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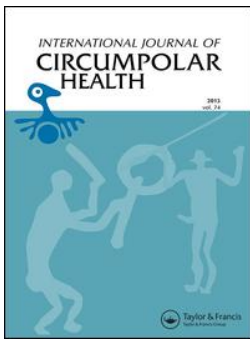
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The impact of Action Schools! BC on the health of Aboriginal children and youth living in rural and remote communities in British Columbia

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Objectives: The aim of the study was to determine the short-term impact of a 7-month whole-school physical activity and healthy eating intervention (Action Schools! BC) over the 2007–2008 school year for children and youth in 3 remote First Nations villages in northwestern British Columbia.

Study design: A pre-experimental pre/post design was conducted with 148 children and youth (77 males, 71 females; age 12.5 ± 2.2 yrs).

Methods: We evaluated changes in obesity (body mass index [wt/ht²] and waist circumference z-scores: zBMI and zWC), aerobic fitness (20-m shuttle run), physical activity (PA; physical activity questionnaire and accelerometry), healthy eating (dietary recall) and cardiovascular risk (CV risk).

Results: zBMI remained unchanged while zWC increased from 0.46 ± 1.07 to 0.57 ± 1.04 ($p < 0.05$). No change was detected in PA or CV risk but aerobic fitness increased by 22% (25.4 ± 15.8 to 30.9 ± 20.0 laps; $p < 0.01$). There was an increase in the variety of vegetables consumed (1.10 ± 1.18 to 1.45 ± 1.24 ; $p < 0.05$) but otherwise no dietary changes were detected.

Conclusions: While no changes were seen in PA or overall CV risk, zWC increased, zBMI remained stable and aerobic fitness improved during a 7-month intervention.

Keywords: *physical activity; aerobic fitness; cardiovascular risk; children; Aboriginal; nutrition.*

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While 26.3% of Canadian children and youth are overweight or obese, 34.5% of off-reserve Aboriginal young people are considered overweight or obese (1). Preliminary results of the 2008 First Nations Regional Longitudinal Health Survey suggest that 56% of children and 43% of youths living in Canadian First Nations communities are either overweight or obese, but obesity levels vary considerably by region (2). In specific First Nations communities the rate of on-reserve Canadian Aboriginal pediatric obesity and overweight has been reported as varying widely from 38% to as high as 70% (3,4). Obesity not only tracks from childhood into adulthood (5) but adults who were obese during childhood also have an increased risk of

developing chronic diseases (6). Aboriginal people in Canada suffer from obesity-related conditions such as diabetes, hypertension and heart disease at 2–3 times the rates of the general population (7). Clearly, something must be done to reverse this trend.

The school environment is an attractive context to promote healthy eating (HE), obesity prevention and physical activity (PA) as children from diverse ethnic and socio-economic strata spend 5 or more hours per day in school (8). Elementary-school-based interventions have successfully increased the amount of PA undertaken during school time (9–11) and have improved dietary habits (12–14).

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Action Schools! BC (AS!BC), as described in detail by Naylor et al. (15), is a whole-school framework for action on PA and HE. Efficacy of the model for improving a host of chronic disease risk factors was established in an urban setting in British Columbia (13,15–17). Although the model included Aboriginal children residing and attending school in urban communities, the initiative did not explicitly target issues and contexts specific to Aboriginal children. In response to concerns about type 2 diabetes and obesity among their children (18), 3 remote Tsimshian Nation communities collaborated with the AS!BC team to implement and evaluate the AS!BC intervention and measurement tools to understand its impact within the specific context of rural, remote Aboriginal communities.

Therefore, our aim was to determine the short-term impact of the AS!BC intervention in 3 rural, remote northern Aboriginal communities. Specifically, we addressed the question: Is there a significant change in health outcomes (obesity-related body composition, PA levels, aerobic fitness, CV risk and HE) for First Nations children and youth living in rural and remote northern communities after participation in AS!BC for 7 months?

