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A comprehensive physical activity promotion programme at elementary school: the effects on physical activity, physical fitness and psychosocial correlates of physical activity

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Abstract

Objective: To evaluate the effects of a comprehensive physical activity (PA) promotion programme in elementary schools on children's total PA levels, leisure-time PA, physical fitness and psychosocial correlates of PA.

Design: A pre-test–post-test design over two school years.

Setting and subjects: Sixteen elementary schools (764 children, mean age: 11.2 ± 0.7 years) were randomly assigned to the intervention condition ($n = 8$) and the control condition ($n = 8$). The intervention included a health-related physical education programme, an extracurricular PA promotion programme and classroom-based PA education lessons. In the total sample, leisure-time PA, psychosocial correlates of PA and physical fitness were measured using a PA questionnaire and the Eurofit test battery. In a sub-sample, total PA levels were measured using an accelerometer.

Results: According to accelerometer data, children's moderate PA and moderate-to-vigorous PA (MVPA) levels decreased less in the intervention schools than in the control schools ($P < 0.01$). The average time spent on MVPA decreased by 9 min per day in the intervention schools compared with 33 min per day in the control schools. Children in the intervention schools reported significantly more moderate PA in leisure time than the controls ($P < 0.05$). No overall improvement of physical fitness and no effects on the psychosocial correlates of PA were found.

Conclusions: The comprehensive PA promotion programme was successful in preventing a decline in children's total activity levels. Furthermore, the intervention increased children's PA engagement in leisure time. Therefore, implementation needs to be encouraged.

Keywords
Health promotion
Physical activity
Physical fitness
Psychosocial correlates
Youth

During childhood and adolescence, regular physical activity (PA) is associated with improvements in physiological and psychological health and is being promoted as an objective for disease prevention[1,2]. Furthermore, increasing children's overall activity may increase children's health-related physical fitness[3]. Nevertheless, a substantial proportion of young people have lower PA levels than recommended for good health[4]. In Europe, the Health Behaviour in School-aged Children survey, executed in approximately 1500 11-, 13-, and 15-year-olds in each of 35 participating countries, revealed that only 34% of all young people reported PA levels that meet the guideline of 'one hour or more of at least moderate intensity PA on five or more days a week'[5]. Furthermore, PA levels decline from childhood to adolescence and adulthood[5–8]. Therefore, the promotion of lifelong PA among youth is an important public health challenge.

The school environment is an ideal setting for the promotion of PA, since all children can be reached. Schools can provide opportunities to be physically active during physical education, during recess, and before and after school hours[9,10]. Furthermore, informing children and their parents about the importance of lifelong PA and the possibilities to be active in the community can contribute to the development of an active and healthy lifestyle.

Several intervention studies in elementary schools have attempted to increase children's PA levels at school by focusing on physical education (PE)[11,12]. School-based PE interventions were evaluated as effective in increasing children's PA levels during PE classes and in improving children's physical fitness[11]. Other intervention studies focused on school break periods to promote PA at school and reported an increase in children's activity levels during those periods[9]. However, to meet public health benefits and to promote lifelong PA, school-based interventions

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should also focus on the promotion of regular PA outside school because children spend a lot of their time in non-school environments[4]. In the literature, only a few comprehensive studies in elementary schools could be located targeting children's out-of-school PA[11,12]. In the USA, the SPARK programme (Sports, Play and Active Recreation for Kids) was designed to increase children's PA levels during PE classes and outside school by implementing a health-related PE programme and a self-management programme[13]. On the same lines, the PA component of the CATCH (Child and Adolescent Trial for Cardiovascular Health)[14,15] and Go For Health[16] programmes was designed to increase children's moderate-to-vigorous PA (MVPA) engagement during PE classes and to promote generalisation of PA. The PA component in both studies included a PE intervention and classroom health curricula. These three US studies were effective in increasing children's PA levels during PE classes. Only the CATCH study found a significant increase in children's vigorous PA outside school[12]. The CATCH study also evaluated children's psychosocial correlates of PA. A short-term effect was found early in the intervention for some of the psychosocial correlates of PA but these effects did not remain until the end of the intervention[17]. However, to maximise their effectiveness, interventions should also target changes in psychosocial correlates of PA to achieve a substantial behavioural change[4,18,19].

