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Research article

Intervention for Spanish overweight teenagers in physical education lessons

Emilio J. Martínez-López [1]✉, Alberto Grao-Cruces [2], José E. Moral-García [3] and Antonio Pantoja-Vallejo [4]

[1] Research group HUM653 Laboratory, Department of Didactic of Musical, Plastic and Body Expression. University of Jaén, Spain, [2] Department of Sport and Computer Science, University of Pablo Olavide, Seville, Spain, [3] Physical activity and Sport Faculty, University of Salamanca, Spain, [4] Department of Pedagogy, Research Group HUM 660 laboratory, University of Jaén, Spain

Abstract

Physical education is a favourable educational framework for the development of programmes aimed at increasing physical activity in children and thus reducing sedentarism. The progressive increase of overweight students demands global control and follow-up measurement of these behaviours in both in and out of school. The pedometer can be a useful tool in this field. It is easy to use and allow Physical Education (PE) departments to quantify their students' number of steps/day. The aim of this study was to determine the effect of a pedometer intervention on body fat and BMI levels in overweight teenagers. Besides, the effects of the programme are analysed according to two other variables: pedometer ownership and gender, distinguishing between out-of-school and school hours, weekdays and weekends. The sample comprises 112 overweight students (49 boys and 63 girls) from 5 secondary schools. Participants were asked to follow a physical activity programme consisting on a minimum of 12000 and 10000 steps/day for boys and girls, respectively. It also allowed them to get up to 2 extra points in their PE marks. Results were measured after 6 weeks of programme application as well as after 6 weeks of retention. Results revealed significantly reduced BMI in the teenagers with their own pedometer ($p < 0.05$). The difference observed in the number of steps/day between boys (12050) and girls (9566) was significant in all measured time periods ($p < 0.05$). Besides, both overweight boys and girls were observed to take 1000 steps/day less at weekends than in weekdays. Therefore, it is concluded that the proposal of 12000 and 10000 steps for overweight boys and girls, respectively, accompanied by a reinforcement programme in their final PE marks, seems sufficient to obtain significant BMI reductions. Besides, PE is shown a favourable framework for the proposal of pedometer-impelled weight loss programmes in overweight youth.

Key words: Pedometer, overweight, school physical education, body mass index, body fat.

Introduction

The widespread, progressive increase in body fat in both developed and developing countries in the 21th century has become a main concern for the World Health Organisation (WHO). Unhealthy eating habits, sedentariness, and physical activity (PA) reduction are pointed out as the main reasons behind this epidemic (Hills et al., 2010). However, although the need of substituting sedentariness by regular PA in overweight students is well-grounded (Hills et al., 2010), the educational initiatives put into practice so far have not been effective enough.

It has been widely proven that parental attention, educational actions and health assistance must supplement one another in the case of overweight students (Flodmark et al., 2006), and that the school context is likely to play very relevant role regarding control and intervention in teenage overweightness (Pate et al., 2006). Physical education (PE) lessons are a particularly favourable framework for the development of programmes and attitudes aimed at increasing PA and reducing sedentariness (Cothran et al., 2010; Subramaniam and Silverman, 2007) by means of methods devised to influence students' out-of-school behaviours (Martínez-López et al., 2010; Trost et al., 2000) and more democratic, contemporary educational policies that increase participation of the youth in PE (Smith et al., 2009). For instance, pedometer quantification of their number of steps/day allows PE teachers to intervene when not in the school (Cox et al., 2006; Flohr et al., 2006; Lubans and Morgan, 2009).

Pedometers are small digital devices that detect and register step swing daily. Thus, approximate distance, speed and pace can be deduced by personalizing average step length. Pedometer use in PE is recommended by the National Association for Sport and Physical Education (NASPE) to prevent inactivity (Durrer and Schutz, 2008) and was proposed for national PA follow-up in Canadian youth (Craig et al., 2010). However, its use is still rather limited, as there is no consensus regarding the number of steps prescribed according to age and gender (Lubans and Morgan, 2009; Michalopoulou et al., 2011), in and out of school (Pal et al., 2009), weekdays and weekends (Pelclová et al., 2010). Furthermore, studies for the promotion of weight loss are still scarce in European contexts (Lubans et al., 2009a).

Although the pedometer useful tool to prevent young people from becoming overweight (Lubans and Morgan, 2008; 2009), its actual effects on real weight loss are still rather uncertain (Bravata et al., 2007), particularly as diet may well disguise the effect of pedometer-measured PA, thus resulting in BMI changes (Beets et al., 2010; Raustorp and Ekroth, 2010). Also, the main available studies are only based on body mass index (BMI) measurements. This is remarkably important as adolescence comprises important body changes such as considerable fat and muscle-mass increases, while height does not always change (Murray and Murnan, 2007). This may lead to inaccurate BMI interpretation, which may be solved by bio-electrical impedance analysis (BIA), as the

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estimation of the fat and muscle-mass indices are adjusted to the participants' body size (Wright et al., 2008).