Materials and Methods

Study design and population

Our study was part of a larger community-based participatory action research project. The initiative was undertaken in response to an invitation from 3 First Nations communities in northwestern British Columbia

based on: (i) their longstanding relationship with a clinician-researcher on our team; and (ii) their concern regarding the elevated risk of diabetes in their communities (18). As a result of the unique relationship and context, we implemented a pre-experimental pre/ post design to conduct our study.

Recruitment and participants

We received approval from the University of Victoria Human Research Ethics Board, the University of British Columbia Clinical Research Ethics Board and the Children’s and Women’s Research Review Committee to conduct the study. We also received approval and support from elected Band Councils, hereditary band elders, hereditary band chiefs, community health directors, school administrators and our target communities to undertake our study in their communities. We obtained written informed consent from parents or caregivers; the children provided verbal and written assent. The process we adopted to acquire consent/assent, to obtain community approval and to travel to very remote locations to undertake this project is described in more detail elsewhere (19). We invited all children in grades 4–12 at each of the schools (n = 3) in the 3 communities to participate. Of the 170 eligible participants, 163 consented to participate (96%), with 148 measured at baseline and 134 at follow-up. Details of the recruitment and reasons for dropping out are displayed in Figure 1.

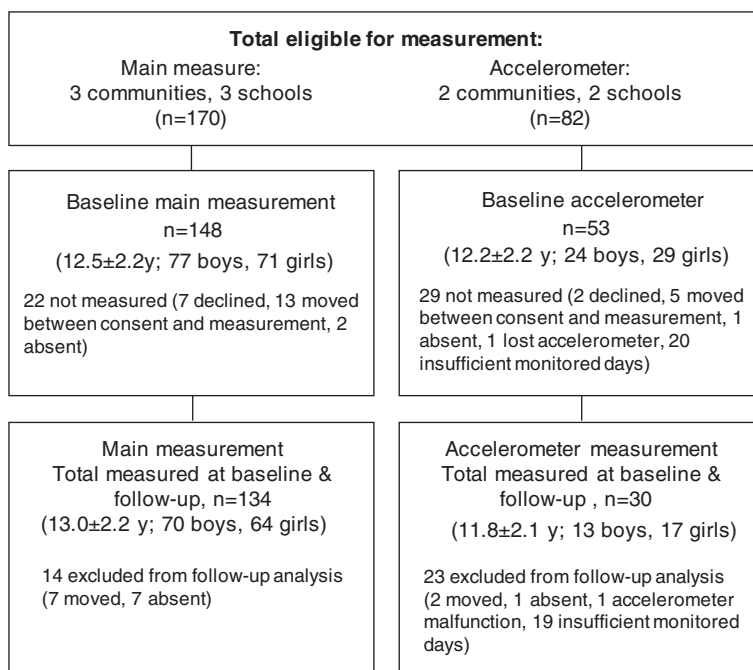


Fig. 1. Participation numbers and reasons for exclusion from measurement over the 7-month intervention.

Action Schools! BC intervention

We have described the AS!BC model in detail elsewhere (15) and have also described its implementation in these 3 communities (20). Briefly, AS!BC is a whole-school model that integrates classroom-based HE education and PA opportunities with recess and after-school activities, and environmental change strategies (e.g., playground equipment) with family and community elements (e.g., school spirit and family events) in order to promote healthy living. A primary feature of the AS!BC model is that it is tailored by each school and teacher according to their context. AS!BC advocates that children should accrue 150 minutes of PA per week during school hours. As well as regular physical education classes (typically 75–80 minutes/week), teachers in the program incorporated an additional 15 minutes per day of teacher-selected, classroom-based PA into their school regimen. For the HE component, teachers strove to incorporate at least one HE activity per month into the “classroom action zone” and implemented a fruit and vegetable (FV) and a sugar-sweetened beverage (SSB) campaign into their classroom or school. To facilitate classroom activities, the AS!BC Support Team (who travelled 3 times by seaplane to visit all of the schools) customized the model with teachers and provided an “Action Bin” replete with classroom PA and HE equipment and resources that teachers needed to deliver their customized model. The AS!BC Support Team also provided support to teachers to enhance the likelihood of successful implementation and sustain-ability (20).