Since an increasing prevalence of overweight and obesity among children[20] and a PA decline with age[5,7] are also present in Europe, the implementation of interventions promoting lifelong PA seems necessary in Europe too. To date, the effectiveness of a comprehensive PA promotion programme has not yet been evaluated in Europe. However, the American programmes like SPARK, CATCH and Go For Health cannot simply be implemented in different European countries because of educational and cultural differences. Therefore, adjustments are needed.

The purpose of the present study was to evaluate the effects of a comprehensive PA promotion programme in elementary schools on total PA levels, PA levels in leisure time, physical fitness and psychosocial correlates of PA.

Methods

Participants and setting

The present study was executed in Belgium, a nation located in East the centre of Europe. Out of all elementary schools in East Flanders ($n = 486$), 16 elementary schools were selected to participate in the study by simple randomisation, taking the actual distribution over Catholic and community schools into account. Participating schools ($n = 16$) were randomly assigned to the intervention condition ($n = 8$) and the control condition ($n = 8$). Pre-test measurements were performed in all children of the fourth and fifth grade (399 boys and 411 girls, mean age: 9.7 ± 0.7 years). Post-test measurements were performed in all children of the fifth and sixth grade (373 boys and 391 girls, mean age: 11.2 ± 0.7 years). The 46 dropouts were caused by children who changed schools or who were not present on the days of data collection. The evaluation was considered to be part of the psychological, medical and social counselling provided by the school for which all parents signed a consent form ($n = 810$). All children present at school on the day of measurements participated in the study. A representative sub-sample was selected to evaluate children's total PA levels by accelerometer, including children of eight schools (four control schools, four intervention schools) randomly selected out of the 16 participating schools. All parents of the children ($n = 312$) were contacted by telephone to participate in the evaluation. The parents of 123 children (39%) gave approval for participation and returned the signed informed consent form. All 123 children participated in pre-test measurements. At post-test, 12 children were excluded from the analyses: four due to accelerometer malfunctions and eight due to sickness on the days of measurement. Finally, a representative sub-sample of 111 children (49 boys, 62 girls) was used. The study protocol was approved by the Ethics Committee of Ghent University.

A priori power analysis showed that a sample size of $n = 300$ in each group was sufficient for finding significant changes in PA in leisure time, physical fitness and psychosocial correlates of PA, and $n = 50$ in each group was necessary to find changes in accelerometer activity levels (power = 0.80, $\alpha = 0.05$). In order to account for possible dropouts, larger samples were provided.

Intervention

The intervention evaluated in the present study was developed to promote physically active lifestyles and was based on the SPARK programme of San Diego State University[13]. SPARK was designed to increase children's PA during PE classes and outside school by implementing a health-related PE intervention and a self-management programme. For the intervention in the present study, the original SPARK programme was adjusted to the educational system and the culture of Belgium (Flanders). Additionally, PA was also promoted during recess periods and lunch breaks, because elementary schools in Belgium organise several recess periods per day and have longer lunch breaks than elementary schools in the USA, making school environmental factors important for the promotion of PA.

The intervention in the present study included: (1) a health-related PE programme, (2) classroom-based health education lessons and (3) an extracurricular PA promotion programme.

Like in the SPARK PE programme, the main goal of the present health-related PE programme was to promote high levels of PA for all children during PE lessons. Additionally,

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the intervention was intended to make teachers aware of the health-promoting role of PE. In the original SPARK PE programme, structured PE curricula were provided and implemented because a substantial amount of the PE teachers were classroom teachers. In the present study, the PE teachers were not asked to follow the entire SPARK PE curriculum because all PE teachers in the present study were PE specialists and public schools in Flanders have a mandatory PE curriculum. The PE teachers of the intervention schools received a manual containing didactical guidelines and sample lessons promoting health-related PE and high activity levels, based on the SPARK principles. The PE teachers were asked to implement the didactical guidelines in all PE lessons. Additionally, the teachers were asked to give at least six of the 49 elaborated sample lessons.

The health education component, based on the self-management programme of SPARK, consisted of six lessons and three repetition lessons and was implemented by a research staff member within the existing health promotion curriculum. The lessons were designed to promote lifelong PA. Like in the SPARK self-management programme, the purpose of the health education lessons was to increase knowledge and to develop and maintain an active and healthy lifestyle by teaching skills including goal-setting, time-planning, problem-solving and self-talk. Children also received homework to promote PA outside school and to stimulate parental support for PA. Furthermore, children were informed through a brochure about sport clubs in the neighbourhood to stimulate sports participation in leisure time.