Literature review suggests that PA monitoring measured, for instance, with pulsometers increases schoolchildren's motivation (Jaakkola et al., 2008) and that pedometer use can quantify schoolchildren's physical activity and be useful to integrate PA into the school syllabus (Oliver et al., 2006). However, pedometer use demands additional motivational measures for students to get to know how to increase their daily PA in PE (Bravata et al., 2007; Lubans et al., 2009b). Setting realistic goals (Lubans et al., 2008; Pal et al., 2009) and taking participants' social and individual differences into account (Jaakkola et al., 2008; Wilson et al., 2010) are considered key factors in pedometer interventions. Step recommendations for school students range between 11000 and 16500 steps/day (Beets et al., 2010). Girls were generally recommended to take a lower amount of steps/day (Lubans and Morgan, 2009). Besides, the socio-emotional features of overweight students may also demand specifically-adapted educational programmes which, together with the use of pedometers, are likely to favour: 1) more determined parental attention, and 2) academic reinforcement.

In the former case, a relation between time and family income, and regular PA level has been proven (Okayasu et al. 2009; Spinney and Millward, 2010). Since the time of study is negatively associated to sports and physical activity (Webber and Mearman, 2009), pedometer use does not demand obese students either additional time or adult surveillance, as it measures everyday movement. Besides, people have been observed to get involved to a greater extent when investing or expending money (Pessiglione et al. 2007; Whyte, 2009). In the latter, the need of extra motivation —not only based on the use of the pedometer yet promoted through the PE subject and based on the achievement of certain goals (e.g., extra marks on PE) —may play an important role in overweight adolescents socialization process to follow a physically active lifestyle (Jaakkola et al. 2008) and consistent relationships between goal orientations and perceptions of motivational climate (Flores et al., 2008).

Thus, we question whether the parental acquisition of a pedometer may influence parents' degree of involvement in the support and supervision of a programme aimed at controlling the weight of their children. This fact is considered particularly interesting because no study so far has proposed the use of the variable "pedometer ownership". According to the foregoing arguments, the main objective of the present work is to know the effects of a 6-week pedometer intervention programme aimed at PA promotion in overweight students, as well as determining the variations in participants' body fat and BMI 6 weeks after intervention (retention period). More precisely, it aims at: 1) quantifying the number of steps taken by overweight students during the programme, distinguishing between out-of-school and school hours, weekdays and weekends; and 2) determining the effects of the implemented programme according to two variables: pedometer ownership and gender.

Methods

This study is a longitudinal pilot study that included two groups (experimental and control). The experimental groups completed a programme based on a fixed number of steps a day; a pedometer was used for evaluation and follow-up purposes. The participants in the first experimental group (G1) used their own pedometer, while those in the second group (G2) borrowed a pedometer from the research team. The control group was subjected to no step-a-day programme and used no pedometer. BMI and body-fat measurements were carried out in the three groups in pre-, post- and retention periods.

Sample

One hundred twelve overweight students from compulsory secondary education took part in this study. Participants came from 5 Spanish secondary education schools and were randomly selected among 506 eligible students. Participant selection followed the criteria of the International Obesity Taskforce (Cole et al., 2000), which sets percentile 85 (P_{85}) as the cut-off point to classify overweight students. The average BMI values in Spanish children and youth provided by the Research Institute on Growth and Development (Orbegozo Foundation) were taken as referential values (Sobradillo et al., 2004).

Out of the 112 students selected by their BMI, three were excluded, as two of them declared having been subjected to diet interventions, and one had PA contraindications. Also seven out of the remaining 109 students abandoned the study during programme implementation: 4 students in G1 and 3 students in G2. Consequently 102 students finally completed the study. The flow of participants is shown in Figure 1. The characteristics of the participants are shown in Table 1. No significant differences were found between groups at baseline.

Instruments

The number of steps was measured with the Omron HJ-152-E pedometer (Omron, Hoofddorp, Holland). This instrument is small, light and visually-attractive, while its memory allows storing data for a week's time. Pedometer reliability was contrasted in studies completed with similar pedometers (Chia et al., 2009). A type-B class-III ASIMED weight scale (Spain) and a portable SECA 214 height scale (Germany) were used for BMI calculation. All measurements were taken with participants wearing light clothes and no shoes. For body fat and muscle mass calculation by BIA, we used the multifrequency tetrapolar body analyser *DualSystem* (SanoCare Human System, Spain) with < 1mA current and 7 fixed frequencies from 1 to 150 kHz.

