# School-Based Physical Activity Does Not Compromise Children's Academic Performance

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**ABSTRACT**

AHAMED Y., H. MACDONALD, K. REED, P.-J. NAYLOR, T. LIU-AMBROSE, and H. MCKAY. School-Based Physical Activity Does Not Compromise Children's Academic Performance. *Med. Sci. Sports Exerc.*, Vol. 39, No. 2, pp. 371–376, 2007. **Purpose:** The purpose of this study was twofold: 1) to evaluate the effectiveness of a school-based physical activity intervention, Action Schools! BC (AS! BC), for maintaining academic performance in a multiethnic group of elementary children, and 2) to determine whether boys and girls' academic performance changed similarly after participation in AS! BC. **Methods:** This was a 16-month cluster randomized controlled trial. Ten schools were randomized to intervention (INT) or usual practice (UP). One INT school administered the wrong final test, and one UP school graded their own test, so both were excluded. Thus, eight schools (six INT, two UP) were included in the final analysis. Children (143 boys, 144 girls) in grades 4 and 5 were recruited for the study. We used the Canadian Achievement Test (CAT-3) to evaluate academic performance (TotScore). Weekly teacher activity logs determined amounts of physical activity delivered by teachers to students. Physical activity was determined with the Physical Activity Questionnaire for Children (PAQ-C). Independent *t*-tests compared descriptive variables between groups and between boys and girls. We used a mixed linear model to evaluate differences in TotScore at follow-up between groups and between girls and boys. **Results:** Physical activity delivered by teachers to children in INT schools was increased by 47 min·wk$^{-1}$ (139 ± 62 vs 92 ± 45, $P < 0.001$). Participants attending UP schools had significantly higher baseline TotScores than those attending INT schools. Despite this, there was no significant difference in TotScore between groups at follow-up and between boys and girls at baseline and follow-up. **Conclusion:** The AS! BC model is an attractive and feasible intervention to increase physical activity for students while maintaining levels of academic performance.
**Key Words:** CHILD HEALTH, EXERCISE, GENDER DIFFERENCES, CAT-3



Childhood physical inactivity is a serious problem. In 2002, approximately 82% of Canadian children aged 9–12 yr were not active enough to meet international guidelines for normal growth and development (5). An inactive lifestyle during childhood places children at greater risk of becoming obese and developing cardiovascular disease in adulthood (21). It is estimated that chronic diseases related to inactivity in adults costs the U.S. health care system $83.6 billion dollars annually (11). In Canada, these costs exceed $5.1 billion annually (13). Despite these alarming data, a practical solution to childhood inactivity remains a major challenge for Western societies. It has previously been suggested that schools by nature have a captive and diverse audience of students and may therefore provide the best avenue to encourage positive physical activity behaviors (14). We note that in our own province, British Columbia, a significant number of schools dedicate less than the recommended 10% of school time to physical education (PE) (8). Further, studies of children's activity levels in PE suggest that less than 50% of class time is spent in moderate to vigorous activity (MVPA) (23).

Given the substantial pressures on children, parents, and school administrators to maximize academic performance (17), it has become increasingly difficult for teachers and school administrators to devote school time to physical

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activity. Further, there is the perception that time spent on nonacademic pursuits negatively impacts children's performance in school (17). However, there have been very few well-designed studies that have addressed this question, and among these studies, mixed results have suggested that physical activity either had no effect on (22) or that it enhanced (10,24,26) academic performance. Discrepancies between studies may be explained by differences in the type, length and intensity of the intervention, and study design (e.g., randomization vs nonrandomization). Thus, whether physical activity detracts from or enhances academic performance remains unclear.

To assess the role of school-based physical activity on academic performance, we conducted a cluster randomized controlled trial that evaluated a multiethnic group of elementary school children attending schools in British Columbia. Intervention schools adopted Action Schools! BC (AS! BC) (19), which is a socioecological best-practices physical activity model that aims to positively influence child health (19). Our primary objective was to compare academic performance total scores between children who participated in AS! BC and those who did not. We hypothesized that increased physical activity delivered to children would maintain or improve academic test scores. Our secondary objective was to assess whether, at the end of the trial, academic performance total scores differed between boys and girls.



