Palestrica of the third millennium – Civilization and Sport
Vol. 18, no. 2, April-June 2017, 87–94

Components of health-related fitness among children in middle school within the Bihor - Hajdú-Bihar Euroregion

Componentele de sănătate ale fitnessului fizic la elevi de gimnaziu din Euroregiunea Bihor - Hajdú-Bihar

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Abstract

Background. According to studies, young people with a high level of physical fitness present a lower risk of cardiovascular diseases, type 2 diabetes and abdominal adiposity. The reference standards of health-related components of physical fitness are directly connected to the risk of developing metabolic diseases.

Aims. We aim to assess the components of health-related fitness among middle school children in relation to their residential area.

Methods. The sample group was made up of 934 children from the Bihor-Hajdú-Bihar Euroregion (525 from the urban area and 409 from the rural area), aged between 10-15 years. The components of health-related fitness were measured using the Hungarian National Student Fitness Test (NETFIT) test battery. For comparing the frequency of the cases we used the Chi-squared test.

Results. Regarding body composition and nutritional status, in Bihor county the number of children with values within the" healthy fitness" zone - body mass index of 7.27% and percent of adipose tissue of 8.14% - was higher in the rural area than in the urban area. In Bihor county, in the case of three motor fitness tests: endurance shuttle run (10.33%), handgrip test (7.12%) and paced push-ups (0.19%), the percentage of those with values within the "healthy fitness" zone was higher among children from the rural area. In Hajdú-Bihar county, in the case of four motor fitness tests: endurance shuttle run (7.32%), trunk lift test (33.45%), standing broad jump (0.48%) and back-saver sit and reach test (15.24%), the percentage of children with values within the "healthy fitness" zone was higher among those living in the rural area.

Conclusions. In Bihor county there is a significant difference between the results from the "healthy fitness" zone and the residential environment regarding body composition ($X^2 = 4.51$, $p < 0.05$), aerobic fitness ($X^2 = 5.83$, $p < 0.05$), the paced curl-up test ($X^2 = 8.70$, $p < 0.01$) and the handgrip test ($X^2 = 3.70$, $p = 0.05$). In Hajdú-Bihar there is a significant difference between the results from the "healthy fitness" zone and the residential environment regarding the back-saver sit and reach test ($X^2 = 11.36$, $p < 0.01$), the paced curl-up test ($X^2 = 38.053$, $p < 0.01$) and the trunk lift test ($X^2 = 51.38$, $p < 0.01$).

Key words: health-related physical fitness, urban and rural, NETFIT, fitness assessment among young people

Rezumat

Premize. Potrivit studiilor, persoanele tinere cu un nivel al fitnessului fizic ridicat prezintă risc scăzut de apariție a unor boli cardiovasculare, diabet zaharat de tip 2 și a adipozității abdominale. Standardele de referință ale componentelor de sănătate ale fitnessului fizic au o legătură directă cu riscul apariției unor boli metabolice.

Obiective. Ne-am propus să evaluăm nivelul componentelor de sănătate ale fitnessului fizic la elevi din ciclul gimnazial raportat la mediul lor de reședință.

Metode. Eșantionul a fost format din 934 de copii din Euroregiunea Bihor-Hajdú-Bihar (525 din mediul urban și 409 din mediul rural), cu vârsta cuprinsă între 10-15 ani. Componentele de sănătate ale fitnessului fizic au fost măsurate cu ajutorul bateriei de teste Nemzeti Egységes Tanulói Fittségi Teszt (NETFIT). Pentru compararea frecvenței cazurilor s-a utilizat testul Chi pătrat.

Rezultate. În ceea ce privește compoziția corporală și starea de nutriție, în județul Bihor, cu 7.27% - indicele de masă corporală și cu 8.14% - procentul țesutului adipos, mai mulți elevi din mediul rural s-au situat în zona de sănătate decât cei din mediul urban. În județul Bihor, în cazul a trei teste motrice: cursa navetă de rezistență (10.33%), dinamometrie manuală (7.12%) și flotări ritmice (0.19%), procentul celor din zona de sănătate a fost mai mare la elevii din mediul rural. În județul Hajdú-Bihar, în cazul a patru teste motrice: cursa navetă de rezistență (7.32%), extensia trunchiului (33.45%), săritura în lungime fără elan (0.48%) și testul de suplețe (15.24%), procentul celor din zona de sănătate a fost mai mare la elevii din mediul rural.

Received: 2017, April 3; *Accepted for publication:* 2017, May 20
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Concluzii. În județul Bihor există o diferență semnificativă între rezultatele din zona de sănătate și mediul de reședință în cazul compoziției corporale ($X^2 = 4.51$, $p < 0.05$) fitnessului aerob ($X^2 = 5.83$, $p < 0.05$) ridicărilor ritmice de trunchi din culcat dorsal ($X^2 = 8.70$, $p < 0.01$) și dinamometriei manuale ($X^2 = 3.70$, $p = 0.05$). În județul Hajdú-Bihar, există o diferență semnificativă între rezultatele din zona de sănătate și mediul de reședință în cazul testului de suplețe ($X^2 = 11.36$, $p < 0.01$), ridicărilor ritmice de trunchi din culcat dorsal ($X^2 = 38.053$, $p < 0.01$) și extensiei trunchiului ($X^2 = 51.38$, $p < 0.01$).

Cuvinte cheie: fitnessul fizic aflat în relație cu starea de sănătate, urban & rural, NETFIT, evaluarea fitnessului la tineret.