Procedure

The present study was structured into two intervention groups (n = 35 and 40) and a control group (n = 34). The research protocol was revised and approved by the academic and ethical committee of the Master's Degree in Research and Teaching on Health and PA Sciences at the University of Jaén (Spain). This study was developed

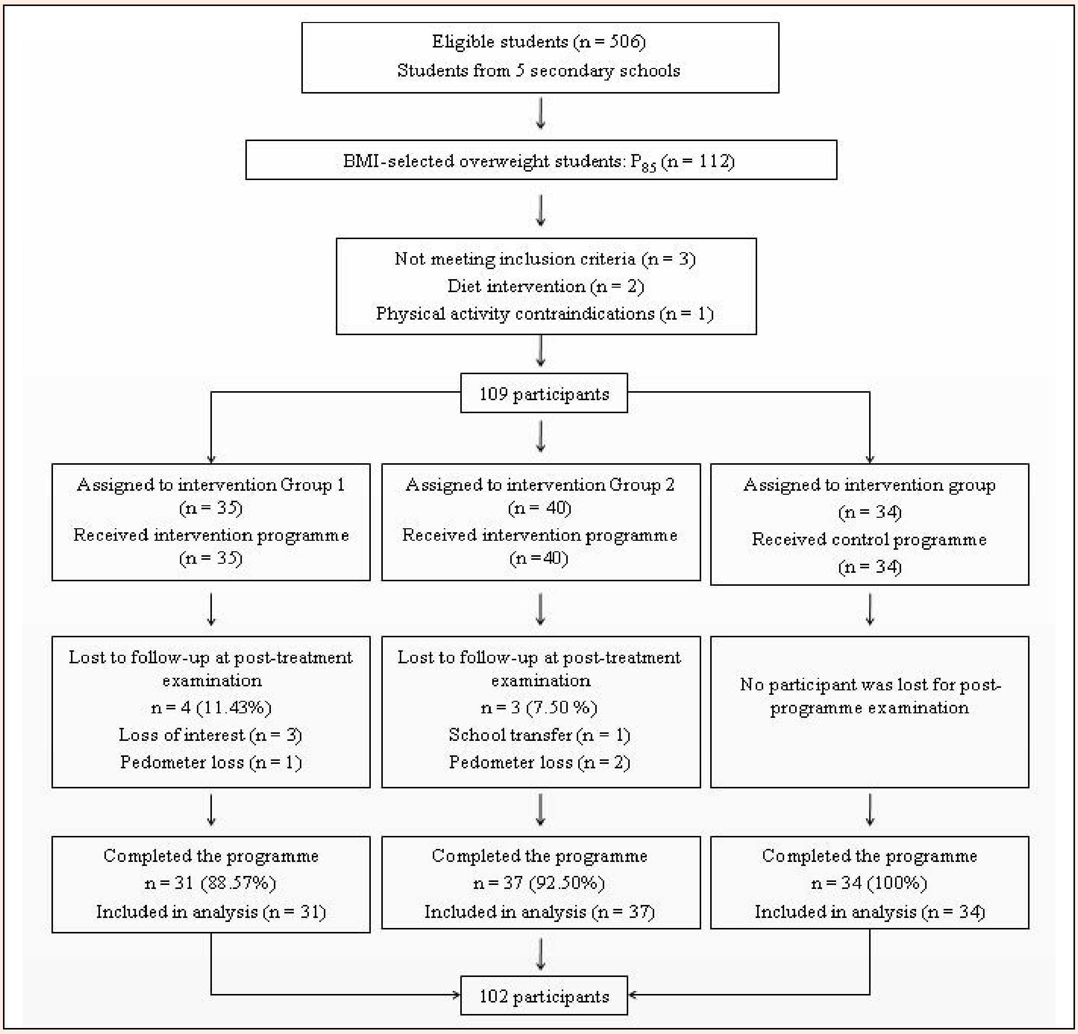

Figure 1. Flow of participants throughout the trial.

between November 2009 and December 2010 according to the ethical guidelines of the Declaration of Helsinki, last modified in 2008. It counts on the authorization of the schools involved and the expressed consent of the participants' parents or tutors after being given full information on the objectives of the study.

Programme application: Participants covered a familiarization period of two days prior to the onset of the study, and the pedometer technique was fully explained until extensive proper use was achieved. Experimental group 1 (G1) wore their own parent-purchased pedometer for 6 weeks. Each student was asked to complete a PA programme consisting of at least 12000 and 10000 steps/day for boys and girls, respectively (Tudor-Locke et al. 2008) and to wear his/her pedometer at all times, except when sleeping and bathing. The same protocol was applied and identical instructions were given to experimental group 2 (G2). However, students in this group did not wear their own pedometer, but they were borrowed from the research team.

Participants in both groups were urged to look up their number of steps at any time to check their degree of programme fulfilment. To increase their motivation towards PA, this programme enabled students to increase their final PE mark with up to 2 extra points according to their number of steps/day. The programme required boys and girls to take a minimum of 12000 and 10000 steps per day, respectively. Additional marks were given to each

Table 1. Anthropometric features of overweight students at baseline (G1 = own pedometer, G2 = borrowed pedometer, and Control Group). Values are represented as means ± (SD). P-values represent inter-group comparison.

