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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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