Introduction

The benefits of doing physical exercises by different categories of people are often presented in the specialized literature. Insufficient physical activity and low levels of health-related fitness among adults are associated with high levels of morbidity and mortality (Blair & Brodney, 1999).

According to the National Institute of Statistics, Romania has the lowest life expectancy, ranking 25th on the list of all 28 member states of the European Union (***, 2013a).

Epidemiological studies show that people with a high level of health-related fitness have 50% less chances to be exposed to non-communicable diseases compared to those with low levels of physical fitness (Myers et al., 2004). Teenagers with low levels of health-related fitness present a higher risk for certain cardiovascular diseases, type 2 diabetes (Moreira el al., 2011) and abdominal adiposity (Ortega et al., 2008b). Physical exercises improve self-esteem, cognitive functions and health by reducing anxiety, depression and negative emotional states (Callaghan, 2004).

According to Plowman & Meredith (2013), the duration of running a distance of 1 mile by a child offers information regarding his/her aerobic capacity, and the results can help determine whether he/she presents a low, medium or high risk of developing a cardiovascular disease. According to the same authors, adults with higher aerobic capacity are at a lower risk of developing cardiovascular diseases. The World Health Organization (***, 2013a) warns that within the last 30 years obesity among children has doubled, and one out of three children in Europe is overweight or obese.

A study of Brug et al. (2012) shows that the distribution of health-related physical fitness of students aged 10-12 is not uniform, and it is different depending on gender, ethnicity, economic status and residential environment. Other studies found that there is no significant difference of physical fitness parameters between students from urban areas and students from rural areas (Krombholz, 1997; Tsimeas et al., 2005), as well as that the living standards of students from the urban environment influence the increase of physical fitness in a positive way, to the detriment of students living in the rural environment (Reyes et al., 2003; Bathrellou et al., 2007).

Chillon et al. (2011) consider that among young people, the relation between physical fitness and their residential environment is specific to each country and region. The level of health-related fitness during childhood and preadolescence is important for adapting the interventions of public health institutions. According to Ujević et al. (2013), for youth the lack of intense physical exercises may cause the development of a sedentary lifestyle and a high health risk.

In 2013, the Cooper Institute in the USA signed a partnership agreement with the Hungarian School Sport Federation regarding the implementation of a test battery for measuring the level of health-related fitness among children in pre-university education, named the Hungarian National Student Fitness Test (NETFIT). This was created based on the Fitnessgram model, the criterion-referenced youth fitness standards that depend on age and gender offering an objective assessment of the students' fitness level.

The NETFIT test battery was developed in April-July 2013, with the contribution of 53 schools, involving 2602 students in the 5th-12th grades. According to Csányi et al. (2014), the study had the following aims:

- to determine, using Fitnessgram tests, the health-related physical fitness level for a representative sample group selected randomly from schools in Hungary;
- to clinically identify metabolic syndrome based on lab analyses concerning body composition and the risk of developing cardiovascular diseases;
- to assess the validity of the Fitnessgram test battery;
- to assess the validity of the Fitnessgram test battery using field measurements and lab measurements;

Kaj et al. (2014) have proposed that depending on the results of the measurements, interpretation should be performed by distributing them into two or three action zones: the "healthy fitness" zone (HFZ), the "to be improved" zone (TIZ) and the "to be strongly improved" zone (SIZ) (high risk of developing diseases).

According to the Cooper Institute, in the case of the NETFIT test battery, the interpretation of motor fitness results must use a criterion-referenced standard, named health standard, according to age and gender. These health standards correspond to a minimum motor performance necessary to avoid some risks of developing diseases that occur as a result of physical inactivity.

Kaj et al. (2014) describe 4 NETFIT components of health-related fitness: body composition and nutrition status, aerobic fitness, musculoskeletal fitness, and flexibility (Table I).

Although in some countries there are studies regarding the relation between physical fitness and health (Ortega et al., 2008b; Milne et al., 2016), these are absent in Romania. Based on the study performed by Lukács & Hanțiu (2017) during the 2014-2015 academic year, as a result of the closeness of the obtained motor values in subjects from the Euroregion, we considered that based on the fitness values that were found, the subjects can be included into different action zones, just like in the case of applying NETFIT in Hungary or the Fitnessgram model in more than 14 countries all over the world.

Aims

The goal of this study was to assess the components of health-related fitness among middle school students from the Bihor - Hajdú-Bihar Euroregion using the NETFIT test battery, and to compare the obtained results according to their residential environment.

Hypothesis

The hypothesis of our research was that among middle school students from this Euroregion there are differences between the components of health-related fitness depending on the students' residential environment.

Material and methods

The study was approved by the Bihor County School Inspectorate (approval no. 13973/04.11.2014) and written requests were sent to six educational institutions from Hajdú-Bihar county. At the same time, the Hungarian School Sport Federation consented verbally to the use of the NETFIT test battery in both counties.

The performed measurements represent a component of the doctoral study program. The parents/custodians of the subjects gave their consent for the subjects to participate in the study.

