Revista de Psicología del Deporte 2017 Vol. 26, núm 1 pp.157-166
Journal of Sport Psychology 2017 Vol. 26, núm 1 pp.157-166
ISSN 1132-239X
ISSNe 1988-5636

Universidad De Almería
Universitat Autónoma de Barcelona

Associations between physical activity and health-related physical fitness in 17 years-old girls

Arunas Emeljanovas*, Irena Valantine*, Kristina Zaicenkoviene, Marjeta Misigoj-Durakovic***, Rasa Kreivyte**, and Miguel-Ángel Gómez-Ruano[13]*****

ASSOCIATIONS BETWEEN PHYSICAL ACTIVITY AND HEALTH-RELATED PHYSICAL FITNESS IN 17 YEARS-OLD GIRLS
KEYWORDS: Physical activity; Health-related physical fitness; Speed and agility; Explosive strength; Trunk strength.
ABSTRACT: The aim of the study was to investigate the relationships between physical activity (PA) and health-related physical fitness (HRPF) of 17-year- old girls. The study was performed in 12 randomly selected secondary schools of Lithuania. The sample consisted of 233 17-year-old girls who were classified into three sub-groups according to their level of PA. PA level was assessed using the modified Short Form of IPAQ questionnaire. Body mass and height were measured and body mass index (BMI) was calculated. HRPF was estimated by measuring speed and agility (10x5m shuttle test), explosive strength (standing broad jump test), trunk strength (sit-up test) and flexibility (sit-and-reach test). Body mass and BMI significantly differed among PA groups with the highest values in the Low PA group and the lowest in the High PA group. Girls experiencing higher PA levels scored better on explosive strength test. Flexibility, trunk strength scores, speed, and agility did not significantly differ among PA groups. The relationship between total volume of PA and explosive strength was low. No significant relationships were found between total volume of PA and other HRPF components. In addition, a significant association in explosive strength was identified. The 17-year-old girls experiencing a higher PA level have better explosive strength. However, no statistically significant relationships were found among 17-year-old girls' total volume of PA and other HRPF components − flexibility, trunk strength, speed and agility.

Physical activity (PA) is an essential part of everyday life, especially during growth and the rapid development of children at school age. The recommendations are based on a paramount body of evidence upon benefits of PA: (*a*) it prevents obesity in schoolchildren; (*b*) it has a positive effect on early prevention of various chronic metabolic and cardiovascular diseases (Dencker, Thorsson, Karlsson et al., 2006; Leppänen et al, 2016; Zlatohlávek et al, 2016); (*c*) it increases one's self-esteem; (*d*) it helps in controlling levels of anxiety and stress (Horst, Paw, Twisk, and Mechelen, 2007; Asbrand et al, 2016); (*e*) it levels state of mind (McCormick, Frey, Lee et al., 2008); and last, by no means the least, (*f*) it surely affects level of physical fitness (PF); (de Souza, 2014). PF is an important factor of health (Lohman, Ring, Pfeiffer et al., 2008; Ortega et al., 2008; Arriscado et al, 2014) confirmed the significant correlations between the level of physical fitness and morbidity and mortality rates caused by chronic diseases. It is suggested that PF is an integrated dimension of most, if not all, functions of the human body related to physical activity (Malina, Bouchard, and Bar-Or, 2004; Cadenas-Sánchez, 2016; Booth, Roberts, Laye, 2012). Indeed, the majority of physiological functions are estimated during physical fitness tests. The level of PA and PF in childhood and adolescence has an influence on the health status in adulthood

13 Correspondence: Miguel-Ángel Gómez-Ruano; Faculty of Physical Activity and Sport Sciences, Polytechnic University of Madrid, C/ Martín Fierro s/n; 28040, Madrid, Spain. E-mail: miguelangel.gomez.ruano@upm.es or magor_2@yahoo.es.
* Department of Health, Physical and Social Education, Lithuanian Sports University, Kaunas, Lithuania
** Department of Sport Managment,Economics and Sociology, Lithuanian Sports University, Kaunas, Lithuania
*** Chair of Medicine of Sport and Exercise, Department of Kinesiological Anthropology and Methodology, Faculty of Kinesiology, University of Zagreb, Croatia
**** Faculty of Physical Activity and Sports Sciences. Technical University of Madrid. Spain.