The extracurricular PA promotion programme focused on recess periods and after-school hours to promote PA. During lunch break and recesses, game equipment was provided to increase children's activity levels. Each class group of the intervention schools received a set of game equipment. Children were allowed to play outdoors with the game equipment during recesses and lunch break. The organisation was assigned to the classroom teachers. Furthermore, extracurricular physical activities were provided once a week during lunch break and after-school hours. The organised physical activities were given by an external PE teacher. Participation was on a voluntary basis. The extracurricular activities promoted positive attitudes towards PA and encouraged the children to be active in leisure time by providing activities and games that can be easily transferred towards leisure time (e.g. rope skipping, Frisbee, ball games).

Procedure

The intervention in the present study was implemented over two school years, starting in November 2002 and ending in April 2004. Pre-test measurements were performed from September to October 2002, post-test measurements from April to June 2004. In the total sample, children's PA levels in leisure time and their psychosocial correlates of PA were measured using a PA questionnaire. The 'Eurofit', a standardised physical fitness test battery, was used to evaluate children's physical fitness levels. Children's total PA levels were evaluated in a representative sub-sample of 111 children using accelerometers.

The sub-sample of 111 children wore the accelerometers for five consecutive days. On the first day, children were familiarised with the accelerometer. They were requested to wear the accelerometer during waking hours, removing the monitor only for water-based activities and sleeping. The accelerometers were worn just above the right hip bone underneath clothes and were held in place by an elastic belt. The children were also asked to record each activity performed without wearing the accelerometer on a record form (e.g. swimming, contact sports, showering), including the duration and the intensity. An accelerometer instruction form for the parents was included to ensure correct accelerometer use. After 5 days, accelerometers and record forms were collected at school.

All children received the PA questionnaire at school. They were asked to complete the PA questionnaire the same day at home together with one of their parents. A letter for the parents was added, clearly instructing that one of the parents had to assist the child in completing the entire PA questionnaire. The questionnaires were collected at school the next day.

The fitness testing was performed at all schools during PE classes in the gym room, following a standardised protocol[21].

Instruments

Accelerometer

The accelerometer has been shown to be a valid, reliable and objective method for monitoring PA in children[22,23]. In the present study, the MTI Actigraph model 7164 (Manufacturing Technologies Inc.) was used. The accelerometers were programmed to record activity counts in a 1-min sampling interval. The 1-min movement counts were downloaded into a personal computer and converted into an Excel file for subsequent analyses. To convert the total activity counts into light (<3 METs), moderate (3.0–5.9 METs) and vigorous intensity activity (>6.0 METs, where MET is metabolic equivalent), the accelerometer count cut-offs of Trost *et al.*[8] for children were used. MVPA engagement was calculated by summing the moderate- and vigorous-intensity activities. Low-, moderate- and vigorous-intensity activities were summed to indicate total PA engagement. The accelerometer data were expressed in min day^{-1}.

PA questionnaire

In previous research, the PA questionnaire, completed with parental assistance, has shown good reliability (intra-class correlation ranging from 0.68, $P < 0.01$ to 0.93,

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$P < 0.01$) and acceptable validity (r ranging from 0.27, $P < 0.05$ to 0.44, $P < 0.01$)[24].

Leisure-time PA (LTPA) was assessed by asking pupils for their main sports practised in leisure time (with a maximum of three sports). Both organised and non-organised sports were included. For each sport, the frequency and the usual time spent on that activity were reported. For coding physical activities of the questionnaire by intensity, the compendium of Ainsworth *et al.*[25] was used. Activities of 3.0–5.9 METs were defined as moderate activities and activities of >6.0 METs were defined as vigorous activities. An LTPA index of moderate intensity and an LTPA index of vigorous intensity were calculated, expressed in min day^{-1}, summing up the three main sports. An LTPA index of moderate-to-vigorous intensity was composed by summing the two indices above. Finally, questions were included on children's psychosocial correlates of PA. Children were asked about their general attitude towards PA, social support, self-efficacy, perceived barriers and benefits[26].