Research protocol

a) Period and place of the research

The transversal study took place from February to May during the 2014-2015 academic year, according to the following schedule: February: 5th graders, March: 6th graders, April: 7th graders, and May: 8th graders. The measurements in six schools from Hajdú-Bihar county: "Benedek Elek" Elementary School in Debrecen, "Svetits" Elementary School in Debrecen, "Karácsony Sándor" Elementary School in Debrecen, "II. Rákóczi Ferenc" Elementary School in Konyár, "Irinyi Károly" Elementary School in Esztár, and "Bessenyei György" Elementary School in Furta, were performed in collaboration with the teachers of the classes, and we considered that measurements should be performed simultaneously in nine institutions from Bihor county as well: "Iosif Vulcan" National College in Oradea, "Szent László" Roman Catholic Theological High School in Oradea, "Dimitrie Cantemir" School with 1st-8th Grades in Oradea, "Szalárdi János" Theological High School in Sălard, "Gáspár András" Middle School in Biharia, "Benedek Elek" Middle School in Cetariu, Middle School No.1 in Santandrei, Middle School No.1 in Nojorid, and Middle School No.1 in Tarian.

b) Subjects and groups

The received data show that the measurements were performed in 934 students (474 in Bihor county and 460 in Hajdú-Bihar county; 473 girls and 461 boys; 525 from urban environment and 409 from rural environment), aged between 10-15 years. The schools participating in the study were selected both from urban areas (3 from Bihor county and 3 from Hajdú-Bihar county) and rural areas (6 from Bihor county and 3 from Hajdú-Bihar county). Table II presents the numerical and percentage distribution of the subjects according to grade, gender and residential environment.

c) Tests applied

The assessment of the subjects from a somatic and motor point of view was performed using the NETFIT test battery, which is similar to EUROFIT. This consisted of 3 somatic measurements (height, weight, percentage of adipose tissue) and 7 motor tests (endurance shuttle run, paced curl-ups, trunk lifts, paced push-ups, handgrip, standing broad jump, back-saver sit and reach). All the obtained data were registered in records.

Somatic measurements were performed using the Seca

Table I

NETFIT components of health-related fitness

Components of health-related fitness	Name of the test	Study area
Body composition and nutritional status	Weight measuring Height measuring	Body Mass Index
	Measuring the percentage of adipose tissue	Percentage of adipose tissue
Aerobic fitness	Endurance shuttle run (15 m or 20 m)	Aerobic capacity
Musculoskeletal fitness	Paced curl-ups	Abdominal muscle strength and endurance
	Trunk lift	Trunk muscle strength
	Paced push-ups	Upper body muscle strength
	Handgrip test	Handgrip strength
	Standing broad jump	Explosive leg strength
Flexibility	Back-saver sit and reach	Knee and hip mobility

(Kaj et al., 2014)

Table II

Distribution of subjects according to grade, gender and residential environment

Grade	Bihor								Hajdú-Bihar							
	Girls		Boys		Urban		Rural		Girls		Boys		Urban		Rural	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
5th	65	13.71	62	13.08	78	16.46	49	10.34	57	12.39	66	14.35	82	17.82	41	8.91
6th	73	15.41	64	13.50	76	16.03	61	12.87	68	14.78	68	14.78	81	17.61	55	11.96
7th	62	13.08	48	10.12	53	11.18	57	12.03	61	13.26	56	12.18	62	13.48	55	11.96
8th	49	10.34	51	10.76	54	11.39	46	9.70	38	8.26	46	10	39	8.48	45	9.78
Total	249	52.54	225	47.46	261	55.06	213	44.94	224	48.69	236	51.31	264	57.39	196	42.61

Table III

Action zones regarding body composition and nutritional status depending on age and gender.

Age	Body mass index (kg/m²)				Percentage of adipose tissue (%)			
	THN	HFZ	TIZ	SIZ	THN	HFZ	TIZ	SIZ
				Girls				
10	≤14.8	14.9-20.1	20.2-24.5	24.6≤	≤11.5	11.6-24.3	24.4-32.9	33.0≤
11	≤15.3	15.4-21.0	21.1-25.8	25.9≤	≤12.1	12.2-25.7	25.8-34.4	34.5≤
12	≤15.9	16.0-22.0	22.1-26.9	27.0≤	≤12.6	12.7-26.7	26.8-35.4	35.5≤
13	≤16.6	16.7-22.8	22.9-27.9	28.0≤	≤13.3	13.4-27.7	27.8-36.4	36.5≤
14	≤17.2	17.3-23.5	23.6-28.6	28.7≤	≤13.9	14.0-28.5	28.6-36.7	36.8≤
15	≤17.7	17.8-24.0	24.1-29.1	29.2≤	≤14.5	14.6-29.1	29.2-37.0	37.1≤
				Boys				
10	≤14.8	14.9-20.1	20.2-24.4	24.5≤	≤8.8	8.9-22.4	22.5-33.1	33.2≤
11	≤15.2	15.3-20.8	20.9-25.5	25.6≤	≤8.7	8.8-23.6	23.7-35.3	35.4≤
12	≤15.6	15.7-21.4	21.5-26.4	26.5≤	≤8.3	8.4-23.6	23.7-35.8	35.9≤
13	≤16.1	16.2-22.2	22.3-27.2	27.3≤	≤7.7	7.8-22.8	22.9-34.9	35.0≤
14	≤16.7	16.8-22.9	23.0-27.9	28.0≤	≤7.0	7.1-21.3	21.4-33.1	33.2≤
15	≤17.3	17.4-23.5	23.6-28.5	28.6≤	≤6.5	6.6-20.1	20.2-31.4	31.5≤

Key: THN = thin, HFZ = "healthy fitness" zone, TIZ = "to be improved" zone, SIZ = "to be strongly improved "zone