## METHODS

### The AS! BC Model

The AS! BC model is described in detail elsewhere (20). AS! BC uses a comprehensive school health framework to target increased physical activity in elementary schools. The model is consistent with the concept of health-promoting schools and comprehensive school health (1), which relies on a whole-school approach with a large range of physical activities integrated into the school environment, rather than traditional classroom-based health education. AS! BC is a whole-school model that provides a tool for schools to create individualized action plans that provide increased physical activity opportunities across six action zones: school environment, extracurricular, family and community, school spirit, scheduled PE, and classroom action. The AS! BC model provided intervention teachers with training and resources to operationalize their action plan, with the ultimate goal of providing students with 150 min of physical activity per week.

One unique aspect of AS! BC was the classroom action zone. Teachers in intervention (INT) schools were required to provide students with 15 additional minutes of classroom physical activity each school day (75 $min \cdot wk^{-1}$). Students were exposed to physical activity throughout the school day and undertook a variety of activities including skipping, chair aerobics, hip hop dancing, playground circuits, and resistance exercises with exercise bands. These activities could be performed in the classroom, hallway, or school playground. Each teacher was provided with a classroom action bin that remained in their classroom. Each bin consisted of equipment such as playground balls, videos, skipping ropes, exercise bands, strength grippers, and teaching resources (teacher activity logs, action pages, planning guide for schools and teachers) to help teachers implement the additional physical activity.

Two key components of the AS! BC model were the AS! BC support team and the AS! BC school facilitators. The AS! BC support team provided resources for INT schools such as training workshops, written materials, classroom action bins, school newsletter inserts for families, and ongoing consultation (onsite and telephone) to administrators and INT teachers. The AS! BC facilitators, two elementary school PE specialists, were seconded to provide support to INT schools on a weekly basis. INT teachers received teacher-on-call support to attend the AS! BC training session provided by facilitators.

### Study Design

We conducted a cluster randomized, controlled, school-based intervention trial with grade 4 and 5 elementary school students. We recruited elementary schools from the Vancouver and Richmond school districts in British Columbia, Canada. Vancouver and Richmond reflect the ethnic diversity of the greater Vancouver region. According to Stats Canada reports, Vancouver comprises many multiethnic groups, with a high proportion of Asian, South Asian, and Caucasian residents. Similarly, according to Stats Canada reports, 35% of families in Richmond stated that Chinese was the language spoken in the home. Presentations were given at district principals' meetings and at 130 schools; we exceeded our recruitment goal with 20 schools (15%) volunteering to participate in the evaluation. To identify schools not already undertaking a school-based physical activity program, we selected schools with a score of 3 or less on the physical activity section of the BC Ministry of Education satisfaction survey (4). The survey asked whether students and parents were satisfied with the physical activity delivered at school, and responses were given on a 1–5 scale (1 = not satisfied and 5 = very satisfied).

Thus, 10 schools were stratified by size (> 300 or < 300 students) and geographic location (Vancouver or Richmond). This was to accommodate the different organizational structure of large versus small schools and the different ethnic demographics between regions. Within strata, schools were randomly assigned to one of three conditions: 1) liaison schools, 2) champion schools, and 3) usual practice schools (UP). Teachers in INT schools received a 1-d training session from the AS! BC facilitators and were provided a basic bin that included selected activity resources (action pages), skipping ropes, therabands, hand grippers, bean bags, etc. Liaison schools were provided external facilitation (2–4 $h \cdot wk^{-1}$ on average), whereas champion schools had less access to the external facilitation (1 $h \cdot wk^{-1}$ on average),

and a facilitator (school champion) was designated from within the school. As the two INT groups delivered the same physical activity model and differed only in the amount of external facilitation provided, these groups were collapsed for analyses. UP teachers received no specialized training but were shown how to complete the teacher logs to properly assess the amount of physical activity provided to students. Ethics approval was obtained from the University of British Columbia clinical research ethics board. All parents and students provided written informed consent to participate in this study.

