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Do school-based physical activity interventions increase or reduce inequalities in health?

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ABSTRACT

Little is known about the effectiveness of school-based health promotion on physical activity inequalities among children from low-income areas. This study compared the two-year change in physical activity among 10–11 year-old children attending schools with and without health promotion programs by activity level, body weight status, and socioeconomic backgrounds to assess whether health promotion programs reduce or exacerbate health inequalities. This was a quasi-experimental trial of a Comprehensive School Health (CSH) program implemented in schools located in socioeconomically disadvantaged neighbourhoods in Edmonton, Alberta, Canada. In the spring of 2009 and 2011, pedometer (7 full days) and demographic data were collected from cross-sectional samples of grade five children from 10 intervention and 20 comparison schools. Socioeconomic status was determined from parent self-report. Low-active, active, and high-active children were defined according to step-count tertiles. Multilevel linear regression methods adjusted for potential confounders were used to assess the relative inequity in physical activity and were compared between groups and over-time. In 2009, a greater proportion of students in the intervention schools were overweight (38% vs. 31% $p = 0.03$) and were less active (10,827 vs. 12,265 steps/day $p < 0.001$). Two years later, the relative difference in step-counts between intervention and comparison schools reduced from −15.5% to 0% among low-active students, from −13.4% to 0% among active students, and from −15.1% to −2.7% among high-active students. The relative difference between intervention and comparison schools reduced from −11.1% to −1.6% among normal weight students, from −16.8% to −1.4% among overweight students, and was balanced across socioeconomic subgroups. These findings demonstrate that CSH programs implemented in socioeconomically disadvantaged neighbourhoods reduced inequalities in physical activity. Investments in school-based health promotion are a viable, promising, and important approach to improve physical activity and prevent childhood obesity, and may also reduce inequalities in health.

1. Introduction

Physical activity is associated with improved physical and mental health among children (Janssen and Leblanc, 2010). However, the majority of children do not meet the recommended 60 min of daily moderate to vigorous physical activity (Colley et al., 2011; Hallal et al., 2012). Similar to other health behaviours and outcomes (i.e. obesity, poor diet, smoking), the prevalence of physical inactivity is more common among socioeconomically disadvantaged children (Currie et al., 2008; Ferreira et al., 2007; Sallis et al., 2000; Seabra et al., 2008; Van Der Horst et al., 2007). This discrepancy in physical activity may contribute to the well-established and robust inequalities in health during both childhood (Chen et al., 2006; Marmot, 2005) and adulthood (Lynch et al., 1997; Poulton et al., 2002). Accordingly, interventions that reduce the inequity in physical activity

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among socioeconomically disadvantaged children may reduce health inequalities later in life.

Schools are an ideal setting to deliver health promotion programs to children (Pate et al., 2006), and various approaches to school-based health promotion have been studied. Programs are deemed successful if the average physical activity level increases. Rose demonstrated that even small increases in the average may shift the population distribution in a favourable direction, lowering the overall risk of disease (Rose, 2001). However, the concern has been raised that intervention effects may be more robust among the healthiest children, and less effective among high-risk children (Brown and Summerbell, 2009; Salmon et al., 2007). That is, even where school-based health promotion programs are successful at improving physical activity across the population of participating students, they have the potential to create new or perpetuate existing health disparities in the prevalence of physical activity among children (Lorenc et al., 2013; Maziak et al., 2008). This has been expressed in the literature as the “inequality paradox”(Frohlich and Potvin, 2008), or the “inverse care law”(Hart, 1971). Several studies have attempted to overcome this paradox and reduce inequities by implementing programs in schools located in disadvantaged communities (Breslin et al., 2012; Caballero et al., 2003; Heath and Coleman, 2002; Jago et al., 2011; Jurg et al., 2006), while others have used a targeted approach, tailoring interventions to the characteristics of specific groups at risk of poor health behaviours or outcomes (Lubans et al., 2010; Pate et al., 2005; Robbins et al., 2013; Webber et al., 2008). Some of these equity-based interventions have reported increases in children’s physical activity (Breslin et al., 2012; Heath and Coleman, 2002; Jurg et al., 2006; Pate et al., 2005; Webber et al., 2008). However, to our knowledge, no experimental studies exist assessing the effectiveness of a population-based intervention by comparing the change in children’s physical activity between intervention schools located in socioeconomically disadvantaged neighbourhoods and non-intervention schools located in middle-income neighbourhoods.

