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RELATIONSHIP BETWEEN MOTOR SKILLS AND BODY COMPOSITION AMONG MIDDLE SCHOOL STUDENTS FROM BIHOR–HAJDÚ-BIHAR EUROREGION

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Abstract: Body composition represents an important component of motor skills and health among children. According to studies an excess of adipose tissue can contribute to the decrease in performance when it comes to sprinting, endurance running, jump tests or several other sports games. The goal of this study is to determine the motor skills and the body composition of middle school students from Bihor–Hajdú-Bihar Euroregion and to present the results of the motor tests separately for subjects with a normal percent of adipose tissue and for subjects with an excess of adipose tissue. The study included 934 subjects aged 10-15, and it used the anthropometric method to determine height and weight, and the bioelectrical impedance analysis to determine the percent of adipose tissue. Motor skills were determined using 9 motor tests of the Eurofit Test Battery. The results of the measurements were statistically processed with the SPSS software. The classification of the body mass index and of the percent of adipose tissue was performed based on orientative standard values taking into consideration the subjects' age and gender. The mean values of the motor tests were calculated separately for subjects with a normal percent of adipose tissue and for subjects with an excess of adipose tissue. Out of the total sample group 21.5% had their percent of adipose tissue below the normal values (8.8% BH; 12.7% HB); 49.9% had normal values (27.3% BH; 22.6% HB) and 28.6% (girls=117; boys=150) had an excess of adipose tissue or were obese (14.67% BH; 13.92% HB). There is a significant relation between body mass index and the percent of adipose tissue ($r = 0.781$, $p < 0.001$, CI = 95%). Students with normal percent of adipose tissue obtained better results than those with an excess of adipose tissue at seven (girls) – eight (boys) motor tests.

Keywords: motor potential, body composition, adipose tissue, middle school students

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INTRODUCTION

According to World Health Organization (2013), obesity is recognized as a major and independent risk factor. One in three children in Europe is overweight or obese and within the last 30 years obesity rates have doubled among children. Maintaining an ideal weight and body composition throughout school years should be a national priority in Romania.

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As stated by Rauner et al. (2013), the cause of the increase of adipose tissue and decrease of motor skills should be sought in the changed lifestyle which results in insufficient physical work among children in their adolescence, a period of growth and development, especially due to the lack of physical exercises.

Children and teenagers prefer the television, video games, computergames and mobile phones and they have an imbalanced nutrition because of the excess ofsweetened soft drinks, saturated fats and fast-food type of foods (World Health Organization, 2013).

According to Pařízková (2014), in most cases overweight or obese students have a reduced cardiorespiratory capacity (VO_2max) in case of maximal effort on the treadmill or on the bicycle ergometer.

The excess adipose tissue (AT) was associated in a negative way with the standing broad jump test and with the bent arm hang test (Kruger et al. 2006). Hypokinesia and a weakened physical condition may cause health problems and the increase of the number of medical treatments (Bovet et al. 2006). It is recommended to identify the teenagers within the sample group in order to prevent them from becoming obese in their adulthood (Jerum & Melnyk, 2001).

In order to determine body composition there were used anthropometric methods like: calipermetry, calculating the fat-free mass based on measuring some perimeters of the body or based on height and body weight, calculating total body water based on height and body weight, or other methods like: hydrodensitometry, DEXA (Dual Energy X-ray Absorbtiometry), bioelectrical impedance analysis (BIA), tomodensitometry X, nuclear magnetic resonance (NMR), infrared spectroscopy (Near Infrared Interactance), etc.

The analysis of body composition by BIA is considered an efficient method and less expensive. Essentially it is based on the difference between the resistance to the electrical current of the fat-free tissue and of the adipose tissue.

The muscles, blood vessels and bones have high water content and are excellent conductors of electricity. Thus, muscle tissue is a better conductor than the adipose tissue which has a higher resistance to the microcurrent. Based on the electrical conductivity of the tissues, the adipose tissue can be determined exactly. The adipose tissue percent refers to the quantity of AT in relation to the total body weight, expressed in percent (Anonim, 2011).