Table IV

Action zones for aerobic fitness according to age and gender

Age	SIZ		TIZ		HFZ	
	TD	VO_2max ml/kg/min	TD	VO_2max ml/kg/min	TD	VO_2max ml/kg/min
			Girls			
10	≤9	≤37.3	10-16	37.4-40.1	17≤	40.2≤
11	≤9	≤37.3	10-16	37.4-40.1	20≤	40.2≤
12	≤14	≤37.0	15-22	37.1-40.0	23≤	40.1≤
13	≤16	≤36.6	17-24	36.7-39.6	25≤	39.7≤
14	≤18	≤36.3	19-26	36.4-39.3	27≤	39.4≤
15	≤21	≤36.0	22-30	36.1-39.0	30≤	39.1≤
			Boys			
10	≤9	≤37.3	10-16	37.4-40.1	17≤	40.2≤
11	≤12	≤37.3	13-19	37.4-40.1	20≤	40.2≤
12	≤16	≤37.6	17-23	37.7-40.2	24≤	40.3≤
13	≤22	≤38.6	23-29	38.7-41.0	30≤	41.1≤
14	≤28	≤39.6	29-35	39.7-42.4	36≤	42.5≤
15	≤34	≤40.6	35-41	40.7-43.5	42≤	43.6≤

Key: TD = traveled distance x 20 meters

Table V

HFZ standards for musculoskeletal fitness and flexibility according to age and gender

Age	HG (kg)		SBJ (cm)		PP (no.rep.)		PCU (no.rep.)		TL (cm)		BSSR (cm)	
	G	B	G	B	G	B	G	B	G	B	G	B
10	14.5≤	18.0≤	125≤	128≤	7≤	7≤	12≤	12≤	23-30	23-30	23≤	20≤
11	15.0≤	18.5≤	130≤	135≤	7≤	8≤	15≤	15≤	23-30	23-30	25≤	20≤
12	15.5≤	19.0≤	133≤	148≤	7≤	10≤	18≤	18≤	23-30	23-30	25≤	20≤
13	16.0≤	20.0≤	135≤	160≤	7≤	12≤	18≤	21≤	23-30	23-30	25≤	20≤
14	16.5≤	23.5≤	137≤	171≤	7≤	14≤	18≤	24≤	23-30	23-30	25≤	20≤
15	17.5≤	27.5≤	139≤	180≤	7≤	16≤	18≤	24≤	23-30	23-30	31≤	20≤

Key: G = girls; B = boys; HG = handgrip; SBJ = standing broad jump; PP = paced push-ups; PCU = paced curl-ups; TL = trunk lift; BSSR = back-saver sit and reach; no.rep. = number of repetitions

213 (Marsden UK) height measure and the Omron BF511 monitor (Omron Corporation, Kyoto, Japan), which uses the BIA (bioelectrical impedance analysis) method to determine the weight and percentage of adipose tissue of the body.

The *endurance shuttle run test* and the *standing broad jump test* were similar to those of the Eurofit test battery. In order to perform these two tests we used the following instruments: measuring tape, chalk/poles, CD player, audio CD and speakers.

When measuring *handgrip strength*, the subjects had to squeeze the handle of the dynamometer twice with each hand, and the result was considered to be the average value of the two best attempts. The measurement was performed with a Takei dynamometer with adjustable handles (Scientific Instruments, Niigata, Japan).

The *paced curl-up test* measures the endurance and strength of the abdominal muscles. Each curl-up was

executed in three seconds: up-down-one, up-down-two, etc., and it was marked by an audio signal. Materials used: isoprene foam mattresses, guidance tapes, CD player, audio CD and speakers.

The *paced push-up test* measures the strength and endurance of the upper body muscles. The rhythm of execution is identical to that of the previous test. Materials used: CD player, audio CD and speakers.

The *trunk lift test* measures the strength of the back muscles. Materials used: mattress, chalk and ruler. The subject had to lie face down on the mattress with their arms stretched, hands under their thighs, legs and head stuck to the mattress, after which they had to execute a slight and controlled lift of their backs with their eyes focused on a point marked with chalk on the mattress (in order to avoid extension of the head). The distance between the subject's chin and the floor was measured in centimeters and noted down.

The *back-saver sit and reach test* is based on the mobility of the knee and hips. To measure this we used a metal box marked from 0 to 50 cm. The students had to bend their trunk forward three times keeping their backs straight, and at the fourth bending they had to place their fingers the farthest possible on the measuring instrument and maintain their position for a few seconds in order to note down the results. After the first execution, the stretched leg became the bent leg and the same measurement was performed again using the same method. Both results were read in centimeters, after which the average value of the two executions was calculated.

In NETFIT, the reference table by age and gender of the International Obesity Task Force (IOTF) was used to interpret the BMI, and according to Kaj et al. (2014), for analyzing the results regarding the percentage of adipose tissue of the body, the reference table of Laurson et al. (2011) was used.

In order to analyze the results regarding BMI values, the percentage of adipose tissue and the endurance shuttle run test, the authors propose the intervention in three action zones: HFZ, TIZ and SIZ by age and gender of the subjects (Tables III and IV).