Variable	G1 (n = 31)	G2 (n = 37)	Control (n = 34)	P value
Age (years)	14.06 (1.67)	13.81 (1.30)	13.24 (1.37)	.063
Weight (kg)	75.44 (12.80)	74.10 (9.70)	70.47 (16.34)	.105
Height (m)	1.63 (0.08)	1.62 (0.07)	1.58 (0.07)	.060
BMI ($kg·m^{-2}$)	27.94 (2.83)	28.28 (3.14)	27.83 (3.92)	.712
Body fat (%)	34.57 (4.48)	34.86 (5.55)	33.92 (4.29)	.638

participant progressively from the previous minimum amount of steps. The maximum extra marks (2 extra points) were given to those who had taken between 16000 and 14000 steps per day for boys and girls, respectively. Every day G1 and G2 participants registered their personal number of steps/day into a record and sent it to their PE teacher via e-mail or SMS message every week.

Result measurement: Students registered their number of steps/day for 6 weeks, distinguishing between school (including their journey to and back from school) and out-of-school hours, as well as between weekdays and weekends.

Regarding their anthropometric measures, each individual was measured three times corresponding to pre-study, post-study and retention test in periods of 6 weeks. All measurements were taken at the students' educational centre, where a room was fitted with a couch and measurement equipment. Measurements were taken in the following order: weight, height and BIA.

BIA is a useful tool, yet its accuracy depends on the use of an appropriate predictive equation (National Institutes of Health Technology Assessment Conference Statement, 1996). For BIA-participant adjustment, the regression equation corresponding to children and youth populations (10-19 years old) contributed by Houtkooper et al. (1996) was applied. The protocol followed for BIA application included several previous requirements such as no drinking large amounts of water, no PA 12 hours before the test, and no alcohol 24 hours before the test. Likewise, participants were asked to remove all metallic objects. Preparation of young participants for analysis was: they started in supine position lying on a non-metallic couch, relaxed, with extended limbs and hand palms on the couch, near the body. After previous cleaning of the area with alcohol, four surface electrodes were placed on their left foot and hand in the following position: 1) at metacarpophalangeal articulation level, 2) between the radius and the ulnar styloid processes, 3) at metatarsophalangeal articulation level, and 4) between the medial and the lateral ankle malleoli. Average test duration was 2 min.

Data analysis

The independent variables for statistical analysis were Group (G1 = own pedometer; G2 = borrowed pedometer, and Control Group) and gender. The average number of steps/day in school hours, weekdays, weekends, and the whole week —as well as anthropometric variables body fat and BMI— were taken as dependant variables. The ANOVA of a factor was used for initial comparison among anthropometric variables. For the analysis of steps in each mentioned period, ANOVA 2(Group)×2(Gender)×2(Time) was completed to analyse differences in the number of steps by groups (G1 and G2) and gender both pre and post. ANOVA 3(Group)×2(Gender)×3(Time) for the analysis of anthropometric measures (body fat and BMI) provided pre, post and retention results according to gender and group (G1, G2 and G Control). Post hoc analysis was adjusted by Bonferroni method. The level of significance was established at $p < 0.05$ for all procedures, performed by means of the Statistical Package for Social Sciences (SPSS, v. 18 for Windows; SPSS, Chicago). The relative percentage change between pre and post measures was calculated as follows: ((post measure – pre measure)/pre measure) x 100.

Results

During the experimental period, 51 cases were tackled (58.82% by e-mail and 41.18% on the phone): 35.29% of these were related to programme-related explanations (chart fill-in, sending, etc.), 23.52% were related to measurement attendance, place and times, 21.56% were pedometer-related, 15.68% were related to e-chart compatibility, and 3.92% to issues related to the effect of the programme on their academic marks. 31.37% of these where conducted by parents, mainly on the phone. An average of 25% of the students handed in incomplete charts (at least one blank item), which had to be filled in later. 69.12% sent them by email, while 30.88% handed in printed papers ("*Teacher, I know no other way to send it*"). Regarding pedometers, 2.94% suffered pedometer failure at some time. In half of these cases pedometers were washed with the trousers; we could recover them later on. In the other half the problem was solved by battery replacement. Besides, 4.41% of the participants lost their pedometer, which had to be replaced.