Body mass index (BMI) is an instrument which represents the standard in the assessment of the risks appeared as a result of excess weight. According to Oswald (2007), in many cases BMI values don't supply information regarding body composition and implicitly, the quantity of AT. Some people may have a high BMI even if they have a low AT level, or have a low BMI and an excess of AT.

In numerous sports it is recommended to have a low level of adipose tissue. The excess AT may contribute to the decrease in performance when it comes to sprinting, endurance running, jump tests or several other sports games. According to Albright & Stern (1998), obesity is defined by the quantity of AT and not by the total body weight.

In 2006 a team of the Health Research Institute of London Metropolitan University drawn up a classification of the AT rate in percentile according to age and gender (McCarthy et al. 2006). This reference curve implies 4 zones: below the normal values; normal values; excess of AT and obesity. These zones were marked by values of 2^{nd}, 85^{th} and 95^{th} percentile. Researchers strived to define a rate similar to the recommendations given by the committees of experts of Centers for Disease Control and Prevention or of the International Obesity Task Force.

OBJECTIVES

The goal of this study was to determine the motor skills and the body composition of middle school students from Bihor–Hajdú-Bihar Euroregion and to present the results of the motor

tests separately for subjects with a normal percent of adipose tissue and for subjects with an excess of adipose tissue

MATERIALS AND METHODS

The selected sample group was made up of middle school students from 50 classes from Bihor–Hajdú-Bihar Euroregion. The measurements were performed with the approval of the Bihor County School Inspectorate, of the schools from the two counties as well as of the parents/guardians of the subjects. The total number of students that participated to the study was 934 out of which 473 were girls and 461 were boys. The measurements took place within the 2014-2015 school year.

Within this study, we used the anthropometric method to determine height, weight and the percent of adipose tissue. In order to determine body composition, the measurements were performed using a height measure (Seca 213 Marsden UK) and an Omron BF511 monitor (Omron Corporation, Kyoto, Japan). Height was measured in cm, the subjects being barefoot and having their heads in Frankfort plane, and weight was measured in Kg. The Omron BF511 body composition monitor uses the BIA method to determine the percent of adipose tissue of the body.

The device measures the resistance to the electrical current of the tissues when a microcurrent flows through them (50kHz. 0.5mA). According to the technical data sheet of the device, the age range for which it classifies the percent of adipose tissue is 6 – 80 years. The value of the AT index is determined based on the resistance of the tissues to the electrical current, on height, weight, age and gender of the subjects. The measuring procedure implied the analysis of the subjects being barefoot, while holding the mobile part of the monitor with both their hands. The analysis lasted about 30 seconds.

The obtained percent of adipose tissue was calculated based on orientative standard values (below normal levels, normal values, excess of adipose tissue and obesity) considering the age and gender of the subjects (McCarthy et al. 2006). In order to estimate BMI the BMI reference chart was used in relation to the age and gender of the subjects (Barlow & Expert Committee, 2007).

In order to assess physical fitness 9 out of the 10 EUROFIT tests were used (the bicycle ergometer test was left out), measuring the flexibility of the lumbar region of the spinal column and of the back of the thigh (sit-and-reach), the general balance ability (Flamingo balance test), muscle power and endurance in the upper part of the body (bent arm hang), the explosive muscle power in the lower part of the body (standing broad jump), power and endurance of the abdominal muscles and of the hip flexor muscles (sit-ups), the power of the arms and forearms (handgrip test), the speed-coordination ability of the upper limbs (plate tapping), speed and coordination capabilities (10x5 m shuttle run) and cardiovascular endurance (endurance shuttle run).

The data of the individual measurements was statistically processed by the Statistical Package for Social Sciences software: version 20.0 SPSS Inc. (SPSS), performing the descriptive analysis and the comparing of the mean values. The independent sample t-test shows whether the mean values of the results obtained at the motor tests by the subjects with normal percent of adipose tissue is significantly different from the results obtained by the subjects with an excess of adipose tissue.

RESULTS

The gathered data show that the measurements were performed on 473 girls and 461 boys from the Bihor – Hajdú-Bihar Euroregion. In Bihor the average age was 12.55 years, and in Hajdú-Bihar it was 12.52 years. The mean values and the standard deviations of the anthropometric measurements and of the motor tests are presented in Table 1 and 2.