(Matton, Thomis, Wijndaele et al., 2006). However, in the previous research studies often investigated components of PF such as balance, coordination, speed or reaction time are more, directly, related to sport results and achievements rather than to the state of health (Howley, 2001). In this study we researched health-related physical fitness (HRPF) components: muscular fitness (explosive strength and trunk strength), flexibility, speed and agility that are described in the Healthy Lifestyle in Europe by the Nutrition in Adolescence (HELENA) study (Ortega, Artero, Ruiz et al., 2008a).

The level of HRPF of schoolchildren in Lithuania and in other regions of the world is decreasing with the rate of negative tendencies becoming ever greater (Westerstahl, Barnekow-Bergkvist, Hedberg, and Jansson, 2003; Wedderkopp, Froberg, Hansen and Andersen, 2004; Volbekienė and Griciūtė, 2007; Zhou, et al, 2016). The number of overweight children in Europe and USA is increasing (Westerstahl, Barnekow-Bergkvist, Hedberg, and Jansson, 2003; Wedderkopp, Froberg, Hansen, and Andersen, 2004; Basch et al, 2016). Their cardiovascular and muscular capacity is unsatisfactory with a tendency to decrease even further. Volbekienė and Griciūtė (2007) indicated a significant decrease of HRPF level in Lithuanian adolescents over the years 1992−2002, especially in cardiovascular endurance and flexibility (Volbekienė and Griciūtė, 2007).

Few studies have justified the relationship between PA and health, but the findings of research studies into the relationship between PA and HRPF remain unclear. The most important studies so far have been focused on the close relationship between PA and various health components (Hardman, 2001; Oja and Borms, 2004). Therefore, the purpose of the current study was to investigate the relationships between physical activity (PA) and health-related physical fitness (HRPF) of 17-year-old girls.

Method

Participants and procedure

The study was performed during March−April, 2010, in twelve randomly selected secondary schools from five Lithuanian cities with the following restrictions: schools for national minorities and schools situated at the outskirts of the city were excluded from the initial sample. In total, 314 of 17-year-old girls were recruited for this study. All the recruited girls were of good health status with no contraindications for the participation in mandatory school Physical Education classes and any kind of PA. Out of the recruited schoolgirls group, 233 met all the requirements of the research study, meaning their parents or legal guardians gave written informed consent; girls agreed voluntarily to take part in the tests; provided data necessary for calculating the total amount of their PA by filling in the questionnaire; and performed all the given PF tests. The Institutional Review Board Approved the investigation. The participants were free to withdraw the study whenever they consider. The study was carried out in two stages: (1) PA assessment using IPAQ in March, and (2) HRPF testing and anthropometry in April.

Anthropometry measures

Body height (BH) was measured by a stadiometer (Edge WH-1070) with an accuracy of ± 1 cm and body mass (BM) by using an electronic scale (Microlife WS 100 for 150kg) with an accuracy of ± 0.1 kg. Body mass index (BMI) was calculated as BM/BH (kg/m^2). The participants were measured wearing only shorts and a t-shirt, without shoes/ trainer and shocks. In order to measure the body height the participants must keep their heels, buttocks, scapulae and head in contact with the vertical backboard. The arms are placed freely by the sides of the trunk and the palms of their hands facing the legs.