Analysis of steps in school hours, weekdays, weekends and whole week

Table 2 reports average results by group and gender at the beginning (Week 1) and end (Week 6) of pedometer use. ANOVA 2(Group)×2(Gender)×2(Time) determined 1) the main Gender effect in school hours $F(1,56) = 6.166$, weekdays $F(1,57) = 7.33$, and the whole week $F(1,57) = 7.710$, and 2) the main Time effect in all periods except in school hours [$F(1,57) = 35.53$, $F(1,57) = 28.679$ y $F(1,57) = 45$ for weekdays, weekends and whole week, respectively]. However, no interaction effects (Group×Gender, Group×Time, Gender×Time or Group×Gender×Time; $p > 0.05$) were found in any period. Detailed analysis of the main Gender effect, after 6 week of study, revealed significant differences between boys and girls in their average number of steps a week (10480 vs. 8554, $p < 0.05$ respectively). Besides, these differences accentuated ($p < 0.01$) in weekdays (10962 vs. 8858 steps) and school hours (4883 vs. 4056 steps, for boys and girls respectively). A substantial reduction in the whole-week average number of steps was observed after the sixth week up to reaching -18.48 and -21.49% fulfilment values for boys and girls, respectively. Besides, intra-group analysis reported that on weekdays, weekends and the whole week participants reduced their number of steps (12070 vs. 9789 $p < 0.001$; 10999 vs. 8449 $p < 0.001$; y 11764 vs. 9406 $p < 0.001$, respectively). No differences were observed in pre-post steps in school hour (4697 vs. 4414 $p = 0.118$). Finally, no differences were observed in the steps measured in any period between G1 and G2 during the 6 weeks of study ($p > 0.05$).

Analysis of anthropometric measures

Figure 2 represents the effect of time of pedometer use on

Table 2. **Effect of the 6-week intervention on the number of steps in overweight teenage boys and girls with their own (G1) or borrowed (G2) pedometer. Data expressed as means ± (SD): school hours (hours at school including trips to and from school), weekdays (school days), weekends (Saturday and Sunday), and whole week: (average weekday steps ×5 + average weekend steps ×2)/7.**

Period	Group	Gender	Pre (week 1) Steps/day	Post (week 6) Steps/day	P value for effect: Group	Gender	Time	Group × Sex	Group × Time	Gender × Time	Group ×Gender ×Time
School hours	Own	Male	4613 (1424)	4812 (1287)	.849	**.016**	.118	.174	.270	.119	.797
		Female	4700 (844)	4363 (771)							
		Total	4663 (1101)	4553 (1023)							
	Borrowed	Male	5135 (869)	4935 (1207)							
		Female	4412 (1475)	3813 (1209)							
		Total	4723 (1307)	4308 (1317)							
	Total	Male	914 (1141)	4883 (1217)**							
		Female	4532 (1255)	4056 (1062)**							
		Total	4697 (1212)	4414 (1195)							
Week days	Own	Male	12190 (2736)	11169 (2962)	.853	**.009**	**<.001**	.306	.069	.560	.468
		Female	11535 (2820)	9550 (2471)							
		Total	11826 (2749)	10270 (2770)							
	Borrowed	Male	13711 (3486)	10797 (3086)							
		Female	11265 (2972)	8311 (3053)							
		Total	12263 (3421)	9408 (3270)							
	Total	Male	13035 (3210)	10962 (2979)**							
		Female	11303 (2875)	8858 (2839)**							
		Total	12070 (3124)	9789 (3064)							
Week ends	Own	Male	13745 (4088)	9414 (4379)	.384	.060	**<.001**	.513	.337	.238	.237
		Female	9920 (3720)	7963 (3301)							
		Total	11620 (4275)	8608 (3810)							
	Borrowed	Male	11343 (3703)	9163 (4105)							
		Female	10222 (4508)	7961 (3175)							
		Total	10505 (4055)	9124 (3636)							
	Total	Male	12411 (3992)	9274 (4147)							
		Female	9878 (3991)	7794 (3185)							
		Total	10999 (4156)	8449 (3685)							
Whole week	Own	Male	12635 (2716)	10668 (3272)	.656	**.007**	**<.001**	.624	.319	.963	.951
		Female	11074 (2849)	9097 (2409)							
		Total	11767 (2849)	9795 (2879)							
	Borrowed	Male	13035 (3305)	10330 (3089)							
		Female	10967 (2989)	8125 (3029)							
		Total	11761 (3253)	9098 (3207)							
	Total	Male	12857 (3007)	10480 (3114)*							
		Female	10896 (2846)	8554 (2776)*							
		Total	11764 (3055)	9406 (3061)							

* and ** stand for step differences (p<0.05 and p<0.01) between boys and girls in the same measure, respectively.

body fat and BMI in each group. No differences were observed between groups (p > 0.05) in baseline in any of both study variables.

BMI analysis of variance

ANOVA 3(Group)×2(Gender)×3(Time) completed on the BMI measure provided the Group×Time interaction $F(4,192) = 5.48$, $p < 0.001$, $\eta^2 = 0.102$, yet not the Group×Time×Gender interaction (p = 0.360). More specifically, the analysis of the simple effect of Time on Group (Figure 2a) showed a significant reduction in average BMI in G1 after 6 weeks of own-pedometer use (pre = 27.95 ±2.86 kg·m^{-2} vs. post=27.64 ±2.71 kg·m^{-2}, p < 0.05). However, no significant increase was observed in average BMI in the Control Group after 6 weeks of study (pre=27.83 ±3.91 kg·m^{-2} vs. post=27.95 ±3.60 kg·m^{-2}, p > 0.05), but they were after 12 weeks (retention = 28.19 ±3.81 kg·m^{-2}, p < 0.01 regarding pre measure). Finally, BMI in G2 (borrowed pedometer) held stable along 12 weeks, as no significant differences were observed between pre, post and retention measures (p > 0.05). Analysis of the simple effect of Group on Time was not significant in any of the three measures ($F_s < 1$).

