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Comparison of physical fitness of Slovak and American high school populations using fitnessgram

Comparación de la condición física de adolescentes eslovacos y americanos utilizando fitnessgram

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Abstract: The aim of this study was to test the application of the test battery Fitnessgram for health-related fitness assessment for 967 students aged 15-19 from Prešov region, Slovakia and the consequent comparison with results of an American population group comprised of 719,441 Texan students. Fitnessgram evaluation of Slovak population group, the Manova, Mann-Whitney U test and the Kruskall-Wallis test all proved existing differences between the groups of boys and girls, especially in curl-up test. Subsequent international comparison presented by percentile of Healthy fitness zone (HFZ) showed that Slovakstudents achieved better results for both BMI and Percentage of Body Fat. On the contrary, the American population group achieved better results in HFZ for most motor tests (curl-up, push-up, Pacer run and sit and reach). The study demonstrated the suitability of the test battery Fitnessgram and points out the negative tendency of particular health-related fitness parameters in Slovakian secondary school students.
Key words: Physical Activity, Adolescent, Healthy Fitness Zone, Test Battery.

Resumen: El objetivo de este estudio fue aplicar la batería Fitnessgram para la evaluación de la condición física relacionada con la salud en 967 estudiantes de 15 a 19 años de la región de Prešov, Eslovaquia, y comparar con los resultados de un grupo de población estadounidense compuesto por 719,441 estudiantes texanos. La evaluación de Fitnessgram del grupo de población eslovaco, y los análisis de Manova, Mann-Whitney U test y Kruskall-Wallis mostraron diferencias significativas entre los grupos de niños y niñas, especialmente en la prueba de abdominales. La comparación internacional posterior presentada de acuerdo a los percentiles de la *Zona de condición física saludable (Healthy fitness zone: HFZ*) mostró que los estudiantes eslovacos lograron mejores resultados tanto para el IMC como para el porcentaje de grasa corporal. Por el contrario, el grupo de población estadounidense logró mejores resultados en la mayoría de las pruebas motoras (abdominales, flexiones, carrera y flexibilidad). El estudio corrobora la utilidad de la batería de test Fitnessgram y señala la tendencia negativa de algunos parámetros de condición física relacionados con la salud en los estudiantes de secundaria eslovacos.
Palabras clave: Actividad física, Adolescentes, Zona de condición física saludable, Batería de test.

Introduction

Movement activity as defined by the EU Working Group (2008) as "any bodily movement associated with muscular contraction that increases energy expenditure above resting levels" is a contemporary issue which is thoroughly discussed worldwide.

Development of modern civilization and a lifestyle of consumption is closely related to the decline in activity required to reach outputs (Straker et al., 2014). Technological development thus leads to a decrease in the volume and intensity of physical activity throughout the population group.

Consequent health impacts resulting from insufficient physical activity have been medically diagnosed. Whether it is cardiovascular disease (Ortega et al. 2011), metabolic disease and risk factors (Ekelund et al., 2007; Martins, Morgan, Bloom & Robertson, 2007) or orthopaedic diseases (Varo et al., 2003), authors commonly agree about the negative impact of low or insufficient physical activity on health status (González et al., 2018; López et al, 2016, 2017, 2018). This phenomenon is referred in numerous studies as a sedentary lifestyle (Etemadi et al., 2011; Tremblay et al., 2010; Tudor –Locke et al., 2012).

Specialists advocate for greater societal interest in the area defined as Health related fitness (Ganley et al., 2011). This is related to the need for objective methods of measuring, diagnosing and describing a real level of physical activity and identifying trends in various population groups.

A unified concept of physical activity does not currently exist within the countries of the EU, nor does a systematic diagnosis of physical activity. Thus, individual member states must deal with this issue independently. This disunity is reflected in the fact that the latest complex studies originate from the end of the 20th century. These consist of the EUROFIT test (Zinzenet al., 2013; Moravec et al., 1996), which targets the European population and the local UNIFIT

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(Kovář & Měkota, 1995) test, which is focused on the Czechoslovak population group.

In light of the aforementioned facts, testing isrealized either by Fitnessgram test battery (Andrade et al., 2014; Ortega et al., 2011; Pugliesle et al., 2013) or data is listed according to normative categories setup for Healthy Fitness Zone (HFZ) by Cooper Institute,based on the results of long-term usage of the Fitnessgram test battery. The advantage is that development of this test battery is a long-term process, systematically and regularly modernized based on current population trends. Such a long-term measurement, particularly in the USA, provides considerable data on the basis of which standards and recommendations are issued and which enables the comparison of local results.

The universal test battery not only enables the comparison of local, usually national, results, but also facilitates broader international research and comparison (Jürimäe et al., 1998; Kajetal., 2013; Lovecchio et al., 2012; et al Wilczewski, 1996). Such data make comparison of partial characteristics of population groups at a local and global scale possible, and may also become a valuable source of information concerning risk factors, as well as provided feedback on the effectiveness of prevention and intervention programmes.

The aim of the study was to provide and analyze detailed data about health-related fitness characteristics in a large test group of secondary school students in eastern Slovakia. Another aim was to evaluate the results in accordance with recommendations for HFZ and to compare descriptive data with the results of a similar American population set. The data, as well as data obtained from repetitive measurements, will be consequently used for evaluation on a national level.

Method

This study is based on data obtained from testing pupils from the Prešov region in eastern Slovakiain 2013 and on data obtained from measurements in the State of Texas, USA in 2012- 2013.

Participants

The measurements were attended by 967 (451 males, 516 females) students from 14 secondary schools in Slovakia, aged 15-19. Detailed descriptive characteristics of the population being tested and age intervals are shown in Table 1.

Table 1. Number of tested students.