For the motor tests regarding musculoskeletal fitness and flexibility, two action zones were proposed: HFZ and TIZ. Motor performances lower than those presented in Table V fall into TIZ.

d) Statistical processing

The data obtained from individual measurements were statistically processed, and based on the Chi-squared test with two nominal variables we compared the case frequencies of subjects with the frequencies depending on their residential environments. Case frequencies were analyzed separately for the two counties. The values of the Chi-squared test were determined using association tables that included the parameters: urban/rural and healthy/to be improved. A confidence interval of 95% was used.

Results

The registered data gathered from the measurements show that the numerical and percentage distribution of the resulting values, as well as the relationship between the residential environment and the action zones is as presented in Tables VI and VII.

Regarding *Body Mass Index*, it can be seen that in Bihor county 182 students (69.73%) from urban environment and 164 students (77%) from rural environment fall into the HFZ, while in Hajdú-Bihar county 187 students (70.83%) from urban environment and 138 students (70.41%) from rural environment fall into this zone. Based on the Chi-squared test, it can be established that regarding distribution in the two action zones, there are no significant differences between the observed frequencies and the expected frequencies in the case of students from urban environment and students from rural environment from Bihor ($X^2 = 2.85$, $p = 0.092$) and Hajdú-Bihar county ($X^2 = 0.0005$, $p = 0.981$).

Regarding the *percentage of adipose tissue*, in Bihor county 165 students (63.22%) from urban areas and 152 students (71.36%) from rural areas fall into the HFZ, while in Hajdú-Bihar county 185 students (70.07%) from urban areas and 129 students (65.82%) from rural areas fall into the same zone. Regarding the percentage of adipose tissue, in Bihor county there is a significant difference between the residential environment and the action zones ($X^2 = 4.51$, $p < 0.05$), while in the case of students from Hajdú-Bihar county this difference is insignificant ($X^2 = 1.29$, $p = 0.256$).

The information regarding the *endurance shuttle run test* shows that out of all 474 students from Bihor county, 174 students (66.67%) from urban environment and 164 (77%) from rural environment fell into the HFZ, while in Hajdú-Bihar 145 students (54.92%) from urban environment and 122 students (62.24%) from rural environment had values within this zone. Regarding the HFZ and aerobic capacity, in Bihor county there were significant differences between the observed frequencies and expected frequencies in the case of students from urban environment and students from rural environment ($X^2 = 5.83$, $p = 0.016$), while in the case of students from Hajdú-Bihar county, the difference was insignificant ($X^2 = 2.52$, $p = 0.112$).

In the *paced curl-up test*, 246 students (94.25%) from urban areas and 185 students (86.85%) from rural areas in Bihor county fell within the HFZ, while in Hajdú-Bihar county, 243 students (92.04%) from urban areas and 137 students (69.90%) from rural areas had values within this zone. Regarding the classification of the results into action zones, in both counties there was no significant association between the observed and the expected frequencies in the case of students from urban and rural environment: Bihor county: ($X^2 = 8.70$, $p = 0.003$); Hajdú-Bihar county ($X^2 = 38.05$, $p < 0.001$).

For the *trunk lift* test, the distribution of HFZ students was as follows: in Bihor 188 students (72.03%) from urban areas and 153 students (71.83%) from rural areas, while in Hajdú-Bihar, 107 students (40.53%) from urban areas and 145 students (73.98%) from rural areas. In Bihor county there was no significant association ($X^2 = 0.0003$, $p = 0.986$), while in Hajdú-Bihar county there was a significant association ($X^2 = 51.38$, $p < 0.001$) between the residential environment and the results of the trunk lift test.

There were 149 students (57.09%) from urban environment and 122 students (57.28%) from rural environment in Bihor county versus 182 students (68.94%)

from urban environment and 129 students (65.82%) from rural environment in Hajdú-Bihar county with values within the HFZ in the *paced push-up* test. There was no significant association between the residential environment and the results of the paced push-up test either in Bihor county ($X^2 = 0.0006$, $p = 0.98$), or in Hajdú-Bihar county ($X^2 = 0.57$, $p = 0.449$).

In the *handgrip test*, 213 students (81.61%) from urban environment and 189 students (88.73%) from rural environment in Bihor county compared to 239 students (90.53%) from urban environment and 174 students (88.78%) from rural environment in Hajdú-Bihar county had values within the health zone. In Bihor county, there was a significant difference between the observed and expected frequencies in the case of students from urban and rural areas regarding the distribution of the handgrip test by action zones ($X^2 = 3.70$, $p = 0.05$), while in Hajdú-Bihar there was no significant difference ($X^2 = 0.35$, $p = 0.55$).

Regarding the *standing broad jump test*, in Bihor county there were 201 students (77.01%) from urban environment and 150 students (70.02%) from rural environment with results falling within the health zone, while in Hajdú-Bihar the respective numbers were 190 students (71.97%) from urban environment and 142 students (72.45%) from rural environment. Concerning the classification of the standing broad jump test into action zones, there were no significant differences between the observed and expected frequencies in the case of students from urban and rural environment either in Bihor ($X^2 = 2.73$, $p = 0.09$) or in Hajdú-Bihar county ($X^2 = 0.07$, $p = 0.7887$).

Concerning the *back-saver sit and reach test*, in Bihor county there were 36 students (13.79%) from the urban area and 18 students (8.45%) from the rural area with results falling within the HFZ, while in Hajdú-Bihar county there were 147 students (55.68%) from urban environment and 139 students (70.92%) from rural environment falling in this zone. In Bihor county there was no significant association ($X^2 = 2.67$, $p = 0.10$), while in Hajdú-Bihar county ($X^2 = 11.36$, $p < 0.01$) there was a significant association between the residential environment and the back-saver sit and reach test results.