Body fat analysis of variance

ANOVA 3(Group)×2(Gender)×3(Time) on BIA measures provided the Group×Time interaction $F(4,192) = 7.02$, $p < 0.001$, $\eta^2 = 0.128$, yet no Group×Time×Gender interaction (p = 0.389). More precisely, analysis of the simple effect of Time on Group (Figure 2b) showed that, after 6 weeks of treatment, similar body fat reduction was observed in the groups that used pedometer (pre=34.57 ±4.65 vs. 34.01 ±4.60% in G1; and pre=34.90 ±4.92 vs. 34.31 ±6.01% in G2); however, differences were not significant (p > 0.05). On the contrary, body fat increased in the Control Group in post measurement (pre = 33.92 ±4.29% vs. post=34.31 ±4.08%), thus reducing significance (p < 0.05) between pre and retention measures

(M=34.75 ±3.71%). Analysis on the single effect of Group on Time was not significant in any of the three measures ($F_s < 1$).

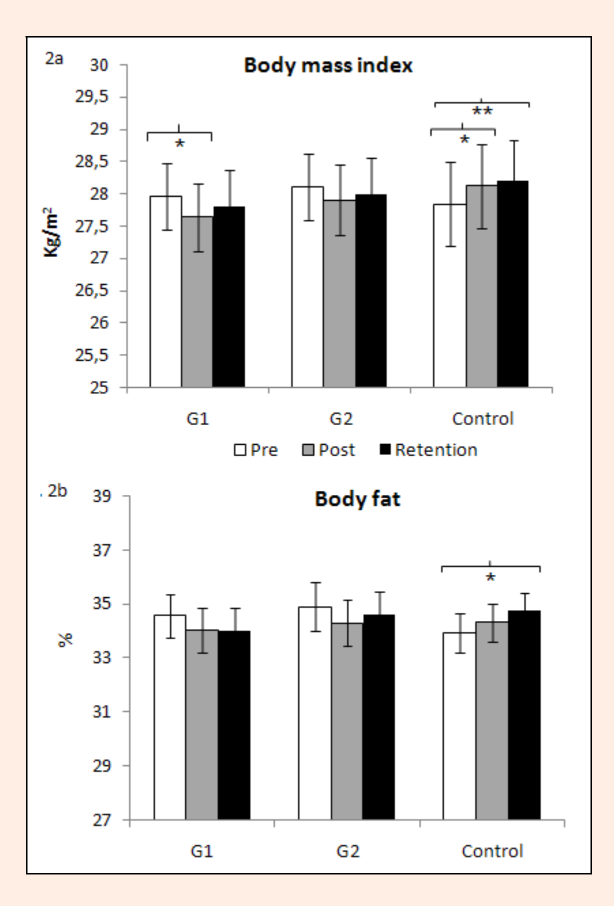

Figure 2. Graphic representation of the single effect of Time (pre = initial measurement, post = 6 weeks after pedometer use, and Retention = up to 12 weeks without pedometer) in G1 = own pedometer, G2 = borrowed pedometer, and Control Group. * $p < 0.05$, ** $p < 0.01$ stand for intra-group differences in the studied variables.

Discussion

The present work studied the effects of a 6-week pedometer intervention aimed at increasing PA in overweight schoolchildren. The programme was well-tolerated by students, as no health deterioration was observed at the end of the treatment and no injury was reported either. The programme's minimum step/day requirement was observed to be exceeded by 58.3% of boys and 41.2% of girls, while only 11 and 22.9% of them, respectively, obtained the maximum mark (2 additional points). However, after 6 weeks of intervention, motivation towards the programme's step/day requirement reduced from 63 to 47.7% in boys and from 60 to 35.5% in girls. Although the degree of fulfilment achieved in overweight individuals was rather high, exceeding those obtained by Lubans and Morgan (2008) in teenagers (32 and 33% for boys and girls, respectively), this remains one of the main problems to solve for future research, particularly as overweight youth present higher sedentariness levels (Martínez-López et al., 2009; Salmon et al., 2005; Veugelers and Fitzgerald, 2005) as well as a lower tendency to PA (Gordon-Larsen et al., 2006; Martínez-López et al., 2011). Consequently, overweight youth is far more likely to give up longer pedometer interventions prematurely.