Number of tested students								Number of tested students in Pacer run					
Age interval	Age group	Total SVK	males SVK	females SVK	Total USA	males USA	females USA	Total SVK	males SVK	females SVK	Total USA	males USA	females USA
all	**1,2,3,4**	**967**	**451**	**516**	**719441**	**427046**	**292395**	**461**	251	210	**366330**	214435	215582
15.0-15.99	**1**	**196**	84	112	**323794**	187669	136125	**107**	53	54	**165139**	94696	70443
16.0-16.99	**2**	**282**	144	138	**239124**	143463	95661	**113**	73	40	**121421**	72327	49094
17.0-17.99	**3**	**205**	94	111	**156523**	95914	60609	**105**	54	51	**79770**	47412	32358
18.0+	**4**	**284**	129	155				**136**	71	65			

Data obtained in the USA originate from a data base run by the Texas Education Agency (TEA, 2014) which contains data on 2,188,241 people who took part in tests. Data were obtained in accordance with well-defined methodology and consequently published by percentile according to student HFZ achievement by school, year and gender (Welk, Meredith, Ihmels & Seeger, 2010). After the selection process, we received data from 719,441 people (427,046 males, 292,395 females) for the age range (15-18 years). Raw data for the Body fat Percentage (BF %) and Pacer run characteristics contained fewer records. Therefore, we will consider data from 19,573 students (10,535 males, 9038 females) for BF% and from 366,330 students (214,435 males, 215,582 females) for Pacer run.

Measures

All participating students in Slovakia went through four tests of the Fitnessgram test battery: the Cadence-based curl – up for abdominal strength and endurance, the cadence-based 90° push-up test for upper body strength, the shoulder stretch and the back saver sit and reach for flexibility. Some of the students (461 total -251 males, 210 females) also took part in the Pacer run test.

The stadio meter (Seca GmbH; Hamburg, Germany) was used to measure stature to the nearest 0.1 cm. Digital scales In Body 230 (Biospace Co., Ltd.; Seoul, Korea) were used to measure weight to the nearest 0.1 kg. Direct segmental multi-frequency bioelectrical impedance analysis In Body 230 (Biospace Co., Ltd.; Seoul, Korea) were used to provide body composition to the nearest 0.1% of body fat percentage.

The students' legal guardians or the students themselves (over the age of 18) were verbally informed of the test procedure and they signed informed consent forms approved by the ethical committee of Prešov University. All measurements were carried out in accordance with the ethical standards of the Declaration of Helsinki (Harriss &Atkinson, 2011).

All teachers in the participating schools were provided with an informational DVD with a detailed description of the test, including the methodology. To ensure maximum objectivity of the measurements, the representative of Prešov University was present. Data were recorded according to predefined protocols.

Data Analyses

In all analyses and data processing we use normative model created by the Cooper Institute for the years 2011-2013(Cooper Institute, 2014). The latest recommendations for 2014 was not used in order to facilitate the comparisons with data provided by TEA from 2012 -2013 which were prepared in accordance with the standards valid for that period of time.

Prešov students' data were classified according to the results in particular tests, HFZ achievement and individual somatometric characteristics.

Raw Fitnessgram data obtained from TEA were sorted according to age and sex in accordance with the rules of the American educational system (NCFES, 2014). Total values for each sub-category became the base for the percentile calculations to show successful completion of the test within HFZ limit. For values of BMI, BF% and Pacer run were further calculated for detailed values in the categories of "some risk" and "high risk".

Primarily for Slovak students data a Sex * Age Group Manova was used to assess the differences in health-related physical fitness between boys and girls as a function of age group. The Mann-Whitney U test was employed to determine the differences in curl-ups and push-ups between boys and girls collapsed over age groups. The Kruskal-Wallis test was used to assess the differences between age groups collapsed over gender in the curl-ups and push-ups. The level of significance for all analyses was set to an effect size of 0.20.

Complex statistical methods to compare results of Slovak and Texas students proved to be irrelevant due to the way the data are transferred by TEA . To provide comparisons we therefore utilise elementary descriptive statistics based on calculated percentiles of HFZ achievements, or possibly "some" and "high"risk categories.

Results

Slovak population analysis

Tables 2a and 2b depict the descriptive statistics of the FITNESSGRAM tests for all age groups by gender. There was no multivariate Sex * Age Group interaction (eta^2 = 0.038, 95% CI: -0.027 – 0.103). Univariate follow-up analyses confirmed these results: all partial eta^2 values were between 0.003 (95% CI: -0.062 – 0.068) and 0.024 (95% CI: -0.041 – 0.089). There were Sex (eta^2 = 0.707, 95% CI: 0.658 – 0.750) and Age Group (eta^2 = 0.0.591, 95% CI: 0.528 – 0.648) multi-variate main effects. The follow-up univariate analyses for the Sex main effect are displayed in Table 3.

Table 2a. Descriptive statistics Means (95% CI) and Standard deviation (95% CI) – SVK students.

AGE Group 1	MALES	FEMALES
Age	15.64 (15.6 - 15.69) ± 0.22 (0.19 - 0.26)	15.58 (15.54 - 15.63) ± 0.23 (0.21 - 0.27)
Height	175.25 (173.8 - 176.71) ± 6.7 (5.82 - 7.9)	164.44 (163.4 - 165.49) ± 5.56 (4.92 - 6.41)
Weight	64.5 (61.77 - 67.22) ± 12.54 (10.88 - 14.78)	57.55 (55.72 - 59.37) ± 9.75 (8.62 - 11.23)
Perc fat	15.51 (13.76 - 17.26) ± 8.06 (7 - 9.5)	24.46 (22.99 - 25.94) ± 7.87 (6.96 - 9.06)
BMI	21.1 (20.35 - 21.84) ± 3.44 (2.98 - 4.05)	20.97 (20.42 - 21.51) ± 2.92 (2.58 - 3.37)
BsLInch	0.42 (-0.26 - 1.11) ± 3.17 (2.75 - 3.73)	2.72 (2.24 - 3.21) ± 2.59 (2.29 - 2.99)
BsRinch	0.65 (-0.04 - 1.34) ± 3.17 (2.75 - 3.74)	2.82 (2.33 - 3.31) ± 2.61 (2.31 - 3.01)
Flex	0.89 (0.82 - 0.96) ± 0.31 (0.27 - 0.37)	0.97 (0.94 - 1) ± 0.16 (0.14 - 0.19)
PacerVO2	44.34 (42.6 - 46.09) ± 6.33 (5.31 - 7.83)	38.95 (37.75 - 40.16) ± 4.4 (3.7 - 5.43)

AGE Group 2	MALES	FEMALES
Age	16.49 (16.45 - 16.54) ± 0.28 (0.25 - 0.32)	16.55 (16.5 - 16.59) ± 0.28 (0.25 - 0.32)
Height	176.64 (175.58 - 177.7) ± 6.44 (5.77 - 7.28)	164.05 (163.12 - 164.99) ± 5.57 (4.98 - 6.32)
Weight	66.75 (64.82 - 68.68) ± 11.71 (10.49 - 13.24)	57.49 (55.66 - 59.32) ± 10.88 (9.73 - 12.34)
Perc fat	15.65 (14.34 - 16.97) ± 7.95 (7.13 - 9)	24.69 (23.48 - 25.9) ± 7.2 (6.43 - 8.16)