To overcome this limitation and determine if school-based health promotion programs exacerbate or reduce inequalities in health, the present study compared the two-year change in objectively measured physical activity among low-active, active, and high-active grade five students attending schools with and without health promotion programs. We also compared changes in physical activity among students by body weight status groups and socioeconomic backgrounds to examine whether health promotion is equally effective among those who would benefit the most.

2. Methods

2.1. Study design

This was a quasi-experimental pre-post design with a parallel non-equivalent comparison group. The Alberta Project Promoting active Living and healthy Eating in Schools (APPLE Schools) was a school-wide intervention that was launched in January 2008 and lasted through June 2011. Cross-sectional samples of grade five students were recruited for measurement each year in the spring term for the duration of the project. Grade five students were of interest because most are pre-pubescent. Pre-pubescent boys and girls have similar body compositions (Guo et al., 1997; Maynard et al., 2001), and have not experienced pubertal weight gain (Ahmed et al., 1998) or marked declines in physical activity (Aaron et al., 2002; Brodersen et al., 2007; Kimm et al., 2000).

The APPLE Schools intervention targeted schools “in need of health promotion”. Accordingly, schools were not randomly assigned to intervention and comparison groups. Schools were considered to become an intervention school if they were located in socioeconomically disadvantaged neighbourhoods and the school principal was willing to support the intervention and research. Based on these criteria, an advisory panel representing five school jurisdictions identified 10 potential schools in the City of Edmonton, Alberta that would benefit from the intervention and therefore qualify for the study. All 10 schools invited elected to participate in the intervention. The comparison schools consisted of a sample of 20 schools also located in Edmonton drawn from a sample of randomly selected schools that participated in the 2008 “Raising healthy Eating and Active Living Kids” (REAL Kids) Alberta survey (Simen-Kapeu and Veugelers, 2010). The REAL Kids Alberta survey aims to assess current lifestyle behaviours (i.e., physical activity, nutrition, sleep) and obesity prevalence rates among a representative sample of children in Alberta, Canada. All 20 schools that were invited agreed to participate in the research. These schools had no prior involvement in health promotion.

2.2. Population

All grade five students within each school were invited to participate in the study. In 2009, among the 10 APPLE Schools, all 412 grade five students were provided with home surveys and consent forms 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 in the evaluation. All students with parent 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 students were enrolled in grade five within the APPLE Schools, however, the survey completion rates and the number of complete pedometer recordings were similar (57.8%). In 2009, 2011, 845 and 680 surveys, respectively were provided to grade five students within the 20 comparison schools. Completion rates of the survey and pedometer recordings were similar in comparison schools in 2009 (53.7%) and 2011 (45.4%). Comparison schools also had fewer grade five students in 2011 than in 2009.

2.3. APPLE schools: the intervention

APPLE Schools uses a Comprehensive School Health (CSH) approach “to make the healthy choice the easy choice”. CSH is described as, “an internationally recognized framework for supporting improvements in students’ educational outcomes while addressing school health in a planned, integrated, and holistic way”(Joint Consortium for School Health, 2008). The framework encompasses the whole school environment and addresses actions in four inter-related pillars, including: social and physical environments; teaching and learning; healthy school policy; and partnerships and services (Joint Consortium for School Health, 2008). In the United States, CSH is more commonly referred to as “Coordinated School Health”, while the synonymous term “Health Promoting Schools” is used in Australia and Europe (Veugelers and Schwartz, 2010). A key component of the APPLE Schools CSH intervention was the placement of a full-time School Health Facilitator (SHF) 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. The overall aim of the project was to create and sustain supportive physical and social environments that cultivate a healthy lifestyle with the involvement of key stakeholders i.e., parents, students, staff, and community.

To reach low-active children and those at high risk of inactivity, intervention schools offered a variety of non-competitive, enjoyable activity choices like Go-Girls/Go-Boys weekly intramurals, dance, skipping and yoga clubs, walking initiatives, and playground programs. APPLE Schools also had easy and ready-to-use equipment in classrooms to facilitate increased activity in class-time outside of physical education. Steps were also taken to improve access to after-school physical activity facilities and programs, and to improve traffic safety to promote and support active transportation. To reach parents, schools regularly organized school-wide activities where students and parents collectively took part in promotions and events. Monthly school newsletters where also distributed to parents describing affordable, easily accessible, and seasonally appropriate activities for children to participate in outside of school. Comparison schools did not have access to a SHF or the health promotion materials used in APPLE Schools, though 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 Albertans to lead healthier lifestyles (www.healthyalberta.com).

