

Effectiveness of a physically active learning program on indicators of physical activity, well-being and academic performance in students

Efectividad de un programa de aprendizaje físicamente activo sobre indicadores de actividad física, bienestar y rendimiento académico en escolares

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Abstract

The aim was to analyse the effects of a programme made of physically active lessons on primary education students' level of school physical activity, physical fitness, school life satisfaction and academic performance. A quasi-experimental methodology was applied and 50 fifth-year primary education students ($M_{age} = 10.62$; $SD = 0.57$) participated. The experimental group ($n = 25$) enrolled in a physically active learning programme within the bilingual Science subject for eight weeks. One physically active lesson was included per week, in addition to the two Physical Education sessions. The results revealed that the physically active learning programme generated a significant increase in students' physical activity during school time ($p < .05$), several physical fitness variables, the student-teacher relationship, the interest in the subject and perceived health. These findings evidenced the importance of including physically active lessons during school hours, in order to improve the low physical activity levels currently shown by primary school students.

Keywords: sedentary lifestyle, physical activity, integrated learning, academic performance, health.

Resumen

El objetivo fue analizar el efecto de un programa de lecciones físicamente activas sobre el nivel de actividad física escolar, condición física, satisfacción del alumnado con su vida escolar y resultados académicos de los alumnos de educación primaria. Se desarrolló una metodología cuasi-experimental en el que participaron 50 alumnos de quinto curso de educación primaria ($M_{edad} = 10,62$; $DT = 0,57$). El grupo experimental ($n = 25$) participó en un programa de aprendizaje físicamente activo en la asignatura de ciencias naturales bilingüe durante ocho semanas. Se incluyó una lección físicamente activa semanal, sumada a las dos sesiones de educación física. Los resultados demostraron que el programa de aprendizaje físicamente activo provocó un incremento significativo de la actividad física en el periodo escolar ($p < .05$), de ciertos valores de condición física, en la relación alumno-profesor, el interés por la asignatura y sobre la percepción de su estado de salud. Estos resultados reflejan la importancia de incluir clases físicamente activas durante la jornada escolar, que mejoren los bajos niveles de actividad física que presenta el alumnado de Educación Primaria en la actualidad.

Palabras clave: sedentarismo, actividad física, aprendizaje integrado, rendimiento académico, salud.

Introduction

The definition of lifestyle or daily habits comprises a number of everyday factors including but not limited to sleeping hours and quality, eating, and amount and type of physical activity (PA; Mozillo et al., 2017). Current society's lifestyle has been widely criticised (Beard et al., 2015; Gruzieva et al., 2019), as it has been proved to be related to the risk of developing certain diseases, as well as to their prevention (Brassington et al., 2019; Porras-Segovia et al., 2019). Stress (Lyzwinski, Caffery, Bambling, & Edirippulige, 2019), high-sugar hypercaloric diet (Javanmardi et al., 2019), physical inactivity and sedentary lifestyle (Lönnberg, Ekblom-Bak, & Damberg, 2019; Ramírez-Velez et al., 2019) and the few and low-quality sleeping hours (Onambele-Pearson et al., 2019), worsened by the excessive use of new technologies (LeBourgeois et al., 2017), are the guidelines that define the lifestyle of a high percentage of the population nowadays.

Relevant national and international studies revealed that serious public health issues like obesity, hypertension and diabetes are behind this sedentary behaviour (Young et al., 2016). At the national level, the results of PASOS study (Gasol Foundation, 2019) have been recently published, including 3,803 Spanish children and adolescents. It was concluded that 34.9% of children and adolescents presented overweight/obesity. According to the results of the study by Ahrens et al. (2014), Spain is the third European country with the highest obesity prevalence in children. Among the obesity-related factors, we can outline those related to eating habits and lack of PA, not having breakfast on a daily basis, or having a television, a computer or video games in their bedroom.