Measurement

We assessed children and youth at baseline (September 2007) and again at 7 months following the school-based intervention (April or May 2008). All measurements were conducted at local schools during regular school hours by the same team of university researchers who travelled by seaplane to each of the communities.

Status of overweight and obesity

We assessed height, weight and waist circumference (WC) and calculated body mass index (BMI; kg/m^2). We assessed height as stretched stature to the nearest 0.1 cm (Seca 214 Portable Stadi-ometer) and weight to the nearest 0.1 kg (Conair digital electronic scale). Height and weight were measured twice and we used the mean for analysis as per Canadian Society of Exercise Physiology protocol (21). We measured WC to the nearest 0.1 cm at the midpoint between the lowest rib and the iliac crest, at the end of normal expiration. To compare BMI and WC across time periods, we used age- and gender-specific z-scores (zBMI and zWC). zBMI was calculated as per the Centers for Disease Control method (22), with overweight defined as ≥ 85 percentile and obese as $\geq 95^{\text{th}}$ percentile (23). zWC was determined from percentile values as per Fernandez et al. (24).

Physical activity (PA)

We estimated PA using a modified version of a valid and reliable tool for assessing moderate-to-vigorous PA (MVPA), the physical activity questionnaire for children (PAQ-c) or adolescents (PAQ-a) (25). We made minor changes to the PAQ by replacing 2 activities that were unavailable in the studied communities (ice hockey and ice skating) with 2 common, culturally oriented PA choices (e.g., seaweed gathering and traditional dance). A physical activity summary score (PA score) was calculated (25) with values ranging from 1 (low active) to 5 (very active). As well, we measured MVPA with GT1M acceler-ometers (Actigraph, Pensacola, FL) in a subset of participants. With a limited number of acceler-ometers and a high recruitment rate, participants from 2 of the 3 communities wore accelerometers for 5–7 days at each measurement period. Accel-erometers were programmed to collect activity counts every 15 seconds, and an age-specific regression equation (26) was used to estimate MVPA. We included all participants with at least 3 monitored days of 10 or more hours/day in our analysis. Our accelerometry protocol is described in detail elsewhere (27).

Aerobic fitness

To assess aerobic fitness, participants performed the Leger-Boucher 20-metre shuttle run as per standard protocol (28) in the school gymnasium; participants ran in groups of no more than 10 students. All participants were verbally encouraged throughout the procedure; the total number of laps completed by each student was recorded by the research assistant.

Cardiovascular risk (CV risk)

We assessed each child’s BMI, WC, blood pressure (BP) and aerobic fitness to determine the percentage of participants with elevated CV risk factors. We measured BP 3 times on the left arm and used the mean of the final 2 measurements for analysis. Risk factors were considered elevated if: (i) BMI was greater than the age- and gender-specific 85th percentile (22); (ii) WC was greater than the age- and gender-specific 90th percentile (24); (iii) BP was greater than the age-, gender-and height-specific 90th percentile (29); or (iv) aerobic fitness laps were less than the age-and gender-recommended standards (30).

Healthy eating (HE)

HE was assessed using a validated 24-hour dietary recall (31) that a member of the research team administered to each participant individually. The EHSA Food Processor Nutrition and Fitness Software (v. 8.7, Salem, OR) was used to generate macro-nutrient servings and total kilocalories consumed. We used hand counting to tally the number of different fruits and vegetables (FV) consumed as well as to assess the number of FV and sugar-

sweetened beverage (SSB) servings using the Canadian Nutrient File (32) for serving sizes.

Statistical analysis

We used Predictive Analytics SoftWare (PASW; v18.0, Chicago, IL) for statistical analyses. We used independent t-tests to compare descriptive characteristics between included ($n = 134$) and excluded ($n = 14$) participants, and paired t-tests to assess differences in outcomes at baseline and follow-up. We established the significance level a priori at $p < 0.05$. To determine if maturation (growth and age) was related to the aerobic fitness outcome, we conducted Pearson product moment correlations and simple linear regression analyses where the independent variables were entered simultaneously.

