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Objectively measured physical activity levels in physical education classes and body mass index

Niveles de actividad física medida objetivamente en las clases de educación física y el índice de masa grasa

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Abstract. Objective: The objective of this study was twofold. First, analyze physical activity (PA) levels during physical education (PE) with different durations (45 and 90 minutes) according to student's obesity status. Secondly, we examine the relative contribution of 45 and 90 minutes PE (45PE and 90PE) for the compliance of the daily PA recommendations according to the body mass index (BMI). Methods: Four public schools were analyzed. The sample comprised 472 youngsters (266 girls) aged between 10 and 18 years old. PA was assessed using an Actigraph accelerometer. The participants were categorized as non-overweight (NOW) and overweight/obese (OW) according to the sex-adjusted BMI. Results: The proportion of Moderate and Vigorous Physical Activity (MVPA) was lower than the 50% recommended by guidelines regardless the PE duration. Our data showed that only 26% of NOW and 13% of OW in the 45PE achieved the recommended levels while 17% of NOW and 11% of OW achieved the recommendation in 90PE. Overall, the 90PE had a higher absolute contribution for daily MVPA recommendations compliance than 45PE. Conclusion: During PE classes youngsters spent a reduced amount of time in MVPA, independently of their weight status.
Keyword: Accelerometer, Physical Activity; Physical Education; Obesity; Young.

Resumen. Objetivo: Este estudio tiene un doble objetivo. En primero lugar, analizar los niveles de la actividad física durante la educación física con diferentes duraciones (45 y 90 minutos) de acuerdo con el estado de la obesidad de los alumnos. En segundo lugar, se analiza la contribución relativa de 45 y 90 minutos de la educación física para el cumplimiento de las recomendaciones diarias de actividad física según el índice de masa grasa. Métodos: cuatro escuelas públicas fueran analizadas. La muestra fue de 472 jóvenes (266 chicas) con edades entre los 10 y 18 años. La actividad física fue medida utilizando un acelerómetro Actigraph. Los participantes fueran clasificados como sin sobrepeso y con sobrepeso/obesidad de acuerdo con el índice de masa grasa ajustado al género. Resultados: La proporción de la actividad física moderada y vigorosa fue inferior al 50% recomendado por las recomendaciones independiente de la duración de la clase de educación física. Nuestros datos muestran que solo unos 26% de los niños sin sobrepeso y unos 13% de niñoss con sobrepeso/obesidad llegaron al los niveles recomendados en las clases de 45 min, mientras el 17% de los jóvenes sin sobrepeso y el 11% con sobrepeso/obesidad han logrado las recomendaciones en las clases de 90 min. En general, las clases de 90 min tienen una mayor contribución para cumplimiento de las recomendaciones diarias de actividad física moderada a vigorosa do que las clases de 45 min. Conclusión: Durante las clases de educación física los jóvenes tuvieran una cantidad reducida de tiempo en actividad física moderada a vigorosa, independiente de su estado de peso.
Palabra clave: Acelerómetro, actividad física; educación física; obesidad; jóvenes.

Introduction

Worldwide, physical inactivity causes 6–10% of cases of coronary heart disease, diabetes and breast and colon cancer and 9% of premature mortality. Data from the WHO European Childhood Obesity Surveillance Initiative (COSI) show that, in some countries, more than 40% of 7- and 8-year-old boys are overweight and more than 20% are obese, while in Portugal, a prevalence of 27.3 % to 33.6 % of excess weight/obesity was found (Antunes & Moreira, 2011).

The need to develop and implement strategies for primary prevention of obesity and cardiovascular diseases in early ages is well recognized (Kavey et al., 2003). Indeed, in youngsters, there is enough evidence pointing out that those whom gather larger amounts of moderate to vigorous physical activity (MVPA) demonstrate lower levels of body fatness and clustered metabolic risk (Andersen et al., 2006; Ekelund et al., 2012).