The current treatment for overweight during childhood is based on lifestyle modifications. The key points of obesity treatment should be healthy eating and PA (Sallis & Glanz, 2009). Regular PA and a physically active lifestyle were associated with lower cardiovascular risk factors (Andersen et al., 2011) and better mental health in children (Biddle & Asare, 2011). Considering the number of hours a child spends at school every day, this is a time period in which healthy lifestyles can be taught and developed. Nevertheless, the current standard classroom is inherently sedentary, and the mandatory lessons largely contribute to children spending seven to eight hours of sedentary time per day (Esliger & Hall, 2009; Mantjes et al., 2012). Despite the increasing demands for teaching time and school spaces, no significant advances have been made to increase PA levels in children (Weiler et al., 2013). Thus, school environments provide a unique opportunity to ensure PA in a large number of children during long periods of time (Rasberry et al., 2011). The inclusion of PA in the standard academic classroom time may reduce or remove sedentary time and may bring added academic benefits such as higher task engagement, learning motivation and enjoyment, and the achievement of certain goals (Grieco et al., 2016; Martin & Murtagh, 2017).

In this regard, various methods to integrate PA in the classroom have been tested (Norris et al., 2015; Webster et al., 2015). These interventions can be called Movement Integration Programmes (MIP). In general, the various approaches have included short interruptions of classroom time (3 - 5min) and PA breaks of different intensities. These are often referred to as 'active breaks', 'energizers' or 'fitness breaks', and are applied either with or without educational content associated. MIPs may also include longer activities where PA is integrated into the academic content teaching, i.e. Physically Active Lessons

(PALs; Routen et al., 2018). PALs are a new teaching method that introduces PA in the school learning environment (Kibbe et al., 2011). The aim of PALs is to increase PA levels in children while preserving academic time. These teacher-guided sessions aim to incorporate PA into academic content teaching (Bartholomew & Jowers, 2011). Norris, Steen, Direito and Stamatakis (2019) have recently published a systematic review and meta-analysis on the effect of PALs on PA, education, health and cognitive parameters. The review included 42 studies that revealed that interventions based on physically active lessons led to a significant increase in PA time during the lesson and a moderate increase in total PA. Furthermore, interventions based on physically active lessons also produced significant improvements in educational outcomes during class time and a moderate improvement in general academic performance. By contrast, no effects were observed on cognitive or health markers.

Given the moving nature of the Physical Education (PE) subject, it could contribute, to some extent, to the physical activity recommendations. However, considering the limited number of hours per week, and that this may be the only activity many children do thanks to its obligatory nature (Fairclough & Stratton, 2006), we encounter the following problem: how can we ensure that all school-age children do, at least, one hour of PA per day?, is it possible to increase children's daily PA time without having to modify the current number of hours of every subject?

Based on these questions, the aim of the present study was to assess the effects of a Physically Active Learning (PALe) programme that included one PAL per week in the Natural Sciences subject. It was hypothesised that primary education students' engagement in a PALe programme would significantly increase the amount of PA the students did during school time and would improve their general health, which would be reflected in improved physical fitness. Moreover, it was hypothesised that the implementation of a PALe programme would not hinder the content learning or the specific goals of the non-moving subject where it was applied and, furthermore, it would improve the students' perception of a number of school life aspects, such as classroom climate, potential for conflict, relationships with classmates and teachers, interest in the subject and enjoyment.

Method

Participants

A total of 50 fifth-year primary education students ($M_{age} = 10.62$ years; $SD = 0.57$), 28 boys and 22 girls, from a state school in Cáceres (Extremadura, Spain) participated in the study. They were all students of the school's bilingual itinerary and received the Natural Science subject in English (*Science*). Intentional convenience (incidental) sampling was conducted in those schools of the city where there were primary education main teachers with specific qualifications and experience as PE teachers, so that they could give PALs without the need for additional training. Student allocation to either the experimental or the control group was done respecting the school groups, i.e. 25 students in each of the two fifth-year groups (clusters). They were homogeneous groups regarding number, age, gender and academic level ($p < .05$). All students from both groups participated in the study, and their specific needs for educational support, if any, did not prevent them from normally participating in the research. The teachers of the two groups were involved; both were main teachers of bilingual primary education with more than 18 years of

teaching experience. The teachers and students voluntarily and altruistically participated in the present study.