Table 1. Mean values and standard deviation of the anthropometric measurements

AM	Bihor			Hajdú-Bihar		
	G n=249 M (SD)	B n=225 M (SD)	Total n=474 M (SD)	G n=224 M (SD)	B n=236 M (SD)	Total n=460 M (SD)
H (cm)	154.42±7.37	157.25±10.19	155.77±8.93	158.36±8.51	159.48±11.46	158.93±10.14
W (kg)	48.58±12.01	51.43±13.42	49.93±12.77	52.55±13.04	52.20±14.06	52.37±13.56
BMI	20.26±4.02	20.59±4.19	20.42±4.10	20.79±4.18	20.30±4.14	20.54±4.16
% AT	24.19±8.06	19.65±8.30	22.03±8.48	23.59±8.53	17.62±8.60	20.52±9.06

Note: AM = anthropometric measurements H = height; W = weight, G = girls, B = boys

Table 2. Mean values and standard deviation of the motor tests

Motor test	Bihor			Hajdú-Bihar		
	G n=249 M (SD)	B n=225 M (SD)	Total n=474 M (SD)	G n=224 M (SD)	B n=236 M (SD)	Total n=460 M (SD)
FBT (no)	8.41±5.00	8.61±5.65	8.51±5.31	7.96±4.55	7.36±4.59	7.65±4.58
PT (sec)	12.52±1.77	12.56±2.53	12.54±2.17	12.28±1.61	12.30±1.89	12.29±1.76
SBJ (cm)	147.37±22.2	168.65±28.2	157.54±27.3	147.73±23.2	165.71±30.4	156.90±28.6
HT (kg)	22.90±5.09	27.13±7.96	24.92±6.94	25.84±6.53	30.10±9.98	28.00±8.72
SU (no)	21.37±3.95	24.89±4.55	23.05±4.59	19.47±4.78	23.10±6.50	21.32±6.00
BAH (sec)	5.30±6.07	11.45±11.27	8.24±9.44	6.83±7.30	13.21±12.15	10.08±10.55
SR (sec)	21.19±1.20	20.15±1.30	20.69±1.35	21.50±1.82	20.25±1.66	20.86±1.85
SAR (cm)	14.97±8.73	9.48±8.01	12.35±8.83	18.58±7.98	11.58±8.19	15.01±8.80
ESR:VO_2max	41.54±4.56	42.96±6.78	42.19±6.25	40.75±4.37	42.26±7.25	41.43±6.11
ESR:no.dist	29.87±10.62	41.33±19.78	35.32±16.66	26.43±12.37	34.50±17.28	30.58±15.61

Note: G = girls, B = boys, FBT = Flamingo Balance Test; PT = Plate tapping; SBJ= Standing Broad Jump; HT = Handgrip Test; SU = Sit-ups; BAH = Bent Arm Hang; SR = 10X5 m Shuttle Run; SAR = Sit-and-reach; ESR = Endurance Shuttle Run, VO_2max estimated after Léger (1988); no.dist = number of travelled distances;

According to Table 3, 21.5% of the total number of subjects had their percent of adipose tissue below normal values (8.8% BH; 12.7% HB); 49.9% had normal values (27.3% BH; 22.6% HB); 12.7% had an excess of adipose tissue (6.1% BH; 6.6% HB) and 15.9% were obese (8.6% BH; 7.3% HB). 28.6% of the total number of subjects had their percent of adipose tissue over normal values (n=117 for girls and n=150 for boys).

Table 3. Distribution of the percent of adipose tissue in the Euroregion

Orientative standard values	Bihor			Hajdú-Bihar		
	G n=249 n	B n=225 n	Total n=474 n	G n=224 n	B n=236 n	Total n=460 n
BNL	44 (17.7%)	38 (16.9%)	82 (17.3%)	49 (21.9%)	70 (29.7%)	119 (25.9%)
Normal val.	146 (58.6%)	109 (48.4%)	255 (53.8%)	117 (52.2%)	94 (39.8%)	211 (45.8%)
Excess AT	23 (9.2%)	34 (15.1%)	57 (12.0%)	27 (12.1%)	35 (14.8%)	62 (13.5%)
Obesity	36 (14.5%)	44 (19.6%)	80 (16.9%)	31 (13.8%)	37 (15.7%)	68 (14.8%)

Note: G = Girls; B = Boys, BNL = below normal values, Normal val. = Normal values,

The gathered data show that there is a significant relation between the BMI and the percent of adipose tissue ($r = 0.781$, $df = 932$ $p < 0.001$, CI = 95%) (Table 4). Most students who have a high level of BMI, also have a high percent of adipose tissue.