The school may be a primary setting in preventing obesity, intervening on the level of food education and taste for exercise, especially through the curricular PE classes (European Commission/EACEA/Eurydice, 2013; Sallis et al., 2012). Indeed, for many youngsters, school activities are the only opportunity to develop significantly PA levels (Sanchez-Vaznaugh, Sánchez, Rosas, Baek, & Egerter, 2012). Besides, PE is the school curricular unit that promotes PA among students. The guidelines for PE indicate that 50% of PE class time should be spent engaged in MVPA to promote health benefits (United States Department of Health and Human Services, 2000). However, generally, studies found low levels of PA in school PE classes, especially of MVPA (Stuart J. Fairclough & Gareth. Stratton, 2006; Viciana, Martínez-Baena, & Mayorga-Vega, 2015), with students engaging less than 50% of class time in MVPA (Ferreira, Mota, & Duarte, 2014; Kremer, Reichert, & Hallal, 2012). For instance, values around 30 minutes per class, with a daily contribution for the total PA around 20%, were described previously (Slingerland, Borghouts, & Hesselink, 2012; Viciana et al., 2015). In Portugal some studies have been conducted to investigate the intensity of PA performed in PE, but few studies analyze PE classes with different duration and their relation with weight status of children and adolescents. Therefore, the purpose of this study was to examine the association between objectively measured PA during PE with different durations and weight status of Portuguese students as well as to assess the compliance with MVPA recommendation during PE classes. Furthermore, we also analyze the contribution of PE for the accomplishment of the daily MVPA recommendations, taking into account BMI.

Material and Methods

Participants and data collection

This was a cross-sectional study completed in elementary and secondary schools as a part of AFINA-te PROJECT STUDY (Physical Activity and Nutritional Information for Adolescents) a longitudinal study developed in the Porto area, Portugal, designed as an intervention project to promote nutritional knowledge and physical activity. Twenty-five public schools within the Porto area (Portugal) were invited by mail and email to participate in the study. From these, 13 schools declined to participate, 6 did not reply to our invitation and 6 schools agreed to take part in this study.

Respondents included 603 children and adolescents who agreed to participate and had parental written consent to take part in the study. After eliminating individuals who did not attend PE classes, the final sample comprised 472 youngsters (29.8%; 206 boys and 266 girls) aged between 10 and 18 years (mean: 14.43 ± 2.79).

Ethical approval for this study was obtained from the Faculty of Sports ethics committee, the Portuguese Foundation for the Science and Technology and by the regional section of the ministry of Education.

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Anthropometric measures

Body mass and height were evaluated in accordance with standard procedures. Weight was measured to the nearest 0.10 kg, with participants lightly dressed (underwear and t-shirt) using a portable digital scale (Tanita Inner Scan BC 532, Wembley, UK). Height was measured to the nearest 0.01 m in bare or stocking feet with children standing upright against a SECA 217 portable stadiometer.. Body Mass Index (BMI) was calculated from the children's height and weight [weight (Kg)/height^2(m)]. The classification of students' BMI was performed according to the internationally agreed procedures proposed by Cole (2000) considering the children's and adolescent's age and sex, in order to be classified as normal, overweight and obese. Thus, in our study children were categorized as non-obese group (NOW), and overweight/ obese group (OW), according to the age and sex-adapted values (Cole, 2000).

Physical Activity

PA and MVPA during PE classes were measured using the Actigraphs accelerometers, model GTM1 and wGT3X-BT (Pensacola, FL, USA). For the purpose of this study, epoch duration or sampling period was set to 5s. The accelerometer was fixed on the students' waist from the beginning to the end of the PE class. After collecting, the data have been downloaded to the software Actilife where they were processed. Initially, wear/ use time was validated, checking that the device was used/ unused and differentiating time to sleep/physical activity according to the algorithm developed by Choi, Zhouwen, Matthews, and Buchowski (2011). Afterwards the data was filtered according to the schedule of PE classes attended. Finally data were analyzed in accordance with specific cut-off points (in counts per minute) developed by Evenson, Catellier, Gill, Ondrak, and McMurray (2008): sedentary activity - 0 to 100; Light - 101 to 2295; Moderate - 2296 to 4011; Vigorous - more than 4012. To study effects the MVPA was considered from 2296.

