FACTA UNIVERSITATIS
Series: **Physical Education and Sport**, Vol. 19, No 1, 2021, pp. 21 - 31
https://doi.org/10.22190/FUPES200601007H

Research article

MEASURING PHYSICAL ACTIVITY, HEART RATE, ENERGY EXPENDITURE AND PERCEIVED EXERTION OF SCHOOLCHILDREN DURING RECESS ACCORDING TO GENDER AND BODY FAT

UDC 796.012:613.25-053.5

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Abstract. *The article compares the intensity of physical activity during recess in second and third grade schoolchildren according to gender and body fat percentage. Sixty-three second- and third-graders, classified with normal or high fat percentage, evaluated by bioelectric impedance (Inbody 720) participated in the study. During 27 periods of 30 minutes of recess, physical activity intensity and heart rate were evaluated with ActiGraph-GT9X accelerometers, the system for observing fitness instruction time (SOFIT) was used to measure the moderate-to-vigorous physical activity index and the energy expenditure, perceived exertion was determined using the Pictorial Children's Effort Rating Table (PCERT). The analysis of variance (ANOVA) 2x2 showed significant differences between measurements according to the percentage of normal fat compared to high, for moderate physical activity (boys: 0.003, girls: 0.005), caloric expenditure (boys: 0.005, girls: 0.005), METS (boys: 0.003, girls: 0.001), and heart rate (boys: 0.005, girls: 0.005). Due to the increased risk of diseases associated with a sedentary lifestyle, it is important to implement strategies during recess that involve more students with greater adiposity in physical activity.*

Key words: *Recess, Physical Activity, School, Gender, Body Fat.*

Received June 01, 2020 / Accepted July 09, 2021
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INTRODUCTION

Gender equality is one of the sustainable development goals proposed by the United Nations (UN) for the reduction of extreme poverty in various dimensions, (Pérez Betancourt and Betancourt Rodríguez, 2019). Meta-analysis and systematic reviews suggest that boys and girls with sedentary lifestyles are at greater risk of presenting pathologies associated with obesity (Brooke et al., 2014; Sims, Scarborough & Foster, 2015). The World Health Organization (WHO) recommends that children between the ages of 5 to 17 spend at least 60 minutes a day practicing physical activity of moderate-to-vigorous intensity.

Although obesity is a complex and multifactorial problem (López-Mojares, 2015), basic education has been identified as an area of opportunity to promote a healthy and active lifestyle from an early age (Kim, 2012). Due to its broad coverage, it is an ideal means for promoting and developing positive attitudes and healthy habits, which serve as a basis for children and adolescents to adopt an active lifestyle as adults (Langford et al., 2015; Lonsdale et al., 2013), thus improving quality of life and reducing costs in the treatment of chronic noncommunicable diseases (Kim, 2012). The intensity of physical activity is defined as the speed or magnitude of the effort required to make an energy expenditure through the musculoskeletal system (Honas et al., 2008). Of the energy expenditure components, physical activity is the only one that can be voluntarily modified. Within school settings, the time devoted to recess has been identified as an area of opportunity to promote the practice of physical activity (Honas et al., 2008, Story, Nanney & Schwartz, 2009). Ridgers et al. (2011) report that during recess time, students can achieve up to 40% of the recommended daily physical activity. A study performed an analysis of differentiated motor behaviors between boys and girls, in which the existence of inequalities in the use and employment of the available space that harmed girls was observed (Cantó Alcaraz & Ruiz Pérez, 2005).

According to the Secretariat of Public Education (SEP for its acronym in Spanish) during the school year there are 30 minutes of recess per school day, this is established within the guidelines for the organization and operation of schools in basic education, as well as mentioning that students can use it to freely play and eat during the school day, it is also mentioned that recess must be invariably guided and supervised by school personnel, without delegating this obligation to students or external personnel (SEP, 2014).

There are different tools to assess physical activity within the school environment through the use of questionnaires, equipment, or instruments of observation, (McKenzie and van der Mars, 2015). In Mexico, research evaluating the intensity of physical activity at recess in primary schools has been performed, using the System for Observing Fitness Instruction Time (SOFIT) as an instrument (Mckenzie, 2002; Mckenzie et al., 1992). When reviewing the state of the art, moderate-to- vigorous physical activity rates during recess of 40% (43% in boys and 36% in girls) have been reported in a study conducted in 12 schools in Mexico City, with fourth and fifth grade students (Jennings-Aburto et al., 2009). Another antecedent of assessment of physical activity in recess was the research performed on 83 female high school students (ages 13 to 15) which identified lower figures (33.7%) of moderate-to-vigorous physical activity than in primary education (Medina et al., 2015).