BMI	21.71 (21.15 - 22.28) ± 3.44 (3.08 - 3.89)	20.97 (20.4 - 21.53) ± 3.36 (3 - 3.81)
BsLInch	1.13 (0.65 - 1.61) ± 2.94 (2.63 - 3.32)	2.62 (2.15 - 3.08) ± 2.77 (2.48 - 3.15)
BsRinch	1.26 (0.77 - 1.75) ± 2.99 (2.68 - 3.38)	2.7 (2.21 - 3.18) ± 2.86 (2.56 - 3.25)
Flex	0.92 (0.87 - 0.96) ± 0.28 (0.25 - 0.31)	0.95 (0.91 - 0.99) ± 0.22 (0.2 - 0.25)
PacerVO2	46.48 (44.67 - 48.3) ± 7.77 (6.69 - 9.29)	36.78 (35.56 - 37.99) ± 3.79 (3.1 - 4.87)

AGE Group 3	**MALES**	**FEMALES**
Age	17.46 (17.4 - 17.51) ± 0.27 (0.23 - 0.31)	17.46 (17.41 - 17.51) ± 0.28 (0.25 - 0.33)
Height	177.07 (175.74 - 178.4) ± 6.5 (5.69 - 7.59)	165.57 (164.47 - 166.67) ± 5.84 (5.16 - 6.73)
Weight	67.69 (65.25 - 70.13) ± 11.93 (10.43 - 13.93)	60.49 (58.36 - 62.62) ± 11.32 (10 - 13.04)
Perc fat	15.54 (14.1 - 16.97) ± 6.99 (6.11 - 8.16)	26.23 (24.7 - 27.77) ± 8.15 (7.2 - 9.39)
BMI	21.86 (21.18 - 22.53) ± 3.31 (2.89 - 3.86)	21.72 (21.05 - 22.38) ± 3.53 (3.12 - 4.07)
BsLInch	1.1 (0.49 - 1.72) ± 3 (2.63 - 3.51)	2.44 (1.87 - 3) ± 3.02 (2.67 - 3.48)
BsRinch	1.36 (0.76 - 1.95) ± 2.91 (2.54 - 3.39)	2.51 (1.95 - 3.07) ± 2.99 (2.64 - 3.44)
Flex	0.91 (0.85 - 0.97) ± 0.28 (0.25 - 0.33)	0.92 (0.87 - 0.97) ± 0.27 (0.24 - 0.32)
PacerVO2	46.59 (44.73 - 48.46) ± 6.83 (5.74 - 8.43)	38.51 (37.2 - 39.82) ± 4.65 (3.89 - 5.79)

AGE Group 4	**MALES**	**FEMALES**
Age	18.76 (18.66 - 18.85) ± 0.55 (0.49 - 0.63)	18.66 (18.59 - 18.73) ± 0.42 (0.38 - 0.48)
Height	177.6 (176.42 - 178.78) ± 6.78 (6.04 - 7.72)	165.27 (164.33 - 166.21) ± 5.92 (5.33 - 6.67)
Weight	69.87 (67.77 - 71.97) ± 12.01 (10.7 - 13.69)	59.51 (57.8 - 61.22) ± 10.78 (9.7 - 12.14)
Perc fat	16.19 (15 - 17.38) ± 6.81 (6.07 - 7.77)	26.4 (25.15 - 27.65) ± 7.88 (7.09 - 8.87)
BMI	22.28 (21.71 - 22.85) ± 3.27 (2.91 - 3.73)	21.62 (21.06 - 22.17) ± 3.52 (3.16 - 3.96)
BsLInch	1.33 (0.79 - 1.87) ± 3.11 (2.77 - 3.54)	2.36 (1.91 - 2.82) ± 2.89 (2.6 - 3.25)
BsRinch	1.39 (0.86 - 1.91) ± 3.02 (2.69 - 3.44)	2.53 (2.09 - 2.98) ± 2.81 (2.53 - 3.16)
Flex	0.82 (0.75 - 0.89) ± 0.38 (0.34 - 0.44)	0.95 (0.91 - 0.98) ± 0.22 (0.2 - 0.25)
PacerVO2	46.05 (43.84 - 48.25) ± 9.31 (7.99 - 11.15)	36.67 (35.33 - 38.02) ± 5.41 (4.62 - 6.55)

Table 2b. Descriptive statistics Medians and Quartiles of curl-ups and push-ups by sex and age group – SVK students.

MALES	Age Group 1	Age Group 2	Age Group 3	Age Group 4
Curl-ups	41 (24 – 75)	33 (20 – 56)	30 (18 – 49.5)	30 (20 – 46)
Push-ups	31 (20 – 40)	32 (25 – 45)	35 (27 – 47)	33 (27 – 45)

FEMALES	Age Group 1	Age Group 2	Age Group 3	Age Group 4
Curl-ups	24 (14 – 37)	25 (12 – 37)	26 (15 – 42)	22.5 (13 – 32)
Push-ups	8 (2 – 13)	8 (2 – 15)	6 (2 – 13)	6 (1 – 14)

Tables 4a and 4b display the medians and interquartile ranges (IQR) of the curl-ups and push-ups by gender and age group, respectively.There were differences in curl-ups (theta, $\theta = 0.375$, 95% CI: 0.341 – 0.412) and push-ups ($\theta = 0.056$, 95% CI: 0.043 – 0.074) between boys and girls collapsed over age groups with the former scoring higher in the curl-ups, while the difference in push-ups was not significant. No differences between age groups were found in the push-ups: chi squared = 5.191 (95% CI: 0.216 – 9.348), df = 3.

Table 3. Univariate results of the Sex main effect – SVK students.

Variable	MALES	FEMALES	Eta² (95% CI)	d (95% CI)
Height (cm)	176.75 ± 6.63	164.83 ± 5.75	0.445 (0.391 – 0.496)	1.93 (1.32 – 2.43)
Percent fat (%)	15.76 ± 7.45	25.49 ± 7.79	0.286 (0.200 – 0.368)	1.27 (0.60 – 1.96)
Pacer distance (m)	1107.49 ± 454.64	641.05 ± 269.77	0.273 (0.186 – 0.355)	1.27 (-37.96 – 26.19)
Aerobic endurance (ml/kg/min)	45.93 ± 7.79	37.73 ± 4.78	0.271 (0.184 – 0.354)	1.28 (0.31 – 1.92)

Table 4a. Medians and Interquartile ranges of the curl-ups and push-ups by gender – SVK students.