2.4. Outcome of interest: physical activity

Daily physical activity was measured using the Omron Hj-720ITC time-stamped pedometer (Omron, Toronto Ontario, Canada). The accuracy and validity of the Omron pedometer has been demonstrated under various conditions (Crouter et al., 2003; Hasson et al., 2009; Holbrook et al., 2009; Zhu and Lee, 2010). Evaluation assistants travelled to schools to distribute pedometers and administer a short survey to students. Students were asked to wear their pedometers for nine consecutive days on the right hip directly in line with their right knee during all waking hours unless showering, swimming, or taking part in activities where an adult felt that doing so may could potentially harm the child. Students were also asked to keep a log of their daily activities, including the duration and whether or not the pedometer was worn. On the third day of data collection, evaluation assistants returned to schools to encourage students to wear the pedometers and to complete their activity diaries. On the ninth day, research staff travelled to schools to collect pedometers and activity diaries, and download data to computers.

2.5. Assessment of other covariates

Students' gender was self-reported in the student survey. Evaluation assistants measured students' standing 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. Students removed their shoes for both measurements. Body Mass Index (BMI) was calculated as weight divided by height^2 (kg/m^2). We defined overweight using the International Obesity Task Force BMI cut-off points adjusted to age and sex specific categories for children and youth (Cole et al., 2000). Information on household income (≤$50,000; $50,001-$100,000; and >$100,000) and level of parental educational attainment (secondary or less, college, university or above) were determined from parent responses in the home survey.

2.6. Statistical analyses

Pedometer records from the first and ninth days were not considered in data analysis due to differing administration and collection times. A valid physical activity data file was defined as a minimum of 8 h of wear-time (Penpraze et al., 2006) on a minimum of two school days and one non-school day. Using the methods we established previously (Vander Ploeg et al., 2012), pedometer steps were complemented with step equivalents of non-ambulatory and non-wear time activities recorded in students' activity diaries. Students' step-counts were averaged to represent a typical week, which was defined as five school days (Monday-Friday) and two non-school days (Saturday, Sunday, holidays).

T-tests and chi-square tests were used to test for differences in physical activity levels and participant characteristics between students attending schools participating in the APPLE Schools intervention and students attending comparison schools in 2009 and 2011. To account for the clustering of students' observations within schools, multilevel linear regression methods were used to examine the effect of the intervention on children's physical activity. We created an interaction term defined as the product of the binary variables year (0 = 2009, 1 = 2011) and intervention (0 = comparison schools, 1 = APPLE Schools) to examine the effect of APPLE Schools. This term represents the two-year change among students attending APPLE Schools relative to the change among students attending comparison schools. Students were categorized as low-active, active, and high-active based on step-count tertiles according to the evaluation year and intervention status. These categories were also generated for girls and boys separately. Students were also stratified by body weight status, household income, and parental educational attainment. Multilevel analyses were adjusted for potential confounders (see footnote in Table 2). School-level variables including lunch and recess length were consistent over-time and therefore not included in modelling procedures. The relative inequity in the number of steps taken per day between children attending interventions schools and comparison schools in 2009 and 2011 was calculated from the difference in the adjusted means of the number of steps taken per day in intervention and comparison schools divided by the adjusted mean steps per day in intervention schools. The change in equity was calculated by adding the relative difference in 2011 to the absolute value of the relative difference in 2009.

To generate cumulative distribution plots based on students' step-counts, students were stratified according to the evaluation year and intervention status, and where appropriate by overweight status, household income, and parental educational status. Next, students were ranked by step-counts and their position in the distribution was plotted against their mean steps per day during a typical week. We used STATA version 12 (StataCorp, College Station

Table 1
Characteristics of grade 5 students attending APPLE Schools and comparison schools in 2009 and 2011.

	2009		2011	
	APPLE Schools[a]	Comparison schools	APPLE Schools	Comparison schools
Gender (%)				
Girls	47.2	50.8	51.0	49.1
Boys	52.8	49.2	49.0	50.9
Weight status (%)[b]				
Overweight/obese	38.3	31.3	35.2	30.1
Normal weight	61.7	68.7	64.8	69.9
Household income (%)[c]				
<50,000	34.7	18.1	33.2	17.8
50,001–100,000	40.0	37.2	31.2	31.8
>100,001	25.3	44.6	35.6	50.4
Parental education (%)				
Secondary or less	31.9	27.9	26.0	19.8
College	39.1	42.8	39.9	45.1
University or graduate	29.0	29.3	34.1	35.1

[a] APPLE Schools = Alberta Project Promoting active Living and healthy Eating Schools.
[b] $P < 0.05$ (2009).
[c] $P < 0.001$ (2009 and 2011).