Along the 6-week intervention, the difference observed in the number of steps/day between boys (12050) and girls (9566) was rather substantial. Nevertheless, these results are similar to those found in overweight teenagers by Beth and Parker (2008) (12592 and 10425 steps/day, in boys and girl respectively), as well as to those observed in normal-weight students by Flohr et al. (2006) (12490 and 10557 steps/day in a 2-week programme), Hohepa et al. (2008) (10849 and 9652 steps/day in a 5-day programme), and Lubans and Morgan (2009) (11865 and 9466 steps/day in a 4-day programme). None of the previous results is near those recommended by Raustorp and Ekroth (2010): 15000 for boys and 13000 for girls. Nevertheless, we must be cautious to set different amounts of steps for boys and girls, especially because we do not know whether these differences in steps can be determined by the programme's different demands for each gender.

Opposite to Duncan et al. (2007), who proved that overweight 7-12 year-olds take around 12% less steps (approx. 2000 steps/day) than normal weight teenagers, our results reveal that overweight students can adjust themselves to the step regime of their normal weight counterparts. However, we certainly believe that greater personalized adjustments become necessary to reach our goal (e.g., relating the number of steps/day to BMI variations). Both overweight boys and girls took an average number of 1000 steps/day (11%) less at weekends than in weekdays. These results are similar to those contributed by Duncan et al. (2006 and 2007), who found that children are significantly less active at weekends than in weekdays. However, they contrast with those reported by Cox et al. (2006) in 5-11 year-olds, who took a higher number of steps at weekends than in weekdays. Steps in weekdays were also observed to be mostly taken by both boys and girls (61.1 and 54.9%, respectively) out of school. Although these results are similar to those contributed by Cox et al. (2006) and Tudor-Locke et al. (2004), they are no surprise, as free-movement possibilities at school are reduced to break times, PE and journeys to and from school. Thus, increasing children's amount of PA at school seems almost impossible.

After 6 weeks of pedometer use, the average number of steps/day was 10682. The difference (10830 vs. 10535 steps/day) between G1 (own pedometer) and G2 (borrowed pedometer) was not significant at any time ($p > 0.05$). A trend towards lower BMI and body fat was observed in both groups, thus contrasting with the increased BMI reported in the control group, which is characteristic of overweight and obese students this age (Sobradillo et al., 2004). However, we pose two questions: 1) What is the progressively reduced amount of steps due to?, and 2) what explains this BMI- and body fat-reducing trend in G1 and G2 with a progressive reduction in steps/day throughout the study? Firstly, we speculate with the specific features of the studied population. For instance, obese children are more sedentary and have less physical activity than their normoweight counterparts (Martínez-López et al., 2009). This lack of adherence to PA may make them more vulnerable to modify their commitment to the steps programme prematurely. The self-determination theory is a widely-used theoretical basis to study behavioral changes in motivational loss in PE (Deci and Ryan, 2000). Although the use of the pedometer can promote autonomous motivation (Standage et al., 2008), we do not know how the positive effects associated to this motivation affected our students. Ntoumanis and Standage (2009) found that students registered in elective PE subjects showed greater autonomous motivation toward out-of-school physical activity. In the present study, although overweight teenagers took part voluntarily, their morphological features soon showed the aims of the study to their normoweight counterparts. Some of our participants may well have passed from volunteers to obliged (extrinsic motivation). That is, they may have suffered reactivity effects: behavioral changes due to knowing that one's behavior is being surveyed (Foley et al., 2011), thus leading to a progressive lack of motivation towards the programme. All the foregoing would be an important aspect to be taken into account and foresee in future research with monitored evaluation. Proposals should be aimed at both complete class groups, where weight loss-related aims can be disguised with the acquisition of healthy habits.

Secondly, some teenagers are likely to have got bored of the pedometer, thus making an intermittent use of it and thus partially omitting their daily PA. On the other hand, significant BMI and body-fat results may have been achieved leaving the last two intervention weeks aside (fifth and sixth weeks), with a lower steps/day average. Indeed, the results recalculated over the four first weeks prove that twice as many teenagers would have passed the proposed programme (data not shown). We need to improve two main aspects: 1) closer follow-up and greater reinforcement of the process by PE teachers. The teacher must show clear expectations and personal interest in the students (Taylor et al., 2009) and promote autonomous motivation (Ntoumanis and Standage, 2009) in obese young, especially from the fourth week onwards, when a sharp motivation drop was observed; and 2) a training assessment of the step programme aimed at the whole class group that allowed adjusting requirements individually according to the achieved goals.

On the other hand, we obtained greater BMI reduction in the group that used their own pedometer ($p < 0.05$). The lack of previous studies that include the aforementioned variable in intervention programmes developed from PE allows no comparison of our results. However, this may be related to people's special motivation towards weight loss in case of reward or monetary cost (Whyte, 2009), a subconscious neurological process that leads to greater efforts when earning comes into play (Pessiglione et al., 2007). Besides, willingness to pay for health improvements is influenced by higher educational, income and BMI levels (Rome et al. 2010). In fact, lack of money is one of the main barriers that lead to physical inactivity (Reichert et al., 2007, Spinney and Millward, 2010). Consequently, perceived value is proven to have a positive influence on loyalty to the service provider organization (McDougall and Levesque, 2000; Lewis and Soureli, 2006). From this viewpoint, students favoured by PE with a pedometer would feel greater commitment with the teacher. We believe that, in spite of the moderate price of pedometers (≈25 Euro = ≈32 US Dollar), pedometer ownership was proven a considerable additional motivational incentive. The parents of children with their own pedometer can be expected to get more involved in their children's overweightness and thus at the same time contribute some other additional measures (e.g., greater diet control, etc.) In fact, low socioeconomic status is associated to higher obesity indices (Aranceta et al., 2005) and, although it remains for further future research, is likely to coincide with the parents who decided not to purchase the pedometer.