	MALES	FEMALES	Theta (95% CI)
Curl-ups	31 (20 – 50)	24 (13 – 37)	0.375 (0.341 – 0.412)
Push-ups	33 (25 – 44)	7 (2 – 14)	0.056 (0.043 – 0.074)

Table 4b. Medians and Interquartile ranges (IQR) of the curl-ups and push-ups by age group - SVK students.

Age Groups	Curl-ups	Push-ups
1 (15.61 ± 0.23 years)	30 (16.75 – 51.25)	14 (6 – 30)
2 (16.52 ± 0.28 years)	29 (14 – 48.75)	20 (7 – 32)
3 (17.46 ± 0.28 years)	29 (17 – 43)	18 (6 – 34)
4 (18.70 ± 0.49 years)	25 (17 – 40)	19 (5 – 33)

Slovak and US population comparison

Tables 5a and 5b compare percentiles of successful completion of HFZ recommendations for Slovak and American populations in somatometric characteristics and body composition. Subsequently Tables 6a and 6b compare percentiles of students who have successfully completed motor tests by reaching HFZ. Both tables, when possible for particular characteristics, show percentile values for individuals belonging to the categories "some" and "high" risk.

Table 5a. Somatometric statistics - BMI.

BMI achieving HFZ percentile [%]							BMI in some risk percentile [%]						BMI in high risk percentile [%]					
Age group	Total SVK	males SVK	females SVK	Total USA	males USA	females USA	Total SVK	males SVK	female SVK	Total USA	males USA	females USA	Total SVK	males SVK	females SVK	Total USA	males USA	females USA
1,2,3,4	**84.6**	**82.2**	**86.6**	**60.2**	**56.3**	**66.0**	**7.6**	**8.7**	**6.6**	**14.1**	**15.9**	**11.5**	**7.9**	9.1	6.8	**25.7**	27.8	22.5
1	**85.2**	81.0	88.4	**58.6**	54.5	64.2	**6.1**	9.7	6.3	**14.6**	16.5	12.0	**8.7**	13.1	5.4	**26.8**	29.0	23.8
2	**84.0**	80.6	87.7	**60.3**	55.8	67.0	**7.8**	9.7	5.8	**14.1**	15.9	11.5	**8.7**	9.7	5.4	**25.6**	28.3	21.4
3	**84.9**	85.1	84.7	**63.4**	60.3	68.2	**7.3**	6.4	8.1	**13.2**	14.9	10.5	**7.8**	8.5	7.2	**23.5**	24.8	21.4
4	**84.5**	82.8	85.8				**8.5**	10.9	6.5				**7.1**	6.3	7.7			

Table 5b. Somatometric statistics – Body fat percentage.

BF% achieving HFZ percentile [%]							BF% some risk percentile [%]						BF% high risk percentile [%]					
Age group	Total SVK	males SVK	females SVK	Total USA	males USA	females USA	Total SVK	males SVK	females SVK	Total USA	males USA	females USA	Total SVK	males SVK	females SVK	Total USA	males USA	females USA
1,2,3,4	**77.6**	80.0	75.6	**62.4**	51.8	77.6	**17.5**	16.2	18.6	**28.5**	38.2	14.4	**4.9**	3.8	5.8	**9.2**	10.0	8.0
1	**75.0**	75.0	75.0	**61.3**	50.0	76.0	**18.9**	17.9	19.6	**28.5**	38.2	15.8	**6.1**	7.1	5.4	**10.2**	11.7	8.3
2	**79.8**	81.3	78.3	**61.8**	50.3	78.6	**15.2**	13.2	17.4	**29.5**	40.4	13.7	**5.0**	5.6	4.3	**8.7**	9.3	7.7
3	**76.6**	79.8	73.9	**65.5**	57.3	80.1	**20.0**	20.2	19.8	**26.8**	34.9	12.3	**3.4**	0.0	6.3	**7.7**	7.8	7.6
4	**78.1**	82.0	74.8				**17.0**	15.6	18.1				**4.9**	2.3	7.1			

Table 6a. Motor test statistics – Curl-up, Push-up, Shoulder stretch, Sit and reach.

Curl-up achieving HFZ percentile [%]							Push-up achieving HFZ percentile [%]					
Age group	Total SVK	males SVK	females SVK	Total USA	males USA	females USA	Total SVK	males SVK	females SVK	Total USA	males USA	females USA
1,2,3,4	**66.7**	67.0	66.4	**80.6**	81.2	79.8	**69.6**	89.6	52.3	**74.3**	71.1	78.9
1	**70.1**	75.9	65.8	**82.1**	82.7	81.1	**65.8**	80.7	54.5	**74.9**	71.3	80.0
2	**65.7**	68.5	62.8	**81.4**	82.1	80.3	**73.0**	90.0	55.8	**74.8**	72.2	78.8
3	**65.5**	59.8	70.3	**76.4**	76.6	76.0	**68.7**	91.2	50.0	**71.9**	69.1	76.4
4	**66.2**	64.8	67.3				**69.6**	93.8	49.4			

Shoulder stretch achieving HFZ percentile [%]							Sit and reach achieving HFZ percentile [%]					
Age group	Total SVK	males SVK	females SVK	Total USA	males USA	females USA	Total SVK	males SVK	females SVK	Total USA	males USA	females USA
1,2,3,4	**91.8**	88.3	94.7	**73.8**	69.7	79.8	**0.6**	1.3	0.0	**68.1**	77.3	55.3
1	**93.8**	89.2	97.3	**75.4**	71.2	81.3	**0.5**	1.2	0.0	**68.0**	77.4	55.6
2	**93.2**	91.6	94.9	**72.6**	68.3	79.2	**0.7**	1.4	0.0	**68.5**	77.6	55.5
3	**91.6**	91.2	91.9	**72.2**	68.8	77.6	**0.0**	0.0	0.0	**67.8**	76.8	54.1
4	**89.0**	82.2	94.8				**0.7**	1.6	0.0			

Table 6b. Motor test statistics – Pacer run.