Results

Reasons for participant exclusion are provided in Figure 1 and baseline participant characteristics are displayed in Table I. Participants ranged from 8.7 to 18.5 years. There were no differences at baseline between participants who were measured in both time periods ($n = 134$) and those measured at baseline only ($n = 14$ drop-outs) with the exception that the dropouts had higher aerobic fitness (32.7 versus 25.4 laps; $p < 0.05$) and were older (14.3 versus 12.3 years; $p < 0.01$).

Status of overweight and obesity

Over one-half (51%) of participants were overweight or obese at baseline; 20% were overweight and 31% were obese (see Table I). Following the intervention, zBMI did not change; however zWC did increase ($p < 0.05$) (see Table II).

Physical activity

Participants accumulated significantly less accelerometer MVPA during weekend days compared to weekdays at both baseline (-46.3 minutes; $p < 0.001$) and follow-up (-28.3 minutes; $p < 0.001$). No significant change in

daily, weekday or weekend MVPA or in the PA score was detected after the 7-month intervention (see Table II).

Aerobic fitness and CV risk

Participants showed a substantial (22%) increase in aerobic fitness laps ($p < 0.001$) (see Table II). Age and growth were not significant predictors of the change in aerobic fitness laps ($F[2] = 0.846$, $p = 0.435$). While we observed a significant decrease in the proportion of children and youth at risk for low aerobic fitness (from 57% to 45%; $p < 0.05$), no other changes were seen in the CV risk profile (see Table III).

Healthy eating

There was a significant increase in the variety of vegetables consumed at follow-up (1.10 ± 1.18 to 1.45 ± 1.24 ; $p < 0.05$); otherwise, patterns of FV consumption, caloric intake and SSB consumption remained unchanged (see Table II).

Discussion

We previously reported in a randomized controlled trial that AS!BC implemented over 1 school year significantly enhanced aerobic fitness in mixed-ethnicity children attending urban schools (17). Here, we extend our previous work by evaluating the AS!BC model in 3 remote First Nations communities and show a similar cardiovascular benefit in Aboriginal children and youth. Specifically, participants improved their aerobic fitness laps by 22% after 7 months. To place this in context, the magnitude of change we observed in aerobic fitness after less than one year was similar to that seen in other nutrition and PA interventions; while minimal changes in aerobic fitness laps were seen in control groups, intervention groups saw significant increases in laps, with a 27% increase in laps for Crete school children over a similar time period (33), a 21% increase for Swiss children (34), a 20.4% gain for Canadian children living in an urban centre (17) and a similar gain in raw laps for a group of Australian children (35). Other nutrition and PA interventions—such as the Kahnawake Diabetes Preven-

Table I. Participant characteristics at baseline

Characteristic	All ($n = 133$)	Males ($n = 70$)	Females ($n = 63$)
Age (years)	12.4 ± 2.2	12.6 ± 2.0	12.1 ± 2.3
BMI (kg/m^2)	23.3 ± 5.3	23.5 ± 5.8	23.2 ± 4.6
% Overweight/Obese ^a	51.4%	48.1%	54.9%
WC (cm)	74.4 ± 13.7	76.4 ± 16.0	72.1 ± 10.3
Systolic BP (mm Hg)	116.5 ± 10.2	119.8 ± 10.4	112.9 ± 8.7^b
Diastolic BP (mm Hg)	61.9 ± 7.7	62.6 ± 7.1	61.2 ± 8.2

BMI = body mass index (wt/ht^2); WC = waist circumference; BP = blood pressure.

^aObesity determined as per Centers for Disease Control (22).

^b $p < 0.05$ for difference between males and females.