In Bihor county there were no significant differences between the distribution of the HFZ and the residential environment in the case of BMI ($X^2 = 2.85$, $p = 0.092$), the trunk lift test ($X^2 = 0.0003$, $p = 0.986$), paced push-ups ($X^2 = 0.0006$, $p = 0.98$), standing broad jump ($X^2 = 2.73$, $p = 0.09$) and the back-saver sit and reach test ($X^2 = 2.66$, $p = 0.10$).

In Bihor county there was a significant difference between the distribution of the HFZ and the residential

Table VI

Numerical and percentage distribution of subjects from Bihor county according to action zones depending on their residential environment and test results

Test name	Bihor n = 474								Chi-squared test	P
	Urban n = 261				Rural n = 213					
	HFZ		TIZ		HFZ		TIZ			
	N	%	N	%	N	%	N	%	X^2	
BMI	182	69.73	79	30.27	164	77.00	49	23.00	2.85	0.09
% AT	165	63.22	96	36.78	152	71.36	61	28.64	4.51*	< 0.05
ESR(VO_2max)	174	66.67	87	33.33	164	77.00	49	23.00	5.83*	0.02
PCU (n)	246	94.25	15	5.75	185	86.85	28	13.15	8.70*	< 0.01
TL (cm)	174	66.67	87	33.33	135	63.38	78	36.62	0.0003	0.99
PP (n)	149	57.09	112	42.91	122	57.28	91	42.72	0.0006	0.98
HG (kg)	213	81.61	48	18.39	189	88.73	24	11.27	3.70*	0.05
SBJ (cm)	201	77.01	60	22.99	150	70.42	63	29.58	2.73	0.09
BSSR (cm)	36	13.79	225	86.21	18	8.45	195	91.55	2.67	0.10

*significant difference $p < 0.05$; ** significant difference $p < 0.01$

Table VII

Numerical and percentage distribution of subjects from Hajdú-Bihar county according to action zones depending on their residential environment and test results

Test name	Bihor n = 474								Chi-squared test	P
	Urban n = 261				Rural n = 213					
	HFZ		TIZ		HFZ		TIZ			
	N	%	N	%	N	%	N	%	X^2	
BMI	182	69.73	79	30.27	164	77.00	49	23.00	2.85	0.09
% AT	165	63.22	96	36.78	152	71.36	61	28.64	4.51*	< 0.05
ESR(VO_2max)	174	66.67	87	33.33	164	77.00	49	23.00	5.83*	0.02
PCU (n)	246	94.25	15	5.75	185	86.85	28	13.15	8.70*	< 0.01
TL (cm)	174	66.67	87	33.33	135	63.38	78	36.62	0.0003	0.99
PP (n)	149	57.09	112	42.91	122	57.28	91	42.72	0.0006	0.98
HG (kg)	213	81.61	48	18.39	189	88.73	24	11.27	3.70*	0.05
SBJ (cm)	201	77.01	60	22.99	150	70.42	63	29.58	2.73	0.09
BSSR (cm)	36	13.79	225	86.21	18	8.45	195	91.55	2.67	0.10

* significant difference $p < 0.05$; ** significant difference $p < 0.01$

Key: HFZ = HFZ + the "thin" subzone (only in the case of BMI and %AT); TIZ = TIZ + SIZ (only in the case of BMI, %AT and ESR); ESR = endurance shuttle run; PCU = paced curl-up test; TL = trunk lift; PP = paced push-ups; HG = handgrip test; SBJ = standing broad jump; BSSR = back-saver sit and reach

environment in the case of the percentage of adipose tissue ($X^2 = 4.51$, $p < 0.05$), endurance shuttle run ($X^2 = 5.83$, $p = 0.016$), paced curl-ups ($X^2 = 8.70$, $p = 0.003$) and handgrip ($X^2 = 3.70$, $p = 0.05$).

In Hajdú-Bihar county there was no significant difference between the distribution of the HFZ and the residential environment in the case of BMI ($X^2 = 0.0005$, $p = 0.981$), the percentage of adipose tissue ($X^2 = 1.29$, $p = 0.256$), the endurance shuttle run test ($X^2 = 2.52$, $p = 0.112$), paced push-ups ($X^2 = 0.57$, $p = 0.449$), handgrip ($X^2 = 0.35$, $p = 0.55$), and the standing broad jump ($X^2 = 0.07$, $p = 0.7887$).

In Hajdú-Bihar county there was a significant difference between the distribution of the HFZ and the residential environment in the case of three tests: paced curl-ups ($X^2 = 38.053$, $p< 0.001$), trunk lift ($X^2 = 51.38$, $p < 0.001$) and back-saver sit and reach test ($X^2 = 11.36$, $p < 0.01$).

Discussions

According to the *Alimentación y Valoración del Estado Nutricional en Adolescentes: Food and Assessment of the Nutritional Status of Spanish Adolescents* (AVENA), *European Youth Heart Study* (EYHS) and *Healthy Lifestyle in Europe by Nutrition in Adolescence* (HELENA) studies, health related fitness is a fundamental health factor in childhood and adolescence.

NETFIT has the advantages of using criterion referenced standards which reflect the fitness level necessary to enjoy good health and to avoid the development of certain metabolic diseases. The goal of teachers is to maintain students within the HFZ or to help them get out of TIZ. Parents can be informed about the results obtained by their children and they can contribute to their education and guidance in order to optimize their physical fitness.

