School-Based Health Promotion and Physical Activity During and After School Hours

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KEY WORDS
child, health promotion, physical activity, school health

ABBREVIATIONS
APPLE Schools—Alberta Project Promoting Active Living and Healthy Eating in Schools
CI—confidence interval
CSH—comprehensive school health
PA—physical activity

Ms Vander Ploeg conducted the data analyses and interpretations and drafted and critically revised the manuscript; and Drs McGavock and Maximova analyzed and interpreted the data and reviewed and critically revised the manuscript. Dr Veugelers conceived and designed the study, data collection tools, and procedures; interpreted the data; and reviewed and critically revised the manuscript. All authors approved the final manuscript as submitted.

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WHAT'S KNOWN ON THIS SUBJECT: The effects of previous school-based physical activity promotion interventions have been modest, and none have demonstrated significant or meaningful increases in children's physical activity outside of school, a period characterized by disproportionally low levels of physical activity in youth.

WHAT THIS STUDY ADDS: This study adds to the evidence-base for the effectiveness of comprehensive school health programs by demonstrating that such novel interventions lead to statistically significant, meaningful increases in the amount of physical activity children achieved on weekends and after school hours.

abstract

OBJECTIVES: Comprehensive school health (CSH) is a multifaceted approach to health promotion. A key objective of CSH is to foster positive health behaviors outside of school. This study examined the 2-year change in physical activity during and after school among students participating in a CSH intervention in Edmonton, Alberta, Canada.

METHODS: This was a quasi-experimental, pre–post trial with a parallel, nonequivalent control group. Intervention schools had to be located in socioeconomically disadvantaged neighborhoods. In the spring of 2009 and 2011, pedometer recordings (7 full days) and demographic data were collected from cross-sectional samples of fifth grade students from 10 intervention schools and 20 comparison schools. A total of 1157 students participated in the study. Analyses were adjusted for potential confounders and the clustered design.

RESULTS: Relative to 2009, children in 2011 were more active on schools days (1172 steps per day; $P < .001$) and on weekends (1450 steps per day; $P < .001$). However, the increase in mean steps between 2009 and 2011 was greater in CSH intervention schools than in comparison schools (school days: 1221 steps per day; $P = .009$; weekends: 2001 steps per day; $P = .005$). These increases remained significant after adjusting for gender and overweight status.

CONCLUSIONS: These findings provide evidence of the effectiveness of CSH to affect children's physical activity during and outside of school. Results of this study justify broader implementation of effective CSH interventions for physical activity promotion and obesity prevention in the long term. *Pediatrics* 2014;133:e371–e378

Physical activity (PA) is a primary determinant of optimal growth and health in children. Children who achieve 60 minutes of moderate to vigorous PA daily are less likely to experience excess body weight and develop obesity-related chronic diseases.[1,2] Given that only 6% to 20% of children in developed countries achieve the recommended 60 minutes of moderate to vigorous PA daily[3,4] and that 20% to 40% are overweight,[5,6] there is a need for novel interventions that increase PA in children.

Schools are considered an ideal setting to deliver interventions that increase PA and prevent childhood obesity.[7] The World Health Organization recommends that school-based interventions use a comprehensive approach for health promotion.[8] This approach, known in Canada as comprehensive school health (CSH), is multifaceted and involves parents, communities, and stakeholders to provide supportive policies, programs, and environments in the whole school community.[9] In the United States, CSH is referred to as coordinated school health, whereas the synonymous term health-promoting schools is used in Australia and Europe. Annapolis Valley Health Promoting Schools[10] and Action Schools! BC[11] are flagship examples of CSH in Canada and are associated with increased PA[10–12] and lower body weights.[11] In the United States, implementation of CSH or multifaceted approaches significantly increased PA levels in school-aged children.[13–16] Although school programs have increased PA in youth, reviews suggest that their effects are modest.[17–20] The Alberta Project Promoting Active Living and Healthy Eating in Schools (APPLE Schools) builds on and extends previous school-based health promotion interventions by offering the placement of a full-time staff member dedicated to facilitating healthy living programming and curricula.[21,22]

