Original Article

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Contribution of physical education classes to daily physical activity levels of adolescents

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Abstract

Introduction: Although practicing physical activity according to recommendations has health benefits, many studies have reported that the level of participation is lower than recommended. *Methods:* In this behavioural epidemiological study, we used a correlational design to determine the contribution made by physical education (PE) classes to daily physical activity in a sample of 694 Spanish adolescents. Physical activity levels were determined using the Four by One-Day Physical Activity Questionnaire. *Results:* 65.1% of adolescents comply with the recommendations on PE school days, compared to 36.6% who do so on the days with no PE class. Moreover, on PE school days, they obtain significantly higher physical activity level scores compared to days with no PE class. *Conclusion:* The study, therefore, shows the fundamental role of PE in increasing daily physical activity levels. Proposals to improve physical activity levels in these adolescents should be put forward, with educational centres being one of the best settings to achieve this goal.

Keywords: adolescents, high school, physical activity, physical education

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INTRODUCTION

Physical activity (PA), understood as "any bodily movement produced by the contraction of skeletal muscle that increases energy expenditure above a basal level" [1, p.29], has four dimensions: modality (type of activity), frequency (number of times per day/week), duration (minutes or hours) and intensity (energy expenditure rate) [2]. According to Strath [2], energy expenditure (EE) associated with each activity is usually expressed as a multiple of the metabolic equivalent (MET). An activity can be considered to be of moderate to vigorous intensity when it involves an EE of at least 4 METs [3].

PA can provide benefits at the physiological, psychological and social levels [4,5]. For PA to be beneficial, it must be practiced according to international guidelines, which recommend that adolescents should engage in 60 minutes/day of moderate to vigorous physical activity (MVPA) [1].

Despite evidence of the benefits of PA and the recommendations in this regard, many studies, such as McMahon et al. [4] in Europe, and Sanz [6] in Spain, have shown that the level of activity of the population in general is low. This is particularly true of adolescents, who are considered a health risk group [7]. The problem will only worsen in the future, since some authors have shown that these levels tend to decrease in later stages of evolution [8], which in return will also influence the quality of life in adulthood [9].

One of the most important settings for disease prevention and health promotion in children and adolescents are schools [10]. Although these centres cannot be considered the sole agents of change, given the existence of other influential environments, such as the family [11], they are one of the main contexts for action. Classroom time per week is divided into at least thirty periods, two of which are compulsory physical education (PE) classes [12].

Several studies have shown the importance of PE classes in enabling adolescents to engage in the recommended daily amount of physical activity. Sánchez-Bano et al. [13] studied a sample of Spanish children aged 10 to 12 years and observed that the average number of steps/day in PE classes was 3318, being higher in boys (3467.3 steps/day) than girls (3107.2 steps / day). This means that boys performed 20.1% of the average11000-16500 steps/day during PE, and girls 28.85%.

In a study in children aged 11 to 12 years, Martínez et al. [14] showed that boys engage in MVPA for more time in PE classes than girls, who tend to engage in lighter physical activity. They also found a relationship between MVPA in PE and during the week.

It is important to determine the PA levels of different population groups and identify the correlates that most influence them [15]. This would, if needed, help formulate proposals for improvement [16] in terms of reversing this situation. From the educational point of view, this is even more important in economically depressed provinces, which have been the focus of very few studies. One such province is Soria, which has the third lowest GDP in Spain and also the smallest population, with 88903 inhabitants in 183 municipalities, 172 of which have less than 1000 inhabitants [17].

The aim of this study was to investigate the contribution of PE classes to improving the PA levels of adolescents in the province of Soria (Spain), specifically: 1) to determine the effect of PE classes in enabling adolescents to meet recommended PA targets, and 2) to analyse the contribution of PE classes to increasing PA levels among adolescents.

METHODS

Participants

The study population consisted of 3224 compulsory secondary education students in the province of Soria (adolescents between 12 and 17 years of age). Of the nineteen schools that offer such studies, nine are located in the provincial capital, Soria. All except two (90%) agreed to participate in the study. Participants were selected using non-probability convenience sampling techniques, based on accessibility criteria. A total of 1236 students were recruited. Each student was given an informed consent form that had to be signed by their parents or legal guardians before they were allowed to take part in the study. Once the results were refined and the exclusion criteria detailed below were applied, the final sample consisted of 694 adolescents. The mean age of the sample was 14.06± 1.27

years. The inclusion criteria were: 1) having responded to the PA questionnaire on all four days, 2) having a PA on those four days that was representative of their usual activity, 3) not having given atypical PA values. Using Epidat 3.1 epidemiological software, an estimation error of 3.3% was found based on the aforementioned population and sample, for a confidence level of 95%, and a standard deviation of 50. The sample consisted of 364 boys (52.4%) and 330 girls (47.6%), with 169 1st year students (24.4%), 179 in the 2nd year (25.8%), 165 in the 3rd year (23.8%) and 181 in the 4th year (26.1%).