Table 4. The relation between BMI and the percent of adipose tissue

		BMI	Adipose tissue
BMI	Pearson Correlation	1	.781
	Sig. (2-tailed)		.000
	N	934	934

In tables 5 and 6 the mean values of the motor tests are presented for both genders, divided into two groups: the students with a normal percent of adipose tissue and the students with an excess of adipose tissue. The independent sample t-test shows whether the mean values of the results obtained at the motor tests by girls and boys with normal percent of adipose tissue is significantly different from the results obtained by the ones with an excess of adipose tissue.

Table 5. Distribution of the mean values of the motor tests in case of girls with a normal percent of adipose tissue and in case of girls with an excess of adipose tissue

Motor test	Bihor			Hajdú-Bihar		
	Normal AT n = 146	Excess AT n = 59	P	Normal AT n = 117	Excess AT n = 58	P
	M (SD)	M (SD)		M (SD)	M (SD)	
Sit-and-reach (cm)	14.56±8.22	14.71±9.19	0.912	19.30±9.63	18.98±7.97	0.827
Flamingo balance (no)	8.04±5.17	9.21±4.89	0.147	7.70±4.43	8.77±4.66	0.134
Sit-ups (n/30sec)	21.71±3.80	20.45±4.23	0.044	19.95±4.83	18.37±4.52	0.036
Handgrip (kg)	22.80±4.84	23.92±4.66	0.138	26.38±6.13	27.21±6.30	0.400
Bent arm hang (sec)	5.84±6.47	3.36±4.35	0.002	7.12±7.28	4.95±5.98	0.046
Standing broad jump (cm)	149.96±21.0	141.46±19.9	0.010	150.25±23.6	137.21±20.3	<0.001
Plate tapping (sec)	12.14±1.55	12.76±1.89	0.031	12.37±1.85	12.12±1.33	0.302
10x5 m shuttle run (sec)	21.05±1.14	21.24±1.27	0.315	21.46±2.20	21.66±1.34	0.449
Endurance shuttle run (no.dist.)	30.07±10.12	26.76±10.07	0.039	28.25±11.32	20.08±8.33	<0.001

Note: the value p calculated with the independent samples t-test; no.dist. = number of travelled distances

Table 6. Distribution of the mean values of the motor tests in case of boys with a normal percent of adipose tissue and in case of boys with an excess of adipose tissue

Motor test	Bihor			Hajdú-Bihar		
	Normal AT n = 109	Excess AT n = 78	P	Normal AT n = 94	Excess AT n = 72	P
	M (SD)	M (SD)		M (SD)	M (SD)	
Sit-and-reach (cm)	9.20±6.61	7.90±6.62	0.203	12.39±8.07	9.83±6.23	0.025
Flamingo balance test (no)	8.33±5.26	10.24±5.85	0.026	7.09±4.74	8.59±4.84	0.052
Sit-ups (n/30sec)	25.52±4.51	23.84±4.61	0.017	23.62±5.94	20.30±5.92	0.001

Handgrip test (kg)	27.00±7.41	27.04±8.08	0.975	30.09±8.84	30.67±12.42	0.741
Bent arm hang (sec)	12.83±11.19	6.68±8.73	<0.001	14.00±12.27	7.61±8.83	<0.001
Standing broad jump (cm)	170.76±26.9	157.80±25.9	0.002	171.10±27.6	141.81±23.0	<0.001
Plate tapping (sec)	12.47±2.09	12.52±1.94	0.856	12.18±1.92	12.93±1.94	0.018
10x5 m shuttle run (sec)	20.05±1.32	20.61±1.32	0.006	20.04±1.62	20.75±1.76	0.010
Endurance shuttle run (no.dist.)	42.88±21.08	34.94±17.33	0.009	39.66±17.44	23.32±12.52	<0.001