The Eurofit test battery

The Eurofit test battery is a valid and reliable test of physical fitness, applicable in school situations, and designed primarily for children[21]. The Eurofit test battery contains nine tests that measure different components of physical fitness: the flamingo balance test (general balance), plate tapping (speed of limb movement), sit and reach (flexibility), standing broad jump (explosive strength), hand grip (static strength), sit-ups (trunk strength and abdominal muscular endurance), bent arm hang (functional strength, arm and shoulder muscular endurance), 10 × 5 m shuttle run (running speed and agility) and 20-m endurance shuttle run (cardiorespiratory endurance). In the present study the sit-up was excluded because the sit-up strongly increases loading of the discs through activation of the iliopsoas[27]. The Eurofit test battery also contains anthropometric measures (height, body mass and body fat by the sum of five skinfolds: biceps, triceps, subscapular, suprailiac, calf). All tests were administered by trained research staff members.

Data analysis

All data were analysed using SPSS for Windows (version 12.0; SPSS Inc.). To evaluate the main effects of the intervention on children's activity levels, physical fitness and psychosocial correlates of PA, linear mixed models analysis was used on the post-test values, with condition entered as factor. School was nested within condition to take school variance into account. In addition, gender was entered as a second factor to evaluate gender differences (gender × condition). All analyses were adjusted for baseline values. The level of statistical significance was set at $P < 0.05$.

Results

Table 1 presents the effects of the intervention on children's total PA levels as measured by accelerometer. Significant effects of the intervention were seen at post-test for the time spent on moderate-intensity PA ($F = 15.32$, $P < 0.01$) and MVPA ($F = 10.26$, $P < 0.01$). The time spent on moderate-intensity PA and MVPA was significantly higher in the intervention schools than in the control schools. This represents a smaller decrease in moderate PA and MVPA engagement from baseline for the intervention schools compared with the control schools. A trend towards significance was found for total PA engagement ($F = 3.57$, $P = 0.06$), revealing that children's total PA engagement in the intervention schools was higher at post-test measurements compared with those in the control schools. This represents an increase in the total PA engagement from baseline for the intervention schools, while it decreased in the control schools. No significant effects of the intervention were seen at post-test measurements for low- and vigorous-intensity PA. No significant gender differences were found on the

Table 1 Mean scores and *F*-values for intervention effects on total PA levels in the intervention schools and control schools, as measured by accelerometer

Accelerometer (min day^{-1})	Condition	Pre-test	Post-test	*F*
Low-intensity PA	Intervention	532.73 ± 61.29	547.75 ± 57.55	0.35
	Control	527.28 ± 57.31	537.88 ± 70.98	
Moderate-intensity PA	Intervention	129.28 ± 38.40	122.90 ± 37.86	15.32**
	Control	137.53 ± 26.89	107.45 ± 27.11	
Vigorous-intensity PA	Intervention	21.48 ± 12.74	18.59 ± 12.76	0.01
	Control	20.98 ± 11.60	17.68 ± 11.28	
Moderate-to-vigorous PA (= MVPA engagement)	Intervention	150.75 ± 48.17	141.50 ± 46.84	10.26**
	Control	158.51 ± 30.84	125.13 ± 33.52	
Low-to-vigorous PA (= total PA engagement)	Intervention	683.48 ± 64.52	689.25 ± 64.83	3.57(*)
	Control	685.79 ± 57.27	663.01 ± 72.84	

PA – physical activity; MVPA – moderate-to-vigorous physical activity.
Data are presented as mean ± standard deviation.
*, $P < 0.05$; **, $P < 0.01$; (*) indicates trend towards significance.

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accelerometer data, which shows that the intervention effects were similar for boys and girls.

The effects of the intervention on LTPA and the psychosocial correlates of PA, measured by the PA questionnaire, are presented in Table 2. A significant intervention effect was found for the LTPA index of moderate intensity ($F = 5.23$, $P < 0.05$). At post-test, children in the intervention schools engaged in more moderate-intensity PA in leisure time compared with children in the control schools. This represents an increase in the time spent on moderate-intensity PA in leisure time from baseline in the intervention schools, while it decreased slightly in the control schools. A trend towards significance was found for the LTPA index of moderate-to-vigorous intensity ($F = 4.50$, $P = 0.06$), revealing a higher MVPA engagement in leisure time in the intervention schools compared with the control schools. This represents a larger increase from baseline in MVPA engagement in the intervention condition than in the control condition. No significant intervention effects were found for the LTPA index of high intensity at post-test. No significant gender differences were found.