Study design

This was a behavioural epidemiological [18] study describing the physical activity levels of adolescents in Soria and is part of the health-related physical activity paradigm [16].

Physical activity measures

The level of PA was determined using the Four by One-Day Physical Activity Questionnaire, initially designed and validated by Cale [3] for British adolescents, and later adapted for Spanish adolescents by Cantera [19] and validated by Soler et al. [20]. This questionnaire has been used in numerous studies, such as Peiró-Velert et al. [21] and Peiró-Velert et al. [22]. The questionnaire is administered on four non-consecutive days or periods and asks subjects about their PA on the previous day, which must be a Saturday, a Sunday, a school day with PE class, and another school day with no PE class. The duration of PE classes is 50 minutes twice a week [12], which means that students receive 100 minutes/week of PE.

Ethical clearance

The research project and protocol were reviewed by the Director and Head of Programs of the Provincial Board of Education of Soria, and approval was obtained to perform it in educational centres in that province. Additionally, the research was approved by the Faculty of Education Ethics in Research Committee in the author´s university.

Statistical Analysis

IBM SPSS v.25 software was used to calculate the statistics. Categorical variables were studied using loglinear analysis following a hierarchical backward elimination method, including chi-square test, z-scores, and odds-ratio as the main effect size indicator. The independent and dependent t-test was used to compare the means of PA levels according to sex and type of day (PE day vs. non-PE day) respectively. Significance was set at $p \leq 0.05$. Cohen's d effect size statistic was added.

RESULTS

A greater compliance (65.1%) with the recommendations (MVPA-G) has been observed on the day students have PE, almost double the compliance when they do not have PE (36.6%). This association is considered significant (table 1) with an effect size (Phi) near 0.3, low-moderate. With regards to the odds-ratio, the results indicate that those who do not take PE have a 3.2 times greater risk of not meeting the PA recommendations than those that do take PE, which is significant considering the confidence interval.

A preliminary frequency analysis for gender differences indicates that the 57.3% of the boys meet the MVPA guidelines, and of these 259 (62.1%) did it in a PE day. Comparing these data with the girls, there are not notable differences: 66.8% of the girls meet the MVPA-G in a PE day. Chi-Square was calculated separately for male and female (table 2), finding a significant association between PE day and MVPA-G compliance in both cases. Odds ratios indicated that the odds of meet the MVPA-G is were 3.21 times higher in a PE day in boys, and 3.43 in girls, so there aren't gender apparent differences.

Table 1. Comparison of compliance with MVPA guidelines: PE day vs. non-PE day, for all participants and for gender.

Gender	Indicators			MVPA guidelines compliance		Total
				No	Yes	
Boys	PE day	NO	Count	206	158	364
			% within PE day	56.6%	43.4%	100.0%
			% within MVPA guidelines compliance	66.2%	37.9%	50.0%
			% of Total	28.3%	21.7%	50.0%
		YES	Count	105	259	364
			% within PE day	28.8%	71.2%	100.0%
			% within MVPA guidelines compliance	33.8%	62.1%	50.0%
			% of Total	14.4%	35.6%	50.0%
	Total		Count	311	417	728
			% within PE day	42.7%	57.3%	100.0%
			% within MVPA guidelines compliance	100.0%	100.0%	100.0%
			% of Total	42.7%	57.3%	100.0%
Girls	PE day	NO	Count	234	96	330
			% within PE day	70.9%	29.1%	100.0%
			% within MVPA guidelines compliance	63.1%	33.2%	50.0%
			% of Total	35.5%	14.5%	50.0%
		YES	Count	137	193	330
			% within PE day	41.5%	58.5%	100.0%
			% within MVPA guidelines compliance	36.9%	66.8%	50.0%
			% of Total	20.8%	29.2%	50.0%
	Total		Count	371	289	660
			% within PE day	56.2%	43.8%	100.0%
			% within MVPA guidelines compliance	100.0%	100.0%	100.0%
			% of Total	56.2%	43.8%	100.0%
Total	PE day	NO	Count	440	254	694
			% within PE day	63.4%	36.6%	100.0%
			% within MVPA guidelines compliance	64.5%	36.0%	50.0%
			% of Total	31.7%	18.3%	50.0%
		YES	Count	242	452	694
			% within PE day	34.9%	65.1%	100.0%
			% within MVPA guidelines compliance	35.5%	64.0%	50.0%
			% of Total	17.4%	32.6%	50.0%
	Total		Count	682	706	1388
			% within PE day	49.1%	50.9%	100.0%
			% within MVPA guidelines compliance	100.0%	100.0%	100.0%
			% of Total	49.1%	50.9%	100.0%

Table 2**.** Statistics and effect sizes for results in table 1.