The use of accelerometers to measure physical activity has shown greater reliability referred to as the reproducibility of the values of a measurement in repeated tests in school-age children as well as a greater validity in the measurement error (Eukelend et al., 2011; Guinhouya et al., 2013). In Mexico, a research with accelerometers evaluated physical activity of sixth grade students in Ciudad Juárez, Chihuahua during recess, finding that

caloric expenditure did not present a significant difference between boys and girls (Zuñiga-Galaviz et al., 2016). These results are controversial, since studies have identified that during recess, boys perform more moderate- to-vigorous physical activity than girls (Springer et al., 2015). In this sense, evidence from studies evaluating physical activity using accelerometers in school-age children have shown results that correlate the presence of high percentage levels of body fat with a sedentary lifestyle (Laguna et al., 2013; Ferrari et al., 2016). With regard to this subject in our country, a research performed on 114 students, of 10 to 14 years of age, regarding the daily use of time, evaluated by a questionnaire, showed the following association: each hour of moderate-to-vigorous physical activity performed by a child represented a 10% decrease in the risk of obesity (categorized by the body mass index), and on the contrary, for every hour of remaining in front of television screens, a 12% risk of obesity increased (Hernández et al., 2001).

Based on a socio-ecological model, there are multiple environmental factors that can determine the intensity of physical activity of students during recess. Cross-sectional and longitudinal research mention that among these factors are the physical facilities that children have, the design of transport strategies, and the schedule promoted by the school (Skala et al., 2012; Brooke et al., 2014; Hollis et al., 2016). Therefore, the purpose of the present research is to compare the intensity of physical activity during recess of second- and third-graders according to gender and percentage of body fat.

MATERIAL AND METHODS

Participants

This research was approved and registered in the Office of Graduate Studies and Research of the Autonomous University of Baja California (Protocol # UABC-EXB-225) and was performed, under a comparative cross-sectional methodological design, with non-probability sampling for convenience (Thomas, 2001), requesting consent from the administrators, teachers, and parents of the Teniente Andrés Arreola Public Primary School, in the City of Mexicali, Baja California, Mexico, explaining the details, benefits and commitments of the research through a letter of consent, creating assessment schedules, and following the ethical principles of research involving human subjects of the Declaration of Helsinki (Puri et al., 2009).

In total, sixty-three third and fourth grade students with an average age of 7.7 ± 0.5 years (30 boys and 33 girls) participated in the study. The groups of students were classified by gender (male or female) and by percentage of body fat (normal or high), determined by means of bioelectrical impedance analysis using the Inbody 720 equipment (Biospace Inc. Korea ®), which examined the body in a segmental manner as five cylinders (four limbs and a trunk) and separately measured the impedance in these parts. Each child was evaluated barefoot, standing, and with a 30º flexion of the glenohumeral joint; eight electrodes were placed on the feet (located on the metatarsal and calcaneus bones) and on the hands (located on the second to fifth metacarpal bones and the phalanx of the thumb). The induction frequency was evaluated with 5 different intensities (5, 50, 250, 500 and 1000 kHz), in order to directly measure the amount of extracellular and intracellular water, with a fat mass estimation sensitivity of 0.1 kg (0.1%), determining the amount and percentage of body fat of each participant and classifying it as percentage of normal body fat (kg), or as percentage of high body fat (kg).

Procedures

As a cross-sectional study, when comparing fixed variables of two groups according to gender and percentage of body fat, of the total of 63 participants, four groups were classified. 1. Boys with normal body fat (n = 15), 2. Boys with high body fat percentage (n = 15), 3. Girls with normal body fat (n = 16), and 4. Girls with high body fat percentage (n = 17). The participants were evaluated at the school facility during twenty-seven recess periods lasting 30 minutes, included in the school day.

Numerical random variables associated with the intensity of the activity during recess were evaluated with the following equipment and instruments:

a. Intensity of physical activity using ActiGraph GT9X accelerometers (percentage in minutes of sedentary, light, moderate, vigorous physical activity, caloric expenditure in Kcal / 30min, intensity of physical activity in METs.
b. Average heart rate using a Polar Bluetooth Smart Heart Rate Monitor.
c. Moderate-to-vigorous physical activity index and energy expenditure rate evaluated with the system for observing fitness instruction time (SOFIT).
d. Perceived exertion through the pictorial children's effort rating table.