### AS! BC Intervention

Teachers in INT schools created an individualized action plan that provided increased physical activity opportunities for students across the six action zones. The classroom action zone was a mandatory component, and teachers in INT schools were required to implement classroom-based activities for 15 min during each school day, 5 $d \cdot wk^{-1}$. Activities offered by teachers included skipping, dancing, and resistance exercises performed with hand grippers and exercise bands. Children in both UP and INT schools participated in their regular program of PE—two 40-min PE classes per week. The AS! BC model is novel in that it complements the 80 $min \cdot wk^{-1}$ of PE time with the 15 $min \cdot d^{-1}$ of physical activity in the classroom (75 $min \cdot wk^{-1}$) to achieve the recommended total (150 $min \cdot wk^{-1}$) (19). Although the intervention spanned 16 months (phase I: April through June 2003; phase II: October 2003 through June 2004), academic performance was evaluated across one school year.

### Study Participants

All grade 4 and 5 students (aged 9–11 yr) who normally participated in school PE and who returned signed consent forms were eligible to participate in the study. At baseline, parental consent was obtained for 396 students ($N$ = 198 boys, 198 girls). Only students with complete academic test score data at both baseline and follow-up ($N$ = 143 boys, 145 girls) were included in our analysis. Parents completed a health history questionnaire for their child, and the ethnicity of each child was determined from these questionnaires. Children were considered Asian if both parents (or all four grandparents) were born in Asia, Caucasian if both parents (or all four grandparents) were born in North America or Europe, or other if they were of a mixed race.

### Measurement Procedures

Baseline measures for height, body mass, and physical activity were acquired in February through March 2003, before the start of the intervention. Height, body mass, and physical activity and baseline measures of academic performance were assessed in June 2003. We conducted the follow-up evaluation in June 2004 after the completion of phase II of the intervention. Academic performance was evaluated across one school year, and measures were taken at the end the academic year (June 2003 and June 2004).

### Anthropometry

Standing height of each participant was measured (without shoes) to the nearest millimeter, using a wall-mounted stadiometer (Seca Model 242, Hanover, MD). Body mass was measured on a calibrated electronic scale (Seca Model 840, Hanover, MD) to the nearest 0.1 kg. For both height and body mass measurements, duplicate measures were taken; if the measures differed by ± 0.4 cm (height) or ± 0.2 kg (body mass), a third measurement was taken. The average of two values or the median of three values was used for analysis. We calculated body mass index (BMI) as body mass/height$^2$ ($kg \cdot m^{-2}$).

### Physical Activity Questionnaire

Children's leisure-time physical activity was determined using a modified version of the Physical Activity Questionnaire for Children (PAQ-C) (7,15). The PAQ-C is a 7-d self-report questionnaire designed to assess daily activity in the moderate to vigorous range. General physical activity scores were calculated as an average physical activity score (PA score) in a continuous range from 1 (low active) to 5 (high active). Validity of the PAQ-C was determined previously using the aerobic step fitness test as the criterion measure (7). Test–retest reliability of the PAQ-C was also assessed during a 7-d period in elementary school students and was $r$ = 0.75 for boys and $r$ = 0.82 for girls (7,15). In addition to baseline and follow-up, the PAQ-C was administered by trained research assistants three other times during the school year (June 2003, September 2003, and January 2004) to account for seasonal variation in physical activity levels. We averaged the five measurements of the PAQ-C (Table 1) to represent the physical activity level for each child. The PAQ-C has been used in previous studies with children of a similar age (3,18).

