

Original Article

**Effects of a structured recess intervention on physical activity levels, cardiorespiratory fitness, and anthropometric characteristics in primary school children**

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**Abstract:**

Non-curricular time spent in school context might provide a potential opportunity to promote physical activity (PA) and enhance children’s health. This study examined the effects of a structured recess intervention over 12 weeks on cardiorespiratory fitness (CRF), PA daily levels and anthropometric characteristics, in 2nd and 3rd grade school children. This non-randomized controlled study included 100 children (age,  $7.5 \pm 0.5$  yr, body mass  $29.6 \pm 6.0$  kg, height,  $1.25 \pm 0.06$  m) recruited from two primary schools, which served as intervention (INT) or control (CON). The INT school underwent a 15 min structured and physically active recess 4 times per week for 12 weeks, while the CON school maintained its usual unstructured recess routine. Steps count and PA at different intensities (Light, LPA; moderate, MPA; vigorous, VPA; moderate-to-vigorous, MVPA) during week days (WD) and weekends (WE) were assessed by accelerometry pre- and post-intervention. CRF and anthropometric parameters were also assessed in both conditions. Overall, there was a main effect of time for cardiorespiratory fitness (+ 4%,  $P = 0.004$ ,  $\eta^2 = 0.042$ ), time spent in LPA (+14.3%,  $P = 0.015$ ,  $\eta^2 = 0.032$ ) and MPA (+28%,  $P = 0.049$ ,  $\eta^2 = 0.021$ ) during WD, although, we observed no time x group interaction:  $P = 0.864$ ,  $\eta^2 = 0.001$ ,  $P = 0.363$ ,  $\eta^2 = 0.005$ ,  $P = 0.085$ ,  $\eta^2 = 0.016$ , respectively. We observed no main effect of time for any of the anthropometric measures ( $P > 0.05$  in all cases), steps count, VPA and MVPA during WD and PA measures during WE. Over the 12 weeks of intervention in this study, we observed higher levels of LPA and MPA during WD, and improved cardiorespiratory fitness, however, this was not different between the INT and CON schools. This may suggest that children engage in sufficient amount of PA during recess on their own, suggesting that adults’ effort to increase PA levels can be focused on other parts of the children’s free time spent in school. However, future in-school research may also benefit from evaluating a more precise volume, intensity and type of PA during recess to induce beneficial effects on children’s fitness and anthropometrics.

**Key words:** school-based intervention, recess, physical activity promotion, MVPA.

**Introduction**

Physical inactivity is considered the fourth main risk factor for global mortality and may contribute to the observed increase in obesity prevalence among children (Tiziana et al., 2018, World Health Organization, 2010). Despite the benefits of regular physical activity (PA) on children’s physical, social and mental health have been profusely documented over the last 30 years (Hallal, Victora, Azevedo, & Wells, 2006; Warburton, 2006), the proportion of European children meeting the current global recommendations of at least 60 minutes of moderate-to-vigorous-intensity physical activity (MVPA) per day is low (2.0 - 34.1%) (Ekelund, 2012; Konstabel et al., 2014). Moreover, PA levels seem to further decrease from childhood to adolescence but also from adolescence to young adulthood (Ortega et al., 2013). Although the proportion of obese children seems to level off in Italy, 21.3% and 9.3% of 8-9 year-old children are still overweight and obese by BMI, respectively (Nardone et al., 2018), and may suffer many adverse health effects if not decreasing their excess body mass (Daniels et al., 2005). Considering that children up to 13 years of age usually spend a substantial proportion of their waking hours (e.g. between 6 and 8 hours) in a school environment, schools have been targeted as potential and suitable settings for intervention programs, aiming to promote healthy habits and opportunities for the

children to be physically active and hence promote their health (Salmon, Booth, Phongsavan, Murphy, & Timperio, 2007). Previous studies suggest that school recess may account for 17-44% of children's daily steps count (Erwin et al., 2012) and contribute from 6-17.9% of the daily recommended 60 min of MVPA (Mota, Gerstner, & Giuliani, 2019; Ridgers, Saint-Maurice, Welk, Siahpush, & Huberty, 2011; Ridgers, Stratton, & Fairclough, 2006). Unfortunately, although a growing body of evidence suggests that physical education (PE) and non-curricular time spent in school (e.g. recess) could significantly contribute to enhance children's physical, social and emotional health in addition to cognitive and behavioral development (Barros, Silver, & Stein, 2009; Pellegrini & Bohn, 2005), time devoted to such activities is constantly being reduced (e.g. for punitive or behavioral reasons) or reallocated to accommodate more time to other academic subjects (e.g. mathematics, English, writing skills etc.) (Murray & Ramstetter, 2013).