The study of De Miguel-Etayo et al. (2014) was one of the first studies in Europe meant to establish the health-related fitness reference standards according to age and gender for children aged between 6-10.9 years.

The results of the study performed by Chillon et al. (2011) show the differences between the components of health-related fitness values among Spanish children from urban environment and rural environment. It was established that students from rural environment had a lower BMI or percentage of adipose tissue, a higher level of aerobic fitness, and higher values of handgrip strength compared to children from urban environment (differences between average values: 1.1 kg, 0.3 kg/m^2 and 4.9 mm, 1.5 ml/kg/min, 0.8 kg). On the other hand, students from rural environment had lower flexibility and a lower number of repetitions in the case of curl-ups (differences between average values = 0.9 cm, 0.9 sec) (n=2569, age 7-16).

In Bihor county the results of the endurance shuttle run test and the handgrip test obtained by girls from urban environment were better by 0.28 ml/kg/min; 1.68 kg less compared to the results of girls from rural environment. Among boys, this difference was 2.63 ml/kg/min; 1.99 kg in favor of those living in rural environment.

In the case of body composition and nutritional status, in Bihor county the difference between students from urban environment and those from rural environment regarding their inclusion in the HFZ was 7.27% (BMI) and 8.14% (AT) in favor of students from rural environment. In Hajdú-Bihar county the difference was 0.42% (BMI) and 4.25% (AT) in favor of students from urban environment.

According to the study performed by Novak et al. (2015), students from urban areas in Croatia showed better speed, flexibility and explosive strength than those living in rural areas (n=9164, age 11-14).

In Bihor county, in the case of three motor tests: endurance shuttle run test (10.33%), handgrip test (7.12%) and paced push-up test (0.19%), the percentage of those from the HFZ was higher for students living in the rural area. In the case of four motor tests: paced curl-ups (7.4%), trunk lift (3.29%), standing broad jump (6.59%) and back-saver sit and reach test (5.34%), the results were in favor of students living in urban areas.

In Hajdú-Bihar county, in the case of four motor tests: endurance shuttle run test (7.32%), trunk lift (33.45%), standing broad jump (0.48%) and back-saver sit and reach test (15.24%), the percentage of those with results within HFZ was higher for students living in rural environment. In the case of three motor tests: paced curl-ups (22.15%), paced push-ups (3.12%) and handgrip test (1.75%), the results were in favor of students from urban environment.

In the seven NETFIT motor tests, the percentage of students with results falling within the HFZ was between 11.39% and 90.93% in Bihor, and between 54.78% and 89.78% in Hajdú-Bihar.

Conclusions

1. In Bihor county there is a significant difference between the results from the HFZ and the residential environment regarding the following components of health-related fitness: body composition ($X^2 = 4.51$, $p < 0.05$), aerobic fitness ($X^2 = 5.83$, $p < 0.05$) and the musculoskeletal fitness component through two tests: the paced curl-up test ($X^2 = 8.70$, $p < 0.01$), and the handgrip test ($X^2 = 3.70$, $p = 0.05$).

2. In Hajdú-Bihar county there is a significant difference between the results from the HFZ and the residential environment regarding flexibility ($X^2 = 11.36$, $p < 0.01$) and the musculoskeletal fitness component through two tests: the paced curl-up test ($X^2 = 38.053$, $p < 0.01$) and the trunk lift test ($X^2 = 51.38$, $p < 0.01$).

3. We think that it is necessary to assess the components of health-related fitness in Romania as well, in a way similar to FITNESSGRAM or NETFIT, and also to establish the criterion reference standards and, implicitly, the action zone specific for them. For this purpose we propose for this study to be performed on a sample group representative for Romania.

Conflicts of interests

The authors declare no conflict of interests.

Acknowledgments

This study received no sponsorship. The results presented in this paper are partial results of current PhD studies undertaken by the first author at the *Faculty of Physical Education and Sport of the "Babeş-Bolyai" University Cluj-Napoca.*

References

Bathrellou E, Lazarou C, Panagiotakos DB, Sidossis LS. Physical activity patterns and sedentary behaviors of children from urban and rural areas of Cyprus. Cent Eur J Public Health. 2007;15(2):66-70.

Blair SN, Brodney S. Effects of Physical Inactivity and Obesity on Morbidity and Mortality: current evidence and research issues. Med Sci Sports Exerc, 1999;31(11 Suppl):S646-S662

Brug J, van Stralen MM, Chinapaw MJ, De Bourdeaudhuij I, Lien N, Bere E, Singh AS, Maes L, Moreno L, Jan N, Kovacs E, Lobstein T, Manios Y, Te Velde SJ. Differences in weight status and energy-balance related behaviours according to ethnic background among adolescents in seven countries in Europe: the ENERGY-project. Pediatr Obes. 2012;7(5):399-411. DOI:10.1111/j.2047-6310.2012.00067.x.

Callaghan P. Exercise: a neglected intervention in mental health care? J Psychiatr Ment Health Nurs. 2004;11(4):476-483. DOI:10.1111/j.1365-2850.2004.00751.x.

Chillón P, Ortega FB, Ferrando JA, Casajus JA. Physical fitness in rural and urban children and adolescents from Spain. J Sci Med Sport. 2011;14(5):417-23. DOI:10.1016/j.jsams.2011.04.004.