### Academic Performance Evaluation

We used the Canadian Achievement Test (CAT-3) to assess student academic performance. The CAT-3 is a standardized achievement test that evaluates student knowledge and skills related to specific subject areas including mathematics, reading, and language. The test is grade specific and does not contain any bias with respect to age, gender, or ethnicity (2). The themes and content of the test are based on the geographic, cultural, and ethnic diversity of Canadian society (2).

CAT-3 tests were administered by classroom teachers to grade 4 and 5 students in INT and UP schools in June 2003 and again in June 2004 (grades 5 and 6). Students recorded their responses on Scantron sheets. With the exception of one UP school who incorporated the CAT-3 as part of the standard school evaluation and scored the tests locally, tests were scored at the CAT-3 test center (Markham, Ontario). We used the total standardized score (TotScore)—a

TABLE 1. Baseline and 16-month change for descriptive variables for girls and boys in usual practice and intervention groups.

| | Usual Practice | | | Intervention | | |
|---|---|---|---|---|---|---|
| | Girls ($N$ = 37) | Boys ($N$ = 36) | All ($N$ = 73) | Girls ($N$ = 107) | Boys ($N$ = 107) | All ($N$ = 214) |
| Baseline age (yr) | 10.3 (0.6) | 10.2 (0.6) | 10.2 (0.6) | 10.2 (0.6) | 10.2 (0.6) | 10.2 (0.6) |
| No. in grades 4/5 | 17/20 | 17/19 | 34/39 | 50/57 | 49/58 | 99/115 |
| No. Asian/Caucasian/other | 29/4/4 | 27/5/4 | 56/9/8 | 56/33/18 | 61/38/8 | 117/71/26 |
| Baseline height (cm) | 140.6 (7.5) | 139.1 (6.2) | 139.8 (6.9) | 140.9 (7.5) | 140.9 (7.4) | 140.9 (7.4) |
| Height change | 8.6 (1.8) | 6.8 (1.7) | 7.7 (2.0) | 7.3 (1.9) | 6.7 (2.2) | 7.1 (2.1) |
| Baseline body mass (kg) | 35.1 (8.4) | 38.8 (10.8) | 36.9 (9.8) | 36.1 (8.9) | 36.4 (9.6) | 36.3 (9.2) |
| Body mass change | 6.6 (2.3) | 6.1 (2.3) | 6.3 (2.3) | 5.7 (2.7) | 5.7 (2.6) | 5.7 (2.7) |
| Baseline BMI ($kg \cdot m^{-2}$) | 17.7 (2.9) | 19.8 (4.4)* | 18.8 (3.9) | 18.0 (3.2) | 18.1 (3.3) | 18.1 (3.3) |
| BMI change | 1.0 (0.9) | 1.0 (0.8) | 1.0 (0.9) | 0.8 (1.1) | 0.9 (0.9) | 0.9 (1.0) |
| Average PA score (1–5) | 2.5 (0.4) | 2.6 (0.4) | 2.6 (0.4) | 2.6 (0.3) | 2.7 (0.4) | 2.7 (0.4) |

Mean (SD) BMI, body mass index; PA, physical activity.
* Boys > girls, $P < 0.05$.

summation of scores from the math, reading, and language/writing components—to represent each child's academic performance.

### Teacher Logs and Physical Activity Delivered

To monitor compliance to the AS! BC model, teachers in INT and UP schools maintained a daily physical activity log. Teachers recorded the type, frequency, and duration of each activity undertaken with their class each day. From the activity logs, we calculated the number of minutes of physical activity per week delivered by teachers to students.

### Statistical Analysis

Independent $t$-tests were used to compare descriptive variables (height, weight, PA score, academic performance) between INT and UP groups at baseline and between boys and girls. To account for the clustered study design, we used a mixed linear model to compare TotScore at follow-up between INT and UP groups and between boys and girls. We designated group and sex as fixed effects and school as the random effect. Because there was 20% variability in academic performance between schools at baseline, we included baseline TotScore as a covariate in the model. All analyses were performed using STATA, Version 9.1 (StataCorpLP). Results were considered significant at $P < 0.05$.