A key objective of CSH is to foster positive health behaviors beyond the school environment.[9] Most studies to date, however, have quantified the effectiveness of school programs in terms of mean daily PA or PA accumulated during school time.[10,11,13,21] Very few have extended their observations beyond school hours, and none have demonstrated meaningful or significant improvements beyond school hours, a period characterized by low PA in youth.[23–28] To determine if the novel APPLE Schools CSH program effectively increased PA in children (particularly outside of school), we designed a quasi-experimental trial to test the hypothesis that, compared with children receiving standard curriculum, children in schools implementing the APPLE Schools model of CSH would display significantly higher levels of PA, particularly outside of school hours.

METHODS

Study Design

This was a quasi-experimental, pre–post trial with a parallel, nonequivalent control group. The APPLE Schools intervention began in January 2008 and lasted through June 2011 and was implemented school-wide. Cross-sectional samples of fifth grade students were recruited for measurement in the spring each year from 2008 to 2011. This design allowed intervention effects to be assessed over time at the school level, while controlling for measurement bias. Grade five students were of interest because most are prepubescent.[29] Accordingly, boys and girls have similar body compositions[30,31] and have not experienced pubertal weight gain[32] or marked declines in PA.[12,33,34]

The APPLE Schools program targeted schools "in need of health promotion" and therefore elected not to use a clustered, randomized controlled design. Separate selection procedures were used to recruit intervention and comparison schools. Schools were considered for the intervention if they were located within socioeconomically disadvantaged neighborhoods and the school principal was willing to support the intervention and research. Based on these criteria, 10 potential schools located in the city of Edmonton and surrounding area were identified. All 10 schools invited agreed to participate. The comparison sample consisted of 20 schools also located in the Edmonton area. Comparison schools were drawn from a sample of randomly selected schools that participated in the 2008 Raising Healthy Eating and Active Living Kids Alberta survey.[35] All 20 schools that were invited agreed to participate.

Population

Within each school, all fifth grade classes and students were invited to participate in the study. Among the 10 APPLE Schools in 2009, home surveys and consent forms were provided to all 412 fifth grade students for their parents to complete and return to school. A total of 358 parents completed surveys (completion rate: 86.9%) and provided their consent for their child to participate. All students with parental consent assented to participate and completed student surveys; 198 of these students also provided complete pedometer recordings and were included in analyses (completion rate: 48.1%). In 2011, only 339 youth were enrolled in grade 5 within APPLE Schools; however, the survey completion rates and pedometer data collection were similar (57.8%). In 2009 and 2011, a total of 845 and 680 surveys, respectively, were provided to fifth grade students within the 20 comparison schools. Completion rates of the survey and pedometer data collection were similar in the comparison schools in 2009 (53.7%) and 2011 (45.4%). Comparison schools also had fewer fifth grade students in 2011 than in 2009.

APPLE Schools Intervention

The APPLE Schools program uses a CSH approach "to make the healthy choice

the easy choice." A key component of the intervention was the placement of a full-time school health facilitator in each school. Their role was to facilitate the development and implementation of the project, to ensure that it met the schools' unique needs for health promotion, and that it aligned with the core principles of CSH. These staff members received 6 weeks of extensive training in PA, nutrition, creating positive social environments, and facilitation strategies to foster increased capacity and sustainability of the intervention. Stakeholders from each school developed an action plan outlining specific goals, objectives, and actions for the project, which fit within the following 4 objectives of APPLE Schools: (1) to improve healthy living habits of students; (2) to increase knowledge about healthy living for the whole school community; (3) to apply and sustain CSH in school communities; and (4) to sustain capacity for healthy environments in school communities.[22] Comparison schools did not have access to a school health facilitator or the strategies and materials used in APPLE Schools, although these schools received materials to implement Alberta Health's provincial Healthy Weights Initiative. This initiative is a public information and education campaign designed to support and encourage inhabitants of Alberta to lead healthier lifestyles.[36] During the study period, there was also a provincial policy in place mandating that schools provide a minimum of 30 minutes of daily PA to students in grades 1 through 9.[37]