We believe that pedometer utility has been proven in overweight students, so pedometers should be incorporated to PE programmes. Nevertheless, further research on pedometer ownership becomes necessary. Although their moderate price would not heavily burden PE material endowment in European educational centres, further research on their suitability seems necessary. On the other hand, in agreement with Bravata et al. (2007), Lubans et al. (2009a) and Pal et al. (2009), who related pedometer effectiveness to the establishment of realistic step goals, we believe that our results strengthen the ongoing application of step programmes with impact on PE mark. Regarding this last point, we suggest that the PE syllabus should include evaluation studies (Heinemann, 2003) in which periodical BMI or body fat measures by BIA is part of the stimulus of the expected effect. Finally, individualized follow-up guidelines regarding body fat or BMI become necessary to avoid premature demotivation in overweight youth, as well as relating programmed out-of-school activities to everyday life, all this within a morally critical pedagogical framework that tackles, from PE, the stigmatization of obese children (Kirk, 2006).

Limitations of the study

This study does not evaluate the participants' PA prior to the use of the pedometer and we cannot therefore know accurately whether this intervention effectively increased their PA levels. And by other, those specifically derived from pedometer inability to either evaluate PA intensity (Olds et al., 2010) or register other PA modes common in children and teenagers such as bicycling, climbing and swimming (Corbin et al., 2004). Likewise, we do not know if pedometers could be manipulated by the students during out-of-school hours. Also, we excluded some variables that may influence comparison with other studies such as seasonal variability (Rowlands and Hughes 2006), which strongly influences outdoor activities and therefore students' opportunities to walk, or regional climate conditions.

Conclusion

In conclusion, the proposal of 12000 and 10000 steps for overweight boys and girls, respectively, accompanied by a reinforcement programme in PE (2 extra points in the subject's final mark), seems sufficient to obtain significant BMI reductions ($p < 0.05$). Significant BMI reduction ($p < 0.05$) was observed in the teenagers with their own pedometers after 6 weeks of intervention programme. The difference observed in the number of steps/day between boys (12050) and girls (9566) was significant in all measured periods ($p < 0.05$). Both overweight boys and girls take 1000 steps/day less at weekends than in weekdays. Besides, and PE is a favourable framework for the proposal of pedometer-impelled weight loss programmes in overweight youth.

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Key points

- A programme of 12000 and 10000 steps for overweight boys and girls, respectively with reinforcement in physical education marks, the body mass index improves.
- Body mass index more reduced was in Spanish adolescent overweight that used their own pedometer.
- The steps/day between boys (12050) and girls (9566) with overweight was different ($p < 0.05$).
- Overweight boys and girls were observed to take 1000 steps/day less at weekends than in weekdays.
- In physical education is possible to apply a programme of steps in obese youth of secondary education schools.

AUTHORS BIOGRAPHY

Emilio J. MARTÍNEZ-LÓPEZ
Employment
Professor of Physical Education, Department of Musical, Plastic and Corporal Expression Didactic, Research Group HUM 653 laboratory. Universidad de Jaén, Spain.
Degree
PhD
Research interests
Young obesity, fitness training, fitness test, didactic of physical education.
E-mail: emilioml@ujaen.es

Alberto GRAO-CRUCES
Employment
Collaborator of Department of Sport and Computer Science, University of Pablo Olavide, Seville, Spain.
Degree
MSc
Research interests
Young obesity, fitness training, fitness test, didactic of physical education.
E-mail: agracru@upo.es

José E. MORAL-GARCÍA
Employment
Professor of Physical Education. Physical activity and Sport Faculty, University of Salamanca, Spain.
Degree
PhD
Research interests
Young obesity, sports and health training, didactic of physical education.
E-mail: josevilches68@hotmail.com

Antonio PANTOJA-VALLEJO
Employment
Professor of Pedagogy. Department of Pedagogy, Research Group HUM 660 laboratory, Faculty of Education sciences, University of Jaén, Spain.
Degree
PhD
Research interests
Didactic of physical education.
E-mail: apantoja@ujaen.es

✉ **Emilio J. Martínez-López**
Dpto. Didáctica de la Expresión Musical, Plástica y Corporal, Facultad de Humanidades y Ciencias de la Educación (D-2), Campus Las Lagunillas. 23071, Jaén, SPAIN