In recent years, many interventional studies have focused on the promotion of PA opportunities for children and have adopted time-efficient activity breaks to be implemented in non-curricular school time showing positive results (Erwin, Beighle, Morgan, & Noland, 2011; Howe, Freedson, Alhassan, Feldman, & Osganian, 2012; Huberty et al., 2011; Whitt-Glover, Ham, & Yancey, 2011). For example, even small 10 min PA breaks in classrooms have the potential to increase children's daily PA by 20-50% (Erwin et al., 2011; Whitt-Glover et al., 2011).

A previous study reported over 100% increase in children's daily PA levels following implementation of a multi-component structured PA intervention modifying and implementing activity zones (e.g. playground markings) to facilitate children's involvement in games during recess (Huberty et al., 2011). Therefore, recess can be considered as a feasible time during in-school free-time for PA interventions with positive effects on children's PA daily levels (Ickes, Erwin, & Beighle, 2013). However, there are fewer studies that investigated the physiological effects of implementing PA during recess. One study reported no changes in cardiovascular risk factors i.e., resting blood pressure, body mass index (BMI), waist circumference (WC) (Howe et al., 2012), whereas another study, reported no changes in children's physical fitness (van der Niet et al., 2016). It may be that previous studies included playful games of low energy expenditure and frequency, which might have been ineffective in reducing weight or induce alterations in body composition. For example, the study by Howe et al., (2012) included games with an estimated energy expenditure of at least 100 kcal per 30 min twice per week, which might have been an insufficient volume of PA to induce weight changes. Similarly, the intensity and volume of the activities (e.g. running games and circuit training) proposed by van der Niet et al., 2016, might have been inadequate to enhance children's physical fitness.

Accordingly, the aim of this study was to assess the effects of introducing a low-cost and unobtrusive PA intervention, characterized by a 15-minute structured recess four times a week, involving games of known vigorous intensity (> 6 METs), on PA daily levels (steps count, LPA, MPA, VPA and MVPA), cardiorespiratory fitness, and anthropometric characteristics associated with cardiovascular risk factors, in primary school children.

## **Material & methods**

### *Participants*

One hundred boys and girls attending 2<sup>nd</sup> (7-8 years) and 3<sup>rd</sup> (8-9 years) grade classes of two Italian public primary schools were enrolled in this non-randomized controlled study. Both schools belonged to the same scholastic institution and were located in the neighborhood of Varese, Lombardy, Italy. Four classes at one school (n=77) were assigned to an intervention (age, 7.6 ± 0.5 yr; body mass, 30.2 ± 6.3 kg; height, 1.25 ± 0.07 m), while two classes of the second school (n=23) served as control (age, 7.4 ± 0.5 yr; body mass, 28.3 ± 5.5 kg; height, 1.28 ± 0.06 m).

The children and their parents were informed of the purpose, experimental procedures and potential side effects of the study and were informed of the possibility to withdraw from the study at any time before both the children and their parents/legal guardians provided written informed consent. The study was approved by the institution review board of the Università Cattolica del Sacro Cuore of Milan and conformed to the standards set by the Declaration of Helsinki.

### *Study design*

The research project was developed during a regular school year (September-May) and was structured in four main phases. Phase one (September-October) included a preliminary analysis aimed at measuring the mean oxygen consumption and intensity of four standardized Italian traditional games (see below). The second phase (November-December) comprised the collection of baseline data of physical activity cardiorespiratory fitness, and anthropometric parameters.

The third phase (January-March), comprised the implementation, in the INT school, of a 15-minute structured and physically active recess, performed at least four times per week (for a total of 60 minutes) for 12 weeks. The CON school carried out a 15 min unstructured recess twice per day. In the fourth phase (April-May), participants repeated the baseline measurements.