Outcome of Interest: PA

PA was determined by using the Omron HJ-720 ITC time-stamped pedometer (Omron Canada Inc, Toronto, Ontario, Canada). The accuracy and validity of the Omron pedometer have been demonstrated under various conditions.[38–41] Students were asked to wear the pedometers for 9 consecutive days on the right hip directly in line with the knee during all waking hours unless showering, swimming, or participating in activities that an adult deemed unsafe. Students were also asked to keep a log of daily activities, including the duration and whether the pedometer was worn.

Assessment of Potential Confounders

Students' gender was self-reported. Evaluation assistants measured students' height and body weight. Height was measured to the nearest 0.1 cm. Body weight was measured to the nearest 0.1 kg on calibrated digital scales. BMI was calculated as weight (kilograms) divided by height squared. Overweight and obesity were defined by using the International Obesity Task Force age- and gender- specific BMI cutoff points.[42] Information on parent educational attainment (secondary school or less; community college; university/graduate school) and household income ($50 000 or less; $50 001–$100 000; more than $100 000) were collected from parent responses in the home survey and used as a proxy for socioeconomic status. Class sizes in Alberta follow the Alberta Education recommendation[43] and were therefore considered to be balanced between groups and not included in modeling procedures.

Statistical Analyses

Due to differing administration and collection times, and potential reactivity to the pedometers, step counts from the first and ninth day were not considered in analyses. A valid PA data file was defined as a minimum of 8 hours of wear time[44] on a minimum of 2 school days (Monday–Friday) and 1 non–school day (weekend and holidays). Pedometer-measured steps were complemented with step equivalents of nonambulatory and non–wear time activities recorded in activity diaries by using established modeling procedures (described in detail elsewhere).[28]

Students' step counts were averaged to represent a typical week (ie, 5 school days and 2 non–school days). Active transportation to school was classified as PA accumulated "during school hours" because these activities are characteristic of behaviors on school days and school attendance. Therefore, PA occurring during school hours was defined as PA between 8:00 AM and 3:59 PM, and PA between 7:00–7:59 AM and 4:00–8:59 PM was defined as non–school hours. Steps were normalized to hourly accumulated steps during these periods by dividing total steps by 8 and 6 hours, respectively. Because other researchers have considered active transport during non–school hours,[23,26,45] we repeated the analyses to include PA achieved from 7:00–8:59 AM and from 3:00–8:59 PM as non–school hour PA (Appendix). The outcome variables generally followed a normal distribution.

The normality assumption of the PA data was assessed by using distributional diagnostic plots and log-transformation. Differences in PA levels and participant characteristics from 2009 to 2011 were assessed by using t tests and χ^2 tests, respectively. To account for the clustering of students' observations within schools, multilevel linear regression methods were used to examine the effect of APPLE Schools on children's PA. Specifically, we used mixed models with schools as a random effect. We created an interaction term defined as the product of the binary variables intervention (0 = comparison schools, 1 = APPLE Schools) and time (0 = 2009, 1 = 2011) to assess the effect of APPLE Schools. This term represents the 2-year change among students attending APPLE Schools relative to the change among students attending comparison schools. All models included gender, household income, and parental educational attainment to adjust for their confounding potential. For each outcome, we also fit a 3-way interaction

term between the main effect of interest and gender (intervention*time*gender) and overweight (intervention*time*overweight). The intraclass correlation coefficient of each outcome was also calculated. Stata version 12 (Stata Corp, College Station, TX) was used to perform the statistical analyses. This study, including data collection and informed parental consent forms, was approved by the Health Research Ethics Board at the University of Alberta.