Pacer run achieving HFZ percentile [%]							Pacer run in some risk percentile [%]						Pacer run in high risk percentile [%]					
Age group	Total SVK	males SVK	females SVK	Total USA	males USA	females USA	Total SVK	males SVK	females SVK	Total USA	males USA	females USA	Total SVK	males SVK	females SVK	Total USA	males USA	females USA
1,2,3,4	**48.4**	56.6	38.6	**71.0**	68.0	75.2	**19.1**	13.5	25.7	**13.2**	13.6	12.7	**32.5**	29.9	35.7	**15.8**	18.4	12.1
1	**48.6**	54.7	42.6	**71.7**	69.4	74.8	**23.4**	9.4	37.0	**12.9**	13.0	12.8	**28.0**	35.8	20.4	**15.4**	17.6	12.4
2	**59.3**	61.6	55.0	**70.6**	67.2	75.5	**11.5**	9.6	15.0	**13.3**	13.7	12.6	**29.2**	28.8	30.0	**16.1**	19.0	11.9
3	**51.4**	55.6	47.1	**70.3**	66.5	75.7	**23.8**	24.1	23.5	**13.7**	14.5	12.5	**24.8**	20.4	29.4	**16.0**	19.0	11.7
4	**44.1**	53.5	33.8				**18.4**	12.7	24.6				**37.5**	33.8	41.5			

The Slovak group achieved better results in comparison to the US group in the field of somatic characteristics. This trend is reflected in both BMI and body fat percentage. HFZ zone for BMI was reached by more than 84% of students (84.0% -85.2% vs. 58.6% -63.4%) in each age group. Accordingly, for the amount of fat on the body HFZ was reached by more than 75% of Slovak students in all sub-groups (75.0% -79.8% vs. 61.3% -65.5%). In both groups we can observe a similar tendency: HFZ for BMI characteristics is achieved by a higher number of girls than boys. Intersexual differences are however more pronounced for American students.

When compared to somatometric characteristics, the American group achieved better performance results in the motor test. The only benchmark test in which Slovak students reached better results was the shoulder stretch, where HFZ was commonly reached by more than 90% of students. The upper body strength push-up test did not show a large gap (74.3% vs. 69.6% achieving HFZ in total). More significant differences can be observed in the abdominal strength test and the endurance curl-up (80.6% vs.66.7% achieving HFZ in total).The most significant difference was found in the sit and reach test. Where American results showed total HFZ achievements nearing 70%, in the Slovak group less than 1% of those tested came near HFZ recommendations. These very poor results in this test for the Slovak group accentuates the fact that none of the girls scored well in this test.

Almost half of the students tested, both Slovak and American, took part in the Pacer test run, which was assessed separately. As with previous tests, US students achieved better results since more than 70% of them reached HFZ. Of the Slovak adolescents, on the contrary, merely less than 50% succeeded in achieving HFZ. An alarming fact from an aerobic endurance point of view is the finding that more than 30% of the tested belong to the category of high risk, a tendency which is getting worse in dependence with age. The high risk zone in the oldest population group was diagnosed

in 37.5% of tested persons; while, as with the preceding age groups, females are at higher risk. The paradox is that females in secondary schools in the US achieve better results than men regardless of age.

In the overall assessment it is not possible to compare the success of an individual given by the number of tests with HFZ achievement. Therefore Table 7 shows comparisons of individuals who did not succeed in any tests from the test battery Fitnessgram and conversely, comparisons of individuals who achieved HFZ in all tests that were completed. While the proportion of failed subjects in both test files appears to be similar, around 1% (1.2% in SVK vs. 0.9 % in the USA didn't achieve HFZ in any test), the group of successful individuals proves a significant difference. Among the Slovak students there were merely 0.6% of individuals (of which none were girls) who met HFZ in all tests. In the US group, however, at least 20% of individuals in each age group succeeded, and girls were always better than boys.

Table 7. HFZ achieving success.

Any test achieve HFZ percentile [%]							All test achieve HFZ percentile [%]					
Age group	Total SVK	males SVK	females SVK	Total USA	males USA	females USA	Total SVK	males SVK	females SVK	Total USA	males USA	females USA
1,2,3,4	**1.2**	0.7	1.7	**0.9**	0.9	0.8	**0.4**	0.9	0.0	**23.4**	21.2	26.6
1	**1.5**	1.2	1.8	**0.8**	0.9	0.7	**0.0**	0.0	0.0	**23.7**	21.5	26.7
2	**1.1**	0.7	1.4	**0.8**	0.9	0.7	**0.7**	1.4	0.0	**23.6**	21.2	27.2
3	**2.0**	1.1	2.7	**1.1**	1.1	1.1	**0.0**	0.0	0.0	**22.5**	20.7	25.4
4	**0.7**	0.0	1.3				**0.7**	1.6	0.0			

Discussion

The study provides a comparison of two population groups that share certain characteristics, and data were obtained and processed with the utmost objectivity. However, it is worth mentioning existing limits to this comparison. The Prešov region is part of the Slovak Republic, an EU member. In an area of 8974 km^2 there is a population of 0.81 mil. The largest city has a population of 0.17 mil. Ethnic composition is relatively homogeneous (97.2% white, 1.4% gypsy), nearly half of the population lives in the three largest settlements (Prešov, 2014).

Texasis the second largest state in the US covering an area of 695,622 square kilometres, home to 25.15 mil. people. There are three cities with a population over 1 mil. in habitants and 29 cities with a population of over 0.1 mil. (TSDC, 2014). The ethnic composition is much more diversified. According to TEA (2014) schools are attended by 51.3% Hispanic, 30% white, 12.7% African, 3.6% Asian and 1.8% multiracial. Moreover, it should be noted that the comparison generalizes data from Texas research which was focused on the entire US population. Such a simplification represents a compromise with respect to the availability of data and particularly the size of data file. It is however obvious, that living and movement habits differ in diverse US locations.

Accordingly, educational systems in the US and Slovakia are not entirely identical. In regard to physical activity it is crucial to note the inclusion of Physical Education in the curriculum. PE lessons are compulsory in primary and secondary schools in Slovakia, while in Texas secondary schools PE is optional. There are also certain differences in the age range of students, since Slovak students generally graduate between the age of 18 and 19. The American educational system includes 12 years of schooling (the last year of high school) until the age of 17-18. The American population group therefore has a final age group of 17-18 years. Nevertheless, for the purposes of comparison it can be assumed hat results of individuals over 18 would be alike and thus normative tables for Fitnessgram include this age group in the category 17+.