Table 2
Inequity in physical activity levels (steps/day) by grade five students attending APPLE Schools and comparison schools over a two year interval (2009–2011) of a Comprehensive School Health intervention.

	2009				2011				Group × time effect[b]	95% CI	Change in equity[c]
	APPLE Schools	Comparison schools	95% CI	Relative inequity[a]	APPLE Schools	Comparison schools	95% CI	Relative inequity[a]			
Overall[d]	10,827	12,265	−2173; −703	−13.3%	13,168	13,207	−830; 751	−0.3%	1399	485; 2312	+13.0%
Girls & boys[d]											
Low-active	7366	8508	−1608; −674	−15.5%	9096	9113	−517; 483	−0.2%	1124	522; 1727	+15.3%
Active	10,489	11,897	−1675; −1139	−13.4%	12,470	12,486	−304; 273	−0.1%	1391	1005; 1778	+13.3%
High-active	14,345	16,509	−3095; −1233	−15.1%	17,399	17,868	−1466; 527	−2.7%	1695	542; 2848	+12.4%
Girls[e]											
Low-active	7424	7874	−962; 62	−6.1%	9315	8895	−108; 947	+4.5%	870	139; 1600	+10.6%
Active	9911	11,100	−1503; −876	−12.0%	12,155	11,656	174; 824	+4.1%	1689	1238; 2139	+16.1%
High-active	13,108	15,319	−3170; −1252	−16.9%	15,716	16,268	−1583; 478	−3.5%	1658	329; 2987	+13.4%
Boys[e]											
Low-active	7462	9666	−2895; −1513	−29.5%	8946	9657	−1481; 59	−7.9%	1493	498; 2488	+21.6%
Active	11,492	12,836	−1858; −830	−11.7%	13,351	14,125	−1346;-204	−5.8%	569	−133; 1272	+5.9%
High-active	15,655	17,659	−3297; −712	−12.8%	19,178	19,472	−1696; 1108	−1.5%	1710	−88; 3508	+11.3%
Weight status[d]											
Excess weight	10,214	11,930	−2788; −643	−16.8%	12,631	12,807	−1418; 1068	−1.4%	1540	−50; 3131	+15.4%
Normal weight	11,159	12,400	−2103; −380	−11.1%	13,531	13,313	−697; 1132	−1.6%	1459	337; 2581	+12.7%
Income[f]											
<$50,000	10,606	11,952	−2984; 292	−12.7%	13,165	11,732	−597; 3463	+10.9%	2779	427; 5131	+23.6%
$50,001–$100,000	10,782	12,112	−2530; −131	−12.3%	12,985	13,442	−1921; 1007	−3.5%	873	−991; 2738	+8.8%
>$100,001	10,994	12,909	−3340; −490	−17.4%	12,709	13,213	−1810; 803	−4.0%	1412	−499; 3323	+13.4%
Education[f]											
≤Secondary	10,083	12,168	−3398; −772	−20.7%	13,150	12,737	−1125; 1951	+3.1%	2498	703; 4293	+23.8%
College	10,999	12,212	−2277; −149	−11.0%	12,590	13,840	−2358; −142	−9.9%	−37	−1562; 1488	+1.1%
University or graduate	10,776	12,487	−2955; −468	−15.9%	13,535	12,882	−703; 2011	+4.8%	2365	782; 3948	+20.7%

[a] ((APPLE Schools − comparison schools)/APPLE Schools)*100.
[b] Represents the interaction of intervention and time: the increase in physical activity among students attending APPLE Schools relative to the increase among students attending comparison schools. The estimations accommodated for clustering of students within schools and are adjusted for potential confounders.
[c] Relative difference in 2009 + Relative difference in 2011.
[d] Adjustments for potential confounders included: gender, parental educational attainment, and household income.
[e] Adjustments for potential confounders included: parental educational attainment and household income.
[f] Adjustments for potential confounders included: gender.

TX, USA) to perform the statistical analyses. The Health Research Ethics Board at the University of Alberta approved this study including data collection and informed parental consent forms.

