Promoting active lifestyles in schools. Effect of school day on daily physical activity levels

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Authors' Contribution: A – Study Design, B – Data Collection, C – Statistical Analysis, D – Manuscript Preparation, E – Funds Collection

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Abstract

Introduction: The effect of school day is a major factor in everyday rhythms during childhood and adolescence. The relevance of Physical Activity (PA) in school-aged children raises the need to: (a) analyse whether Primary School pupils achieve the recommended levels of daily PA; (b) find out the impact of school day and, specifically, Physical Education (PE) classes on levels of PA compared to weekends; and (c) explore the differences according to sex in daily PA at these ages. *Method:* A cross-sectional study was carried out, using a sample of 126 participants (aged 10.2±0.48 years; 51.6% girls, 48.4% boys) from primary schools. Data on the steps taken by pupils during a week were recorded with an ADXK362 three-axis accelerometer integrated into a wristband. Descriptive (means and standard deviation) and inferential analyses (Student's T-Test) were performed, assuming a 95% confidence interval ($p<0.05$). The magnitude of the difference was quantified with power (1-β), α=0.05 (bilateral). *Results:* The average of steps was lower than the minimum recommended, revealing a weekly pattern in which, the most active children were so throughout the week and vice versa. Significant variations were found depending on the days of the week ($r=0.40$, $p<0.001$, $d=0.63$) or whether they had PE classes ($r=0.65$, $p<0.001$, $d=0.79$). School day contributed significantly to greater activity and families were less physically active on weekends ($t=6.62$, $p<0.001$, $d=0.70$). Girls had a lower level of PA than boys, and more difficulty reaching the recommended levels of daily PA ($t=-4.05$, $p<0.001$, $d=0.96$), except on weekends. *Conclusion:* Pupils do not reach the minimum recommended daily steps for their age, with a well-established gender gap in favour of boys. School day (especially when PE is taught) increases their daily PA more than at weekends.

INTRODUCTION

Childhood and adolescence are stages of special interest for the study of daily Physical Activity (PA), both for their intrinsic value (healthy lifestyles at an early stage) and their prospective value (life routines in adulthood). The effect of school day is a major factor in everyday rhythms during these years, despite being a rather controversial aspect. On the one hand, it is reported that students are not sufficiently active during the school day and spend a lot of time indoors, which reduces their PA [1]; on the other hand, it is recognised that students are more active on weekdays than on weekends [2]. Thus, schools can be an invaluable resource for children from families with lower socioeconomic status (SES) to ensure the recommended levels of PA [3].

Both perspectives demand that schools become active lifestyle promoters. For that reason, specific programmes to increase daily steps are developed from the subject of Physical Education (PE) [4, 5], and the effects of recess on PA levels [6] or the contributions of after-school PA programmes to the recommended amount of daily PA [7] are studied. The analysis of weekday role and its interaction with schoolchildren's leisure time has become a central element in research on daily PA at early ages.

The gender influence in PA practice has been widely backed up by the research and spans all stages of life [8]. Childhood and adolescence are not an exception, even though the effects of the school day on both sexes have been nowhere near enough documented [9]. Greater efforts should head for understanding the underpinning of that sex differences, the influence of the school day, after-school times, and family to be able to design strategies to promote the practice of PA, as specific and effective as possible [10].

Walking is one of the most common physical activities in any culture and life stage [11] and the objective recording of PA through the measurement of steps walked has become a widely standard in research [12]. One of the foremost authors in the research field of PA based on the steps recording is Catrine Tudor-Locke, together with her team of collaborators [12, 13, 14]. Only eight years have elapsed between their review to determine some minimum daily steps guidelines for childhood and adolescence [13] and their recent research of revision and reflection on the maturity of this field of study [14], but the revolution in *wearable technologies* has led to a quantum leap in this area of study [15].