### *Experimental procedures*

#### *Physical activity levels*

Children's PA levels were objectively evaluated with a single-axis accelerometer (LifeCorder Plus, Kenz, Japan). The LifeCorder Plus is reported to show good validity and reliability against a more commonly used accelerometer (ActiGraph) in children (McClain, Sisson, Washington, Craig, & Tudor-Locke, 2007). The device is a small (75.0 x 42.0 x 29.1 mm) and light (45g) waist-worn monitor that allows the measurement of step count ( $\text{steps}\cdot\text{day}^{-1}$ ) and times ( $\text{min}\cdot\text{day}^{-1}$ ) in specific intensities of PA (e.g. sedentary, light, moderate and vigorous) with proprietary algorithms, which are extracted through the Physical Activity Analysis Software (PAAS, Lifestyle Coach ver. 1.0, Suzuken CO., 2006), provided by the manufacturer.

The children wore the device for seven consecutive days, and only recordings of minimum of 10 hours per day for at least 3 weekdays (WD) and 1 weekend (WE) day were considered as valid worn time, and further analyzed (Ekelund et al., 2004). In order to take into consideration sports or recreational activities performed by the children but not recordable with the LifeCorder Plus (e.g. swimming, water sports) each participant was given a personal diary to record the type and duration of that specific activity.

The corresponding METs value, according to the Compendium of energy expenditure for youth of Ridley, Ainsworth, & Olds, 2008, was used to calculate the minutes of PA in the corresponding intensity category. Accordingly, total daily PA was the result of the sum of the data recorded by the accelerometer and diary logged self-reported PA by the children related to sports or recreational activities where the device was not worn.

#### *Cardiorespiratory fitness*

The 6-minute walking test (6MWT) was adopted to evaluate participants' cardiorespiratory fitness. The 6MWT is validated against indirect calorimetry ( $r = 0.44$ ,  $P < 0.0001$ ) and has a high degree of repeatability (ICC [95% CI], 0.94 [0.89-0.96]) for the assessment of exercise tolerance and endurance in healthy children (Li et al., 2005). The children were instructed to walk up and down over a measured walking course of 30 m (for a total of 60 m), marked on the ground every 3 m, and to cover as much distance as possible in 6 minutes.

#### *Anthropometric measurements*

Body mass and height were measured on a calibrated Digital Scale with Stadiometer (Seca, Hamburg, Germany) to the nearest 0.1 kg and 0.5 cm, respectively. During anthropometric measurements participants wore light sports clothes, and were tested barefoot. BMI was calculated as weight divided by height squared ( $\text{kg}\cdot\text{m}^{-2}$ ), and age- and gender-specific z-scores of BMI were computed.

Waist circumference (WC) was assessed by an inelastic tape horizontally around the waist between the lowest rib margin and the anterior iliac crest, arms at the sides and abdomen relaxed (Moreno et al., 2007). The average value of the two measurements was recorded.

As a measure of body composition, children's skinfold thickness was measured and consequently body fat percentage (BF%) was estimated. In particular, the millimeter (mm) skinfold was measured in triceps and subscapular on the right side of the body to the nearest 0.1 mm with a skinfold caliper (Harpenden Caliper, Gima, Italy). The instrument was calibrated to exert a constant pressure of  $10 \text{ g}\cdot\text{mm}^{-2}$ .

Every skinfold was measured twice by the examiner and the average of the two measurements was considered in the analyses. A third measurement was performed if a difference greater than 2 mm was observed between the first two measurements (Reilly, Wilson, & Durnin, 1995). The BF% was derived from the sum of the skinfold thickness according to the equations of Slaughter et al., (1988) and differentiated by sex.