Physical Education Classes

The PE classes observed form part of the regular school curriculum defined by the Ministry of Education and Science and are carried out twice a week, by a specialized physical education teacher. To assess «normal» non-intervened PE, no instructions were given regarding the content of those lessons. The content of class was recorded because it is known that it can be determinant for the PA intensity.

We observed students' behavior into the two PE classes that they have during the week, for a total of 119 PE classes, 23 45PE classes and 96 90PE classes, and later the mean percentage of the PA developed was calculated. Each session of 45PE has a duration lasting 20 to 49 minutes (mean: 31.68±6.48) and 90PE has a class duration ranging 42 to 84 minutes (mean: 66.20±7.23). The PE class time record was set when at least 51% of the students were present and the class record was ended-up when at least 51% left the PE setting. This record was used to calculate the duration of each class. The measure of the outcome (mean proportion of class time spent in PA) was obtained by dividing the mean class time spent in PA by the mean total duration of the classes.

Statistical Analysis

A descriptive analysis (means and sd.'s) was calculated to describe young's characteristics. For data analysis, we have checked the normality of variables. The association between PA intensities and BMI were analyzed through a general linear model (GLM) - ANCOVA. Each model was adjusted for gender, age and modality practiced in the class, as these can be considered confounding variables. Initially, we tested the influence of all the variables and when some wasn't significant it was removed from the model. The comparisons between compliance with MVPA in PE classes' recommendations (more than 50% of class time in MVPA) according to the BMI were evaluated with one sample t-test. The comparisons between contributions of PE classes to the compliance of daily PA recommendations in accordance to BMI (% of time that PE classes contribute for the compliance of 60 minutes of MVPA per day) were calculated using an Independent T-Test. A stepwise logistic regression analysis was performed to examine the association between MVPA in 45PE and 90PE classes and weight status.

All data were analyzed by statistical software SPSS® 20.0 for a significance level of 5%.

Table 1.
Descriptive statistics of study participants.

	NOW (n=315)	WO (n=157)	P-value
Age (years)	14.85±2.64	13.57±2.89	**0.000**
Weight (Kg)	52.26±11.70	64.79±15.67	**0.000**
Height (cm)	160.54±12.04	156.64±12.11	**0.001**
BMI (Kg/m^2)	20.01±2.39	26.03±3.34	**0.000**
SB (minutes)			
45 min. Classes	3.22±3.09	4.01±6.33	0.170[b]
90 min. Classes	12.65±11.50	12.69±7.83	0.972[d]
LPA (minutes)			
45 min. Classes	14.81±5.83	16.23±6.03	0.199[b]
90 min. Classes	32.34±10.06	35.72±10.03	**0.001[e]**
MPA (minutes)			
45 min. Classes	6.58±3.96	4.99±2.74	**0.026[c]**
90 min. Classes	11.89±6.82	14.91±6.84	0.066[d]
VPA (minutes)			
45 min. Classes	4.21±3.98	3.31±3.52	0.191
90 min. Classes	8.60±8.37	6.60±5.08	**0.008[e]**
MVPA (minutes)			
45 min. Classes	10.62±5.60	7.94±4.53	**0.011[c]**
90 min. Classes	20.46±11.42	17.09±9.37	**0.001[d]**
Physical Activity Patterns (%)			
SB			
45 min. Classes	10.55±9.09	13.70±9.71	0.085[b]
90 min. Classes	19.00±16.15	19.05±11.48	0.974[d]
LPA			
45 min. Classes	53.89±19.58	58.67±19.63	0.137
90 min. Classes	49.56±15.48	54.25±15.30	**0.002[e]**
MPA			
45 min. Classes	23.81±12.03	18.51±9.41	**0.002[b]**
90 min. Classes	18.25±10.30	16.05±9.98	**0.026[e]**
VPA			
45 min. Classes	14.99±12.09	11.00±10.04	0.083[b]
90 min. Classes	13.18±12.05	10.04±8.05	**0.005[e]**
MVPA			
45 min. Classes	36.73±17.40	38.72±14.52	**0.021[c]**
90 min. Classes	31.37±17.34	26.04±14.02	**0.001[d]**