Over the past decade, numerous systematic reviews have also been carried out on the factors that influence the participation in PA in school-aged children [16], especially at playtime or recess [3, 11], or its effect on academic behaviour [17], and the use of accelerometers for its measurement [3]. Thus, in addition to the renowned studies by Tudor-Locke and her team, it is possible to highlight others such as that of Da Silva and collaborators [18] have stressed the take-off of the research based on the objective recording of PA, as well as the special interest on childhood and youth. The emergence of empirical studies show that a maturation of the field is taking place, as the effectiveness and reliability of instruments relatively new in their use are beginning to be analysed [19].

Measuring daily steps and increasing the knowledge about them at school has the potential of transferring the scientific research evidence to its more practical-applied dimension. Firstly, there is a possibility to set out public health recommendations that can be incorporated into social policies and programs to improve children's global health; secondly, the scientific evidence reports the impact of daily school-age PA rates on academic performance and other related school behaviours (such as attention or concentration) that affect academic performance and learning skills [17]. Teachers, specially, in Early Childhood and Primary Education, require training, counselling, and support to know how to integrate spontaneous and structured routines of PA with different intensities into the school timetable, so that their pupils experiment a benefit from them, even in adverse weather conditions [20].

Considering the contributions of the previous literature, the present study proposes the following hypotheses:

H_1: Primary school students do not reach the recommended level of daily PA (steps) for their age.

H_2: The most active students are so both at weekdays and weekends, whether there are special stimuli to promote PA or not.

H_3: Factors such as school attendance (school days) and the practice of PA during PE classes make primary school students more active.

H₄: The levels of PA practice are higher in boys than in girls, both overall and in terms of differences between school days and weekends and on days with or without PE classes.

The evidence on the current relevance of this topic raises the need to verify the proposed hypotheses, for which the following objectives are proposed: (a) analysing whether Primary School pupils achieve the recommended levels of daily PA specified by international health agencies and whether the presence of personal patterns affects PA levels; (b) finding out the impact of the school day and specifically the subject of PE on levels of PA compared to weekends; and (c) exploring the existence of significant differences according to sex in the amount of daily PA at these ages.

MATERIAL AND METHOD

A quantitative study was carried out, with a cross-sectional and descriptive design. The use of the daily step-recording taken by the participants as a variable is consistent with the procedure used in previous studies with children in such disparate parts of the world as United States [12], Czech Republic [21], Chile [22], Peru [23], among others. This methodology allows to contrast with the healthy recommended level of daily PA provided by research [14] and make a comparison between the activity performed at weekdays and weekends and between girls and boys.

Participants
A sample of *n* = 126 Primary School students from four schools in the city of A Coruña (Galicia, Spain) and its metropolitan area were recruited for this study. The mean age was 10.2 years (*SD* = 0.48), with 51.6 % girls and 48.4 % boys, from two public (70.6 %) and two state-funded private (29.4 %) schools.

Measures
The level of daily PA performed by students was measured through an ADXK362 three-axis accelerometer integrated into a wristband that recorded their activity for a week. The use of accelerometers has been demonstrated as a reliable and accurate method of recording (objective) PA in this age group [22, 24].

It was taken into account that introducing wristband could have a motivational effect towards PA due to the novelty. During the first few hours of use, it is common that students pay special attention to the device, which may momentarily influence their PA level. To control over this effect, the first day that students wore the wristbands was eliminated from the analysis, as was the day the devices were picked up, as the activity recording was not complete on that day either. Therefore, students' PA in one complete week was registered.

If participants pointed out that their accelerometers were not recording their steps properly and measurement problems were verified, these data were removed from the analysis. Participants were asked to indicate whether they had forgotten to wear the accelerometer for a significant period of time (more than 3 hours) and, if so, that day was not included in the calculation of the activity completed. Daily steps were calculated from the average number of steps walked during the days recorded. In addition to the general weekly average, estimations were made for specific periods: school days, weekends, and days with and without PE classes.

To avoid the seasonal effect on PA levels [25], recordings were made during the same season of the year (Spring 2019). Given that weather conditions also have an important effect on PA levels [26], the days with particularly adverse weather (severe cold or rain) were considered to be noted down and removed from the analysis. However, none of the days had to be deleted for this reason.