#### *Metabolic analysis of the games*

In phase one, a preliminary analysis was conducted on a subgroup ( $n=16$ ) of children (age:  $7.5 \pm 0.5$  yr; height:  $1.26 \pm 0.07$  m; body mass:  $30.8 \pm 5.1$  kg). The main purpose of this phase was to measure the energy expenditure, i.e. oxygen uptake ( $\text{VO}_2$ ), of four traditional children's games and to determine their relative intensity: Sparviero (Hawk), Mago libero (Free magician), Scalpo (Scalp), and Palla avvelenata (Poison ball). During each 15-minute activity proposed during PE in curricular hours, the children wore a portable metabolic unit (K4b<sup>2</sup>, Cosmed, Italy) for breath-by-breath gas exchange analysis to determine the energy cost of the activities. The average intensity of each activity was analyzed and expressed in Metabolic Equivalent of Tasks (METs) ( $1 \text{ MET}: 3.5 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ ).

Following offline analyses, all the four games tested required 6 METs or greater (a 6-fold or greater increase above resting metabolic rate) and therefore were classified as vigorous-intensity PA (Howe, Freedson, Feldman, & Osganian, 2010; Ridley et al., 2008). The energy expenditure of each activity (METs) is shown in Fig. 1.

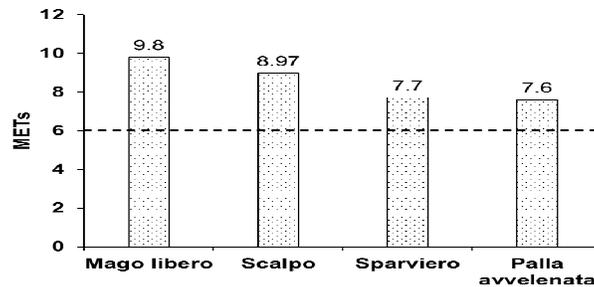


Fig. 1. Average intensity (METs) of the four Italian traditional games proposed in the intervention from the highest, Mago libero (Free magician), to the lowest, Palla avvelenata (Poison ball). The black dashed line indicates the threshold of vigorous intensity (> 6 METs).

### Intervention

The children in the INT school underwent 15 minutes of structured recess based on traditional games of known vigorous intensity suited to the children's abilities. Accordingly, the games of Sparviero (Hawk) and Mago libero (Free magician) were chosen for 2<sup>nd</sup> grade students, while Scalpo (Scalp) and Palla avvelenata (Poison ball) were selected for 3<sup>rd</sup> grade students (Casolo et al., 2011). Briefly, Mago libero (*Free magician*) requires the division of the players in two teams: magicians and free. The task of the magicians is to chase the free and "immobilize" the opponents by touching them. In the game of Palla avvelenata (*Poison ball*) the players, divided in two teams, each protecting its part of the field, aim at "eliminating" the opponents hitting them with a ball. In the Scalpo (*Scalp*) game, every player, equipped with a scalp of his team's color, has to contribute to retrieve a "treasure" (e.g. ball, flag, clubs) placed in the opposite side of the field, avoiding to be in turn "scalped". In the game of Sparviero (*Hawk*), one player is placed in the middle of the pitch and aims at catching all the other players that, in turn, have to walk or run across the field to reach the other side (Casolo et al., 2011). Every activity was supervised and carried out by trained instructors.

### Statistical analysis

The Shapiro-Wilk confirmed all data to not deviate from normal distribution. Baseline between-group differences in physical activity (steps count, LPA, MPA, VPA, MVPA in both WD and WE), cardiorespiratory fitness, as well as anthropometric characteristics (age, height, body mass, BMI, BMI Z-score, WC, BF%) were investigated with one-way univariate analyses of variance (ANOVAs). Multiple two-way ANOVAs (group x time) were performed to assess differences between groups (group: INT vs CON) and testing conditions (time: pre- vs post- test) of the dependent variables analyzed. The dependent variables included were: physical activity level with its subcomponents (steps count, LPA, MPA, VPA, MVPA), 6MWT, anthropometric parameters (BMI, BMI z-score, WC, BF%). Effect sizes were calculated as partial eta squared ( $p\eta^2$ ) where 0.01-0.05, 0.06-0.13 and  $\geq 0.14$  was considered small, medium and large effect sizes, respectively (Richardson, 2011). All statistical analyses were performed with StatView Software (version 5.0.1) and are presented as mean  $\pm$  standard deviation (SD) unless otherwise stated. The alpha level was set at 0.05.