Note: the value p calculated with the independent samples t-test; no.dist. = number of travelled distances

Girls with a percent of adipose tissue within normal limits have obtained better results at 7 out of nine motor tests than those with an excess of adipose tissue: Flamingo balance test (BH: $p = 0.147$; HB: $p = 0.134$), sit-ups (BH: $p = 0.044$; HB: $p = 0.036$), bent arm hang (BH: $p = 0.002$; HB: $p = 0.046$), standing broad jump (BH: $p = 0.010$; HB: $p < 0.001$), 10x5 m shuttle run (BH: $p = 0.315$; HB: $p = 0.449$), endurance shuttle run (BH: $p = 0.039$; HB: $p < 0.001$), sit-and-reach (HU: $p = 0.827$), plate tapping (BH: $p = 0.031$). In both counties girls with an excess of adipose tissue had better results at the handgrip test (BH: $p = 0.138$, HB: $p = 0.400$).

Boys with a percent of adipose tissue within normal limits have obtained better results than those with an excess of adipose tissue at 8 out of nine motor tests: sit-and-reach (BH: $p = 0.203$; HB: $p = 0.025$), flamingo balance test (BH: $p = 0.026$; HB: $p = 0.052$), sit-ups (BH: $p = 0.017$; HB: $p = 0.001$), bent arm hang (BH: $p < 0.001$; HB: $p < 0.001$), standing broad jump (BH: $p = 0.002$; HB: $p < 0.001$), plate tapping (BH: $p = 0.856$; HB: $p = 0.018$), 10x5 m shuttle run (BH: $p = 0.006$; HB: $p = 0.010$) and endurance shuttle run (BH: $p = 0.009$; HB: $p < 0.001$). At the handgrip test boys with an excess of adipose tissue had better results in both counties (BH: $p = 0.975$; HB: $p = 0.741$).

DISCUSSIONS

The results of this study show that the mean values of the percent of adipose tissue for girls increases with age from 22.97% at age 11 to 26.92% at age 14. For boys this percent decreases from 20.93% at age 11 to 15.69% at age 14.

According to a study performed in Milan by Lovecchio et al. (2009), the mean value of the sit-and-reach test was 22.37±9.26 for girls (n=698) of age 11, compared to the results of girls from Bihor (n=64) who had 14.58±8.84 or 15.17±6.75 obtained by girls from Hajdú-Bihar (n=52). At the same test, boys (n=768) from Milan had better results 15.37±9.39 then those from Bihor (n=47) 10.53±6.84 and those from Hajdú-Bihar (n=50) 9.14±5.75. The mean values of the sit-ups test was 18.25±5.0 for girls from Milan which are lower compared to the results of girls from Bihor who had 20.91±3.37 but higher then the results of girls from Hajdú-Bihar who had 17.38±4.46.

Comparing the results of the Eurofit tests performed by Şerbescu, (2008) among boys (n=89) of age 10 from Oradea (in the year 2004) and the results of this study for boys (n=47) of age 11, we find out that except the sit-and-reach test, at seven motor tests (Flamingo balance test < 5.04 (n), plate tapping < 0.95 (sec), standing broad jump > 37.91 (cm), sit-ups >7.88 (n), bent arm hang > 6.43 (sec), 10x5 m shuttle run < 2.51 (sec) and endurance shuttle run > 0.45 kmh^{-1}), we see that the more recently tested students had better results. Comparing the results of girls of age 10 (n=109) from 2004 and of girls of age 11 (n=64) from 2014, we see that at the Flamingo balance test < 4.65 (n), plate tapping < 0.33 (sec), standing broad jump > 35.48 (cm), sit-ups

> 5.01 (n), bent arm hang < 0.66 (sec) and 10x5 m shuttle run < 2.49 (sec), the students of this study had better results.