Instruments

Physical Activity Level. It was assessed through the number of steps recorded by *Xiaomi Mi Band 3 wearable fitness tracker*. It is a wrist-worn fitness tracker that allows for PA monitorisation. Nowadays, the main wrist fitness trackers are able to reliably measure heart rate, number of steps, distance and sleep duration, which can be used as effective health evaluation indicators, but the measurement accuracy of energy consumption is still inadequate (Xie et al., 2018). This device was chosen because it presented the best accuracy-price relationship of the 17 devices examined by El-Amrawy and Nounou (2015). In our case, among all the variables available, we exclusively assessed the number of steps made during school time, i.e. 9 a.m. to 2 p.m. According to Toth et al. (2018), consumer-grade wrist-worn devices presented a step count error that may be acceptable for those wanting to track behaviour changes.

Health-Related Physical Fitness Level. The high-priority Alpha-fitness test battery was used (Ruiz et al., 2011). The authors recommended the use of this test battery when the time for testing is limited, as it occurs in school environments. The battery consists of the following tests: 1) 20-m shuttle run test to assess cardiorespiratory fitness; 2) handgrip strength test; 3) standing broad jump to assess musculoskeletal fitness; and 4) waist circumference. An EH101 hand dynamometer and Tanita BC-545N scales were used.

Academic Performance. In order to assess academic performance, the grades in *Science* corresponding to the regular evaluation periods immediately before and after the intervention phase (2nd and 3rd evaluation periods of 2018/2019 school year) were recorded and analysed in the intervention and control groups.

Perceived Health Status. Perceived health was assessed through a single question; the interviewees were requested to rate their health as 'excellent, good, fair, bad or poor' (Castro-Piñero et al., 2014).

International Survey on Children's Well-Being (ISCWeB). This is a standardised survey designed by ISCI (see www.isciweb.org). Aimed at children between 8 and 12 years old, it included various instruments, such as the Overall Life Satisfaction Scale (SLSS), the Brief Multidimensional Student's Life Satisfaction Scale (BMSLSS) and the Personal Well Being Index-School Children (PWI-SC), among others. A number of items related to different areas of school children's lives were selected and used as school satisfaction predicting variables. The areas included were: (a) relationships with teachers, (b) relationships with classmates, and (c) other school-related aspects.

Procedure

A quasi-experimental design was applied with pre- and post-test measurements in an experimental and a control group. All participants were requested to fill in an informed consent prior to participation. In the case of minors, their parents or legal guardians did it for them to authorise their engagement. All participants were informed about the confidentiality of their answers and results. All procedures were conducted following the recommendations provided by the American Psychological Association (2019) and the Declaration of Helsinki (AMM, 2017). Furthermore, the present study received approval from the Bioethics Committee (239/2019) of the authors' university.

First of all, the centres, main teachers and groups to participate in the study were selected. Those schools in

Cáceres where there were primary education main teachers with qualifications and experience in PE were previously contacted and thoroughly informed. The school teachers and managing teams were informed in a personal interview about the research aims and procedures, as well as the tasks and responsibilities that the teachers who accepted to voluntarily participate in the study would be assigned. Subsequently, once the participating schools and groups were selected, a meeting with the students' parents and legal guardians was held to inform them about the research and to collect their informed consent. The study comprised an observation and previous measurement phase (four weeks), an intervention phase (eight weeks) and a post-intervention final measurement phase (one week).