### Results

The baseline and post-test values for the PA levels, the cardiorespiratory fitness, and anthropometric features, by group, are presented in **Table 1** and **Table 2**. In particular, no differences were observed between the two groups except for height ( $P = 0.027$ ), and BMI ( $P = 0.001$ ) at the baseline.

#### Physical activity levels

Overall, 86% and 91% of the children did not reach the global recommendations for PA during WD or WE, respectively, at the baseline compared to 82% and 78% during WD or WE, respectively, at post-test (Fig. 2 B). The analysis of children's PA levels during the weekdays (WD) pointed out that daily time spent in LPA ( $P = 0.015$ ,  $p\eta^2 = 0.032$ ) and MPA ( $P = 0.049$ ,  $p\eta^2 = 0.021$ ) increased during WD from baseline to post-test. However no time by group interaction was observed (LPA:  $P = 0.363$ ,  $p\eta^2 = 0.005$ ;  $\Delta$  change: INT: +17.5 $\pm$ 22.8%, CON: +5.7 $\pm$ 16.5%; MPA:  $P = 0.085$ ,  $p\eta^2 = 0.016$ ;  $\Delta$  change: INT: +37.8 $\pm$ 50.2%; CON: +7.2 $\pm$ 26.7%).

Moreover, no changes were observed for WD VPA (interaction time x group:  $P = 0.476$ ,  $p\eta^2 = 0.003$ ) and WD MVPA (interaction time x group:  $P = 0.182$ ,  $p\eta^2 = 0.010$ ) following the intervention.

Similarly, no changes were observed for WD steps count (interaction time x group:  $P = 0.102$ ,  $p\eta^2 = 0.015$ ) between baseline and post-test.

The analysis of children's PA levels during the weekend (WE) did not show any differences between baseline and post-test and between groups for time spent in LPA (interaction time x group: 0.416,  $p\eta^2 = 0.004$ ),

MPA (interaction time x group: 0.743,  $p\eta^2 = 0.001$ ), VPA (interaction time x group: 0.835,  $p\eta^2 = 0.001$ ), MVPA (interaction time x group: 0.730,  $p\eta^2 = 0.001$ ) and steps count (interaction time x group: 0.531,  $p\eta^2 = 0.002$ ).

*Cardiorespiratory fitness*

Cardiorespiratory fitness increased between baseline and post-test ( $P = 0.004$ ,  $p\eta^2 = 0.042$ ), however, the change was not different between the two groups (interaction time x group:  $P = 0.864$ ,  $p\eta^2 = 0.001$ , INT: +4.2%; CON: +4.0%).

*Anthropometric characteristics*

All anthropometric features (BMI, BMI z-score, and WC) did not change between baseline and post-test in both groups (Table 1).

Body fat percentage did not change from baseline to post-test in both groups (interaction time x group:  $P = 0.630$ ,  $p\eta^2 = 0.001$ ).

Table 1. Baseline and post-test mean values of participants' physical activity daily levels by group, during both WD and WE. Data are shown as mean  $\pm$  SD.

	INT School (n = 77)		CON School (n = 23)		P value ( $p\eta^2$ )
	Pre	Post	Pre	Post	
<b>LPA (min·day<sup>-1</sup>)</b>					
WD	75.2 $\pm$ 17.6	86.7 $\pm$ 19.1	75.8 $\pm$ 15.6	78.7 $\pm$ 13.2	0.015* (0.032)
WE	82.8 $\pm$ 24.3	86.6 $\pm$ 32.7	79.1 $\pm$ 28.5	91.5 $\pm$ 22.4	0.093
<b>MPA (min·day<sup>-1</sup>)</b>					
WD	24.6 $\pm$ 9.7	32.4 $\pm$ 13.5	23.2 $\pm$ 8.0	23.5 $\pm$ 5.8	0.049* (0.021)
WE	24.1 $\pm$ 13.4	27.2 $\pm$ 15.0	22.3 $\pm$ 12.1	27.2 $\pm$ 14.7	0.105
<b>VPA (min·day<sup>-1</sup>)</b>					
WD	14.0 $\pm$ 13.2	15.0 $\pm$ 11.0	12.2 $\pm$ 5.2	10.2 $\pm$ 6.5	0.773
WE	9.6 $\pm$ 14.0	12.3 $\pm$ 17.3	8.2 $\pm$ 9.1	10.9 $\pm$ 9.1	0.452
<b>MVPA (min·day<sup>-1</sup>)</b>					
WD	39.9 $\pm$ 19.0	47.2 $\pm$ 21.8	35.1 $\pm$ 11.1	33.6 $\pm$ 9.2	0.377
WE	34.7 $\pm$ 23.8	39.6 $\pm$ 25.8	30.51 $\pm$ 16.3	38.3 $\pm$ 19.9	0.123
<b>Step count (steps·day<sup>-1</sup>)</b>					
WD	10445 $\pm$ 2804	12409 $\pm$ 3538	10174 $\pm$ 3291	10344 $\pm$ 1856	0.052
WE	10405 $\pm$ 3544	11383 $\pm$ 4820	10048 $\pm$ 3943	11944 $\pm$ 4016	0.051