Procedures
First, the contact was established with the management team of the participating schools. They were informed of the objectives and procedure of the study. Once their approval was obtained, the families were requested to give permission for their children to participate by means of an informed consent form that the students took home and returned signed (in the case of an affirmative response). After defining the participating group in each educational centre, two researchers went to the schools

to nominally place the accelerometer (activity wristband) on each participant and eight days later they went to pick them up.

Data from the wristbands were manually introduced by the researchers into a data matrix for analysis. Days with an activity of less than 1000 or more than 30.000 steps were identified as outliers and removed from the analysis.

Statistical analysis

Data analysis was carried out with the support of the Statistical Package for Social Sciences SPSS v.21 (IBM Corp., Armonk, NY, USA) to calculate descriptive and inferential statistics, and with G*Power 3.1 to estimate the effect size.

Descriptive analyses were performed to report the daily volume of steps of the whole group, as well as grouped from Monday to Friday, during the weekend, and on days where there was some stimulus especially related to PA, in this case, the PE class. Figure 1 shows, as a reference, the minimum recommended PA values (expressed in steps) for this age group and gender [13].

Inferential analysis was conducted to compare the existence of differences in the amount of PA completed between girls and boys (Student's T-test for two independent samples), between school days and weekend, and between weekdays with and without PE classes (Student's T-test for two related samples in the latter two cases). A 95 % confidence interval ($p < 0.05$) was assumed to consider the significance of the differences. The magnitude of the difference of the two means and the post hoc statistical power of the tests were quantified with G*Power 3.1 with power (1-β), α = 0.05, and two-tailed or bilateral. Considering the conventional Cohen's values for *d*, an effect size was small when *d* = 0.2, medium when *d* = 0.5 and large when *d* = 0.8 or higher. Considering that the study has a sample of *n* = 126, in which a more pronounced deviation occurs, for the calculation of the statistical potential and the effect size in the case of correlations, p_0 = 0.8 was considered for the analysis.

RESULTS

Results indicate that pupils do not reach the recommended number of daily steps for their age. School days are significantly more active for pupils than weekends, and on days when they have PE classes, they also accumulate more steps than on other weekdays. Girls are less physically active than boys in all the variables studied, except for PA during the weekend, where both groups present similar values.

Daily steps. Descriptive analysis.

Figure 1 shows that the average number of daily steps walked by students from the last two years of Primary Education is around 9000. This is far from the recommended amount of healthy PA that the research and the national and international health agencies propose, both for girls and boys.

Once the analysis of the whole group has been finished, the presence of personal patterns in the level of PA was explored; that is, whether the most active and sedentary people are so in all circumstances, or whether this pattern varies depending on the measurement day (weekdays vs. weekend days) or some other reason. Therefore, it was examined the correlation between the number of steps taken on different days of the week, between school days and weekends, as well as between days with and without PE classes. The hypothesis was that a correlation between these variables would indicate a homogeneous pattern of PA, i.e., the existence of a tendency for people to be more or less active in all situations. If there were no correlation at certain days of the week, it would indicate that students are more or less physically active depending on the weekday/weekend days, or stimuli available.

As it can be seen in Table 1, there is a positive correlation between steps walked on different days of the week. Even though, in general, weaker correlations seem to be identified between those performed on school days and those at weekends, a clear pattern of correlation has been found, showing that most active individuals tend to be so through the week and vice versa. This tendency was confirmed by the evidence of moderate correlations between the average number of school days and weekend days (*r* = 0.40, $p < 0.001$, *d* = 0.63) and between the number of steps taken on days with and

without PE classes ($r = 0.65$, $p < 0.001$, $d = 0.79$). Both positive and highly significant correlations, with a large effect size and a sample correlation coefficient inside the interval [0.72-0.86], confirmed the existence of PA profiles (either active or sedentary) that keep their tendency to be active or sedentary in different circumstances throughout the week, by using a sample size ($n = 126$) higher than the required for this analysis ($n = 108$) to ensure a power ($1 – β$) > 0.95; the power of this *N* was 0.95.