Physical Activity Levels

Physical activity of schoolgirls was measured using the modified Short Form of the International Physical Activity Questionnaire (IPAQ, 2005). The data on intensity (METs), frequency (days/week) and duration (minutes/day) of high, moderate and low (walking) PA lasting for at least 10 minutes at a time was used to calculate the total volume of PA during one week (MET-minutes/week). The participants were divided into three groups (using a k-means cluster analysis) according to the reported and assessed weekly PA levels: the participants with the total volume of PA during one week up or equal to 1,387 MET-minutes/week were included in the Low PA group (N = 78); the Moderate PA group (N = 116) consisted of the participants whose total volume of PA during one week ranged between 1,387 and 3,001 MET-minutes/week; and the participants with the total volume of PA per week being equal to or above 3,001 MET-minutes/week were classified in the High PA group (N = 39).

Health-related Physical Fitness

Health-related physical fitness was estimated by measuring the following components (EUROFIT, 1993): (*a*) Speed and agility by the 10 x 5m shuttle test (*ms*), (*b*) Explosive strength by the standing broad jump test (*cm*), (*c*) Trunk strength by the sit-up test (*N*/30 s), and (*d*) Flexibility by the sit-and-reach test (*cm*).

All of the participants were informed about the aim of the study, content of the questionnaire and process of answering, and methodology of HRPF tests' performance. A specially trained team of measurers performed IPAQ interviews and HRPF tests. All the tests were carried out in the indoor gym (constant conditions) of the participants' school and was scheduled during the regular physical education classes. In addition the tests were conducted according to the procedures described in each testing standard protocol. The visual models were used with simplified instructions by the team of measurers in order to help the participants to understand the test procedure. Also, the tests were carried out during two successive weeks, with the current testing being applied some eight weeks later.

Statistical Analysis

Statistical analysis of the results was performed using computer programs SPSS and MS Excell. Appropriate statistical methods were used to calculate means and standard deviations (± *SD*). One-way analysis of variance (ANOVA) and Tukey's *post hoc* test were used to establish the differences among the groups. Effects sizes (*ES*) were calculated using the Cohen's *f* to show the magnitude of the effects and their interpretation was based on the following criteria: 0.1 = *small*, 0.25 = *moderate*, > 0.4 = strong (Cohen, 1988). The relationships between PA levels and HRPF components were identified using Pearson's correlation analysis. A significance level of 0.05 and 0.01 were used.

Results

Physical activity

The data on intensity (METs), frequency (days/week) and duration (minutes/day) of high, moderate and low (walking) PA are presented in Table 1. All registered PA indexes, except or walking (day/week) since the groups reported the same amount of walking every day, significantly differed among the groups, increasing from the Low to the Moderate and High PA groups, respectively.

Table 1

The data of Intensity, Frequency and Duration of High, Moderate and Low Physical Activity in Particular PA Group of Participants.

PA index	Physical activity group			Average ($\bar{x}$ ± SD)*	*p*	ES
	Low PA (n = 78)	Moderate PA (n = 116)	High PA (n = 39)			
Total volume (MET-minutes/week)	1213.0±49.0*	2342.13±426.52	3517.15±476.40	2160.98±871.30	< .001	3.91
High PA (day/week)	0.78±0.48	1.97±0.73	2.95±0.76	1.74±1.00	< .001	2.19
High PA (min/day)	12.95±7.58	25.09±8.60	33.33±12.48	22.40±11.62	< .001	1.57
Moderate PA(day/week)	2.09±0.54	3.21±0.86	4.31±0.86	3.02±1.08	< .001	1.81
Moderate PA (min/day)	28.91±7.24	38.19±10.64	50.58±12.00	37.12±12.24	< .001	1.24
Walking (day/week)	7.0±0.00	7.0±0.00	7.0±0.00	7.0±0.00	1.00	0.00
Walking (min/day)	37.44±6.12	63.53±12.67	81.79±12.75	57.85±19.27	< .001	2.80

Note. * ($\bar{x}$ ± SD) — arithmetic mean ± standard deviation.

Body Size and BMI in Different PA Groups

While body height did not show any significant difference among PA groups of participants ($F = 1.11$; $p = .33$; $ES = 0.07$), body mass significantly differed among PA groups with the highest values in the Low PA group and the lowest in the High PA group of the investigated girls ($F = 6.08$; $p = 0.003$; $ES = 3.37$). Like body mass, BMI also significantly differed among the PA groups of the investigated girls ($F = 7.55$; $p < .001$; $ES = 2.96$; Figure 1).