CONCLUSIONS

The performed study allowed us to establish the followings:

- the prevalence of the excess of adipose tissue was 28.6%
- girls with a normal percent of adipose tissue obtained better results than those with an excess of adipose tissue at 7 motor tests: Flamingo balance test, plate tapping (partially), standing broad jump, sit-ups, bent arm hang, 10x5 m shuttle run, endurance shuttle run and sit-and-reach test (partially)
- boys with normal percent of adipose tissue had better results than those with an excess of adipose tissue at 8 out of 9 motor test.
- in both counties girls as well as boys with an excess of adipose tissue had better results at the handgrip test.

REFERENCES

Albright, A.L., & Stern, J.S. (1998). *Adipose Tissue.* Encyclopedia of Sports Medicine and Science. Retrieved from: http://www.sportsci.org/encyc/adipose/adipose.html

Anonimous. 2011. *Body Composition Monitor –Instructions-Manual*. Retrieved from: www.omronhealthcare.com/bf511 -instruction-manual-hbf-511

Barlow, S.E., & Expert Committee. (2007). *Expert Committee Recommendations Regarding the Prevention, Assessment, and Treatment of Child and Adolescent Overweight and Obesity:* Summary Report. Retriewed from http://www.ncbi.nlm.nih.gov/pubmed/18055651

Bovet, P., Shamlaye, C., Gabriel, A., Riesen, W., & Paccaud, F. (2006). *Prevalence of Cardiovascular Risk Factors in a Middle-income Country and Estimated Cost of Treatment Strategy*. BMC Public Health. Retrieved from: https://bmcpublichealth.biomedcentral.com/articles/10.1186/1471-2458-6-9

Jerum, A., & Melnyk, B.M. (2001). *Effectiveness of Interventions to Prevent Obesity and Obesity-Related Complications in Children and Adolescents*. Retrieved from: http://www.ncbi.nlm.nih.gov/pubmed/12024535

Kruger, R., Kruger, H.S., & Macintyre, U.E. (2006). *The Determinants of Overweight and Obesity Among 10- to 15-year-old Schoolchildren in the North West Province, South Africa* – the THUSA BANA (Transition and Health during Urbanisation of South Africans; BANA, children) study. Retrieved from: http://www.ncbi.nlm.nih.gov/pub med/16684387

Léger, L.A., Mercier D., Gadoury, C., & Lambert, J. (1988). *The Multistage 20 m Shuttle Run Test for Aerobic Fitness*, Retrieved from: http://www.ncbi.nlm.nih.gov/pubmed/3184250

Lovecchio, N., Bussetti M., & Eid, L. (2009). *Flexibility and Abdominal Strength Among Young Student: Eurofit Protocol*.Retrieved from: https://www.researchgate.net/publication/26369 among_young_student_Eurofit_protoco

McCarthy, H.D., Cole, T.J., Fry, T., Jebb, S.A., & Prentice, A.M. (2006). *Body Fat Reference Curves for Children*. Retrieved from: http://www.ncbi.nlm.nih.gov/pubmed/16570089

Oswald, T. (2007). *Research Shows BMI Often Not an Accurate Indicator of Body Fat*. Retrieved from: http://msutoday .msu.edu/news/2007/research-shows-bmi-often-accurateindicator-of-body-fat/

Pařízková, J. (2014). *Fatness and Fitness Related to Exercise in Normal and Obese Children and Adolescents*. Retrieved from: http://www.sciencedirect.com/science/article/pii/S1018364714000354

Rauner, A., Mess, F., & Woll, A. (2013). *The Relationship Between Physical Activity, Physical Fitness and Overweight in Adolescents*: A Systematic Review of Studies Published in or After 2000. Retrieved from:http://www.ncbi.nlm. nih.gov/pubmed/23375072

Șerbescu, C., Flora, D., Hanțiu, I., & Courteix, D. (2006). *Effect of a Six-Month Training Programme on the Physical Capacities of Romanian School Children*. Retrieved from: https://www. researchgate.net/publication/6810849_Eff ect_of_a_six-month_training_programme_on_the_physical_capacities_of_Romanian_schoolchildren.

World Health Organization. (2013). Global Action Plan for the Prevention and Control of Noncommunicable Diseases 2013-2020. Retrieved from: http://www.who.int/nmh/publications/ncd-action-plan/en/

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