Comparative between school days and weekend, and school days with and without PE classes

As noted previously, there seem to be two criteria that have a particular impact on the levels of students' daily PA at this age group: (a) the *day of the week,* in reference to the moment of the week (school days or weekend) and (b) the *existence of specific stimuli* for the practice of PA. The first criterion is more clearly related to unorganised or everyday PA, to daily routines at different days of the week and has higher level of self-management; and the second one is linked to activities organized by an institution and directed by an adult. In this case, it was represented by the PE classes, but it could be applied to other activities, such as after-school activities.

Student's T-test for two related samples was used to examine whether the differences identified in the descriptive analysis were statistically significant (Table 2). The average of steps walked on weekdays and on weekend, as well as the mean number of steps on days with and without PE were compared.
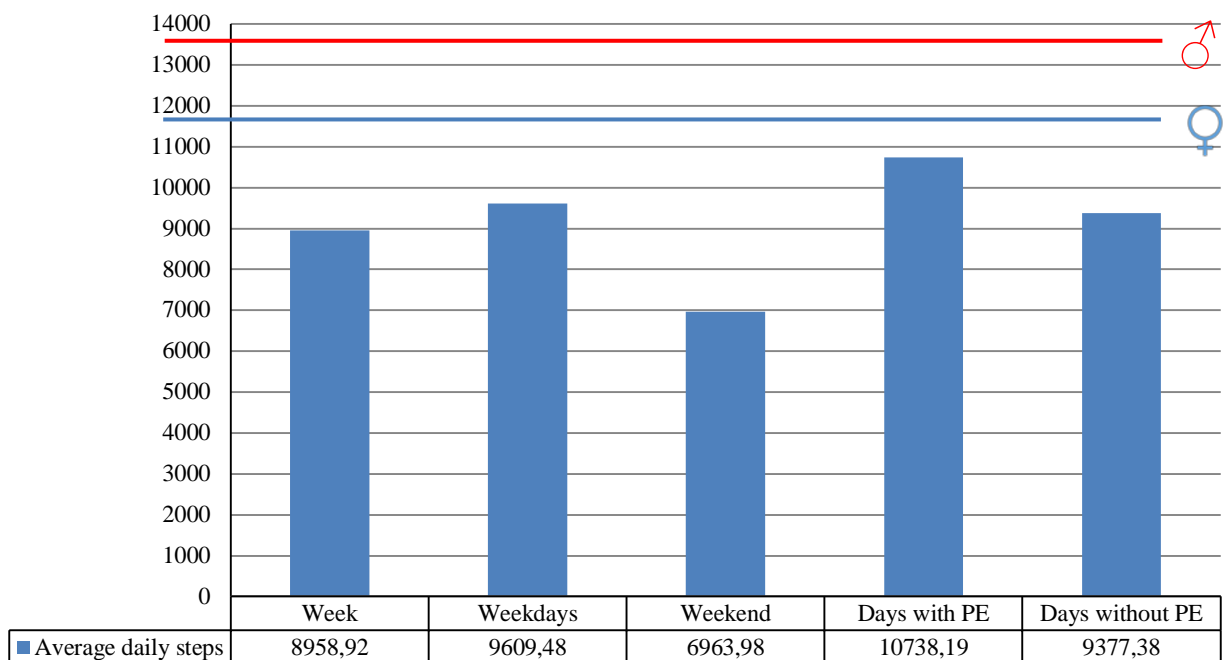

Figure 1. Average daily steps during a week, the weekdays, the weekend, and on days with and without PE classes. Source: own elaboration. The step references for boys (red line) and girls (blue line) at these ages are taken from Tudor-Locke and collaborators [14].

	Week	Weekdays	Weekend	Days with PE	Days without PE
■ Average daily steps	8958,92	9609,48	6963,98	10738,19	9377,38

Table 1. Pearson's (r) correlation between steps taken on different days of the week.

