006). *The proposed model of attitude toward advertising through sport.* Unpublished Doctoral Dissertation. Tallahassee, FL: The Florida State University.

Book:
Borg, G. (1998). *Borg's perceived exertion and pain scales*: Human kinetics.

Chapter of a book:
Kellmann, M. (2012). Chapter 31-Overtraining and recovery: Chapter taken from Routledge Handbook of Applied Sport Psychology ISBN: 978-0-203-85104-3 *Routledge Online Studies on the Olympic and Paralympic Games* (Vol. 1, pp. 292-302).

Reference to an internet source:
Agency. (2007). Water for Health: Hydration Best Practice Toolkit for Hospitals and Healthcare. Retrieved 10/29, 2013, from www.rcn.org.uk/newsevents/hydration

2.5. Tables

All tables should be included in the main manuscript file, each on a separate page right after the Reference section.

Tables should be presented as standard MS Word tables.

Number (Arabic) tables consecutively in the order of their first citation in the text.

Tables and table headings should be completely intelligible without reference to the text. Give each column a short or abbreviated heading. Authors should place explanatory matter in footnotes, not in the heading. All abbreviations appearing in a table and not considered standard must be explained in a footnote of that table. Avoid any shading or coloring in your tables and be sure that each table is cited in the text.

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2.5.1. Table heading

Table heading should be written above the table, in Title Case, and without a full stop at the end of the heading. Do not use suffix letters (e.g., Table 1a, 1b, 1c); instead, combine the related tables. *See* example:

- ✓ **Table 1.** Repeated Sprint Time Following Ingestion of Carbohydrate-Electrolyte Beverage

2.5.2. Table sub-heading

All text appearing in tables should be written beginning only with first letter of the first word in all capitals, i.e., all words for variable names, column headings etc. in tables should start with the first letter in all capitals. Avoid any formatting (e.g., bold, italic, underline) in tables.

2.5.3. Table footnotes

Table footnotes should be written below the table.

General notes explain, qualify or provide information about the table as a whole. Put explanations of abbreviations, symbols, etc. here. General notes are designated by the word *Note* (italicized) followed by a period.

- ✓ *Note.* CI: confidence interval; Con: control group; CE: carbohydrate-electrolyte group.

Specific notes explain, qualify or provide information about a particular column, row, or individual entry. To indicate specific notes, use superscript lowercase letters (e.g. $^{a, b, c}$), and order the superscripts from left to right, top to bottom. Each table's first footnote must be the superscript ^{a}.

- ✓ ^{a}One participant was diagnosed with heat illness and n = 19.^{b}n =20.

Probability notes provide the reader with the results of the texts for statistical significance. Probability notes must be indicated with consecutive use of the following symbols: * † ‡ § ¶ || etc.

- ✓ *P<0.05,†p<0.01.

2.5.4. Table citation

In the text, tables should be cited as full words. *See* example:

- ✓ Table 1 (first letter in all capitals and no full stop)
- ✓ ...as shown in Tables 1 and 3. (citing more tables at once)
- ✓ ...result has shown (Tables 1-3) that... (citing more tables at once)
- ✓ ....in our results (Tables 1, 2 and 5)... (citing more tables at once)

2.6. Figures

On the last separate page of the main manuscript file, authors should place the legends of all the figures submitted separately.

All graphic materials should be of sufficient quality for print with a minimum resolution of 600 dpi. MJSSM prefers TIFF, EPS and PNG formats.

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2.6.1. Figure legends

Figures should not contain footnotes. All information, including explanations of abbreviations must be present in figure legends. Figure legends should be written bellow the figure, in sentence case. *See* example:

- ✓ **Figure 1.** Changes in accuracy of instep football kick measured before and after fatigued. SR – resting state, SF – state of fatigue, *p>0.01, †p>0.05.

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All graphic materials should be referred to as Figures in the text. Figures are cited in the text as full words. *See* example:

- ✓ Figure 1
- × figure 1
- × Figure 1.
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- ✓ ….result has shown (Figures 1-3) that... (citing more figures at once)
- ✓ ….in our results (Figures 1, 2 and 5)... (citing more figures at once)

2.6.3. Sub-figures

If there is a figure divided in several sub-figures, each sub-figure should be marked with a small letter, starting with a, b, c etc. The letter should be marked for each subfigure in a logical and consistent way. *See* example:

- ✓ Figure 1a
- ✓ …in Figures 1a and b we can…
- ✓ …data represent (Figures 1a-d)…

2.7. Scientific Terminology

All units of measures should conform to the International System of Units (SI).

Measurements of length, height, weight, and volume should be reported in metric units (meter, kilogram, or liter) or their decimal multiples.

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✓ 45±3.4	✓ p<0.01	✓ males >30 years of age
× 45 ± 3.4	× p < 0.01	× males > 30 years of age

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Latin names of species, families etc. should be written in italics (even in titles). If you mention Latin names in your abstract they should be written in non-italic since the rest of the text in abstract is in italic. The first time the name of a species appears in the text both genus and species must be present; later on in the text it is possible to use genus abbreviations. *See* example:

- ✓ First time appearing: *musculus biceps brachii*

Abbreviated: *m. biceps brachii*

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Montenegro Sustainable Maritime Competence Development Initiative

University of Montenegro/ Maritime Faculty Kotor and Alesund University College/ Faculty of marine technology and operations are partners in a project called *Montenegro Sustainable Maritime Competence Development Initiative*, funded by the Ministry of Foreign Affairs of Kingdom of Norway.

Off-shore simulator installed at the Maritime faculty Kotor, unique at the Mediterranean region

Delegation from Montenegro on study visit in Norway

The project is within the HERD (Higher education, research and development) program for maritime sector intended for the Western Balkans. The project, worth around 1.4 million euros, is aiming toward improving human resources competence in the maritime sector in Montenegro through the transfer of knowledge and experience from the Norwegian experts, primarily off-shore business in which they are among the most competent in the world.

So far, the project has provided the following major activities: a joint Norwegian-Montenegrin maritime training center for is established at the Maritime Faculty Kotor, center for cooperation and innovation in the maritime industry at the Maritime Faculty Kotor is established, research equipment for marine engineering and electro-technical laboratory is provided, specialized training for the teaching staff of the Faculty is enabled, developing English language teaching materials is provided, harmonization of curricula with the requirements of International Maritime Organisation STCW Convention, exchange of experience between Norwegian and Montenegrin pilot services in order to increase the safety of navigation, the exchange of experiences between port authorities and the authorities, organisation of a number of thematic workshops is provided as well.

The project is of great importance to the University of Montenegro/Maritime faculty Kotor in efforts to become recognizable institution in the Mediterranean region.

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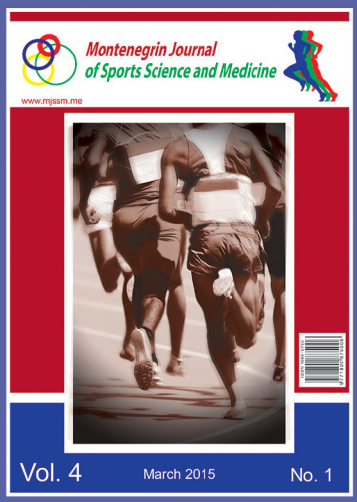

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