The lower number of Pacer run test participants was somewhat of a complication for data processing since the 461 tested Slovaks caused a reduction of the data base by more than a half. Nevertheless this figure still provides a sufficient number of individuals in all subcategories for statistical analysis to be made.

The data collections could be affected to some extent due to test trainings before the testing itself, which is somewhat common in some American institutions. Students in the Slovak Republic were not especially trained prior to testing and individual tests were not trained for in advance. Thus Corbin's recommendation (2010) of first practice be for testing was not fulfilled. Nevertheless, with regard to the structure of PE classes at schools, the readiness of students for testing can be considered to be adequate. This issue will become the subject of one of the future studies which will examine results of repeated measurements of the tests in questions for one and the same test file.

The different number of tests provided in the USA and the Slovak Republic also pose certain limits to data evaluation. While data from Texas often include results of all six

tests for the Fitnessgram test battery, in the Slovak Republic only four or five tests were taken. This was caused by a more intensive survey which also involved other research activities, and this simplification is an acceptable compromise between the data obtained and the research feasibility under the given circumstances. For these objective reasons it was not possible to include a comparison of the percentile of students who achieved HFZ in a specific number of tests, which is common in the data files obtained from TEA, 2014. We concur with Welk, Meredith, Ihmels & Seeger (2010) that boys have higher fitness levels, but, based on the current health-related standards, more girls than boys meet the minimal levels for health defined by HFZ. Data processing and interpretation was further burdened by the fact that TEA does not provide raw data. Therefore comparison figures were adjusted to available sources.

Testing, on the basis of random selection, took place at 14 schools in the Prešov region of the Slovak Republic. At the same time, the selective process, according to the criterion, covered all types of schools, from technical to humanities-oriented. Testing itself did not include any specific motivational methods or activities. No negative student reactions were reported during the tests nor did teachers report negative experiences during the tests or afterwards (Zhu, Welk, Meredith, & Boiarskaia, 2010).

From independent observation of the physical activity of tested students in Slovakia we concluded that the strength endurance and aerobic endurance of both boys and girls groups appear to be comparable, while standards for boys are more demanding. On the contrary, in the Sit and reach lower body flexibility test, girls achieved unambiguously better results, yet according to the norms none of them managed HFZ.

Flexibility tests discovered differences between the results for the lower and upper body, which can be considered a somewhat paradoxical finding. While Slovak students (both boys and girls) achieved significantly better results in the Shoulder stretch test than their US peers, results in the Sit and reach test were substantially unfavourable for the Slovak population group. Less than 1% of students achieved HFZ in this test; none of them was a girl, which is an alarming finding. This result considerably differs from any studies published so far; therefore we verified the data retrospectively to avoid procedural errors. Both data and testing were found to be proper and the conclusion arising from this finding is that lower body flexibility represents the greatest limit for Slovak students.

The issue in question concerning somatometric characteristics is whether in respect to the health risk it is more appropriate to use BMI or body fat percentage (BF%). We believe that the results of BF% measurements by bioelectrical impedance analysis which we had carried out in the Slovak Republic provide rather objective characteristics of the tested person. Here it is necessary to point out that the measurements of body fat percentage in the Slovak Republic was provided solely by bioelectrical impedance analysis, however the method used in the US is not known. Moreover, US data are available for 35,939 students out of 719,441. Despite that fact, it is obvious, particularly from the Slovak group results that setting the body fat percentage as the assessment criterion increases the percentile of individuals who do not achieved HFZ. For the risk zone group, however, the percentage of individuals approaching the higher health risk level has paradoxically declined. It is essential to note that our evaluation was carried out with relation to data from the US, according to the norms for years 2011 – 2013, and that boundary values of BMI given in the tables for years 2013 - 2014 (Cooper Institute, 2014) have been changed.

Interval values implying a health risk for BMI, however, have not moved so radically as to affect the number of students achieving HFZ, in comparison to norms for BF%, which remained unchanged. It can therefore be assumed that the difference between achieving HFZ for BMI and BF% calculated according to standards for 2013 – 2014 will be even greater.

Results of this study focusing on the somatometric characteristics of Slovak students generally correspond with the results of the nation wide survey of physical development of children and youth carried out by the Ministry of Health SR (UVZSR, 2014). These data show that although decade the average body height of boys aged over 16 has not increased in the last and that of girls has even declined, the average weight of both has significantly increased - boys (of 3.4 kg in average) and girls (of 1.2 kg average). This has had a negative impact on BMI values, which in the last decade has increased in the range of 1.01 - 1.27 for boys and 0.35 - 0.87 for girls. Especially alarming is the comparison of the past two decade's trends in the oldest age group of 17-18 years. For boys, the increase in the average weight between years 1991 - 2001 was of 0.6 kg. Whereas the increase in 2001 - 2011 was 3.8 kg on average.

Similarly, an increase of average weight of girls in the first period in question was only 0.15 kg. This average significantly increased to 1.7 kg in the 2001 – 2011 period. These data detect a similar trend observed e.g. in the USA (Institute of Medicine, 2012; Hedley et al., 2004) and may indicate an acceleration of negative results in the coming years.

The connection of trends in somatometric factors and physical fitness with the political system in the Slovak region is to some extent speculative. The political change in 1989 brought certain changes in life, eating, and exercising habits, which may be reflected in the observations.

Comparison of the results of US and Slovak population groups should serve as a source of information about negative

trends in health-related fitness. Above all it should stimulate the utilization and sharing of the preventive activities prepared and/or implemented in each of the population groups. Thus, if there exists a time lag before socio-economic trends pronounced in the North America and Western Europe are transferred to the countries of Central and Eastern Europe, it would be more than appropriate to take advantage of the US experience, either positive or negative, in the field of prevention and motivation for physical activity and to attempt for its application in the Central European region. Indeed, if we generalize the results of our comparative study we will come to certain paradox. While the Slovak population group proves to have better somatometric characteristics, American students achieved better results in most motor tests.