RESULTS

Characteristics of grade five students within intervention and comparison schools in 2009 and 2011 are presented in Table 1. In 2009, children accumulated a mean ± SD of 12 311 ± 3767 and 10 555 ± 5491 steps per day on school days and non–school days, respectively. Students' mean age was 10.9 years, and 49.5% were girls. Approximately 25% of children came from households of low income or low parental education, and 33.8% of the entire cohort was overweight or obese. In 2011, the proportion of overweight students was slightly lower (31.9% vs 33.8%; $\chi^2 = 0.75$, $P = .39$) and household income (higher than $100 000: 45.1% vs 37.5%; $\chi^2 = 7.26$, $P = .007$) and parental education (university or graduate school: 34.8% vs 29.2%; $\chi^2 = 6.25$, $P = .012$) were higher. The distribution of boys and girls was identical in both the intervention and comparison schools. Compared with students who provided valid pedometer data, those who did not were more likely to be boys (44.6% vs 31.1%; $\chi^2 = 36.09$, $P < .001$) and overweight (38.5% vs 33%; $\chi^2 = 4.33$, $P = .037$). In addition, the failure to provide valid pedometer data was more common in 2011 compared with 2009 (42.2% vs 34.9%; $\chi^2 = 10.86$, $P < .001$).

In 2009, students from intervention schools achieved ~2000 (12.9%) fewer steps daily than students from comparison schools (10 707 vs 12 292 steps per day; $P < .001$) (Table 1). Differences in PA were most evident on non–school days compared with school days. Relative to students from comparison schools, students from intervention schools were also more likely to be overweight (31.3% vs 38.3%; $\chi^2 = 4.7$, $P = .03$) and to come from households making less than $50 000 annually (18.1% vs 34.7%; $\chi^2 = 23.1$, $P < .001$).

Daily and hourly step-counts increased between 2009 and 2011 in both intervention and comparison schools, although the increase was less pronounced in children from comparison schools (Table 1). Specifically, during a typical week, PA increased by 21.1% in APPLE Schools and by 6.7% in comparison schools. In multilevel analyses, adjusted for gender and socioeconomic status proxies, children with 3 years of "exposure" to the APPLE Schools intervention (2011) achieved an additional 2152 steps per day on school days (95% confidence interval [CI]: 1415 to 2888), 2936 steps per day (95% CI: 1802 to 4069) on non–school days, and 2341 steps per day (95% CI: 1604 to 3079) during a typical week compared with children with only 1 year of exposure (2009). In adjusted multilevel analyses, 3 years of exposure to APPLE Schools was associated with greater steps per hour during both school hours (87 steps per hour; 95% CI: 39 to 135) and non–school hours (239 steps per hour; 95% CI: 153 to 324) than those with 1 year of exposure to the intervention.

A significant interaction was observed between group and time in the adjusted multilevel model, such that children from APPLE Schools experienced increases of 1221 steps per day (95% CI: 306 to 2135) on school days, 2001 steps per day (95% CI: 600 to 3402) on weekend days, and 1399 steps per day (95% CI: 485 to 2312) during a typical week beyond the increases observed on these days among children from comparison schools (Table 2). The intervention effect was also significant when assessing the change in hourly steps outside of school hours between APPLE Schools and comparison schools ($\beta^{**} = 137$; 95% CI: 31 to 242). Exposure to APPLE Schools effectively normalized PA levels in the intervention schools relative to those in the comparison schools (postintervention steps per day during a typical week: APPLE Schools, 12 966; comparison school, 13 120 [$P = .67$]). None of the 3-way interaction terms for gender or overweight were statistically significant for any outcome; therefore, we are certain that there were no gender-specific or weight group–specific effects of the intervention.

DISCUSSION

To our knowledge, this is the first comprehensive study of the effectiveness of CSH on PA levels in elementary schoolchildren that used full-time, school-based facilitators dedicated to healthy living in each school. The data presented here support observational studies[10] and randomized controlled trials[11,13,14,46] by providing experimental evidence that creating environments which support healthy eating and active living leads to changes in PA in children. Furthermore, the data expand on these studies by demonstrating that a more intensive form of CSH elicits significant, clinically relevant increases in PA. Finally, and most importantly, the results of this study provide evidence that behaviors learned while "exposed" to CSH extend beyond the school environment and are transferred to non–school days. Collectively, these data provide compelling evidence that the APPLE Schools model of CSH is an effective approach for the promotion of PA in youth.