LP, light physical activity; MPA, moderate physical activity; VPA, vigorous physical activity; MVPA, moderate-to-vigorous physical activity; WD, weekdays; WE, weekend. Differences between baseline and post-test are indicated with \* when  $P < 0.05$ .

Table 2. Baseline and post-test mean values of participant's anthropometric characteristics and cardiorespiratory fitness by group. Data are shown as mean  $\pm$  SD.

	INT School (n = 77)		CON School (n = 23)		P value ( $p\eta^2$ )
	Pre	Post	Pre	Post	
<b>Cardiorespiratory fitness</b>					
6MWT (m)	621 $\pm$ 58	647 $\pm$ 55	600 $\pm$ 53	624 $\pm$ 25	0.004* (0.042)
<b>Anthropometrics</b>					
BMI (kg·m <sup>-2</sup> )	19.2 $\pm$ 2.7 <sup>#</sup>	19.5 $\pm$ 2.9	17.1 $\pm$ 2.3	17.4 $\pm$ 2.6	0.610
BMI z-score	0.001 $\pm$ 1.001	-0.001 $\pm$ 1.001	-0.001 $\pm$ 1.0	0.002 $\pm$ 0.999	0.963
WC (cm)	58.9 $\pm$ 6.3	59.7 $\pm$ 6.9	58.8 $\pm$ 7.8	58.9 $\pm$ 8.4	0.749
BF (%)	18.6 $\pm$ 5.2	19.6 $\pm$ 4.5	17.3 $\pm$ 4.6	18.2 $\pm$ 4.2	0.294

6MWT, six-minute walking test; BMI, body mass index; WC, waist circumference; BF, body fat. Baseline differences between the two groups are indicated with <sup>#</sup> when  $P < 0.05$ . Differences between baseline and post-test are indicated with \* when  $P < 0.05$ .

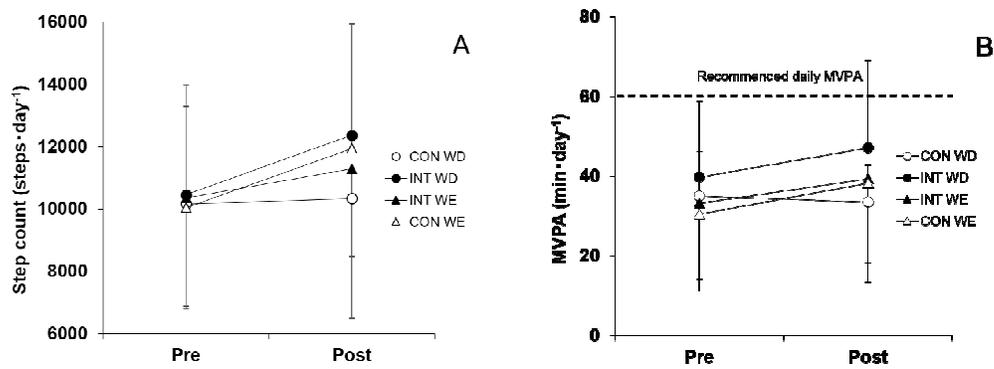


Fig. 2. Changes in step count (steps·day<sup>-1</sup>) between baseline and post-test in WD and WE (A), by group. Changes in MVPA (min·day<sup>-1</sup>) between baseline and post-test in WD and WE, by group (B).