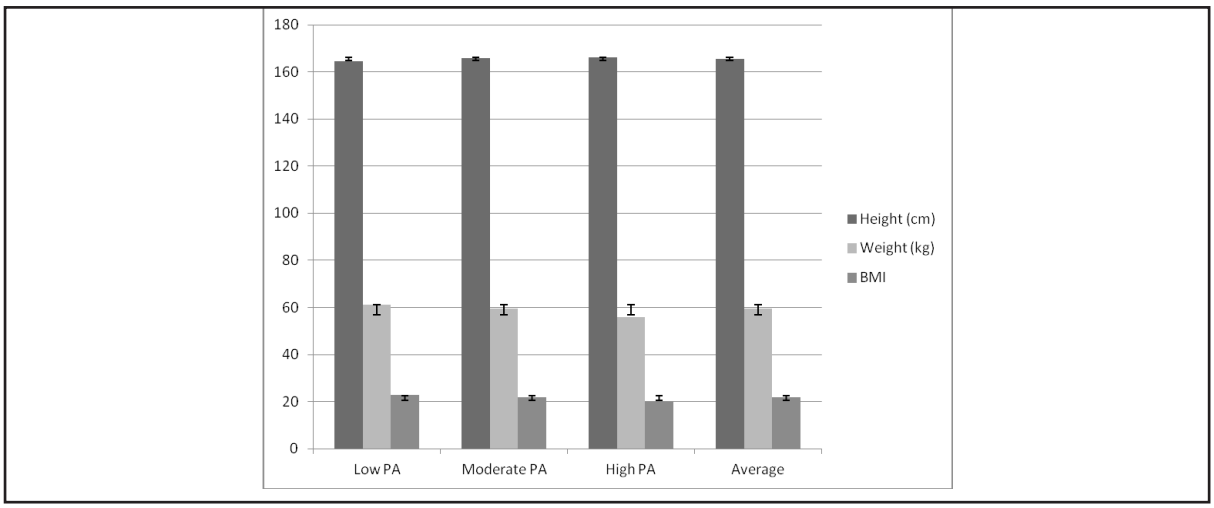

Figure 1. Height, weight and BMI variation between the groups.

Health-related Physical Fitness in Different PA Groups

The results of high PA, moderate PA, and low PA group on the HRPF tests are presented in Figures 2-5. It was found that 17-year-old girls experiencing higher PA weekly levels scored better on explosive strength test. Differences in explosive strength among the three groups were statistically significant ($F = 40.24$; $p < .001$; $ES = 2.78$) (Figure 2). Flexibility and trunk strength scores were higher in High PA group, but no significant difference was found among PA groups ($F = 0.69$; $p = .504$; $ES = 0.51$; and $F = 0.52$; $p = .593$; $ES = 0.45$) (Figure 3; Figure 4). The groups of girls experiencing different PA levels show no significant differences in speed and agility ($F = 0.18$; $p = .839$; $ES = 0.73$) (Figure 5).

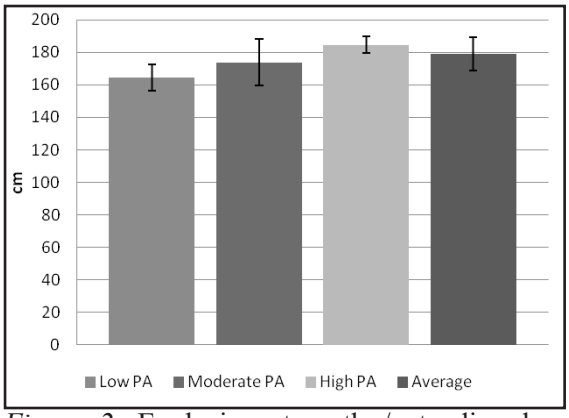

Figure 2. Explosive strength / standing broad jump (cm) (Physical fitness index/test results ($\bar{x}$ ± SD) arithmetic mean and standard deviation.