3. Results

Characteristics of grade five students within intervention and comparison schools in 2009 and 2011 are presented in Table 1. The average age of students was 10.9 years and 49.5% were girls. The proportion of girls and boys was similar in the intervention and comparison schools. Approximately one quarter and one third of all students came from low-income and low-education households. However the proportion of youth from low-income and low-educated homes was higher in intervention schools than in comparison schools (household income < $50,000: 31.9% vs. 18.0% $\chi^2 = 40.08$, $p < 0.001$; parental educational attainment ≤ secondary school: 29.2% vs. 24.1% $\chi^2 = 5.44$, $p = 0.02$ in intervention and comparison schools respectively; Table 1). One third of all students were overweight or obese, and more of these students were from intervention schools (36.9% vs. 31.0% $\chi^2 = 8.30$, $p = 0.004$).

In 2009, students from intervention schools accumulated approximately 2000 fewer steps per day than students from comparison schools (10,827 vs. 12,265 steps/day, 95% CI: −2173; −703; Table 2) equating to a 13.3% difference in daily physical activity levels. From 2009 to 2011, physical activity levels increased in both intervention (+2341; $p < 0.001$) and comparison schools (+942; $p = 0.004$). Daily physical activity level increased 13.0% (effect size = 1399; 95% CI: 485; 2312) more in children from intervention schools than in children from comparison schools. "Exposure" to the APPLE Schools intervention effectively increased physical activity levels of children living in disadvantaged neighbourhoods to the extent that they approximated those of children living in higher socioeconomic status neighbourhoods (13,168 vs. 13,207 steps/day, 95% CI: −830; 751).

In 2009, the proportion of students meeting the recommended levels of daily physical activity was substantially lower in students in the intervention schools compared to comparison schools (Fig. 1a). The discrepancy in activity levels between intervention and comparison schools was most pronounced among children classified as low-active, particularly boys (Table 2). Following the 2-year intervention, children within the low-active group from intervention schools experienced an increase in activity 15.3% greater than that of low-active children from comparison schools (effect size = 1124; 95% CI: 522; 1727). This increase in physical activity following the APPLE Schools intervention was greater for children in the low-active group than those in active (+13.3%; effect size = 1391; 95% CI: 1005; 1778) and high-active groups (+12.4%; effect size = 1695; 95% CI: 542; 2848) (Table 2). Daily physical activity increased among children attending APPLE Schools within each physical activity category, however physical activity increased only among children above the ~50^{th} percentile from comparison schools (Fig. 1a). This figure also shows that by 2011 steps were approximately equal between the entire distribution of children from APPLE Schools and comparison schools, regardless of baseline physical activity level or socio-economic status.

3.1. Sub-group analyses

In 2009, girls from intervention schools were also less active than girls from comparison schools across all activity groups. However, activity levels were most similar between girls from