CSH programs that successfully elicited behavior change in children have included formal curricula[13,15] or customizable strategies, actions, and resources developed by school committees based

TABLE 1 Characteristics of Fifth Grade Students Attending APPLE Schools and Comparison Schools in 2009 and 2011

Characteristic	APPLE Schools			Comparison Schools		
	2009	2011	P^a	2009	2011	P^a
No. of schools	10	10		20	20	
No. of students	198	196		454	309	
PA, mean ± SD			<.001			<.05
School days, steps/d	11 371 ± 3306	13 375 ± 3653		12 723 ± 3885	13 550 ± 4188	
Non–school days, steps/d	9048 ± 5317	11 944 ± 6651		11 216 ± 5441	12 044 ± 6072	
Typical week, steps/d	10 707 ± 3331	12 966 ± 3898		12 292 ± 3779	13 120 ± 4127	
School hours, steps/h	850 ± 233	933 ± 222		944 ± 271	978 ± 271	
Non–school hours, steps/h	762 ± 356	986 ± 419		861 ± 423	954 ± 491	
Gender, %						
Girls	47.2	51.0		50.8	49.1	
Boys	52.8	49.0		49.2	50.9	
Household income, %			<.05			
<$50 000	34.7	33.2		18.1	17.8	
$50 001–$100 000	40.0	31.2		37.2	31.8	
>$100 001	25.3	35.6		44.6	50.4	
Parental education, %						<.05
Secondary school or less	31.9	26.0		27.9	19.8	
Community college	39.1	39.9		42.8	45.1	
University or graduate	29.0	34.1		29.3	35.1	
Overweight, %	38.3	35.2		31.3	30.1	

Typical week comprised 5 school days and 2 non–school days (weekend day or holiday).

[a] *P* values of differences between 2009 and 2011 derived by using χ^2 tests or *t* tests where appropriate.

on local needs.[10,11,14] These programs have been implemented by generalist teachers, expert physical education teachers, or program champions. APPLE Schools extended the concept of a "program champion" by offering the placement of a full-time health facilitator in each school for the duration of the intervention. The school health facilitators are hired as new school staff members. Their role in the school is dedicated to facilitating the development and implementation of healthy living programming and curricula. In addition, the project generates annual research reports with school-specific outcomes. These reports provide an opportunity to reflect on achievement of goals and objectives throughout the project and to further tailor the project to meet schools' needs. Finally, the APPLE Schools project developed professional learning communities to provide networking and professional development opportunities for teachers. Similar to other models of CSH,[10,11,13,14,16,21] the APPLE Schools program successfully increased PA in youth. Importantly, the effect observed with APPLE Schools (~2900 steps per day on weekends) was substantially greater than that seen with other studies. The data presented here reinforce the concept that CSH interventions generally yield positive results compared with those that target single components such as school, family, or community.[47–51] Together, the data support the notion that CSH is an effective model for increasing PA-related behaviors in youth and extend it by suggesting that this outcome is possible within socioeconomically disadvantaged schools.

TABLE 2 Intervention Effect and Increases in PA Between 2009 and 2011 Among Fifth Grade Students Attending APPLE Schools and Those Attending Comparison Schools

Characteristic	Increase in PA in APPLE Schools		Increase in PA in Comparison Schools		Group × Time Interaction		ICC
	β*	95% CI	β*	95% CI	β**	95% CI	
School days, steps/d	2152	1415 to 2888	931	387 to 1475	1221	306 to 2135	0.037
Non–school days, steps/d	2936	1802 to 4069	935	106 to 1764	2001	600 to 3402	0.000
Typical week, steps/d	2341	1604 to 3079	943	401 to 1485	1399	485 to 2312	0.018
School hours, steps/h	87	39 to 135	40	4 to 75	47	−12 to 107	0.069
Non–school hours, steps/h	239	153 to 324	102	39 to 165	137	31 to 242	0.022

β* represents the increase in PA between 2009 and 2011 and was derived from multilevel regression analysis that accommodated clustering of students within schools and adjusted for the confounding potential of gender, parental educational attainment, and household income. β** represents the intervention effect: the increase in PA among students attending APPLE Schools relative to the increase among students attending comparison schools. The estimations accommodated for clustering of students within schools and adjusted for the confounding potential of gender, parental educational attainment, and household income. ICC, intraclass correlation coefficient.