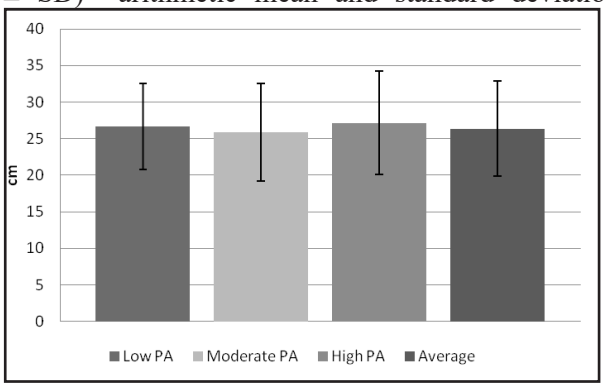

Figure 3. Flexibility/sit and reach (cm) (Physical fitness index/test results ($\bar{x}$ ± SD) arithmetic mean and standard deviation.

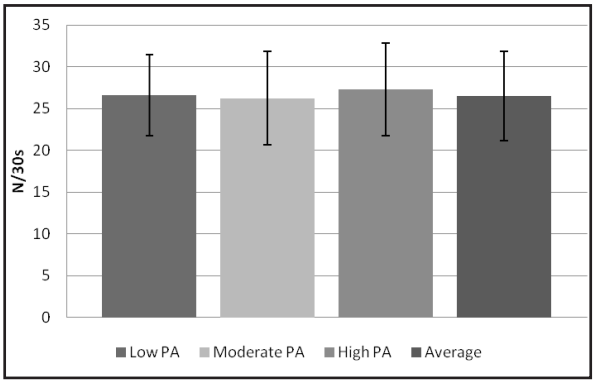

Figure 4. Trunk strength/ sit-ups (N/30s) (Physical fitness index/test results, $\bar{x}$ ± SD) arithmetic mean and standard deviation.

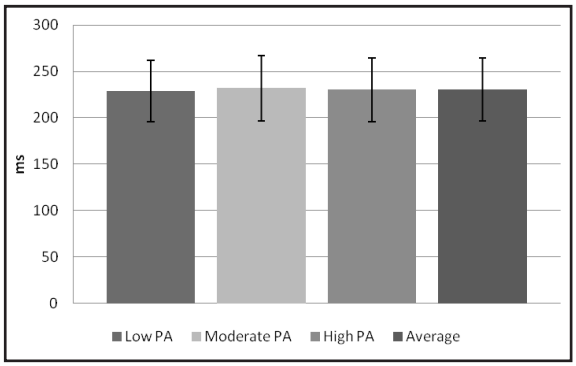

Figure 5. Speed and agility/ shuttle 10x5m (ms) (Physical fitness index/test results, $\bar{x}$ ± *SD*).

Note. ($\bar{x}$ ± *SD*) — arithmetic mean and standard deviation.

Relationships between Total Volume of PA and HRPF

The correlation between total volume of PA and HRPF components are provided in Table 2. Significant but very low and inverted relationship between total volume of PA and body mass (r = .17; p = .012) and BMI (r = -.18; p = .005) was found.

Table 2

Correlations Between Total Volume of PA and HRPF Components.

Indicators of physical fitness	Body size			Explosive strength / *standing broad jump*	Flexibility/ *sit and reach* (cm)	Trunk strength/ *sit-ups* (N/30s)	Speed and agility/ *shuttle 10x5m* (ms)
	Height (cm)	weight (kg)	BMI (kg/ m^2)				
r	.057	- .165*	- .183**	.430**	.028	.034	.006
p	.384	.012	.005	.000	.676	.604	.922

Note. * Correlation is significant at the 0.05 level (2-tailed); ** Correlation is significant at the 0.01 level (2-tailed).