In order to obtain data which would be comparable from a long-term perspective within Europe it is also crucial to create or adopt an appropriate and modern tool for acquiring and analysing data on the somatometric characteristics and physical fitness of the population. Even though these tools have already existed at both European and national levels, they have always failed in the long-term. It is not only national fragmentation which often makes effective comparison of Member States difficult, but repetitive utilizations of these tools for longitudinal and repeated measurements are also somewhat problematic. The norms for these test batteries were set on a one-time basis and there is a missing component that would further work with them, as is the case of the Fitnessgram test battery in the USA. This battery is sheltered by the Cooper Institute, which regularly works to modernize it and attempts to adjust it to modern trends and technologies, as well as to make it approachable to non-professionals. Thanks to these activities, Fitnessgram remains a vibrant and modern tool. The question for professionals across the EU and the European institutions is, which solution is preferable: whether to create an original instrument or to locate an existing system such as Fitnessgram and to implement it in the European context. Both concepts bring benefits and pitfalls because the system should enable not only the evaluation of local results, but also a comparison of those results on a continental and global scale. The obvious fact is that this operation is of utmost importance and requires immediate response.

The experience of our research team implies that the Fitnessgram test battery can be easily applicable in the European environment. However, age normative tables created by the Cooper Institute are limited by the age of 17+. For the needs arising from the school system of European countries, it would be convenient to stratify the norm to age intervals of 17-18 and 18+, since European secondary school students customarily terminate their studies at the age bordering or higher than 18.

Conclusion

In comparison with the US population group the Slovak students achieved better results in somatometric characteristics in which a higher percentage of tested individuals achieved HFZ for both BMI and body fat percentage. On the contrary, American students were better in achieving HFZ in most of physical tests where they achieved better results not only in strength and endurance in push-ups and curl-up tests, but also in aerobic endurance test at Pacer run. Somewhat different results were obtained in tests of flexibility. Slovak students were better in the shoulder stretch test, while the American group succeeded a great deal better in the sit and reach test. The sit and reach test can be considered the greatest weakness of Slovak students, as merely 0.6% of them reached HFZ. Taking the intersexual division into account we have to point out that none of the tested Slovak girls successfully passed this test.

The study, along with other documents (UVZSR, 2014), points out the deteriorating performance of the Slovak population in somatometric characteristics and in the results of motor testing. At the same time, this trend has significantly accelerated in the past decade. To enable better diagnosis and evaluation of the situation, it is desirable to establish an effective tool and methodology at both the national and European levels for data collection and better monitoring of these trends. At the same time it is necessary to increase the pressure on the development of preventive activities and in particular their implementation into the curriculum of the educational system. Without taking these steps a significant increase of hypomobility can be expected in a very shorttime. This prognosis will especially strike younger people and will have a secondary impact on the health and socio-economic spheres.

Competing interests

The authors declare that they have no competing interests.

Abbreviations

BMI: Quatelet index (body mass index)
BH: body height
BW: body weight
PBF: percentage of body fat mass
BFMI: body fat mass index
PFFM : percentage of fat free mass
FFMI: fat free mass index
WHR: waist to hip ratio
WC: waist circumference
VFA: visceral fat area
PM: protein mass

MM: mineral mass ()
K-W ANOVA: Kruskal-Wallis analysis of variance
η^2: effect size - Eta squared
τ: Kendall Tau correlation

Authors' contributions

BV coordinated the group of examiners participating in the measurements. VS contributed to data gaining and coordinated the preparation of the manuscript. JJ conceived and designed the study. PC prepared raw data and performed statistical analysis, helped to draft the manuscript and finalized the manuscript. MZ helped to draft the manuscript and finalized the manuscript. All authors contributed to and approved the final manuscript.