The methodological procedures established to determine each variable are detailed below.

Physical activity with ActiGraph GT9X Link accelerometers measurement

It is a triaxial accelerometer to measure the amount and frequency of human physical activity, (ActiGraph Inc. Pensacola, Florida, USA®) size 3.5 x 3.5 x 1 cm and 14 grams of weight, which when used measured the amount of movement through an accumulation of filtered and measured acceleration for a set period of time, stored in the device after being measured by changes in acceleration 30 times per second. The accelerometer was placed on the right hip of each student with the help of a compatible accessory, adjusting to the elastic of the clothing at the student's waist, which was worn during the 30 minutes of recess.

Heart rate measurement

Simultaneously, the Bluetooth Smart Heart Rate Monitor (Polar Inc, Finland®), compatible with the ActiGraph GT9X Link accelerometer, was utilized to determine heart rate (bpm) during the 30 minutes of recess. The data obtained for the participants was downloaded into ActiLife Software 6.13 Full Version, license 5791-4A8D-01-90FF-8CF6 (ActiGraph Inc. Pensacola, Florida, USA®), to determine the percentage time in minutes of sedentary behavior, light, moderate, vigorous physical activity and the combination of moderate-to-vigorous physical activity MVPA and average heart rate in beats per minute during recess.

Moderate-to-vigorous physical activity index measurement

In order to assess this variable, the System for Observing Fitness and Instruction Time (SOFIT) instrument was utilized (Mckenzie, 2002; Mckenzie et al., 1992). The methodology was performed with two trained observers who randomly selected 4 students (2 men and 2 women) based on the class list using the procedures in the SOFIT manual. At recess time, the participants were observed in a rotating sequence of 12 intervals for 20 seconds each, the observations being repeated throughout the entire recess, following an audio that indicated the recording times of the activity. To perform this activity, a Samsung YP-U6AB

MP3 player was utilized as an instrument. To determine the intensity, codes were utilized to classify activity levels, which allowed estimating the energy expenditure associated with physical activity. This procedure was classified into five codes: 1) Lying down, 2) Sitting, 3) Standing, 4) Walking, and 5) Very active which corresponds to running or an activity with a higher energy expenditure. From the quantification of these codes, the moderate-to-vigorous physical activity index (IAFMV by its Spanish acronym) was established, adding percentage codes 4) Walking and 5) Very active of the total time of the physical education class.

Energy expenditure rate measurement

The energy expenditure rate in kcal / kg / min was calculated from the time values in the codes: 1) Lying down, 2) Sitting, 3) Standing, 4) Walking, and 5) Very active using the rate of energy expenditure formula (kcal / kg / min) = lying fraction x 0.029 kcal / kg / min + sitting fraction x 0.047 kcal / kg / min + standing fraction x 0.051 kcal / kg / min + walking fraction x 0.096 kcal / kg / min + very active fraction x 0.144 kcal/kg/min. The two data collectors were trained following the SOFIT protocol standard, memorizing the operational definitions of the codes and learning the methodological procedures. Reliability measures were taken in 100% of the observations (Kappa statistic 0.93).

Perceived exertion measurements

The perceived exertion was determined using the Pictorial Children's Effort Rating Table (PCERT), which was developed by Yelling et al., (2002), the scale was based on the Borg CR-10 scale (Borg, 1982). Figures were added to the scale in order to adjust it to the cognitive development of the children, making it more appropriate to choose an option with a representative value for the children's age, with scores from 1 to 10 with an average value corresponding to 5. The same student was tested again in the classroom, immediately after recess ended.

Analysis

Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS), version 23.0 for Windows (IBM Corporation, New York, USA). Two-way (2 x 2) mixed analysis of variance (ANOVA) tests were performed. The factors were: sex (men, women), adiposity groups (normal, high). The significance level was established a priori at $p \leq 0.05$ and the 95% confidence interval (95% CI) was considered appropriate.

RESULTS

Tables 1 and 2 show the mean descriptive statistics (M) and standard deviation (± SD) of the variables studied during the thirty minutes of the evaluated 27 recess periods.