During the observation phase, and with the aim to quantify the amount of PA that students did during school time, every student from the experimental group was provided with a fitness tracker (Xiaomi Mi Band 3). A brief initial training was provided to ensure valid and reliable measurements: how to set up the 'Notify and Fitness for Mi Band' app, how to continuously record the number of steps with the fitness tracker, and how to collect and send the data recorded to the researcher on a weekly basis. To do so, it was necessary to have the students' parents collaborate by making their mobile electronic devices available for the research for this purpose. It must be highlighted that the activity trackers were provided to the students one week before the data collection period, so that they could familiarise themselves with the device. Thus, the base level of PA during school time, i.e. from 9 a.m. to 2 p.m., was assessed in the experimental group for four observation weeks.

Simultaneously, during the same time period and in collaboration with the experimental group's main teacher, the first PALs were designed, and the methodological criteria to put them into practice were agreed on. For this purpose, the aims and contents of the *Science* area curriculum were combined with PE-specific methodology, spaces and materials. A flexible PAL schedule was established, with one PALe session per week on one of the days on which the students did not have PE lessons. During the last week of the observation phase, pre-test measurements of the students' physical fitness and school satisfaction were recorded by means of the tests and questionnaires described in the 'Instruments' section. These tests and questionnaires were directly applied by the researcher in both groups, to ensure homogeneous data collection.

During the intervention phase, and only in the experimental group ($n = 25$), eight PALs were conducted, one per week, consisting in giving *Science* lessons through physical activities on the school playground. These activities consisted of motor games, chasing games, relay races, treasure hunts, etc. *Science* contents were incorporated into these activities according to the area curriculum. During the whole period, the students' PA was continuously recorded through the activity trackers.

In the week immediately after the end of the intervention phase, post-test perceived physical fitness was assessed.

Data Analysis

The statistical software SPSS 25.0 (IBM, 2017) was used for data analysis. First of all, two one-factor ANOVAs were conducted, one with the aim to analyse the differences in the number of steps between the observation and the intervention phases in the experimental group students, and the other one to analyse the differences in the number of steps depending on the type of day (without PA, with PE and with PAL; both are

within-group comparisons). Subsequently, a repeated-measures ANOVA was performed, using the physical fitness parameters as dependent variables and the measurement (initial vs. final) as the within-subject factor. Lastly, a repeated-measures ANOVA was conducted, taking academic performance and perceived satisfaction as dependent variables, the measurement (initial vs. final) as the within-subject factor and the group (control vs. experimental) as the between-subject factor. In this last model, the effects of the intervention were estimated from the Group*Measurement interaction.

Results

Daily Physical Activity During School Time

The number of steps made during school time by 22 students from the experimental group was recorded by means of fitness trackers during the observation (four weeks) and the intervention (eight weeks) periods. A repeated-measures ANOVA was performed to compare the number of steps made during the observation and the intervention periods. Table 1 shows the results of comparing these two periods. A significant difference can be observed between the means of the two periods.

Table 1. Mean numbers of steps and multivariate tests

	Observation		Intervention		F	p	n ²
	Mean	SD	Mean	SD			
Nr. of steps	3,331.21	652.13	3,720.04	683.49	12.756	.020*	.389

Note. Analyses performed in the experimental group. * $p < .05$.

Furthermore, the 62 school days recorded were grouped for analysis into three categories: 1) days without PA; 2) days with PE lesson; and 3) days with PAL. A one-factor ANOVA was applied, taking the type of day as the factor.

Table 2 displays the mean numbers of steps made on every type of day and the comparison among them.

Significant differences were found between the days without PA and the days with PE lesson, and between the days without PA and the days with PAL. By contrast, no differences in activity were detected between the days with PE and the days with PAL.

Table 2. Mean numbers of steps based on the type of school day and multiple comparisons

	1. Days without PA		2. Days with PE		3. Days with PAL		Differences between pairs		
	Mean	SD	Mean	SD	Mean	SD	1 vs. 2	1 vs. 3	2 vs. 3
Nr. of steps	2,151.82	509.31	4,030.23	1,061.91	3,473.41	784.92	<.001**	.001**	.229

Note. Analyses performed in the experimental group. ** $p < .01$; *** $p < .001$.