## RESULTS

Before follow-up testing, 61 students attending INT schools moved or were absent on the day of testing, and 11 students moved or were absent from the UP schools. One UP school chose not to send participants' test results to the CAT-3 test center for scoring, which was a guideline for participation in the academic performance component and was therefore excluded. We also excluded one INT school that administered the wrong test at follow-up ($N$ = 36). Therefore, eight schools (six INT, two UP) are represented in the analysis.

### Program Compliance

At baseline, INT schools reported 183 min of physical activity per week, on average, whereas UP schools reported 140 min of physical activity per week, on average. Academic performance was evaluated across the phase II interval, during which INT teachers delivered 47 min more physical activity per week than UP teachers (139 ± 62 vs 92 ± 45, $P < 0.001$). Teachers in INT schools completed eight (SD 3) activity logs on average during April through June 2003 (compliance = 67%) and an average of 29 (SD 6) activity logs during October through May 2004 (compliance = 83%). All but three INT schools were within 10% of meeting the guideline of 150 $min \cdot wk^{-1}$.

### Student Demographics

Descriptive variables at baseline and for 16-month change are provided (Table 1). At baseline, there was no significant difference in physical activity between children attending INT schools compared with those attending UP schools. Overall, 37% of boys and 24% of girls in the final sample had a BMI that would classify them as overweight or at risk for overweight according to CDC standards (16).

### Academic Achievement

Children attending UP schools had significantly higher AP scores at baseline than children attending INT schools ($P$ = 0.001; Table 2). However, there was no difference in AP scores between children attending INT schools and

TABLE 2. Baseline and adjusted mean follow-up total academic performance scores for girls and boys in usual practice and intervention groups.

| | Usual Practice | | | Intervention | | |
|---|---|---|---|---|---|---|
| | Girls ($N$ = 38) | Boys ($N$ = 36) | All ($N$ = 74) | Girls ($N$ = 107) | Boys ($N$ = 107) | All ($N$ = 214) |
| Baseline total score | 1714.6 (138.1) | 1638.8 (152.6) | 1676.7 (149.3)* | 1597.6 (152.4) | 1593.1 (153.3) | 1595.4 (152.5) |
| Adjusted mean values for follow-up total score | 1711.1 (15.8) | 1666.0 (17.4) | 1688.6 (16.6) | 1686.1 (9.1) | 1658.3 (10.0) | 1672.2 (9.6) |

Baseline values presented as mean (standard deviation).
Follow-up total score presented as adjusted mean (standard error).
* Control > intervention, $P$ = 0.001.

children in UP schools at follow-up (−15.3; 95% CI: −41.8, 11.2). These results are presented in Table 2. There was also no sex-by-group interaction for AP score, and boys and girls performed similarly on the test at follow-up ($P = 0.27$). Further, there was no difference in AP score between Asian and Caucasian children within schools ($P = 0.15$), nor was there a significant race-by-group interaction ($P = 0.48$).

## DISCUSSION

### Comparison between INT and UP schools

We found that despite dedicating approximately 10 additional minutes of daily physical activity, children's academic performance was not compromised. Children attending INT schools undertook an additional 50 min of physical activity per week, on average, compared with children attending UP schools. Despite this, academic performance total test scores were not significantly different between treatment groups at final measurement. This was not explained by differences in the examination between years or the timing of administration. We administered a standardized, grade-specific examination, and thus the test was equally challenging at both baseline and follow-up. Further, tests were administered at the same time each year (June), so the amount of instruction to students during the year was the same at both test periods. Thus, there were no differences in the type or timing of test administration between groups.

Although the most novel and consistent component of the AS! BC model was classroom action, teachers in INT schools provided significantly more opportunities for students to be physically active during school by implementing physical activity across all six action zones (20). The whole-school approach of introducing physical activity across six action zones advances existing school-based models of physical activity that intervened within PE only.