Table II. Baseline and follow-up anthropometric, physical activity, fitness and dietary variables

Variable	Baseline	n	Follow-up	t	p
Anthropometrics:					
zBMI	1.12 ± 0.86	133	1.10 ± 0.87	1.066	0.288
zWC	0.46 ± 1.07	133	0.57 ± 1.04	-2.303	0.023
zBP Systolic (mm Hg)	0.85 ± 0.80	131	1.00 ± 0.90	-1.790	0.076
zBP Diastolic (mm Hg)	-0.10 ± 0.67	131	-0.18 ± 0.69	1.116	0.267
Physical activity & fitness:					
Aerobic fitness laps	25.4 ± 15.8	114	30.9 ± 20.0	-4.065	0.000
PA Score	2.75 ± 0.72	134	2.83 ± 0.79	-1.449	0.150
MVPA - overall (min/day)	152.3 ± 36.2	30	147.7 ± 45.5	0.597	0.555
- weekdays (min/day)	166.5 ± 40.4 ^a	30	161.3 ± 51.9 ^b	0.613	0.545
- weekends (min/day)	120.2 ± 41.9 ^a	19	133.0 ± 48.6 ^b	-1.23	0.234
Dietary intake:					
Kcal/day	1839.8 ± 761.5	115	1730.2 ± 744.2	1.418	0.159
% Calories from carbohydrate	58.9 ± 11.9	115	59.5 ± 12.4	-0.355	0.724
% Calories from sugar	27.3 ± 13.3	115	28.4 ± 11.8	-0.74	0.461
% Calories from protein	12.9 ± 5.8	115	13.4 ± 5.6	-0.765	0.446
% Calories from fat	28.2 ± 9.0	115	27.2 ± 9.1	0.931	0.354
FV servings/day	2.75 ± 2.45	115	3.21 ± 3.20	-1.306	0.194
Vegetable servings/day	1.31 ± 1.7	115	1.48 ± 1.55	-0.807	0.421
Fruit servings/day	1.44 ± 1.77	115	1.72 ± 2.61	-1.063	0.290
# FV type	2.07 ± 1.55	115	2.39 ± 1.90	-1.528	0.129
# Fruit type/day	0.97 ± 1.03	115	0.94 ± 1.21	0.201	0.841
# Vegetable type/day	1.10 ± 1.18	115	1.45 ± 1.24	-2.226	0.028
SSB (mls/day)	835.4 ± 725.5	115	927.2 ± 553.4	-1.423	0.158

zBMI = body mass index (wt/ht²) z-score (23); zWC = waist circumference z-score (24); zBP = blood pressure z-score (29); PA Score = physical activity score; MVPA = moderate-to-vigorous physical activity; FV = fruit and vegetable; SSB = sugar-sweetened beverage.

^ap < 0.001 for difference between weekdays and weekends.

^bp < 0.001 for difference between weekdays and weekends.

tion Program directed at a Canadian Mohawk community (36) and the Child and Adolescent Trial for Cardiovascular Health study (37)—have reported either no change or a decrement in aerobic fitness following intervention. We acknowledge the clearly established link between overweight/obesity and chronic disease in adults (38). Moreover, an independent, compelling and distinct relationship between aerobic fitness and all-cause mortality has also been established in adults (39). Indeed, in adults, a 1 metabolic equivalent (MET) increase in

aerobic fitness decreased the risk of all-cause mortality by approximately 15%. While the 22% improvement in our lap score cannot be directly converted to METs, it does represent an average increased running time of over 40 seconds in a test where each additional 60 seconds of running represents a 1 MET increase in VO₂max (28). Further, research supports the notion that, for young people, the harmful consequences attributed to overweight and obesity can be counteracted by having high levels of aerobic fitness (40). Thus, we consider the

Table III. Percentage of participants with CV risk factors at baseline and follow-up

Variable	Baseline	n	Follow-up	t	p
% with a least 1 risk factor	73.7%	133	72.9%	0.179	0.858
% Overweight/Obese ^a	52.2%	133	53.4%	-0.818	0.783
% High WC	26.5%	132	26.5%	0.818	1.000
% Elevated BP	30.3%	131	35.9%	-1.044	0.298
% Low aerobic fitness	57.3%	96	44.8%	2.319	0.023

WC = waist circumference; BP = blood pressure.

^aObesity determined as per Centers for Disease Control (22).

improved aerobic fitness in these First Nations children and youth to be an important finding.