Day	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Monday	-	-	-	-	-	-
Tuesday	0.457***	-	-	-	-	-
Wednesday	0.452***	0.577***	-	-	-	-
Thursday	0.511***	0.607***	0.484***	-	-	-
Friday	0.367***	0.471***	0.476***	0.383***	-	-
Saturday	0.187	0.342**	0.126	0.412***	0.213*	-
Sunday	0.284**	0.420***	0.283**	0.294***	0.267**	0.428***

* $p<0.05$; ** $p<0.01$; *** $p<0.001$. Source: Own elaboration.

Table 2. Mean, standard deviation, Student' T-test (for two related samples), Cohen's d and observed power (P) comparing the children's steps on weekdays and weekend, and days with and without PE classes.

Indicator	Mean ± SD	N	T	d	P
Weekdays	9609.48 ± 3275.58	107	6.62***	0.70	1
Weekend	6963.98 ± 4149.31				
Days without PE	9377.38 ± 3637.58	115	-4.85***	0.37	0.99
Days with PE	10738.19 ± 3644.49				

*** *p*<0.001. Source: Own elaboration. Abbreviature: PE – Physical Education

Table 3. Mean, standard deviation, Student' T-test (for two related samples), Cohen's d and observed power (P) comparing the children's steps on weekdays and weekend, and days with and without PE classes.

Average daily steps	Sex	N	Mean ± SD	T	d	P
Week	G	61	7934.35 ± 2095.08	-4.05***	0.76	0.98
	B	56	10074.95 ± 3404.65			
Weekdays	G	61	8434.21 ± 1927.19	-4.36***	0.82	0.99
	B	56	10898.25 ± 3803.17			
Weekend	G	57	6540.89 ± 3903.95	-1.12	0.22	0.29
	B	50	7446.30 ± 4402.37			
Days without PE	G	61	8047.68 ± 2309.92	-4.43***	0.83	0.99
	B	56	10857.82 ± 4189.39			
Days with PE	G	60	9735.63 ± 2725.95	-3.14**	0.59	0.90
	B	55	11831.90 ± 4193.62			

*** *p*<0.001. Source: Own elaboration. Abbreviature: PE – Physical Education; G – Girl; B – Boy

The results showed highly significant differences in both cases: school days were more physically active (2645.50 more steps) than on weekend, and on the days of PE classes had more steps (1360.81 more steps) than the rest of the weekdays. The effect size (d) of the variable school days-weekend was larger than whether or not PE classes were taken. During weekend, the decrease in PA was very significant and the effect of PE classes was positive, but moderate.

Comparison of PA levels by sex
The presence of sex differences is a constant in studies on levels of PA. To study this effect, we applied Student's T-test for two independent samples (Table 3).
As expected, the differences between the levels of practice of girls and boys were highly significant, in favour of boys' group. The magnitude of the effect (d) of the sex variable was higher with respect to the total average of steps, to the steps taken during the school days and in days without PE classes. On weekends and days with PA classes this effect was much smaller, and even not significant in the case of weekends.

DISCUSSION

To provide a more comprehensive and organized discussion of the results, this section has been structured according to the three initial objectives of the study, and in response to the main hypothesis formulated.

Recommended daily steps and PA levels
One of the issues in PA research based on steps-recording has been to *translate* the daily PA recommendations of the World Health Organization (WHO) for childhood and adolescence [21], as well as estimate the minimum number of steps to consider a person to be active. The well-known systematic review of Tudor-Locke and collaborators [13], which places the WHO recommendation of

60 minutes of daily PA at 1300-15000 steps for school-age boys and 11000-12000 steps for their girl peers, is taken as a reference for discussing the results. In Spain, Parra and his colleagues [22] suggest a generic threshold of 10000 steps for adolescents (11000 for boys and 10500 for girls), although it should be taken into account the significant drop in PA levels in the transition between Primary and Secondary Education [27,28]. In any case, the average of 9000 of the studied group has been below the minimum recommended daily PA for these ages, confirming the first of the proposed hypothesis. Moreover, this reality seems to be the predominant tendency in the context of other developed countries [29], even aggravated by the effect of the COVID-19 pandemic, becoming a major concern [30]. In the following sections, the emphasis is place on discussing which days of the week and which groups stray the furthest from the healthy PA recommendations.