Gender	Indicators	Value	Asymptotic Significance (2-sided)	Approximate Significance	95% Confidence Interval	
					Lower	Upper
All participants	Pearson Chi-Square	113.01*[a]	0.000			
	Effect size (Phi)	0.28		0.000		
	Odds Ratio for PE day (no/yes)	3.23			2.59	4.03
	N of Valid Cases	1388				
Boys	Pearson Chi-Square	57.26*[b]	0.000			
	Odds Ratio for PE day (no / yes)	3.21			2.36	4.37
	N of Valid Cases	728				
Girls	Pearson Chi-Square	57.91*[c]	0.000			
	Odds Ratio for PE day (no / yes)	3.43			2.48	4.74
	N of Valid Cases	660				

* 0 cells (0.00%) have expected count less than 5: a. The minimum expected count is 341.0; b. The minimum expected count is 155.50; c. The minimum expected count is 144.50.

Table 3. Parameter estimates of the loglinear model.

Effect	Estimate	SE	Z	p	95% Confidence Interval	
					Lower Bound	Upper Bound
Gender*PE day*compliance	-0.008	0.028	-0.286	0.775	-0.064	0.048
Gender*PE day	0.043	0.028	1.500	0.134	-0.013	0.098
Gender*compliance	-0.148	0.028	-5.205	0.000	-0.203	-0.092
PE day*compliance	0.299	0.028	10.545	0.000	0.244	0.355
Gender	0.050	0.028	1.751	0.080	-0.006	0.105
PE day	0.002	0.028	0.073	0.941	-0.054	0.058
Compliance	-0.011	0.028	-0.393	0.694	-0.067	0.044

SE – standard error; Z – z-scores; p - statistical significance

Table 4. Mean daily energy expenditure (METS) of students according to PE.

EE	Gender	PE	N	Mean (SD)	S_x	t	p	d
during PA	Total	Yes	694	38.17 (4.61)	0.18	11.66	0.000	0.44
		No	694	35.88 (4.01)	0.15			
	Boys	Yes	364	39 (5.63)	0.03	7.51	0.000	0.39
		No	364	36.53 (4.75)	0.25			
	Girls	Yes	330	37.26 (2.87)	0.16	10.55	0.000	0.48
		No	330	35.16 (2.81)	0.15			
during MVPA	Total	Yes	694	7.41 (5.57)	0.21	13.89	0.000	0.55
		No	694	4 (5.06)	0.19			
	Boys	Yes	364	8.93 (7.23)	0.38	9.17	0.000	0.48
		No	364	5.08 (5.86)	0.31			
	Girls	Yes	330	5.92 (3.67)	0.20	12.15	0.000	0.67
		No	330	2.8 (3.66)	0.20			

EE - Energy expenditure; PE - physical education; N - number of respondents; SD – standard deviation; S_x - standard error of the mean; t - t-test value; p - statistical significance; d - size of the Cohen effect

In Table 4, which compares the total daily EE according to the performance or not of PE, significant differences were obtained (p = 0.000) in favour of school days with PE, regardless of the sex of the student. The differences were also significantly greater on both days in boys (PE school day: t(551.32) = 5.18, p = 0.000, d = 0.61; non-PE school day: t(598.52) = 4.65, p = 0.000, d = 0.35).

For a deep analysis loglinear model was calculated to study the interactions. Step by step backward elimination statistics indicated that the model wasn´t fit to the highest-order interaction (PE day * MVPA guidelines compliance * Gender), according to the Likelihood Ratio ($\chi 2$ (2) = 2.36, p = 0.30). In the second step, K-way and Higher-Order Effects analysis indicated that there was a significant effect when removing two-way interactions (i.e., the PE day * gender, MVPA-G * gender, PE day * MVPA-G interactions) from the model ($\chi 2$ (4) = 138.2, p = 0.00). Z-score (table 3) tells us specifically that the higher significant effect is the interaction between PE day and MVPA guidelines compliance. Gender variable has also a significant effect when interacting with MVPA-G compliance.

Table 4 contains the variation of total daily EE during MVPA. The differences in EE in favour of PE school days are statistically significant not only in terms of the mean of all participants, but also in terms of sex.