Table 1 Descriptive statistics of the variables evaluated in recess of participating boys (n = 30).

Variables	Body Fat % (kg) Normal (n = 15)	Body Fat % (kg) High (n=15)
	M ± SD	M ± SD
Sedentary behavior (%)	3.6 ± 1.6	7.3 ± 1.9
Light physical activity (%)	26.0 ± 5.0	33.9 ± 6.7
Moderate physical activity (%)	61.1 ± 6.1	52.6 ± 5.9
Vigorous physical activity (%)	9.3 ± 2.6	6.2 ± 3.1
Caloric expenditure in Kcal/30min	94.2 ± 14.2	85.47 ± 16.7
Intensity of physical activity in METs.	4.87 ± 0.8	4.30 ± 0.7
Average heart rate (bpm)	119.3 ± 10.5	111.0 ± 9.1
Moderate-to-vigorous physical activity index (%)	48.4 ± 19.6	44.3 ± 17.3
Energy expenditure rate (kcal/kg/min)	0.0710 ± 0.006	0.0653 ± 0.007
Perceived exertion	4.7 ± 1.70	4.6 ± 1.82

Note: Comparative table of the mean, standard deviation (±) for the group of boys (% of normal or high body fat (kg)). Variables measured with ActiGraph GT9X Link accelerometers (ActiGraph Inc. Pensacola, Florida, USA®), bluetooth smart heart rate monitor (Polar Inc, Finland ®), compatible with the accelerometer, classifying percentage (%) in intensity of physical activity as sedentary, light, moderate, vigorous and deriving energy expenditure in METs and Kcal / 30min. The moderate-to-vigorous physical activity index (%) resulted from the percentage sum of the codes 4) walking and 5) very active evaluated by SOFIT; as well as calculating the energy expenditure rate in kcal / kg / min from the time values in all the codes (Mckenzie et al., 1992). The perceived exertion was determined using the Pictorial Children's Effort Rating Table (PCERT) validated by Yelling et al., (2002).

Table 2 Descriptive statistics of the variables evaluated in recess of participating girls (n = 33).

Variables	Body Fat % (kg) Normal (n = 16)	Body Fat % (kg) High (n=17)
	M ± SD	M ± SD
Sedentary behavior (%)	5.6 ± 2.6	8.9 ± 3.8
Light physical activity (%)	29.8 ± 8.2	39.5 ± 10.1
Moderate physical activity (%)	55.9 ± 5.2	45.7 ± 5.7
Vigorous physical activity (%)	8.7 ± 5.5	5.9 ± 3.3
Caloric expenditure in Kcal/30min	87.35 ± 15.47	83.95 ± 16.60
Intensity of physical activity in METs.	4.41 ± 0.5	4.0 ± 0.4
Average heart rate (bpm)	117.9 ± 10.3	109.1 ± 9.7
Moderate-to-vigorous physical activity index (%)	41.5 ± 11.3	39.3 ± 12.3
Energy expenditure rate (kcal/kg/min)	0.0665 ± 0.007	0.0601 ± 0.005
Perceived exertion	4.8 ± 1.90	4.7 ± 1.20

Note: Comparative table of the mean, standard deviation (±) for the group of girls (% of normal or high body fat (kg)). Variables measured with ActiGraph GT9X Link accelerometers (ActiGraph Inc. Pensacola, Florida, USA®), bluetooth smart heart rate monitor (Polar Inc, Finland ®), compatible with the accelerometer, classifying percentage (%) in intensity of physical activity as sedentary, light, moderate, vigorous and deriving energy expenditure in METs and Kcal / 30min. The moderate-to-vigorous physical activity index (%) resulted from the percentage sum of the codes 4) walking and 5) very active evaluated by SOFIT; as well as calculating the energy expenditure rate in kcal / kg / min from the time values in all the codes (Mckenzie et al., 1992). The perceived exertion was determined using the Pictorial Children's Effort Rating Table (PCERT) validated by Yelling et al., (2002).

The mixed 2 × 2 (groups x measurements) analysis of variance (ANOVA) test, establishing the significance level a priori at $p \leq 0.05$ and a confidence interval of 95% (CI 95%). There were no differences between groups according to gender in the studied variables. From figures 1 to 4, the study variables with an appropriate significance level in terms of measurements are observed.