Interventions directed at the primary prevention of diabetes or obesity in First Nations young people have been unsuccessful in their attempts to reduce the prevalence of overweight. The Pathways study showed no significant differences in BMI or percent fat between intervention and control American Indian children after 3 years, with BMI and percent fat increasing similarly in both groups (41). The Kahnawake diabetes prevention intervention study reported increased age- and gender-adjusted BMI in both elementary school control and intervention groups (36).

In other diabetes prevention studies with First Nations young people, mean BMI increased (42) or did not change (43), despite intervention. Thus, we view our outcome—where zBMI remained constant over the intervention period—as positive. While an average zBMI greater than 1 (as seen in our participants) is high, impeding the rise in BMI is an important first step in controlling obesity (23).

In spite of zBMI not changing, zWC increased, affirming the findings that WC may change independently of BMI (44). This may reflect the tendency of Aboriginals to accumulate fat centrally (45). Some studies suggested that WC was a better marker of CV risk factors than BMI in children and youth (46). Others (44) demonstrated that young people with a high BMI and high WC were twice as likely to have high triglycerides, high insulin levels and metabolic syndrome when compared to peers who had a normal WC but carried excess body weight. While 47% of participants in the current study had a normal BMI and normal WC, 29% had either a normal BMI and high WC or a high BMI and normal WC; 24% had both a high WC and high BMI. We share these findings with the caveat that we were unable to undertake ethnic-specific comparisons for WC as norms for Aboriginal children are unavailable.

As in previous studies, we observed no change in MVPA measured by accelerometry or questionnaire (9,17,41). Even when evaluating accelerometry within and outside of the school day (data not shown), no differences in MVPA were detected. We outlined a number of factors that may have influenced this finding. First, the weather at baseline was considerably warmer ($13.4 \pm 1.2^\circ\text{C}$ versus $8.9 \pm 3.0^\circ\text{C}$; $p < 0.001$) and drier (43% versus 58% rain days; ns) (47) compared to follow-up. Since adolescents are more physically active on warmer days and on days with no rain (48), it is not surprising that MVPA remained unchanged at follow-up. Second, enthusiastic teachers began implementing the program before and during baseline measurement in spite of requests to wait until after baseline measurement. Regrettably, this could have elevated baseline MVPA levels, masking potential improvements in PA at follow-

up. Third, 3 days of accelerometer monitoring may have been insufficient to capture habitual activity patterns (49). However, given our limited access to these remote communities and with relatively few participants wearing accelerometers for 4 or more days, we accepted a 3-day minimum for our analyses. Given the significant improvement we report for aerobic fitness, the PA measures we adopted may have lacked the sensitivity to capture the change in PA that likely mediated the aerobic fitness benefit.

To achieve a 22% improvement on the aerobic fitness test, frequency, duration and/or intensity of activity must have increased, even though our tools were unable to detect it. From the teachers' activity logs, as reported in Naylor et al. (20), it appears that extra classroom PA was delivered to participants. Classes averaged 75 minutes of weekly physical education plus an additional 65 minutes of PA outside of physical education classes. This classroom PA likely contributed to enhancing aerobic fitness; a similar dose of PA resulted in modest increases in steps for male students during our preliminary trial (10).

In terms of overall CV risk, almost three-quarters of participants had at least 1 of 4 CV risk factors both pre- and post-intervention (73.7% versus 72.9%; $p > 0.05$). It is encouraging that the number of children and youth in the risk category for aerobic fitness decreased at follow-up, although we observed no improvements in the other risk categories. Comparing CV risk with other studies is difficult as there are many different risk variables, and cut-points for risk are not standardized. Even so, the results of our study are more alarming than results reported elsewhere. Ribeiro et al. (50), who assessed CV risk in 8–15-year-old Portuguese youth, and Reed et al. (17), who assessed 9–11-year-old Canadian children, both found that approximately 50% of participants presented with at least 1 of 4 CV risk factors. Clearly, the Aboriginal young people in our study are at an unacceptably high health risk. Thus, minimizing cardiovascular and diabetes risk should be a major public health objective for this population.