Mean EE during MVPA in PE classes was 3.72 METs (± 5.3), 5.71 METs (± 4.33) on school days, and 5.93 METs (± 4.38) on mean week days. In boys, this EE was 3.74 METs (± 5.54), 6.92 METs (± 5.03) and 7.4 METs (± 4.83), respectively. In girls, this EE was 3.7 METs (± 5.02), 4.37 METs (± 2.84) and 4.31 METs (± 3.12), respectively.

As include in Table 5, on PE school days students engage in MVPA for an average of 92.01 minutes, and on non-PE school days they do so for 45.73 minutes. This difference is statistically significant in terms of the overall sample, and for boys vs. girls (PE school day: t(629.229) = 5.1, p = 0.000, d = 0.38; non-PE school day: t(675.28) = 5.56, p = 0.000, d = 0.42). It was also observed that boys engage in MVPA for longer than girls.

Table 5. Mean daily duration (minutes) of MVPA based on PE.

Gender	PE	N	Mean (SD)	S_x	t	p	d
Total	Yes	694	92.01(58.35)	2.22	18.87	0.000	0.77
	No	694	45.73(51.94)	1.97			
Boys	Yes	364	102.36(67.37)	3.53	12.17	0.000	0.64
	No	364	55.84(56.6)	2.97			
Girls	Yes	330	80.6(43.77)	2.41	15.48	0.000	0.85
	No	330	34.58(43.72)	2.41			

PE - physical education; N - number of respondents; SD – standard deviation; S_x - standard error of the mean; t - t-test value; p - statistical significance; d - size of the Cohen effect

In addition to the information provided in Table 5, it is interesting to note that the average duration of MVPA during PE classes was 44.68 minutes/day (± 14.31), the average duration during the school day 68.73 minutes/day (± 43.43), and the average duration of the total days measured was 69.16 minutes/day (± 46.41). Studying the data by sex showed that the average duration of MVPA in boys was 43.87 minutes/day (± 15.62), 78.79 minutes/day (± 48.41) and 81.36 minutes/day (± 49.53), respectively. In girls, these results were 45.56 minutes/day (± 12.67), 57.64 minutes/day (± 33.95) and 55.69 minutes/day (± 38.51), respectively. From these data it is possible to know that PE accounts for 48.56% of total time engaged in MVPA on a PE school day, 32.5% of total time engaged in MVPA on a school day, and 16.15% of total weekly MVPA time.

DISCUSSION

The results show significant differences between the percentage of young people that meet PA targets on PE school days vs. non-PE school days. The percentage of students that meet PA targets on non-PE school days (namely, less than 50%) is in line with other studies [6, 23, 24]; on PE school days, however, 65.1% of students meet recommended targets.

PE is mandatory in Spanish schools, but only 24 - 35 hours are allocated to these classes per academic year, less than the 102-108 hours in France and Austria [25]. Based on the results obtained, increasing the number of hours allocated to PE would increase the percentage of students meeting PA targets, and the average number of days they do so.

With regard to the second objective, significant differences were found in total daily EE, total daily EE during MVPA, and duration of MVPA, with average scores being higher on PE school days. These differences were also observed according to sex and were greater in boys vs. girls.

The higher results found in boys with respect to girls is in line with the scientific evidence, and could be due to various factors, for example: gender stereotypes and perceived barriers to physical activity. Fernández et al. [26] found that instrumental activities are more related to masculinity and affective-expressive activities to femininity. The main barriers perceived by females is lack of time, pressure of responsibilities, and hours devoted to study [27].

The contribution of PE to the weekly duration of MVPA in Soria students (48.56%) is lower than that found by Viciana et al. [28], who observed that PE contributed 29.9% in boys and 24.1% in girls. Several studies have shown that increasing PE time has positive health results in children and young people [29, 30].

When an increase in teaching hours is not possible, educational centres, should facilitate extracurricular leisure activities [31] or take advantage of recess periods [32].

Our results set an objective evidence that supports the creation of scenarios that encourage adolescents to acquire healthy lifestyles, particularly PA-related habits in the school environments, considering the PE as the keystone. This could be achieved by consolidating relationships among students, families, friends, teachers and social workers in educational centres, mainly in disadvantages provinces.

CONCLUSIONS

Significantly higher levels of compliance with PA recommendations, total daily EE, total daily EE in MVPA and duration of MVPA were observed on PE vs. non-PE school day. These differences were also observed in boys vs. girls. The PA levels achieved by adolescents in PE classes account for almost half of the time engaged in MVPA that day. In addition, the percentage of students who meet recommended PA targets increases by 28.5% on PE school days vs. non-PE days. With respect to the four days on which data were collected, nearly 16% of the time engaged in MVPA occurred during PE classes. Finally, it would be advisable to put forward proposals to improve PA levels in adolescents in the province of Soria, not only in schools, but in their daily lives.

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