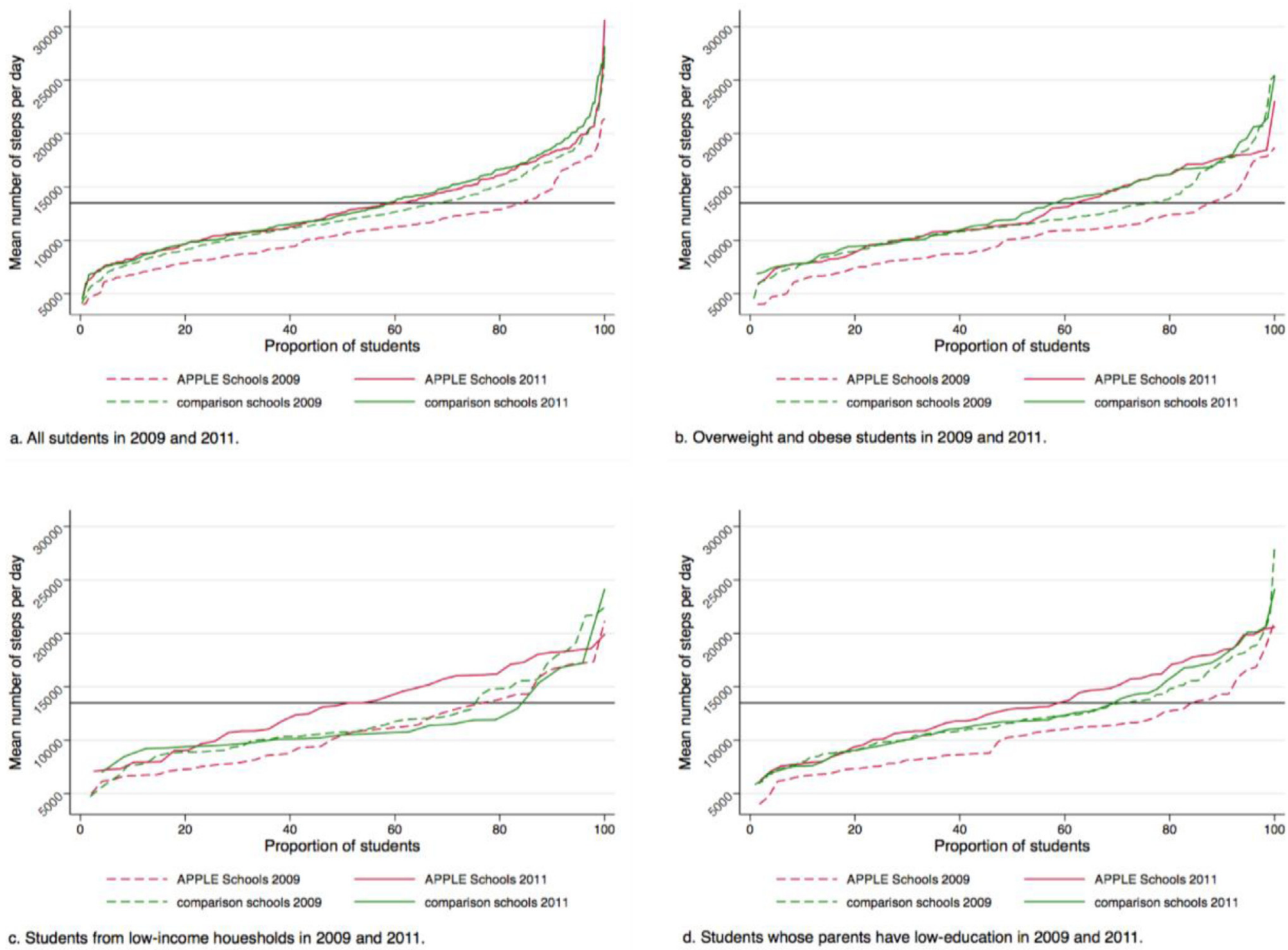

Fig. 1. Mean number of steps taken per day among a) all students; b) overweight or obese students; c) students from low-income households; d) students whose parents are low-educated from APPLE Schools and comparison schools in 2009 and 2011.

intervention and comparison schools in the low-active group (Table 2). In 2011, daily physical activity levels among girls in the intervention schools exceeded those of girls from comparison schools (Fig. 1). In fact "active" girls from the intervention schools were significantly more active than "active" girls from comparison schools (12,155 vs. 11,656 steps/day, 95% CI = 174; 824). The largest relative increase among girls was observed among this group.

In 2009, healthy weight and overweight children from intervention schools were 11.1% and 16.8% less active than children of the same body weight status from comparison schools; taking 1241 (95% CI: −2103; −380) and 1716 (95% CI: −2788; −643) fewer steps daily. Following the intervention, activity levels increased among overweight and normal weight children from intervention schools such that they were nearly equal to those among children from comparison schools (normal weight: 13,531 vs. 13,313, 95% CI: −697; 1132; overweight: 12,631 vs. 12,807, 95% CI: −1418; 1068). While activity levels increased among both weight status groups, the increase, relative to comparison schools was more pronounced among overweight children from APPLE Schools (Table 2). From 2009 to 2011, all overweight children from intervention schools accumulated more steps daily, while daily step-counts increased only among overweight children above the ~40th percentile in comparison schools (Fig. 1b). Following the intervention, across the distribution, the mean number of steps taken per day among overweight children from intervention schools and comparison schools were approximately equal (Fig. 1b).

Across all income and education groups in 2009, children from intervention schools were less active relative to those from comparison schools. The relative inequity in physical activity levels between intervention groups was greatest between children whose parents were low-educated (i.e., having a secondary school education or less) (−20.7%; 10,083 vs. 12,168 steps/day; 95% CI: −3398; −772), and least among children from low-income households (−12.7%; 10,606 vs. 11,952 steps/day; 95% CI: −2984; 292) (Table 2). From 2009 to 2011, children within the low-education and low-income groups from intervention schools experienced increases in physical activity 23.8% (effect size = 2498; 95% CI: 703; 4293) and 23.6% (effect size = 2779; 95% CI: 427; 5131) greater than children within these groups from comparison schools, respectively (Table 2). These increases were more pronounced than those observed among children within the middle (+1.1%; effect size = −37; 95% CI: −1562; 1488) and high (+20.7%; effect size = 2365; 95% CI: 782; 3948) education, and within the middle (+8.8%; effect size = 873; 95% CI: −991; 2738) and high (+13.4%; effect size = 1412; 95% CI: −499; 3323) income groups (Table 2). The increase in daily step-counts among the entire distribution of students from low-income and low-education households among APPLE Schools relative to those from comparison schools is evident in Fig. 1c and d.