Previous results related to the effect of PE-based interventions on academic performance are equivocal. The Vanves study in France (12), as reviewed by Shephard (25), the Trois Rivieres study in Quebec (24), and Project SPARK in California (22) demonstrated improved academic performance scores when additional time (60 $min \cdot d^{-1}$, on average) was allocated for PE. However, the SHAPE study in Australia provided 210 min of additional physical activity per week and reported no significant differences in academic performance after their intervention (25). There are several distinguishable differences between these studies and the study we conducted apart from the intervention model. These include nonrandomization of subjects (10,22,25), the use of nonstandardized academic tests, and the provision of nutritional supplements to students (12,25). In the current study, schools were the unit of randomization, and our aim was not to alter but, rather, to enhance and complement the existing school PE curriculum. Finally, AS! BC was delivered by generalist teachers who were provided training, resources, and facilitation, rather than by PE specialists.

### Comparison between Boys and Girls

Our secondary question was to evaluate whether boys and girls responded differently to the intervention. In the current study, boys' and girls' *academic performance* scores were similar at baseline and changed similarly during the intervention period. This is consistent with studies that showed no difference in math scores between girls and boys in elementary school (6).

Our findings also support many other studies (24) suggesting that boys were more physically active than girls at a similar age, although this was not our primary question. Shepherd et al. (24) showed that boys 10–12 yr of age participated in more MVPA per day compared with girls of the same age. Girls were more likely to be involved in sedentary past times (24). Our findings also support the current literature that identifies a clear trend for increased overweight and obesity among Canadian children (9). On the basis of BMI calculations and compared with CDC standards (16), a substantial proportion of boys and girls in our study were classified as overweight or at risk for overweight. Together, these findings underscore the need for innovative and effective school-based physical activity and healthy eating models that address child health and health behaviors.

### Limitations of the Study

We acknowledge that our study has several limitations. First, despite randomization, there were group differences in academic performance between INT and UP schools at baseline. Although we controlled for baseline differences in academic performance between groups, it is possible that teachers and/or students in the control schools were higher performers, and this may have influenced change in academic performance between schools. We also note that a greater proportion of UP students were Asian (77%) compared with the INT sample (55%). However, because we did not observe a difference in AP score between Asian and Caucasian children within schools ($P = 0.15$) or a significant race-by-group interaction ($P = 0.48$), it is unlikely that the uneven distribution of children across ethnicities in INT and UP groups influenced our results.

Second, we were unable to directly assess socioeconomic status among schools, although socioeconomic status may influence academic standing of schools (1). We estimated the proportion annual parental income at less than $30,000 (Canadian) for both groups on the basis of Stats Canada data related to geographic location. Approximately 30% of parents in the UP groups and 28% of parents in the INT groups had an annual income of less that $30,000 (CDN). Third, differences between INT and UP schools may have been exacerbated by the small numbers of UP schools. It was unfortunate that one UP school scored their own test and that one INT administered the wrong examination, with both consequently excluded from the analysis. The imbalance between groups may have decreased our power to show an effect for the intervention.

Fourth, we used an indirect measure of physical activity (self-report questionnaire) to assess physical activity levels of children. Although this tool has been previously validated against direct measures of physical activity (3,7,15), it may not have been sensitive enough or specific enough to assess the school-based physical activity habits of children. In the future, direct measures of physical activity, such as accelerometry (27), would strengthen studies that address the relation between enhanced physical activity and academic performance. Finally, we conducted this trial during one academic year. It is likely that a prolonged, sustained effort to alter the physical activity environment of schools would provide a clearer indication of the effectiveness of initiatives such as AS! BC on selected outcomes, including academic performance.

In summary, AS! BC effectively increased physical activity delivered to students in elementary schools. The additional 10–15 min of school time devoted to physical activity did not compromise the academic achievements of boys and girls. Thus, AS! BC may be an attractive alternative for government and school administrators who aim to promote a school-based physical activity model.

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