### Discussion

The aim of this study was to investigate the effects of implementing a 15-minute structured recess four times a week for a total of 60 min of VPA per week on daily levels of physical activity, cardiorespiratory fitness, and anthropometric characteristics, in primary school children aged 7-9 years. In general, children's physical activity levels, time spent in LPA and MPA during WD increased in both schools. Conversely, the participant's daily levels of PA did not change during the WE. The cardiorespiratory fitness improved similarly in both groups following the intervention. No other significant differences were detected.

In-school active recess promotion and implementation seems to be a fairly new area of research and accordingly, relatively few intervention studies have been conducted (Erwin, Ickes, Ahn, & Fedewa, 2014). The similar changes in PA daily levels, where both groups increased their time spent in LPA and MPA during WD might be due to the seasonal change between the testing periods (Pre-test: November-December, Post-test: April-May) (Riddoch et al., 2007). When analyzing the average PA values of both pre- and post-tests for both groups, we found that children spent higher amounts of their active time in LPA (69%) compared to MPA (21%), VPA (10%) and MVPA (31%), independently of WD or WE ( $P < 0.001$ ). Additionally, the children spent more time in LPA during WE compared to WD (+6.8%,  $P = 0.030$ ) and more interestingly, less time in MVPA during WE compared to WD (-12.1%,  $P = 0.025$ ). This finding suggests that during WD, children might be more involved in organized activities that occur routinely (e.g. recess, lunch breaks, sport activities) and make them more physically active compared to WE, usually characterized by free-time spent with family where there might be lower stimuli for engaging in PA. Therefore, future studies aiming at the promotion of active behaviors and healthy lifestyle among children, should probably consider a more direct involvement and active participation of the parents, whose potential and beneficial role would be to provide to their children more opportunities for being physically active in the WE as well, where children's PA levels are generally lower. In general, in light of our findings the volume of our implementation was probably too low to significantly enhance children's PA daily levels. In fact, significantly higher PA daily levels were observed in previous studies which proposed at least one daily active break lasting from 10 to 30 min (Erwin et al., 2011; Howe et al., 2012).

Although children improved their cardiorespiratory fitness, their aerobic performance enhancement might be partially explained by physical growth (Tremblay et al., 2010). Considering the strong genetic component associated with children's aerobic fitness, longer and more frequent PA bouts than those proposed in our study during the structured recess, might be needed to differentiate from improvements induced by normal growth and physical training (Baquet, Van Praagh, & Berthoin, 2003). Nevertheless, the possibility of the children in the CON school to also perform unstructured PA during their recess time cannot be excluded and may also explain the similar improvements observed in our study.

The 12-week intervention proposed in this study seemed to be insufficient to positively impact children's anthropometric characteristics (BMI, BMI z-score, WC) and body composition (BF%), which is consistent with previous findings (Howe et al., 2012). Thus, it seems that PA performed by children during recess was insufficient to induce the necessary large energy expenditure changes to elicit any significant change in weight and/or adiposity. In this regard, an interdisciplinary health behavior approach including a reduction of sedentary behaviors (e.g. television viewing), an optimized control of energy intake and finally, a potential increase of daily amounts of PA, may be needed to combat the growth of obesity prevalence in children, which may also result in favorable outcomes in cardiorespiratory and metabolic risk profiles (Gortmaker et al., 1999).

### Strengths

There are a number of strengths to our study. To date and to the best of our knowledge, no study have investigated the effects of implementing an active recess intervention on such a comprehensive health-related set of variables simultaneously. Additionally, the metabolic analysis of games, which was used to determine the

energy expenditure of the traditional games and their relative intensity, ensured that the PA proposed during the structured recess most likely was of vigorous intensity (> 6 METs). Moreover, the four games, that can be performed both indoor and outdoor independent of the season, were acceptable, easy to learn and defined enjoyable and exciting by the participants thus, the intervention seem feasible to implement in any school. Finally, PA levels and steps count were objectively evaluated by accelerometry, which probably is more accurate compared with self-reported methods for assessing PA (Chomistek et al., 2017; Plasqui & Westerterp, 2007).