4. Discussion

This study provides compelling evidence that school-based health promotion reduces health inequities among children. First, we showed that after two years of a CSH program, physical activity levels of children living in disadvantaged neighbourhoods increased to the extent that they approximated those of children living in middle to high socioeconomic status neighbourhoods. Second, we showed that the least active children become more active. Third, we showed that overweight and socioeconomically disadvantaged subgroups were evenly, if not favourably, reached.

The concern has been raised that school-based programs may be less effective for high-risk children, particularly among those attending schools in disadvantaged areas (Brown and Summerbell, 2009; Salmon et al., 2007). Children living in disadvantaged areas are more likely to be physically inactive, be overweight and suffer form chronic disease (Achat and Stubbs, 2012; Crespo et al., 2000; Gidlow et al., 2006; Lovasi et al., 2009; Maher and Olds, 2011; Wang and Lim, 2012). Environments in socially disadvantaged neighbourhoods often lack access to outdoor playgrounds and recreational facilities, and high crime rates and violence make it unsafe to play outside (Davidson et al., 2010; Gidlow and Ellis, 2011; Veugelers et al., 2008). Several studies have responded to this concern by developing interventions that specifically target children attending schools in these “obeseogenic environments” (Breslin et al., 2012; Caballero et al., 2003; Fairclough et al., 2013; Heath and Coleman, 2002; Jago et al., 2011; Jurg et al., 2006). These programs have been implemented by generalist teachers, experts in physical activity, or program champions, and have included formal curricula and resource packages for teachers, students, and parents, provided equipment and training for classroom teachers, and have made changes to the social and physical environments (Breslin et al., 2012; Caballero et al., 2003; Fairclough et al., 2013; Jago et al., 2011; Jurg et al., 2006). The duration of these programs has ranged from 12 weeks (Breslin et al., 2012) to 3 years (Caballero et al., 2003). Of these studies, interventions with shorter implementation periods (i.e. 12 or 20 weeks) demonstrated statistically significant increases in physical activity (Breslin et al., 2012; Fairclough et al., 2013) while those implemented for longer periods did not (Caballero et al., 2003; Jago et al., 2011; Jurg et al., 2006), suggesting that change is difficult to sustain long-term. Here we demonstrate that the provision of a SHF within the school environment, without any major changes to the built environment, is an efficacious approach for increasing physical activity levels of children living in socially disadvantaged neighbourhoods, and that these increases were sustained for two years. APPLE Schools is an expensive and intensive school-based program. However, to assess “intervention dose” the program has since expanded to include 40 schools. SHFs were placed in the new APPLE Schools in varying capacities; some schools have full-time facilitators who work 5 days each week, while others have part-time facilitators who work either 2.5 days or 1 day each week. It would be of interest in future studies if these lower doses of the intervention produce similar effects, as this may enhance the sustainability of the program.

The results presented here extend findings from previous interventions by demonstrating that CSH programs in schools in disadvantaged areas can improve activity levels such that they are comparable to those of children from randomly selected schools in higher advantaged neighbourhoods in Alberta, Canada. Previous studies have demonstrated increases relative to children from equally disadvantaged neighbourhoods, but because of study design limitations, were unable to show that they brought activity levels of disadvantaged children to a level comparable to advantaged children (Fairclough et al., 2013; Jurg et al., 2006). Accordingly, the present study demonstrates that CSH is an efficacious approach to bridge the gap in health inequalities in school-aged children.