For the psychosocial correlates of PA, no significant effects of the intervention were seen at post-test measurements and no significant gender differences were found.

Table 3 presents the intervention effects on physical fitness as measured by the Eurofit test battery. No significant effects of the intervention were seen at post-test for the different physical fitness tests. Significant intervention effects were found for the anthropometric measures. Children's height ($F = 5.77$, $P < 0.01$) and sum of skinfolds ($F = 5.24$, $P < 0.05$) were significantly higher in the control schools than in the intervention schools. This represents a slightly larger increase from baseline in height and the sum of skinfolds in the control condition compared with the intervention condition. A significant gender difference was found for explosive strength (standing broad jump) ($F = 4.63$, $P < 0.05$). In girls, explosive strength at post-test measurements was significantly higher in the intervention schools than in the control schools.

Discussion

The aim of the present study was to evaluate the effects of a comprehensive PA promotion programme in elementary-school children. The present study findings indicate that the intervention was effective in promoting PA. The intervention was successful in preventing a decline in children's total MVPA engagement. Furthermore, the intervention increased children's LTPA.

The accelerometer data showed a clear intervention effect on children's total activity levels. The intervention succeeded in preventing a decrease in children's daily moderate PA and MVPA engagement. The average daily time spent on MVPA decreased by only 9 min in the intervention schools, compared with 33 min in the control schools. Furthermore, a trend for significance was found in children's total daily PA engagement, revealing an increase in children's total activity levels in the intervention condition by 6 min daily while it decreased by 23 min daily in the control condition. The results of the control condition support previous findings that PA levels decline

Table 2 Mean scores and *F*-values for intervention effects on LTPA and psychosocial correlates of PA in the intervention schools and control schools, as measured by the PA questionnaire

Questionnaire	Condition	Pre-test	Post-test	*F*
Physical activity (min day^{-1})				
LTPA index of moderate intensity	Intervention	9.70 ± 16.19	12.25 ± 18.44	5.23*
	Control	8.99 ± 16.57	8.66 ± 15.40	
LTPA index of high intensity	Intervention	14.10 ± 18.77	15.96 ± 20.01	0.33
	Control	12.31 ± 17.76	14.01 ± 19.04	
LTPA index of moderate to high intensity	Intervention	23.80 ± 21.68	28.20 ± 24.66	4.50(*)
	Control	21.30 ± 22.44	22.67 ± 21.83	
Psychosocial correlates of PA†				
Attitude: PA is pleasant	Intervention	4.22 ± 0.81	4.22 ± 0.78	0.49
	Control	4.18 ± 0.84	4.26 ± 0.79	
Attitude: PA is safe	Intervention	3.65 ± 0.65	3.67 ± 0.66	0.24
	Control	3.56 ± 0.59	3.67 ± 0.61	
Self-efficacy for PA	Intervention	3.60 ± 0.99	3.71 ± 0.93	0.53
	Control	3.45 ± 1.00	3.65 ± 0.94	
Social support	Intervention	3.47 ± 0.90	3.43 ± 0.89	0.12
	Control	3.41 ± 0.90	3.50 ± 0.89	
Perceived barriers	Intervention	1.98 ± 0.80	1.91 ± 0.70	0.51
	Control	2.22 ± 0.86	2.03 ± 0.74	
Perceived benefits	Intervention	3.55 ± 0.71	3.54 ± 0.61	0.08
	Control	3.58 ± 0.71	3.57 ± 0.62	

LTPA – leisure-time physical activity; PA – physical activity.
Data are presented as mean ± standard deviation.
* $P < 0.05$; **, $P < 0.01$; (*) indicates trend toward significance.
† Response is on a 5-point scale (1 = strongly disagree, 5 = strongly agree).