External factors affect PA levels, but the most active people are so at different days of the week, whether there are special stimuli to promote PA (such as school classes) or not. Rowlands and others [31] found out that the individuals' step profile over time is not randomly defined, but that there is a more or less stable pattern that tends to repeat and remain over time, with fluctuations depending on different variables. In their longitudinal study, adults repeated their workday activity pattern for almost the entire year. According to this research and taking into account the differences between adult's workdays and childhood school days, the results of the present study also point to the existence of a weekly pattern that is repeated during the school year. This confirms the second hypothesis proposed, again in correspondence with the first objective of the study. It is concluded that the most active boys and girls are more likely to be so throughout the week and vice versa, with variations (within their personal active or sedentary tendency) depending on different circumstances, such as the days of the week (weekdays vs. weekends) or whether they have PE classes.

Comparison between school days-weekends and days with-without PE classes.

The findings of this study support the third hypothesis proposed, since it was found that school days contribute to the students being more active, and when families have most free time (weekends) children are least physically active. Far from the rhetoric that places weekdays as a limiting factor for childhood movement, other research reports similar results in Primary Education [32], but also in Early Childhood Education [4], as well in the adolescent stage [33].

According to these data, the school day would be a factor that favours daily PA in childhood, in line with the contributions of Hubáčková and colleagues [9] who found that, during classroom hours, a relevant percentage of the pupils participating in their study reached the recommended minimum frequency of steps per hour. Regarding the weekends, authors such as Czajka and collaborators [34] linked the decrease in PA to the parental influence, highlighting the need to improve the healthy literacy in adults about the currently recommended PA guidelines. This parental influence can be established at two levels: the first one, their level of PA and that of their children are connected (fathers and mothers more active have more active sons and daughters, and vice versa); and the second one, at this age, leisure habits of adults directly determine those of children, whose autonomy in decision-making is still limited [35]. Moreover, PA levels drop with age, so the movement needs of parents will always be less than those of their kids. Hence the need to raise awareness among adults that it is important for them to get active themselves, especially on weekends, so that their children do so. Interventions designed to make children more active should include their parents. Future research should explore the mechanism by which families influence their kids and other attributes and styles of parents as possible moderators of their descendants [36].

With respect to the subject of PE, data indicate that it positively affects to the daily number of steps, although its influence is moderate. This direct effect on the number of daily steps, which increase the possibilities of these children achieving the minimum recommended daily PA parameters has been documented in other contexts [37]. However, besides the direct increase of PA, one of the priority objectives of this subject is to encourage students to be more active out of classes. This is a complex and multidimensional process, where the indirect influence of PA subject is relevant. Several studies report that a higher perception of usefulness, enjoyment, and motivation [38,39] or perceived competence [10] in PE classes have positive effect on student's daily PA levels.

Gender comparison of PA performed

The gender disparity in the practice of PA whereby women are less active than men, also during childhood and adolescence is a long-standing and consolidated finding in scientific literature. Being female is one of the most reliable predictors of low levels of PA [16, 13], but also, the decrease in activity levels that occurs with age is much more noticeable in girls than in boys [1, 40]. The results of this study are consistent with this tendency, since in almost all circumstances studied the PA levels of girls were significantly lower than those of boys. Regarding the number of daily steps, data were similar by sex, although slightly higher than those found by Al-Kutbe and his team [41] in an age-matched group, but in a different territorial context. In the present research, the average of steps taken by girls is close to 8000 steps per day, compared to the 6000-7000 found in the aforementioned study.