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References

1. Andrade, S., Ochoa-Avilés, A., Lachat, C., Escobar, P., Verstraeten, R., Van Camp, J., ... & Kolsteren, P. (2014). Physical fitness among urban and rural Ecuadorian adolescents and its association with blood lipids: a cross sectional study. *BMC pediatrics*, *14*(1), 106.
2. Cooper Institute. (n.d.). Standards for Healthy Fitness Zone. Retrieved July 21, 2014, from http://www.cooperinstitute.org/pub/file.cfm?item_type=xm_file&id=656
3. Cooper Institute. (n.d.). Standards for Healthy Fitness Zone 10.x. . Retrieved July 21, 2014, from http://www.cooperinstitute.org/pub/file.cfm?item_type=xm_file&id=2576
4. Corbin, C. B. (2010). Texas youth fitness study: a commentary. *Research quarterly for exercise and sport*, *81*(sup3), S75-S78.
5. Ekelund, U., Anderssen, S. A., Froberg, K., Sardinha, L. B., Andersen, L. B., Brage, S. (2007). Independent associations of physical activity and cardiorespiratory fitness with metabolic risk factors in children: the European youth heart study. *Diabetelogia, 50,* 1832-1840.
6. EU Working Group. (2008). *EU Physical Activity Guidelines Recommended Policy Actions in Support of Health-Enhancing Physical Activity*. Brussel: EU Working Group.
7. Ganley, K.J., Paterno, M.V., Miles, C., Stout, J., Brawner, L., & Girolami, G., et al. (2011). Health-Related Fitness in Children and Adolescents. *Pediatric Physical Therapy*, *23*(3), 208-220.
8. González-Carcelén, C. M., López-Sánchez, G. F., Sánchez-García, C., Ibáñez Ortega, E. J., Díaz Suárez, A. (2018). Composición corporal e imagen corporal de estudiantes de Ciencias del Deporte. *Revista Internacional Sportis: Revista Técnico Científica del Deporte Escolar, Educación Física y Psicomotricidad*, *3*(4).
9. Etemadi, A., Golozar, A., Kamangar, F., Freedman, N. D., Shakeri, R., Matthews, C., ... & Dawsey, S. M. (2011). Large body size and sedentary lifestyle during childhood and early adulthood and esophageal squamous cell carcinoma in a high-risk population. *Annals of oncology*, mdr494.
10. Harriss, D.J., & Atkinson, G. (2011). Update - Ethical Standards in Sport and Exercise Science Research. *International Journal of Sports Medicine*, *32*(11), 819-821.
11. Hedley, A. A., Ogden, C. L., Johnson, C. L., Carroll, M. D., Curtin, L. R., & Flegal, K. M. (2004). Prevalence of overweight and obesity among US children, adolescents, and adults, 1999-2002. *Jama*, *291*(23), 2847-2850.
12. Institute of Medicine (US). Committee on Accelerating Progress in Obesity Prevention, & Glickman, D. (2012). *Accelerating progress in obesity prevention: solving the weight of the nation*. Washington, DC:: National Academies Press.
13. Jürimäe, T., & Volbekiene, V. (1998). Eurofit Test Results in Estonian and Lithuanian 11 to 17-Year-Old Children: A Comparative Study. *European Journal of Physical Education*, *3*(2), 178-184.
14. Kaj, M., Németh, J., Tékus, E., & Wilhelm, M. (2013). Physique, body composition and physical fitness of Finish, Hungarian and American adolescents. *Exercise and Quality of Life*, *5*(1), 19-29.
15. Kovář, R., & Měkota, K. (1995). UNIFITTEST (6-60): tests and norms of motor performance and physical fitness in youth and in adult age. (1. vyd., 108 s.) Olomouc: Vydavatelství Univerzity Palackého.
16. López-Sánchez, G. F., López-Sánchez, L., & Díaz-Suárez, A. (2016). Effects of a physical activity program on the general dynamic and segmentary coordination of children with ADHD. *Journal of Sport and Health Research, 8*(2), 115-128.
17. López-Sánchez, G. F., Díaz-Suárez, A., Radzimiński, Ł., & Jastrzębski, Z. (2017). Effects of a 12-week-long program of vigorous-intensity physical activity on the body composition of 10-and 11-year-old children. *Journal of Human Sport & Exercise, 12*(1), 235-244. doi: 10.14198/jhse.2017.121.19
18. López-Sánchez, G. F., Nicolás-López, J., & Díaz-Suárez, A. (2018). Effects of a program through vigorous-intensity physical activity on blood pressure and heart rate of 10-11 year-old school children. *Journal of Sport and Health Research*, *10*(1), 13-24.
19. López-Sánchez, G. F., Borrego-Balsalobre, F. J., Díaz-Suárez, A., & Smith, L. (2018). Effects of a 12-week-long program of vigorous-intensity physical activity on the body composition of 6-and 7-year-old children. *Journal of Human Sport & Exercise, 13(2proc), S445-S453.* Doi: https://doi.org/10.14198/jhse.2018.13.Proc2.28
20. Lovecchio, N., Casolo, F., Invernizzi, P., & Eid, L. (2012). Strength in Young Italian Students: Results from Eurofit Test and Comparison Among European Data. *Polish Journal of Sport and Tourism*, *19*(1), 13-15.
21. Martins, C., Morgan, L. M., Bloom, S. R., & Robertson, M. D. (2007). Effects of exercise on gut peptides, energy intake and appetite. *Journal of Endocrinology*,*193*(2), 251-258. Moravec, R., Kampmiller, T., & Sedláček, J. (1996). *Eurofit. Telesný rozvoj a pohybová výkonnosť školskej populácie na Slovensku: Physique and motor fitness of the Slovak school youth*. Slovenská vedecká spoločnosť pre telesnú výchovu a šport. NCFES. (n.d.). The structure of education in the United States. *The structure of education in the United States*. Retrieved July 24, 2014, from http://nces.ed.gov/programs/digest/d99/fig1.asp
22. Ortega, F. B., Ruiz, J. R., España-Romero, V., Vicente-Rodriguez, G., Martínez-Gómez, D., Manios, Y., ... & Castillo, M. J. (2011). The International Fitness Scale (IFIS): usefulness of self-reported fitness in youth. *International journal of epidemiology*, *40*(3), 701-711.
23. Prešov. (n.d.). Basic information. - *VÚC Prešov*. Retrieved July 20, 2014, from http://www.po-kraj.sk/en/facts/basic-information/ Pugliese, L., Armellini, D., Bonato, M., & La Torre, A. (2013). Physical

fitness and academic performance in high school students. In *Sport sciences for health*(Vol. 9, No. 1 Suppl., pp. S46-S47). Springer.
24. Straker, L., Campbell, A., Mathiassen, S. E., Abbott, R. A., Parry, S., & Davey, P. (2014). Capturing the pattern of physical activity and sedentary behavior: exposure variation analysis of accelerometer data. *Journal of physical activity & health*, *11*(3), 614-625. TEA. (n.d.). Fitness Data. . Retrieved July 25, 2014, from http://www.tea.state.tx.us/FitnessData.html
25. TEA. (n.d.). Enrollment Trends. . Retrieved July 25, 2014, from http://www.tea.state.tx.us/acctres/enroll_index.html
26. Tremblay, M. S., Colley, R. C., Saunders, T. J., Healy, G. N., & Owen, N. (2010). Physiological and health implications of a sedentary lifestyle. *Applied Physiology, Nutrition, and Metabolism*, *35*(6), 725-740.
27. TSDC. (n.d.). Texas Demographic Data User Conference. *Texas State Data Center*. Retrieved July 20, 2014, from http://txsdc.utsa.edu/ Tudor-Locke, C., Craig, C. L., Thyfault, J. P., & Spence, J. C. (2012). A step-defined sedentary lifestyle index:< 5000 steps/day. *Applied physiology, nutrition, and metabolism*, *38*(2), 100-114.
28. UVZSR. (n.d.). Telesný vývoj detí a mládeže v SR. . Retrieved July 24, 2014, from http://www.uvzsr.sk/docs/info/hdm/Antropometria.pdf
29. Varo, J. J., Martínez-González, M. A., de Irala-Estévez, J., Kearney, J., Gibney, M., & Martínez, J. A. (2003). Distribution and determinants of sedentary lifestyles in the European Union. *International Journal of Epidemiology*, *32*(1), 138-146. Welk, G. J., Meredith, M. D., Ihmels, M., & Seeger, C. (2010). Distribution of health-related physical fitness in Texas youth: a demographic and geographic analysis. *Research quarterly for exercise and sport*, *81*(sup3), S6-S15.
30. Wilczewski, A., Sklad, M., Krawczyk, B., Saczuk, J., & Majle, B. (1996). Physical development and fitness of children from urban and rural areas as determined by EUROFIT test battery. *Biology of Sport*, *13*, 113-126.
31. Zhu, W., Welk, G. J., Meredith, M. D., & Boiarskaia, E. A. (2010). A survey of physical education programs and policies in Texas schools. *Research quarterly for exercise and sport*, *81*(sup3), S42-S52.
32. Zinzen, E., Cahoor, D., Borms, W. D., & Van Roy, P. (2013). 23 Eurofit test Battery: a tool for measuring occupational motor fitness. *Sport, Leisure and Ergonomics*, 155.