The relationship between total volume of PA and explosive strength was low (r = .430; p < .001). No significant relationships were found between total volume of PA and other HRPF components − flexibility, trunk strength, speed and agility.

Discussion

Health-related physical fitness seems to be a very important indicator of the health of children and adolescents (Ruiz, Ortega, Gutierrez et al., 2006). Therefore PA, especially of moderate and high intensity, should also be regarded a significant indicator of health (Strong, Malina, Blimkie, et al., 2005; Brug et al., 2012). Then, it is highly important to pay attention to both indicators when creating public health policy.

Although physical fitness is hereditary to a great extent (Malina, 2001), daily physical activity and, health status are also related to it (Corbin, Pangrazi, and Franks, 2000). The results of the present study show that the volume and intensity of PA of the Lithuanian 17-year-old girls do not fully comply with the generally accepted recommendations (daily moderate-to-vigorous physical activity for at least 60 minutes) is suggested to be health-enhancing and recommended by children and adolescent experts (Ringuet, and Trost, 2001).

Was suggested that improvement of cardiovascular fitness through regular physical activity would be an important method for reducing the metabolic risks of childhood obesity (Kim et al., 2016). While body mass and BMI significantly differed among the researched groups experiencing different levels of PA, the associations between these anthropometric indicators and PA were very low. It was found that the 17-year-old girls experiencing a higher PA level have better explosive strength. The significant differences among the three groups of the participants experiencing different PA levels in explosive strength were found and this HRPF component was found to be significantly related to PA. The same tendency was previously reported by Volbekienė et al. (2008). Hard physical activity (≥9 METs) holds greater potential for cardiorespiratory fitness compared to physical activity of lower intensities. In these findings there was no relationship between sedentary behaviour and cardiorespiratory fitness and was suggested that, for children, advice should focus on higher intensity physical activity and not sedentary behaviour as a means to maintain or improve cardiorespiratory fitness (Denton et al., 2013). However, some other authors, like Moliner-Urdiales et al. (2010) found no association between PA and strength tests in adolescent girls aged 12.5 to 17.5 years after controlling for age, pubertal status and fat-free mass.

In the current study no significant differences were found among PA groups in the results of flexibility, trunk strength, speed and agility tests. In younger, 14-year-old girls, Hands et al. (2009) found the reverse impact of PA on flexibility showed that girls of a low PA level had better flexibility results. This discrepancy between the findings of the current and the mentioned study can be attributed to the fact that the 17-year-old girls are physically more mature than the 14-year-old girls, thus their flexibility is probably less susceptible to environmental influence like PA levels. However, this presumption needs further investigations. Research results on trunk strength (sit-up test) match Huang and Malina's (2002) findings, which demonstrated over a sample of Taiwan teenage girls that the PA level had no influence on trunk strength results. Huang and Malina (2010) determined that relationship between BMI and fitness varied among tests. BMI significantly and differentially influenced individual fitness tests, but effects varied with age and sex. Higher BMIs were generally associated with lower fitness. Our research did not show that HRPF components – speed and agility depend upon PA level, although some authors have established such dependence yet in 6 to 10-year-old children (Pereira, Seabra, Silva et al., 2011).

The findings of the current study investigating relationships between PA and HRPF components revealed the significant association in explosive strength (Oja, Bull, Fogerlholm, and Martin, 2010; Emeljanovas, Venskaityte, Mišigoj-Durakovic, and Poderys, 2012; Gruodytė, Volbekienė, Rutkauskaitė, and Emeljanovas, 2011). The 17-year-old girls experiencing a higher PA level have better explosive strength. However, no statistically significant relationships were found among 17-year-old girls' total volume of PA and other HRPF components such as flexibility, trunk strength, speed and agility. Summarizing the results of the research done and of the previous research findings, it can be stated that the relationship between PA and HRPF exists. However, questions about the nature and structure of these relations remain scarce. Further longitudinal and experimental studies are needed.

RELACIONES ENTRE LA ACTIVIDAD FÍSICA Y LOS COMPONENTES DE LA SALUD Y LA CONDICIÓN FÍSICA DE MUJERES JÓVENES DE 17 AÑOS.