BMI: body mass index; SB: Sedentary Behavior; LPA: Light Physical Activity; MPA: Moderate Physical Activity; VPA: Vigorous Physical Activity; MVPA: Moderate and Vigorous Physical Activity. Data are expressed as means and standard deviations. Bold text indicates significant P values (p<0.05). [a] Adjusted values for age. [b] Adjusted values for modality practiced in the class. [c] Adjusted values for age and modality practiced in the class. [d]

Results

Table 1 shows descriptive of PA during PE classes by weight status. The prevalence of overweight/obese was 33.3%. OW were heavier, smaller and had a higher BMI than their NOW peers (P<0.05). Data show statistical significant differences between weight status categories in minutes of MVPA in 45PE and 90PE (p<0.05). NOW were significantly more engaged (36.73%) in MVPA during 45PE (10.62 min) than (28.72%) their OW (7.94 min) and the same occurs in 90PE, with NOW engaged in MVPA 31.4% of the total time (20.46 min) and OW 26.04% (17.09 min). Overall, participants did not meet the recommendation for 50% MVPA, either in 45PE or 90PE.

As shown in figure 1 the percentage of NOW that did not meet the recommendations in 45PE was 74%, while for OW was 87%. In 90PE classes 83% of NOW and 89.1% of the OW did not meet the recommendations, respectively. NOW have committed significantly more percentage of time (p<0.05) than OW in moderate PA in 45PE and 90PE (18.25% vs 18.51% and 18.25% vs 16.05%, respectively), vigorous PA in 90PE (13.18% vs 10.04%), MVPA in 45PE (36.73% vs 28.72%) and in 90PE classes (31.37% vs 26.04%). In contrast, OW spent more time than NOW in light PA in 90PE classes (54.25% vs 49.56%, p<0.05).

Table 2 shows that there are differences in the contribution that 45PE and 90PE classes gave for the compliance of daily MVPA recommendations. NOW group had higher contribution than OW (p<0.05). Interesting, 90PE contributes significantly more (p<0.05) for the daily MVPA recommendations compliance than 45PE did either in NOW (34% vs 18%) or OW (29% vs 13%).

Table 2.
Contribution that PE class gives to the compliance of daily MVPA recommendations (60 minutes of MVPA per day) according to BMI.

	NOW	OW	P-value
MVPA (%)			
45 min. Classes	17.70±9.50*	13.23±7.81*	**0.011**[a]
90 min. Classes	34.10±19.41	28.48±15.59	**0.001**[b]

MVPA: Moderate and Vigorous Physical Activity. Data are expressed as means and standard deviations. Bold text indicates significant P values ($p<0.05$).[a] Adjusted values for age and modality practiced in the class.
[b] Adjusted values for gender and modality practiced in the class.*Significant differences between 45 and 90 minutes PE classes in each BMI group.

Table 3.
Logistic regressions showing the association between physical activity guidelines for physical education classes and obesity status.

	OR	(95% CI)	P-value
No meet (=50% MVPA)			
45 min. Classes	**2.5**	**(1.5-5.8)**	**0.04**
90 min. Classes	1.8	(0.9-3.0)	0.09

MVPA: Moderate and Vigorous Physical Activity. Bold text indicates significant P values ($p<0.05$).

Logistic regressions showed that OW were approximately three times more likely to not achieve the PE - MVPA recommendations than their NOW counterparts ($p<0.05$) in 45PE (Table 3). No statistical significant associations were found for 90PE classes.