Significant differences were only observed between measurements of the percentage of normal body fat compared to high body fat for the variables of % of moderate physical activity (men: 0.003, women: 0.005) figure 1, caloric expenditure in Kcal/30min (men: 0.005, women: 0.005) figure 2, intensity of physical activity in METs (men: 0.003, women: 0.005) figure 3, heart rate (bpm) (men: 0.005, women: 0.005) figure 4.

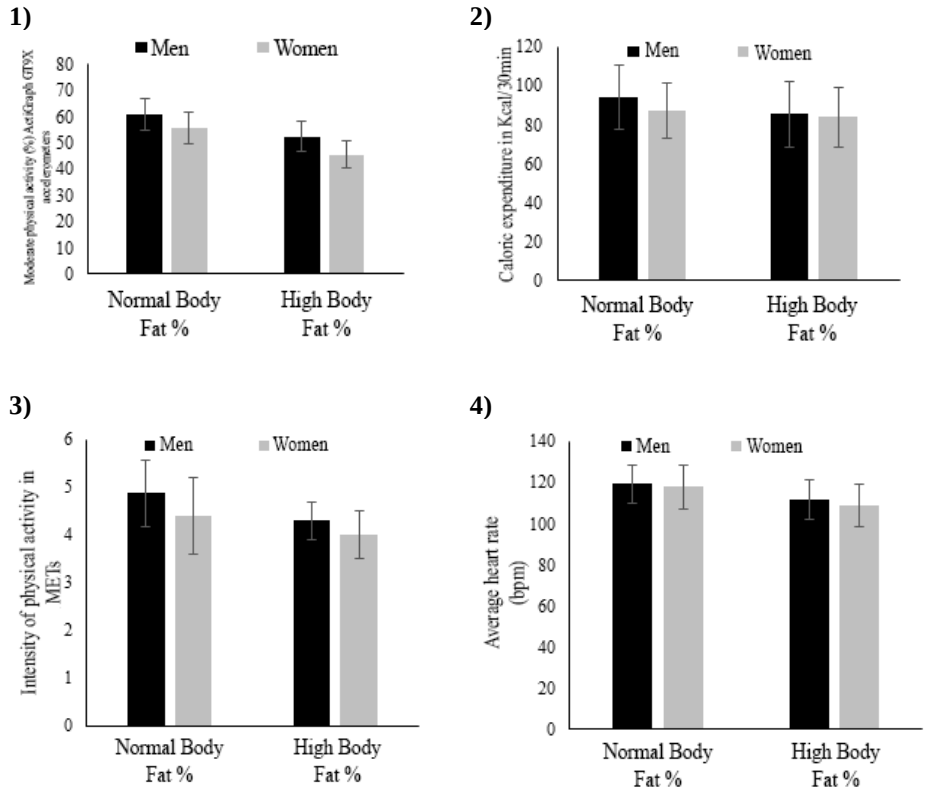

Fig. 1 Statistical inference of the variables evaluated in recess of participating boys (n = 30).

DISCUSSION

When comparing the variances in the fixed variables by gender, no significant differences were observed; however, the main finding of this research was that boys or girls with greater adiposity show less energy expenditure, less heart rate intensity, and less moderate physical activity during recess. The results of the present study reflect an equal physical activity between genders; on the other hand it is understood that there are multiple

environmental factors that can determine the intensity of physical activity, energy expenditure, and perceived exertion of students in recess and during the school day (Hernández-Álvarez et al., 2010; Hollis et al., 2016; Skala et al., 2012). However, when analyzing results of studies with similar methodological procedures performed in Mexico, when using accelerometers, it can be verified that there is a significant difference between boys and girls (Zuñiga-Galaviz et al., 2016). On the other hand, it is important to identify this factor in early educational ages to prevent a sedentary lifestyle, given that the time of moderate-to-vigorous physical activity during recess for Mexican secondary school students is reported to be 33.7% (Medina et al., 2015), which are lower figures than in the present study and those reported by Zuñiga -Galaviz et al. (2016).

When analyzing more of the research performed in Mexico utilizing SOFIT as an evaluation instrument, the data of this research was corroborated, observing indices of moderate-to-vigorous physical activity between 40% to 50% of recess time (Jennings-Aburto et al. 2009; Hall-Lopez et al., 2017).