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Table 3 Mean scores and *F*-values for intervention effects and gender differences on physical fitness, as measured by the Eurofit test battery

		Pre-test			Post-test			*F*	
Eurofit test battery	Condition	Total sample	Boys	Girls	Total sample	Boys	Girls	Intervention effects	Gender differences
Eurofit physical fitness									
Balance (trials/60 s)	Intervention	16.01 ± 5.28	16.52 ± 5.21	15.54 ± 5.32	15.37 ± 5.09	15.71 ± 4.76	15.05 ± 5.38	0.01	0.38
	Control	18.04 ± 4.48	18.18 ± 4.30	17.91 ± 4.64	15.87 ± 4.78	15.93 ± 4.38	15.82 ± 5.12		
Plate tapping (s)	Intervention	16.35 ± 2.49	16.41 ± 2.52	16.30 ± 2.48	13.35 ± 1.58	13.45 ± 1.54	13.25 ± 1.61	0.05	0.01
	Control	16.21 ± 2.44	16.04 ± 2.36	16.37 ± 2.50	13.35 ± 1.53	13.33 ± 1.35	13.36 ± 1.69		
Sit and reach (cm)	Intervention	17.96 ± 6.90	15.98 ± 6.63	19.84 ± 6.63	16.69 ± 7.56	13.92 ± 6.61	19.33 ± 7.48	0.01	1.03
	Control	17.56 ± 7.13	16.31 ± 6.43	18.69 ± 7.55	16.32 ± 7.67	14.51 ± 6.74	17.97 ± 8.10		
Standing broad jump (cm)	Intervention	144.62 ± 19.98	150.87 ± 17.98	138.69 ± 20.04	155.74 ± 20.85	160.83 ± 18.19	150.91 ± 22.17	0.44	4.63*
	Control	140.42 ± 19.56	146.30 ± 17.27	135.07 ± 20.02	150.93 ± 22.08	158.34 ± 18.61	144.18 ± 22.87		
Hand grip strength (kg)	Intervention	16.49 ± 3.46	17.08 ± 3.49	15.93 ± 3.35	20.05 ± 4.26	20.20 ± 3.90	19.91 ± 4.57	1.32	0.55
	Control	16.18 ± 3.74	17.00 ± 3.82	15.42 ± 3.51	20.26 ± 4.79	20.96 ± 4.79	19.62 ± 4.72		
Bent arm hang (s)	Intervention	12.92 ± 12.48	15.70 ± 13.41	11.14 ± 10.99	14.01 ± 12.89	17.02 ± 14.16	11.14 ± 10.84	0.41	2.72
	Control	11.37 ± 12.61	13.86 ± 13.07	9.02 ± 11.67	12.40 ± 12.85	16.30 ± 14.32	8.72 ± 10.02		
Speed shuttle run (s)	Intervention	21.61 ± 1.95	21.24 ± 1.92	21.96 ± 1.91	22.26 ± 1.62	21.96 ± 1.61	22.55 ± 1.58	0.55	0.01
	Control	23.19 ± 2.17	22.92 ± 2.01	23.71 ± 2.19	22.63 ± 1.58	22.89 ± 1.54	23.71 ± 1.56		
Endurance shuttle run (min)	Intervention	3.94 ± 1.89	4.71 ± 1.99	3.21 ± 1.46	4.23 ± 1.77	4.91 ± 1.85	3.58 ± 1.41	0.13	1.07
	Control	3.34 ± 1.87	3.90 ± 1.99	2.81 ± 1.59	3.72 ± 1.85	4.41 ± 1.95	3.08 ± 1.49		
Anthropometric parameters									
Height (m)	Intervention	1.40 ± 0.07	1.40 ± 0.07	1.40 ± 0.08	1.48 ± 0.08	1.48 ± 0.07	1.50 ± 0.08	5.77**	1.84
	Control	1.40 ± 0.08	1.40 ± 0.08	1.40 ± 0.08	1.49 ± 0.08	1.49 ± 0.08	1.50 ± 0.08		
Body mass (kg)	Intervention	33.78 ± 7.10	33.08 ± 6.66	34.42 ± 7.45	40.11 ± 8.80	38.83 ± 8.31	41.30 ± 9.09	3.19	0.37
	Control	34.62 ± 7.91	34.03 ± 6.95	35.16 ± 8.70	42.07 ± 10.74	40.91 ± 9.43	43.16 ± 11.75		
Sum of skinfolds (mm)	Intervention	50.77 ± 25.00	44.25 ± 24.30	56.93 ± 24.13	55.56 ± 27.79	49.39 ± 26.62	61.39 ± 27.67	5.24*	2.22
	Control	52.01 ± 27.30	44.88 ± 24.94	58.83 ± 27.79	64.04 ± 39.67	54.93 ± 35.19	72.74 ± 41.81		