Csányi T, Karsai I, Kaj M, Finn K. Assessment of health-related fitness in Hungary: the Netfit, as the Hungarian fitnessgram initiative, 2014. Available online at: https://www.researchgate.net/publ ication/264544617_ASSESSMENT_OF_HEALTHRELATED_FITNESS_IN_HUNGARY_THE_NETFIT_AS_THE_HUNGARIAN_FITNESSGRAM_INITIATIVE.

De Miguel E, Gracia M, Ortega FB, Intemann T, Foraita R, Lissner L, Oja L, Moreno LA. Physical Fitness Reference Standards in European Children: The IDEFICS Study. Int J Obes (Lond). 2014 Sep;38 Suppl 2:S57-66. doi: 10.1038/ijo.2014.136.

De Miguel-Etayo P, Gracia-Marco L, Ortega FB, Intemann T, Foraita R, Lissner L, Oja L, Barba G, Michels N, Tornaritis M, Molnár D, Pitsiladis Y, Ahrens W, Moreno LA; IDEFICS consortium. Physical fitness reference standards in European children: the IDEFICS study. Int J Obes (Lond). 2014;38 Suppl 2:S57-66. DOI:10.1038/ijo.2014.136.

Kaj M, Csányi T, Karsai I, Marton O, Csányi T. Kézikönyv a nemzeti egységes tanulói fitsségi teszt (NETFIT) alkalmazásához. Budapest: Magyar Diáksport Szövetség, 2014.

Krombholz H. Physical performance in relation to age, sex, social class and sports activities in kindergarten and elementary school. Percept Mot Skills. 1997;84(3 Pt 2):1168-1170. DOI:10.2466/pms.1997.84.3c.1168.

Laurson KR, Eisenmann JC, Welk GJ. Body fat percentile curves for U.S. children and adolescents. Am J Prev Med. 2011;41(4 Suppl 2):S87-S92. DOI:10.1016/j.amepre.2011.06.044

Lukács NCS, Hanțiu I. Relationship between Motor Skills and Body Composition Among Middle School Students from Bihor - Hajdú - Bihar Euroregion. An Univ Oradea-Fasc Ed Fiz Sport. 2017; XXVII:3-9.

Milne N, Leong GM, Hing W. The relationship between children's motor proficiency and health-related fitness. J Paediatr Child Health. 2016;52(8):825-831. DOI:10.1111/jpc.13236

Moreira C, Santos R, de Farias Júnior JC, Vale S, Santos PC, Soares-Miranda L, Marques AI, Mota J. Metabolic risk factors, physical activity and physical fitness in Azorean adolescents: a cross-sectional study. BMC Public Health. 2011;11:214. DOI:10.1186/1471-2458-11-214.

Myers J, Kaykha A, George S, Abella J, Zaheer N, Lear S, Yamazaki T, Froelicher V. Fitness versus physical activity patterns in predicting mortality in men. Am J Med. 2004;117(12):912-918. DOI:10.1016/j.amjmed.2004.06.047.

Novak D, Bernstein ER, Podnar R, Vozzolo Y. Differences in the Fitness Levels of Urban and Rural Middle School Students in Croatia. Phys Educ. 2015;(72):553-576. DOI: 10.18666/TPE-2015-V72-I4-6115.

Ortega FB, Ruiz JR, Castillo MJ, Sjöström M. Physical fitness in childhood and adolescence: a powerful marker of health. Int J Obes (Lond). 2008a;32(1):1-11. DOI:10.1038/sj.ijo.0803774.

Ortega FB, Artero EG, Ruiz JR, Vicente-Rodriguez G, Bergman P, Hagströmer M, Ottevaere C, Nagy E, Konsta O, Rey-López JP, Polito A, Dietrich S, Plada M, Béghin L, Manios Y, Sjöström M, Castillo MJ; HELENA Study Group. Reliability of health-related physical fitness tests in European adolescents. The HELENA Study. Int J Obes (Lond). 2008b;32(Suppl 5):S49-S57. DOI:10.1038/ijo.2008.183.

Plowman SA, Meredith MD. Fitnessgram/Activitygram Reference Guide (4th Ed). Dallas, TX: The Cooper Institute, 2013.

Reyes ME, Tan SK, Malina RM. Urban-rural contrasts in the growth status of school children in Oaxaca, Mexico. Ann Hum Biol. 2003;30(6):693-713. DOI:10.1080/03014460310001612792.

Tsimeas PD, Tsiokanos AL, Koutedakis Y, Tsigilis N, Kellis S. Does living in urban or rural settings affect aspects of physical fitness in children? An allometric approach. Br J Sports Med. 2005;39(9):671-674. DOI:10.1136/bjsm.2004.017384.

Ujević T, Sporis G, Milanović Z, Pantelić S, Neljak B. Differences between health-related physical fitness profiles of Croatian children in urban and rural areas. Coll Antropol. 2013;37(1):75-80.

***. Institutul Național de Statistică. Speranța de viață, 2013a. Avalaible online at: http://www.insse.ro/cms/files/publicatii/pliante20statistice/07-Speranta20de20viata_n.pdf. Accessed on 25 May 2017.

***. World Health Organization. Global Action Plan for the Prevention and Control of Non Communicable Diseases 2013-2020, 2013b. Avalaible online at: http://www.who.int/nmh/events/ncd_action_plan/en/. Accessed on 25 May 2017.