Weekends and after-school hours are recognized as "critical windows" for PA promotion in youth[52] because these time periods are characterized by low PA.[23–28] Previous studies implementing CSH have recognized the need to promote PA outside of school hours,[11,13–16,53,54] although few reported stratified findings, and of those that did, increases were negligible or nonsignificant.[15,16] The data presented here suggest that including a staff member within the school dedicated to promoting healthy living increases PA on school days as well as non–school days. Importantly, the

increased PA levels were more pronounced than those on weekdays and during school hours. To foster positive PA behavior during these times, school health facilitators regularly informed parents about opportunities for PA in their community and coordinated with local providers. Collectively, these data reinforce the key principle of CSH: that coordinated efforts between schools, community stakeholders, and parents are achievable and lead to measurable changes in healthy living behaviors in children.

From the current study, it seems that Alberta Health's Healthy Weights Initiative increased PA in students from comparison schools. However, because this initiative was implemented in all publicly funded schools across Alberta (including intervention schools), it is difficult to quantify its effect because there is no control group with which to compare outcomes.

The strengths of the current study include the use of an objective measure of PA, a large sample size, adjustments for nonambulatory and non–wear time activities, measured height and weight, and adjustments for socioeconomic factors. The study has a few limitations, however, that must be acknowledged. First, schools were not randomly selected or assigned to intervention or comparison groups, possibly increasing the risk of selection bias and exaggerating the effect size associated with the intervention. Another potential source of selection bias is the low compliance rate with pedometer wear-time criteria. However, rates of noncompliance were similar between the comparison and intervention schools; therefore, it is unlikely that this factor influenced the observed effect size. Last, parent responses and student records in activity diaries remain subjective and prone to bias.r

CONCLUSIONS

The APPLE Schools program significantly increased PA in children, particularly outside of school hours. Accordingly, the data from this study add to the evidence base for the effectiveness of CSH and provide evidence to support investing in broader implementation of such programs for their potential to prevent obesity and consequent chronic disease.

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APPENDIX Intervention Effect and Increases in PA During and Beyond School Hours, and Active Transportation Between 2009 and 2011 Among Fifth Grade Students Attending APPLE Schools and Those Attending Comparison Schools

Characteristic	Increase in PA in APPLE Schools		Increase in PA in Comparison Schools		Group × Time Interaction		ICC
	β*	95% CI	β*	95% CI	β**	95% CI	
School hours, steps/h	91	43 to 139	79	43 to 115	11	−48 to 71	0.158
Non–school hours, steps/h	176	106 to 246	54	3 to 106	121	35 to 208	0.033
Active transportation							
To and from school	117	−81 to 315	−266	−414 to −117	383	136 to 629	0.133
To school[a]	84	−24 to 192	−130	−211 to −49	214	79 to 348	0.179
From school[b]	33	−99 to 164	−136	−234 to −38	169	5 to 332	0.110

During school hours was defined as the hours between 9:00 AM and 2:59 PM. Beyond school hours was defined as the hours of 7:00 to 8:59 AM and 3:00 to 8:59 PM. β* represents the increase in PA between 2009 and 2011 and was derived from multilevel regression analysis that accommodated clustering of students within schools and adjusted for the confounding potential of gender, parental educational attainment, and household income. β** represents the intervention effect: the increase in PA among students attending APPLE Schools relative to the increase among students attending comparison schools. The estimations accommodated for clustering of students within schools and adjusted for the confounding potential of gender, parental educational attainment, and household income. ICC, intraclass correlation coefficient.

[a] Steps accumulated between 8:00 and 8:59 AM.

[b] Steps accumulated between 3:00 and 3:59 PM.

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