Physical Fitness

Table 3 below contains the physical fitness data from the experimental group students, measured through the high-priority Alpha-fitness battery. The measurements obtained from the initial and final (after the intervention with PAL) tests are presented, as well as results of the repeated-measures ANOVA.

With regard to the students' body composition, statistically significant differences ($p < .001$) were found between the pre- and the post-test measurements of body weight and height, while no differences were detected in waist circumference. As regards physical fitness, improvements were found in all strength and endurance variables, them being significant for lower-limb extension strength ($p < .001$) and for endurance measured through the Course Navette ($p = .020$).

Table 3. Student's physical fitness measured through the high-priority Alpha-fitness battery

	Initial measurement		Final measurement		ANOVA
	Mean	SD	Mean	SD	<i>p</i>
Body weight	40.37	10.73	41.47	11.61	<.001**
Height	143	7.40	144	7.60	<.001**
Waist circumference	64.76	9.00	63.52	9.31	.097
Handgrip strength 1	17.41	4.98	17.70	3.86	.511
Handgrip strength 2	15.69	4.86	16.31	3.95	.153
Broad jump	134.32	17.58	146.16	17.27	<.001**
Endurance	230.61	115.67	277.20	155.47	.020*

Note. Analyses performed in the experimental group. * $p < .05$; ** $p < .01$.

Academic Performance

Table 4 contains the mean grades obtained by the students from the control and the experimental groups in *Science*, where the intervention was conducted by implementing PALs on a weekly basis. The grades obtained in the second and third evaluation periods, which corresponded in time to the pre- and post-tests, are shown, as well as the comparisons between them.

While both groups achieved an improvement in their grades, the one shown by the experimental group was statistically significant. However, the Group*Measurement interaction was not significant. The evolution of the grades for both groups can be seen in Figure 1. Despite both of them being positive, that of the experimental group was more evident.

Students' Perception and Satisfaction

Lastly, Table 4 also contains the descriptive statistics of the variables resulting from the fourth instrument

described, those related to the students' perception of and satisfaction with certain aspects of their school life. As it can be observed, no significant differences were found in the dimensions assessed between both groups as a consequence of the intervention.

Figure 1 shows the evolution of the students' interest in the *Science* subject, where the intervention was conducted through PALs. When examining the evolution over time of the mean values of this dimension, it was detected that the students' interest in the subject increased between the pre- and post-test in the experimental group, while it decreased in the control group. Nevertheless, the slopes for both groups were not significantly different.

A similar trend was observed in the dimension '*Perceived health status*'. Although the students' perceived health status was good in both groups, it worsened during the intervention period in the control group, while there was a major improvement of .29 out of 5 points in the experimental group (Figure 1). Nonetheless, the differences within or between groups were not significant.