Data are presented as mean ± standard deviation.
*, $P < 0.05$; **, $P < 0.01$.

with age[5–8]. From the beginning of the intervention (mean age: 9.7 ± 0.7 years) until the end of the intervention (mean age: 11.2 ± 0.7 years), a clear decrease in PA levels was found. This is in line with the study of Trost *et al.*[8], who argued that the age-related decline in PA already starts at elementary school. The PA intervention, evaluated in the present study, was able to reduce this decrease to a large extent. No gender differences were found for children's total activity levels, implying that the intervention was as effective in boys as in girls. This is an important finding from a public health perspective, since girls are typically at risk for low activity levels, even at young age[4,7]. On the other hand, no significant effects were found for vigorous PA in the current study. A possible explanation could be that the intervention was especially designed to promote lifelong PA and that most lifetime activities are typically of moderate intensity. In addition, accelerometers averaged children's activity over a 1-min epoch, levelling down vigorous-intensity activities. However, additional attention may be needed for the promotion of vigorous-intensity activities.

Self-reported PA measurements indicated that the intervention was effective in increasing children's moderate PA and MVPA in leisure time. Again, no effects were found on vigorous activities. Furthermore, no gender differences were found, implying that the intervention was as effective in boys as in girls. In the literature, only one intervention study in elementary schools could be located that was effective in increasing children's LTPA[12]. In reporting the effects of the CATCH programme in fifth-grade children, Luepker *et al.*[14,15] indicated that children in the intervention group reported significantly more daily vigorous activity than the control group. The SPARK programme and Go For Health study found no changes in children's out-of-school PA[12]. In their evaluation of a nutrition and physical activity programme in elementary-school children, Donnelly *et al.*[28] found that self-reported out-of-school PA increased in the control condition and decreased in the intervention condition.

The intervention in the present study was expected to improve children's physical fitness by increasing children's activity levels. However, no overall improvement of physical fitness was found in the intervention condition. A possible explanation could be that both conditions already had good scores for the different fitness tests at pre-test compared with the Eurofit profile charts of Flemish youth[29]. Furthermore, the primary aim of the study was to improve children's activity levels. In addition, significant intervention effects for PA were found mainly for moderate-intensity activities and not for vigorous-intensity activities. Because improvements in physical fitness are associated with participation in both moderate- and vigorous-intensity PA[3], the lack of increased vigorous-intensity activity in the intervention condition could also explain this finding. Other intervention studies in elementary schools also reported no effects on children's physical fitness[14,15,28]. The anthropometric parameters showed a slightly more favourable evolution in the intervention schools compared with the control schools. However, the inclusion of measurements of children's puberty stage and maturation would be required to examine if this evolution can be attributed to the intervention or not.

In the present study, no significant effects were found on children's psychosocial correlates of PA, which is probably due to a ceiling effect. Children's psychosocial correlates of PA were already quite positive in both conditions at pre-test, making it difficult to find significant improvements. These results are in line with those of the CATCH study, which also failed to find effects on children's psychosocial correlates of PA after two years of intervention[17].

Drawbacks of the present study are the quasi-experimental design of the study and the small number of schools involved.

A strong point of the present study is that the PA intervention integrated several school environmental factors to promote lifelong PA, including PE lessons, health education lessons, recess periods and after-school hours. Furthermore, the intervention is not expensive and most components can be implemented within existing school programmes by the schools themselves. However, it may be useful to incorporate health education regarding PA promotion in the professional course of future primary-school teachers, enabling them to implement health principles in their daily work and to enter into a professional career with a positive attitude towards PA promotion. In the present study, positive intervention effects were found for children's total PA and PA performed in leisure time. However, more research is needed to further evaluate which aspects of the intervention were most successful and which aspects need to be adjusted or improved. Although the more comprehensive approach makes it difficult to identify which aspects of the intervention were successful, we believe that such an approach is more appropriate to target children's physical activity behaviour, which is influenced by a diversity of factors.

It can be concluded that the comprehensive PA intervention, combining a health-related PE intervention, health education lessons and an extracurricular PA promotion programme, was effective in promoting PA in elementary-school children. Because many European young people have lower PA levels than recommended for good health, the implementation of such interventions needs to be encouraged.

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