The World Health Organization recommends practicing physical activity in intensities of metabolic equivalents (METs) with a value of 3 (moderate) and 6 (vigorous) (OMS, 2014). The results of this research report average METS of between 4.0 and 4.87 during recess, which were significantly higher in boys and girls with normal than high body fat. Our results are similar to research that using physical accelerometers to measure physical activity in school-age children and associated the presence of high levels of adiposity with time spent in light activities and sedentary behavior (Laguna et al., 2013; Ferrari et al., 2016). The intensity of physical activity monitored with heart rate was significantly higher regardless of gender in students with normal adiposity compared to those classified with high body fat. The physical effort thresholds during recess time were of 58% in participants with % normal body fat and of 51% in schoolchildren with % high body fat, using the formula established by the American College of Sports Medicine (ACSM) FC max = 206.9– (age in years × 0.67) (ACSM, 2011). Regarding the perceived exertion evaluated with the pictorial children's effort rating table (Yelling et al., 2002), no significant differences were observed between groups and measurements. When comparing the heart rate figures of this study, they are not equivalent to those established by the instrument, which establishes the perceived exertion as above 4, with heart rates that correspond between 120 and 130 (bpm) (ACSM, 2011).

Recess is an ideal leisure space for playing, socializing and promoting moderate-to-vigorous physical activity, and it has been reported that during this phase of the school day children can achieve up to 40% of the recommended daily physical activity (Ridgers et al., 2011, Ceballos-López, Susinos-Rada & García-Lastra, 2019). Schools are spaces of wide coverage, environments where students during the school day develop habits and norms that govern future behavior and lifestyle (Langford et al., 2015, Stuart Rivero, López Gutiérrez & Granado Mejías, 2018). Within our context, the design and operation of educational programs and strategies that involve students with more adiposity in physical activity, could be favorable, given that they have 150 minutes per week, helping to increase energy expenditure for physical activity as recommended by the WHO (López-Fernández et al., 2020; Pérez-Trabazo et al., 2020).

CONCLUSIONS

This research has its limitations; however, it is necessary to perform future studies and take into account factors such as socioeconomic levels, public and private education, type of evaluation, and use probabilistic sampling to have extrapolated results, as well as a series of environmental variables such as sedentary behavior, to determine the affinities for the practice of physical activity by students, physical spaces and school programs, leaving a line of research to develop at recess time.

The results of this study provide important and valid information that contributes to a better understanding between recess time and the intensity of physical activity during the school day, which is useful to professionals who work in teaching in basic education when performing an educational intervention in the recreation area and indirectly contribute to the solution of problems of sedentary behavior, especially in children with more compromised health indicators, such as the one that occurs in 33.2% of school age Mexican students who are categorized as overweight and obese (ENSANUT, MC 2016).

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MERENJE FIZIČKE AKTIVNOSTI, OTKUCAJA SRCA, POTROŠNJE ENERGIJE I NAPORA UČENIKA TOKOM VELIKOG ODMORA PREMA POLU I PROCENTU TELESNE MASTI

Članak upoređuje intenzitet fizičke aktivnosti tokom velikog odmora kod učenika drugog i trećeg razreda, prema polu i procentu telesne masti. U studiji je učestvovalo 63 učenika drugog i trećeg razreda, kojima je normalan ili visok procenat telesne masti određen bioelektričnom impedansom (Inbodi 720). Tokom 27 perioda odmora od 30 minuta, intenzitet fizičke aktivnosti i broj otkucaja srca procenjeni su AcceGraph-GT9Ks akcelerometrima, a sistem za praćenje vremena podučavanja u fitnesu (SOFIT) korišćen je za merenje umerenog do snažnog indeksa fizičke aktivnosti i utroška energije, dok je napor određen pomoću tabele za ocenjivanja napora za decu (PCERT). Analiza varijanse (ANOVA) 2x2 pokazala je značajne razlike između merenja na osnovu normalnog procenta masti u poređenju sa visokim, umerene fizičke aktivnosti (dečaci: 0,003, devojčice: 0,005), utroška kalorija (dečaci: 0,005, devojčice: 0,005), METS (dečaci: 0,003, devojčice: 0,001) i pulsa (dečaci: 0,005, devojčice: 0,005). Zbog povećanog rizika od bolesti povezanih sa sedećim načinom života, važno je tokom odmora primeniti strategije koje uključuju više učenika sa većim procentom telesne masti u fizičke aktivnosti.

Ključne reči: *veliki odmor, fizička aktivnost, škola, pol, telesne masti*.