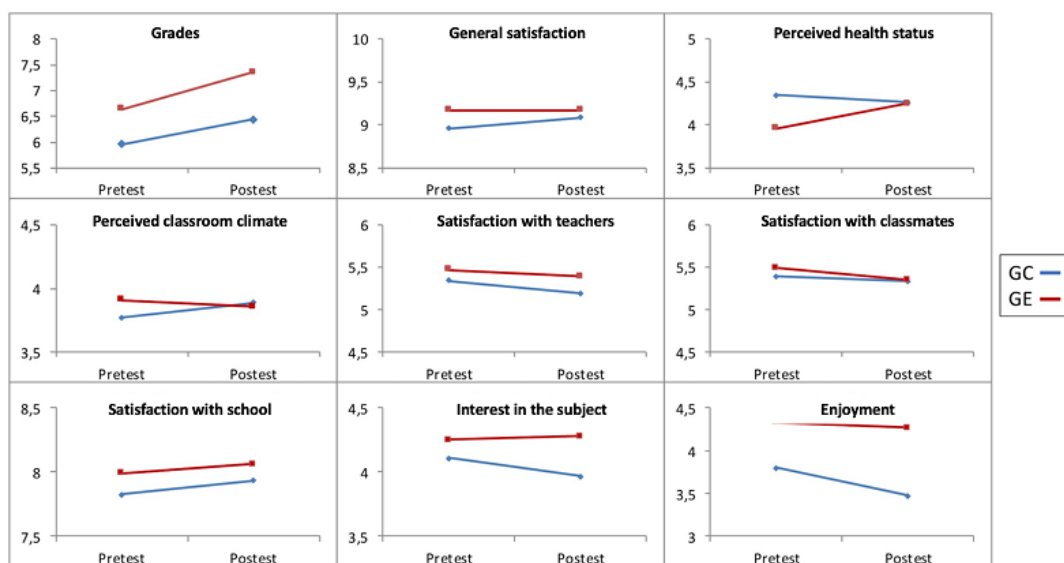


Figure 1. Control and experimental group scores in the pre-test and post-test

Table 4. Students' perception and satisfaction

Dimension	Control group			Experimental group			Group*Measure interaction
	Pre-test	Post-test	p	Pre-test	Post-test	p	
Grades	5.96±1.805	6.44±1.501	.065	6.64±1.655	7.36±1.655	.002*	.402
Perceived health status	4.348±0.714	4.261±0.689	.480	3.958±0.807	4.250±0.608	.284	.075
Perceived classroom climate and potential for conflict	3.768±0.566	3.891±0.454	.049	3.910±0.396	3.854±0.308	.677	.051
Students' satisfaction with their teachers	5.341±0.643	5.188±0.618	.131	5.465±0.518	5.389±0.519	.237	.503
Students' satisfaction with their classmates	5.391±0.802	5.333±0.853	.936	5.486±0.581	5.347±0.560	.149	.709
Students' satisfaction with their school	7.826±1.214	7.935±1.061	.394	7.993±1.057	8.063±0.747	.852	.859
Interest in the subject	4.109±0.643	3.967±0.490	.304	4.250±0.521	4.281±0.348	.879	.286
Enjoyment	3.804±0.901	3.478±0.665	.090	4.333±0.654	4.271±0.489	.621	.262

Note. * $p < .05$.

Discussion

The aim of this study was to determine the effect that a PALE implementation process through PALs could have on school time PA, students' physical fitness, curriculum competencies and students' perception of certain aspects of school life. The first study hypothesis stated that engaging in this PALE programme would have a positive effect on school time PA for all students by significantly increasing it. It was verified that the recorded PA, measured as the number of steps during school time, significantly increased the days on which PALs were conducted, compared to those on which they were not. This increase was such that the PA done by the students on a day with PAL was statistically comparable to that of a day with PE lesson. The confirmation of this first hypothesis is the main contribution of this paper, which proves the ability and feasibility of PALE to help increase PA levels and reduce sedentary lifestyle during school time without necessarily having to modify the number of hours of the different subjects. Therefore, it was confirmed that this PALE methodology may be a solution to the students'

physical inactivity during school hours, with the purpose to encourage and consolidate healthy lifestyle habits through the daily practice of physical exercise and sports, as established in the forty-sixth additional provision of the 3/2020 Organic Law of 29th December, through which the 2/2006 Education O. L. of 3rd May was modified. In keeping with Dobbins et al. (2013), our results confirmed the clear effectiveness of school-based PA interventions, as it was also concluded in recent studies that showed a PA increase following these interventions (Sevil et al., 2019; Vaquero-Solis et al., 2020). Likewise, the results of the study conducted by Goh et al. (2019) revealed that the students' PA levels increased after participating in a PA-based curricular programme. Moreover, the PA levels increased regardless of weight category, and those students with healthy body weight presented the largest increase after the intervention.