### **Limitations**

There are also some limitations to our study that should be addressed. First of all, the volume (60 min·week<sup>-1</sup>) and duration (12 weeks) of the implementation might have been too low to induce significant changes in anthropometric characteristics associated with cardiovascular risk factors. Moreover, the participants of the CON school had two daily-unstructured recesses of 15 min each in which they followed their normal habits (e.g. free to decide if playing freely or just standing), compared to the INT school that had only one daily structured recess of 15 min four times per week plus another unstructured recess. Therefore, the CON school had practically at least a double opportunity to be physically active compared to the INT school. However, we could not interfere with the existing daily schedule of the CON school and thus we can't completely rule out the fact that children in the CON school also performed similar amounts of PA during their recess on their own. Moreover, for logistical reasons, this intervention study was not randomized, which introduces the possibility for confounding of our results. Additionally, the non-significant differences between groups in our study may also be due to the uneven sample sizes between the INT (n=77) and CON school (n=23).

Future studies aiming at evaluating the implementation of our proposed games within a structured recess intervention will benefit from adopting a more robust approach, preferably with an individual or cluster randomized distribution, and similar sample sizes between groups.

### **Final reflections: implications for school health**

With unprecedented and rapid worldwide increases in the prevalence of childhood overweight and obesity (Wang & Lobstein, 2006), the implementation and promotion of effective strategies to increase physical activity levels has become a public health priority (World Health Organization). In particular, school-based strategies to maximize children's involvement in physically active behaviors during free time spent in the school context (e.g. recess, lunch breaks) are advocated because of the associated potential health and academic benefits (Ickes et al., 2013). In particular, the school-based PA implementations strategies should be low-cost and above all, should not intrude on the existing daily schedules in order to not interfere with the academic learning. Specifically, school recess offers an ideal opportunity for children to be physically active on a daily basis and hence enhance their health. In addition, the concept of promoting a "structured" recess is emerging because it is suggested that children often need help in developing games and should be encouraged by trained adults (teachers, school-staff or volunteers) to participate in physical activity during their in-school free time (Murray & Ramstetter, 2013). However, currently more evidence must be provided to the school policies makers to support the feasibility and the beneficial effects associated with the implementation of a structured and physically active recess.

The school-based intervention proposed here, which consisted of the inclusion of a daily structured PA recess (4 times per week) without changing normal time schedules and sacrificing time spent in other academic subjects, proved to be low-cost and easy to implement and is thus feasible in a primary school context.

In light of our findings, we recommend that future school-based interventions should be longer than 3 months and particularly, include at least one physically active daily recess lasting more than 15 minutes, comprising of games and activities of vigorous intensity but also more specific exercises in order to enhance children's physical fitness. Specifically, in order to maximize children's participation and inclusion, teachers, supervisors and/or educators should implement games and activities matched to the children's sex, age and developmental needs without neglecting their enjoyment. Physical activity experts and eventually PE teachers could train and assist curricular teachers in leading active recesses and to make them aware of PA health-related, social, emotional and cognitive benefits for children.

### **Conclusions**

Over the 12 weeks of intervention in this study, we observed higher levels of LPA and MPA during WD, and improved cardiorespiratory fitness, although this was not different between the INT and CON school. This may suggest that children engage in sufficient amount of PA during recess on their own, suggesting that adults' effort to increase PA levels can be focused on other parts of the children's free time spent in school. However, future in-school research may also benefit from evaluating a more precise volume, intensity and type of PA during recess to induce beneficial effects on children's fitness and anthropometrics.

### **Conflicts of interest**

The authors declare that the research was conducted in the absence of any commercial or financial relationship that could be constructed as potential conflict of interest

### Author Contributions

AC: in charge of the manuscript writing process, data analysis, statistics and interpretation of the results; EHS: data interpretation, significant manuscript writer and reviser; MB, FC: significant manuscript writer and reviser, and data interpretation; CG: concept and design, data acquisition and interpretation and significant manuscript reviser. All authors have approved the final version of the submitted manuscript for publication and are accountable for all the aspects of the work.

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