This leads us to point out that the third hypothesis of this study has been confirmed, since it was concluded that girls have a lower level of activity and more difficulties to reach the minimum recommended level of daily PA than boys. However, only a partial confirmation can be noted given that, contrary to expectations, weekends were the only circumstance in which no differences were identified between the two groups. Therefore, although PA levels continue to be higher in boys at weekends, is comparable between the sexes. This phenomenon has been described in other contexts: Frago [6] reported that gender differences in the practice of PA are reduced during the weekends in Primary School children. In this sense, many of the factors that trigger this inequality are potentially modifiable, suggesting that the gap between boys and girls can be reduced. In this sense, strategies aimed at increasing PA levels at early ages should be multidimensional and will likely need to be different for boys and girls [10].

CONCLUSIONS

Based on the results obtained, three main conclusions can be drawn. The first one is that pupils of Primary Education do not reach the daily steps recommended for their age, neither during the week nor at weekends. The average number of steps achieved in the children studied is around 9000, far from the 12000 and 14000 steps recommended for girls and boys at this age. In the light of these results, it became necessary to investigate what personal (intrinsic) variables are determinant for a person to be more or less active, what makes people have a greater or lesser need for PA in their daily lives and, in the case of children, what strategies can be implemented in school routines to increase daily PA levels.

The second conclusion was that there are homogeneous patterns of daily physical activity in the boys and girls studied: the most active and sedentary are so in all circumstances. Therefore, strategies aimed at improving student health through the subject of PE should not be focused exclusively on increasing the number of hours per week (direct effect) – even though it is obviously necessary –, but rather at a methodological change that boosts students' affinity of the subject and for the motor practice. This would have a multiplying effect on PA outside school hours (indirect effect).

Finally, it was concluded that there are highly significant differences in the number of steps per week concerning the day of the week, specific stimuli for the practice of PA and gender. The number of steps achieved was higher on weekdays, on days with PE and for boys. This result provides information on the physical practice habits of schoolchildren in two ways. On the one hand, it reinforces the idea already expressed in this paper that, during the weekends, the children's autonomy in decision-making about their leisure time is very reduced, and the activities carried out on Saturdays and Sundays are very much conditioned by adults' decisions. Thus, the less active habits of parents would lead to a significant decrease in children's PA practice and would equalize boys and girls who, not having many possibilities of deciding on their leisure time, see their activity conditioned by the preferences of their parents. On the other hand, the fight against gender inequality in the school context is ineffective regarding the motor practice, since on school days in general and on days with and without PE classes in particular, the differences in motor practice between boys and girls are very significant.

STRENGTHS, LIMITATIONS AND FUTURE RESEARCH

Some strengths and limitations in this research should be noted and taken into consideration for future studies. One of the most noteworthy advantages has been the use of accelerometers to obtain objective data on daily PA of the sample 24 hours a day during a whole week -including weekends -, as opposed to a collection limited to school days with and without PE classes. This provides an interesting insight into the life routines of the population studied and an approach to the knowledge about the variables that may be influencing the poor compliance of the recommended levels of activity at these ages. Among the weak points of the study, it should be highlighted the sample size. A larger sample size (more participants and different age ranges) would allow more consistent conclusions to drawn for the data analysis, especially in relation with multivariable tests. Future research could be complete with higher samples from other public and state-funded private schools, as well as include other relevant agents, such as teacher or families. In this sense, the study could be completed with qualitative measures (discussion groups with teachers, families, and students and/or in-depth interviews) that would enable us to understand social and/or cultural variables that may be influencing the rhythms of children's lives. Finally, in spite of the have taken into account the sex as a relevant variable that modifies pupils' daily PA levels, it would be interesting to introduce and analyze some more variables directly linked with the gender roles at schools (e.g. the PA that girls and boys perform during their school recess, the relation between sex-age and daily PA) and also other variables related to personal factors (e.g. weight, PA interests, family socioeconomic status, distance from home to school…) or school factors (e.g. the importance give to PA levels, the non-academic activities performed in relation to health promotion…). These variables, among others, could make a deeper exploration and explanation of the factors that could be associated with achieving the recommended daily PA in order to conduct programs oriented to promote an active lifestyle in children.

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