Within disadvantaged schools, there remain subgroups of students who are more “in need” of health promotion than others. These groups include students who are low-active and overweight, those whose parents are low-educated, and those from low-income households (Maziak et al., 2008). Similar to students living in disadvantaged neighbourhoods, students within these groups may be less likely to benefit from health promotion programs than healthier or more advantaged subgroups. Recent systematic reviews have attempted to determine whether school-based health promotion reduces or exacerbates health inequalities, but were unable to do so because few studies report subgroup effects or effects were examined only for specific population subgroups (De Bourdeaudhuij et al., 2011; Humphreys and Ogilvie, 2013; Lorenc et al., 2013; Magnee et al., 2013; Yildirim et al., 2011). To the best of our knowledge, this is the first experimental study to demonstrate that school-based health promotion can improve physical activity among the entire distribution of students, and reduce health inequalities by improving physical activity levels more favourably amongst the most disadvantaged subgroups. The APPLE Schools CSH program was implemented school-wide and did not specifically target disadvantaged subgroups. To reach the unique needs of each school as well as the various subgroups within schools, each APPLE School formed an “APPLE Core Committee” comprised of the SHF and key stakeholders i.e., students, staff, parents, community partners. The role of the committee was to collaboratively identify goals and develop “Action Plans” to support students in creating and sustaining positive behaviour change. The program also generated annual research reports with school-specific outcomes. These reports provided an opportunity to reflect on achievement of goals and to further tailor the project to meet schools’ needs. All “actions” taken in the APPLE Schools to improve students’ health were designed to be multifaceted and touch on the four pillars of CSH. The data presented here support the notion that multifaceted interventions generally yield larger effect sizes compared to those that target single components such as policy, built environments, education, or family/community (Brown and Summerbell, 2009; Heath et al., 2012; Kriemler et al., 2011; Salmon et al., 2007). It is possible that other multifaceted or CSH programs have also reduced inequities, but to show this would require further analysis.

The findings from the present study are also consistent with the idea that “upstream” interventions are more likely to reduce health inequalities than “downstream” interventions (Lorenc et al., 2013; Orleans, 2000; Raine, 2010). Upstream interventions aim to prevent unhealthy behaviour and promote those that improve health through policy, and changes to the social and physical environments, while downstream interventions focus on individual factors including education. Downstream approaches are said to exacerbate inequalities because they favour people with better social and economic resources and are therefore, better able to benefit from health promotion or interventions (Lorenc et al., 2013; Orleans, 2000). APPLE Schools used a CSH, upstream approach, to create school environments that made “the healthy choice the easy choice” (Schwartz et al., 2010). To facilitate increased “uptake” of the intervention in terms of physical activity, all APPLE Schools offered more opportunities for physical activity outside of physical education class, partnered with local recreational facilities to reduce costs and improve access, and created “safe school zones” and “walking school buses” to promote increased active transportation to and from school. The effectiveness of the program as a whole has been shown to improve diet quality and reduce the prevalence of overweight and obesity (Fung et al., 2012), and to improve children's activity levels outside of school hours and on weekend days – periods that are characterized by physical inactivity (Vander Ploeg et al., 2014). The demonstrated success of APPLE Schools in improving health behaviours, particularly among the least active children and those from the most disadvantaged circumstances, adds to the evidence-base for the effectiveness of school-based health promotion to improve health outcomes and reduce health inequalities among school-aged children.

From the current study, it appears that Alberta Health's Healthy Weights Initiative increased physical activity in students from comparison schools. However, because this initiative was implemented in all publically 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.

Strengths of the current study include the use of an objective measure of children's physical activity, the large sample size, adjustments for non-ambulatory and non-wear time activities, measured height and weight to assess body weight status, and the ability to adjust for parental educational attainment and household income. However, there are a few limitations of the current study that should be addressed. First, schools were not randomly selected or assigned to an intervention or control condition, possibly increasing the risk of selection bias and exaggerating the effect size associated with the intervention. Another potential source of selection bias were the low compliance rates with pedometer inclusion criteria. These rates, however, were similar among intervention and comparison schools. As such, it is unlikely that this influenced the size of the observed effect. Additionally, when parent and student consent and survey completion rates are considered, the participation rate improved considerably such that they approximated 80–85%. Last, parent responses and student records in activity diaries also remain subjective and prone to bias. However, previously we showed that adjustments to pedometer-measured steps for step-equivalents estimated from activity diaries are relatively even across activity groups (Vander Ploeg et al., 2012). Accordingly, it is unlikely that this affected the observed effect size.

5. Conclusion

Our study demonstrated that school health programs in socioeconomically disadvantaged neighbourhoods can reduce inequalities in physical activity. Although the school health programs were mostly ecological in nature and did not specifically target student subgroups, they were effective in increasing physical activity levels more favourably among low-active students than active and high active students. Likewise, they improved physical activity levels more favourably for the most disadvantaged groups, namely overweight students, those from low-income households, and those whose parents were low-educated. The health and other benefits that result from the increase in physical activity may contribute to the reduction in inequalities in health. Investments in school-based health promotion, therefore, are not only a viable, promising, and important approach to improve physical activity levels and to prevention of childhood obesity, but they may also reduce health inequalities.

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