The second study hypothesis suggested that this significant increase in students' PA should entail an improvement in their general health, reflected in improved physical fitness. Conclusive improvements in the students'

body composition were not found in our study, which could be partially due to the short duration of the intervention period or to the low number of PALs per week. The latest recommendations on healthy PA provided by the World Health Organization (WHO, 2020) establish that children and adolescents should do at least an average of 60 minutes per day of moderate- to vigorous-intensity aerobic activity. Therefore, a higher number of sessions and for a longer time would be needed to be able to adequately assess changes in body composition.

Significant improvements were, however, detected in certain physical fitness variables, such as lower-limb extension strength and endurance. Consequently, it was not possible to fully confirm this hypothesis, and further research is needed in this line with a longer intervention duration and a higher number of PAlE sessions per week. These results agree with Dobbins et al. (2013), who observed that PA-based interventions significantly increased the students' maximal oxygen consumption and their amount of moderate- to vigorous-intensity PA activity during school hours. Nevertheless, the authors observed that studies generally found small effects and presented a moderate to high bias risk, so they suggested the need for additional research on school-based PA interventions (Dobbins et al., 2013).

Thirdly, as researchers and teachers, we were concerned that the PAL implementation could have a negative influence on the level of acquisition of the non-motor subject's goals and contents, in our case, Science. We confirmed that not only the learning was not hindered but, in our case, it was even fostered and improved compared to the control group. This finding is in agreement with Tomporowski et al. (2011), who obtained a positive association between a combination of movement and learning through PALs, and the learning outcomes. Furthermore, other studies have proved that the performance of tasks involving physical activity was positively associated with an improvement in the students' academic performance (Ulstad et al., 2016). Likewise, Sibley and Etnier (2003) identified a significant positive relationship between PA and cognition in children in a meta-analysis. Despite this, we consider that this hypothesis should be tested in the future through standardised questionnaires, expressly designed for research.

Lastly, it was hypothesised that the use of this methodology would improve the students' perception of a number of school life aspects, such as classroom climate, potential for conflict, relationships with classmates and teachers, interest in the subject and enjoyment. The results obtained did not allow for confirmation of this hypothesis, except in some cases, such as the improved relationship only with the teacher who gave the PALs, the increased interest in the subject and the improved perceived health.

This research presents a number of limitations. Firstly, the small sample size prevents from generalising the results to a larger scale. Therefore, future studies must examine the effect of including PA in lessons with larger samples. Besides, the effect of including PA in the lessons could not be compared with a control group, but it was compared within group in every experimental group. Thus, the study design allowed for comparison of the number of steps made during school time on days without PE, on days with PE and on days with PAL. It must also be highlighted that a within-group (experimental group) comparison was conducted only for the activity and physical fitness variables, while the academic performance and students' perception and satisfaction variables were compared between groups (control group vs. experimental group). Another limitation of the present research is that PA level was analysed through the number of steps, which

prevents from assessing different PA intensities, as well as sedentary time. Nevertheless, there are studies (El-Amrawy & Nounou, 2015) that have proved the validity and reliability of this type of device to assess PA levels through the number of steps. Lastly, due to the large number of variables included in the study, it was not possible to discuss all of them in depth, so the discussion has focused on those that presented significant differences.

Nonetheless, this research also presents a number of strengths that contribute to expanding the existing research on the inclusion of PAlE in the classroom. On one hand, the positive outcomes obtained from this research encourage to include this kind of PAlE in schools and, by doing so, improve the students' comprehensive development. On the other hand, given the difficult implementation and the lack of this type of research in this education phase, the study design (i.e. intervention programme) was also a noteworthy strength.

Therefore, in light of the results, we can conclude that the implementation of a PAlE-based methodology in school curricula could progressively contribute to a potential solution to primary education students' inactivity. Besides, it seemed to be a valid strategy to improve the students' physical fitness and the general classroom climate (i.e. student-teacher relationship). Lastly, the influence of this type of intervention on the students' academic performance was also brought to light.

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