PALABRAS CLAVE: actividad física; condición física y salud; velocidad y agilidad; fuerza explosiva; fuerza de tronco.

RESUMEN*:* El objetivo del presente estudio consistió en investigar las relaciones entre la actividad física y los componentes de la salud y la condición física de mujeres jóvenes de 17 años. El estudio se realizó en 12 escuelas de enseñanza secundaria de Lituania aleatoriamente seleccionadas. La muestra se compuso de 233 alumnas de 17 años que se clasificaron en tres subgrupos en función de su nivel de actividad física. El nivel de

actividad física se evaluó utilizando el cuestionario breve modificado del IPAQ. Los valores de talla y peso se registraron y se calculó el índice de masa corporal (IMC). Los valores de condición física y salud se estimaron midiendo la velocidad y la agilidad (10x5m test de desplazamiento), la fuerza explosiva (test de salto desde parado), fuerza de tronco (test de abdominales) y la flexibilidad (test de estiramiento desde sentado). Los resultados mostraron que el peso corporal y el IMC fueron significativamente diferentes entre los grupos con valores más elevados en el grupo de menor nivel de actividad física y los valores más elevados en el grupo de mayor nivel de actividad física. Las chicas que mostraron niveles más elevados de actividad física destacaron en el test de fuerza. Los valores de los test de flexibilidad, fuerza de tronco, velocidad y agilidad no diferían entre los grupos de nivel de actividad física. La relación entre el volumen total de actividad física y fuerza explosiva fue reducida. Asimismo, las alumnas del grupo de mayor nivel de actividad física mostraron mayores niveles de fuerza explosiva. Sin embargo, no se encontraron diferencias estadísticamente significativas entre el volumen total de actividad física y otros componentes de la condición física y la salud (flexibilidad, fuerza de tronco, velocidad y agilidad).

ASSOCIAÇÕES ENTRE ATIVIDADE FÍSICA E APTIDÃO FÍSICA RELACIONADA COM A SAÚDE EM RAPARIGAS DE 17 ANOS

PALAVRAS-CHAVE: Atividade física; Aptidão física relacionada com a saúde; Velocidade e agilidade; Força explosiva; Força do tronco.

RESUMO: O objetivo do estudo foi investigar as relações entre a atividade física (AF) e a aptidão física relacionada à saúde (AFRS) em raparigas de 17 anos. O estudo foi realizado em 12 escolas secundárias na Lituânia, selecionadas aleatoriamente. A amostra foi constituída por 233 meninas de 17 anos, que foram classificadas em três subgrupos de acordo com o seu nível de AF. O nível de AF foi avaliado usando a versão curta do questionário IPAQ. A massa corporal e a altura foram medidas, sendo calculado o índice de massa corporal (IMC). A AFRS foi estimada medindo velocidade e agilidade (10x5m shuttle test), força explosiva (standing broad jump test), resistência do tronco (sit-up test) e flexibilidade (sit-and-reach test). A massa corporal e o IMC diferiram significativamente entre os grupos com diferentes níveis de AF verificando-se valores mais altos no grupo com AF mais baixa e valores mais baixos no grupo com mais AF. Raparigas com níveis de AF mais altos obtiveram melhoresresultados no teste de força explosiva. A flexibilidade, a força do tronco, a velocidade e a agilidade não diferiram significativamente entre os grupos com diferentes níveis de AF. A relação entre o volume total de AF e a força explosiva foi baixa. Não foram encontradas relações significativas entre o volume total de AF e outras componentes da AFRS. Além disso, foi identificada uma associação significativa entre o nível de AF e a força explosiva, sendo que as raparigas com maior nível de AF apresentavam maior valor de força explosiva. No entanto, não foram encontradas relações estatisticamente significativas entre o volume total de AF e as outras componentes da AFRS nas raparigas de 17 anos de idade - flexibilidade, força do tronco, velocidade e agilidade.

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