We observed no change in SSB consumption and only a small improvement in FV intake. This may have been the result of too little time devoted to HE activities. Teacher logs indicated that an average of 15 minutes of HE activities was delivered twice per week over the year, including both the SSB and FV campaigns (20). Other successful FV interventions have dedicated 42–60 or more minutes per week to HE activities (12–14). While other successful nutrition/SSB interventions involved replacing sugar-sweetened soft drinks with diet (sugar-free) options at school (43) or at home (51), or by banning junk food sold or brought to school (52), ours involved classroom education and student tracking. We accept that the clinical relevance of increasing fruit and vegetable variety by just under half a fruit or

vegetable each day is not clear. However, this small increase may prove a marker for a more substantial change in health behaviours that may ultimately lead to increased FV consumption and a better micronutrient profile over the students' lifespans. Anecdotal reports highlighted that fruits and vegetables were particularly vulnerable to transportation and storage issues in these remote communities.

One strength of our study was that it represented a "natural" experiment that illustrated the potential impact of a focused, comprehensive school health model within the context of remote Aboriginal communities and the challenges faced by teachers and students every day. Another strength was the high consent (96%) and participation (87%) rates that demonstrated the willingness of residents to participate in interventions that aim to promote child health. Furthermore, there was little apparent difference between participants measured at both time periods and those measured only at baseline.

Our findings should be interpreted in light of several limitations related to study design, measurement and the intervention itself. The most significant limitation was our inability to include a comparison group. Our research was based on a long-term partnership with the First Nations communities that we approached and all of these communities wished to be involved in the intervention. These partnerships are key to an ethical approach to working with Aboriginal communities in Canada (53). Thus, we were unable to recruit "comparator" communities with which we had no relationship and there was insufficient time to establish new relationships during the relatively short grant-funding time frame. Furthermore, each small community in our study was geographically and socially unique (20) thus it would not have been possible to find a representative comparison community.

Measurement limitations included the use of self-report to assess PA and HE. While the PAQ is a self-report measure, it has good internal consistency and validity compared with several other PA measures (25). To overcome issues related to self-reported PA, we also included an objective measure of PA in a subset of participants. However, extreme seasonal differences in weather and early uptake of the intervention by teachers may have influenced our ability to accurately assess change in PA. In addition, many participants failed to comply with accelerometry protocol (a daily wear period of > 10 hours was required to be considered a valid day). This resulted in many follow-up files with less than 3 valid days; their data were excluded from analysis. By using a single dietary recall we may have misrepresented usual patterns of food consumption (54). Unfortunately, administering multiple dietary recalls was not possible given our travel constraints. In addition, 20% of the 24-hour recalls were carried out on a different day (weekend versus weekday) at baseline compared with

follow-up. Finally, our findings related to overweight and obesity may be influenced by our use of zWC measurements that were based on non-Aboriginal population standards; fat distribution differs between non-Aboriginal and Aboriginal children (55).

Higher lap scores after the 7-month period may, in part, reflect normal growth and development of children. That said, changes in height and weight did not significantly affect the lap score (as per the regression analysis we performed). Further, when we used age-adjusted lap score cut-points to determine CV risk (30), the CV risk for low cardiovascular fitness had significantly decreased at follow-up (see Table III), confirming that critically low aerobic fitness had improved. Although improvements in the shuttle run may reflect enhanced motivation or effort, based on the magnitude of the increase it is unlikely that these factors alone explain the changes we observed.

Finally, our study may have been limited by the design of the intervention, which was developed for grades K-9. However, given the structure of schools in these remote northern communities, we administered the intervention to all grades. Naylor et al. (20) reported that some teachers from the higher grades were concerned about the potential for disruptive student behaviour, especially during the PA breaks, as a barrier to implementation of the model in older students.

Conclusion

In conclusion, it is imperative that effective strategies be devised to improve the health of children and youth residing in remote First Nations communities. In our study, the positive effect of AS!BC on aerobic fitness and the ability of this school-based model to stay the current upward trajectory of age- and gender-adjusted BMI in Aboriginal children and youth holds great promise for effectively enhancing the health of this population.

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Conflict of interest and funding

The authors declare that there are no conflicts of interest.

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