Discussion

This study examined the association between objectively PA intensity levels during 45PE and 90PE and weight status of Portuguese students. The relevance of our study relies on the fact that little is known about how PA intensity PE with different durations is associated with obesity in youngsters and also the guidelines accomplishment for MVPA taking account weight status.

We found a prevalence of 33% of OW that are similar to those found in previous studies in Portuguese population (Rito, Paixão, Carvalho, & Ramos, 2012). The Portuguese Institute of Sport and Youth has conducted a study aiming analyze the fitness levels of Portuguese population and they found that 1 in 3 young (32.7%) have OW according to WHO classification (Baptista et al., 2011).

Our data suggest that differences in MVPA levels during 45PE and 90PE were associated with weight status being NOW engaged in more intense activities ($p<0.05$) than their OW counterparts [(45PE: 37% vs. 29%, respectively; 90PE: 31% vs. 26%)]. In addition, the percentage of the OW students that met the recommended guidelines in 45PE classes was around 13% and 11% in 90PE classes. These results are worth to discuss because it is expected that PE is a setting that provides high levels of PA and uses tools and strategies that lead them to adopt healthy lifestyles. Several studies have addressed the relationship between PA and obesity in activities and/or settings outside school PE. Moreover, our results also showed that OW were approximately three times more likely not to meet the e»50% MVPA during 45PE classes than their NOW peers. Previous studies focused on relationship between PA carried out during PE and weight status suggested that there was little evidence about the body mass affecting the levels of PA during PE classes, because it is common OW youngsters to commit themselves to track the movements performed by their peers with normal-weight (Stuart J. Fairclough & Gareth Stratton, 2006; Kremer et al., 2012). However, a recent study aiming to compare the objectively measured PA levels across PE, school playtime and extra-curricular sport in secondary school students,found statistical differences between MVPA values reached during PE classes (NOW: 76.9 min; OW: 68.7 min) (Mayorga-Vega & Viciana, 2015), which are, however, much higher than those found in our study.

A reason for the differences in our outcomes may be based on the fact that in short lessons (45PE) teachers tend to make more games, which require a greater children's and adolescents' commitment, that may lead students with OW not to follow their NOW peers. The lack of motivation, or simply not being as efficient as the performances of colleagues, may be associated with less effort in class (Fairclough & Stratton, 2005). In 90PE classes we observed a tendency to OW being the least likely to meet recommendations, but we have not found statistically significant differences between being OW and not meeting the recommendations for PE classes. This can be related to the lower intensity of the class, the use of more analytical exercises and transmission of information time carried out for a longer period of time. Longer lessons may promote longer bouts of management and transition time, both of which compromise learning results (Smith, Monnat, & Lounsbery, 2015), allowing OW students to track their colleagues NOW. Despite not finding statically differences in MVPA performed in PE classes between NOW and OW (37% vs 36%), a study conducted by Stuart J. Fairclough and Gareth Stratton (2006) has reported that in comparison with NOW adolescents, OW might not be provided with optimal psychological experiences during PE classes because their presented values for enjoyment and perceived competence lowers than the NOW (Stuart J. Fairclough & Gareth Stratton, 2006).

A previous study (Cawley, Frisvold, & Meyerhoefer, 2013) conducted with the objective to measure the causal effect of PE time on the weight of elementary schoolchildren found that PE lowers BMI z-score and reduces the probability of obesity among 5th graders, but this effect is mainly among boys. This represents some of the first evidence of a causal effect of PE on youth obesity, and thus offers at least some support for the assumptions behind the Centers for Disease Control and other organizations that recommended the increasing of the amount of time that school children and adolescents spend in PE.

There are convincing evidences that PA takes many benefits to health and intervention programs can help promoting healthy weight in children and adolescents, offering higher intensity levels, especially of MVPA (Mark & Janssen, 2011). Extracurricular programs seems to have even more relevance for OW youth (Aires et al., 2015), once they need to improve their skills, their fitness levels and feel more effective on physical activities could take them to enjoy more the practice. An intervention study conducted by Mark and Janssen (2011) revealed an inverse relation between total, low, moderate and vigorous intensity PA with total body and trunk fat assessed by DEXA. Other study (Sun et al., 2011), observed also a decrease in body fat, trunk fat and waist circumference, related to exercise compliance, but did not significantly decrease body weight and BMI. A meta-analysis conducted by Guerra, Nobre, Silveira, and Taddei (2013) suggested that, regardless of the potential benefits of PA to reduce participant's weight in school environments, the interventions did not have a statistically significant effect. However, it is difficult to generalize from these results because the duration, intensity and type of PA used in the interventions varied greatly.

In Portugal, a longitudinal intervention study has been conducted, focusing in young people with OW. The ACORDA Project is an 8-month multidisciplinary, school-based intervention program, aimed to change behaviors by providing easy access to PA (Aires et al., 2015). The intervention promotes significant results: important cardiometabolic outcomes as fasting glucose, plasmatic total cholesterol and systolic blood pressure have decreased significantly. However, the favorable results for PA did not result in significant decreases in body fat or trunk fat, neither in BMI or waist circumference, which can be explained by the fact that the target group was not exclusively of OW children. Though, this study found that their intervention provided a significant increase in PA levels and reduced cardiovascular risk factors in school youngsters, highlighting the relevance of this type of intervention through promotion of PA and the positive effect on children and adolescents health, especially for OW.

The offer of extracurricular programs that contribute to the ability development, the exploration of PA in a more pleasurable way, without the pressure and competitiveness of more skilled colleagues, could be a great way to motivate OW and to provide them tools that lead to the adoption of more active lifestyles.

The large standard deviation found in our study suggests wide individual variations in MVPA and the importance of considering participants' intra-individual variability. Such variation in activity levels reflects the influence of contextual and pedagogical factors (such as: lesson objectives, content, environment, teaching styles …) (Bevans,

Fitzpatrick, Sanchez, Riley, & Forrest, 2010; McKenzie, Marshall, Sallis, & Conway, 2000). This variability is particularly important bearing in mind that generally low levels of MVPA are being committed in PE classes and so it is important to understand how we can help students to be more active in PE classes and, consequently, throughout their day. Our study shows an association with MVPA carried out in PE classes and weight status, suggesting that being OW is related to a lower activity in class, so it is important that we can reverse that bidirectional relation because it is not just less practice of PA that contributes to the weight increasing in young. Being OW also makes them less active and this creates a cycle of inactivity that it is difficult to fight.

So it is important to create PE programs more committed with health benefits, seeking to contribute more to high MVPA levels, because OW is an unfortunate reality and the sooner we join efforts to fight it more young people we can help to understand the importance that PA can have on their life and their well-being. It is also important to increase teacher's consciousness about the association between time spent in lesson contexts, promotion of PA, and student engagement in MVPA, which is essential for fitness development (Smith et al., 2015).

Some limitations of the study should also be recognized. The study included school youngster's from a metropolitan area only, which makes difficult to generalize the findings. Further, it is not possible to infer causal relationships between PA levels in PE classes and overweight status with such a cross-sectional design. However, this study focuses on the assessment of PA levels using an objective measure, through the use of accelerometers, that enhances our findings.

Conclusion

Our findings suggest that during PE classes youngsters spent a reduced amount of time engaged in MVPA, independently of their weight status. NOW and OW who meet the recommendations do it just above the reference value and those that do not meet the recommendations only reach half the recommended amount. Furthermore, NOW spent significantly more time engaged in MVPA than OW. In contrast, OW spends more time in LPA in 90PE classes than NOW. OW were approximately three times more likely to not meet the > 50% MVPA in 45PE classes than their NOW counterparts.

These findings have important policy implications for physical education curriculum, emphasizing that it is fundamental that health stays at the center of the planning, because such a curriculum engaged in contributing for the increase of the MVPA levels, collaborating for a controlled weight status, could help PE to achieve their purposes, contributing to young people to be more active and healthier.

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