

Original quantitative research

From best practice to next practice: implementing Comprehensive School Health in rural and remote northern communities

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Abstract

Introduction: Northern communities in Canada experience a disproportionate burden of chronic diseases including mental illness. To mitigate the growing health inequalities, an ongoing Comprehensive School Health program promoting healthy lifestyle behaviours and mental health and well-being was expanded to rural and remote northern communities. We report on the program's impact on knowledge, attitudes, lifestyle behaviours (healthy eating, physical activity, screen time), weight status and the mental health and well-being of elementary school students during the first four years of implementation.

Methods: Following a repeated cross-sectional design, we surveyed 440, 352 and 384 Grade 4 to 6 students (9–12 years old) from eight schools in 2016, 2018 and 2020/21, respectively. Students were approximately equally represented by girls and boys.

Results: Between 2016 and 2018, students reported modest increases in vegetable and fruit consumption and dietary variety; declines in screen time; no changes in physical activity; and declines in attitudes toward healthy lifestyle and in mental health and well-being. Between 2018 and 2020/21, lifestyle behaviours deteriorated substantially, while attitudes and mental health and well-being continued to decline.

Conclusions: A program that was successful in socioeconomically disadvantaged urban neighbourhoods had a favourable, though modest, impact on selected lifestyle behaviours, but not on attitudes and mental health and well-being, in rural and remote northern communities. In light of cultural differences and logistical challenges in Canada's North, systematic and proactive adaptations to local contexts, increased intensity, and longer program delivery are essential to facilitate sustainable improvements in lifestyle behaviours and mental health and well-being.

Keywords: *children, nutrition, physical activity, screen time, sleep, mental health, self-esteem, school health, public health*

Highlights

- A school-based health promotion program targeting lifestyle behaviours and mental health and well-being—APPLE Schools—has been implemented in rural and remote northern Canadian communities to improve health and mitigate health inequalities.
- Surveys among Grade 4 to 6 students in 2016, 2018 and 2020/21 revealed initial modest improvements in lifestyle behaviours that dissipated during the COVID-19 pandemic.
- Attitudes toward health and healthy lifestyles did not improve between 2016 and 2020/21.
- Systematic and proactive adaptations and increased intensity and duration of health promotion programming are essential to yield substantive and sustainable improvements in lifestyle behaviours, and mental health and well-being in Canada's North.

negative self-esteem, psychological stress, depression).³

The prevalence of unhealthy lifestyle behaviours and mental health problems in children is high in Canada: in 2018, only 52% and 54% of Canadian school-aged children consumed fruit and vegetables,

Introduction

Healthy lifestyle behaviours and mental health and well-being are essential to a young person's healthy growth and development.¹ Once established at a young age,

unhealthy lifestyle behaviours and mental health problems appear to be difficult to reverse and to track easily into adulthood.² They can result in spiralling negative consequences for both physical (e.g. obesity, diabetes) and mental health (e.g.

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respectively, on a daily basis; 25% were meeting the recommended 60 minutes of moderate-to-vigorous physical activity (MVPA); and the average daily screen time was 4 to 5 hours (depending on grade and sex).⁴ Unhealthy lifestyle behaviours might be even more prevalent among children in socioeconomically disadvantaged settings such as rural and remote northern communities with a disproportionately high burden of chronic diseases and mental illness.⁵

APPLE Schools (*A Project Promoting Healthy Living for Everyone in Schools*) was initiated in 2007 to promote health and to tackle health inequalities. APPLE Schools is an innovative, internationally recognized, not-for-profit health promotion program targeting schools in socioeconomically disadvantaged communities. Inspired by a grassroots initiative, the Annapolis Valley Health Promoting Schools program,⁶ and drawing on the principles of the World Health Organization's Ottawa Charter for Health Promotion,⁷ APPLE Schools takes a Comprehensive School Health approach to promoting healthy lifestyle behaviours and mental health and well-being by transforming the culture of school communities to one where "the healthy choice is the easy choice."⁸ Recognizing the unique context in which each school functions, APPLE Schools works with stakeholders from the communities to tailor operations to the needs of each specific school community. We have previously demonstrated the two-year effect of APPLE Schools in socioeconomically disadvantaged communities in rural and urban settings: compared to comparison schools, APPLE Schools increased children's physical activity during and outside of school⁹ and their fruit and vegetable consumption, and improved diet quality, as a result decreasing their likelihood of obesity.⁸

The present study reports on the four-year effect of the program on the knowledge, attitudes, lifestyle behaviours, and mental health and well-being of Grade 4 to 6 students attending schools in rural and remote northern communities in Canada.

Methods

APPLE Schools was launched in 2008 in 10 schools in the province of Alberta, Canada. After establishing its effectiveness in these schools, the program has expanded and is currently functioning in

74 schools in socioeconomically disadvantaged communities in rural and urban Alberta, British Columbia, Manitoba and Northwest Territories.¹⁰

By 2016, APPLE Schools had started their program in schools in rural and remote northern communities. During the first two years, a part-time (0.5 full-time equivalent [FTE]) school health facilitator is placed in each school to facilitate the development and implementation of an action plan and strategies for healthy eating, active living and mental health and well-being, while considering the unique community and school-specific characteristics, needs and challenges that may present barriers or opportunities to health promotion.

The School Health Facilitator responsibilities include engaging key stakeholders (e.g. families, staff, community); contributing to the schools' vision, plan and curriculum for health (both during instructional and non-instructional school time); engaging in development of cross-curricular links and teaching across the curriculum; facilitating professional development days for teachers and school staff; organizing family information nights, nutrition programs and cooking clubs, after-school physical activity programs, peer education campaigns, weekend events and celebrations; creating hallway displays; circulating newsletters; ensuring the implementation of provincial, district and school policies related to health, nutrition, physical activity, and mental health and well-being; changing the physical and social environment to support the development of healthy habits; and coordinating and involving partnerships and services both in the development and implementation of school-specific action plans and policies focussing on the well-being of students, staff, families and community members. In the third year, the 0.5 FTE is reduced to 0.2 FTE. In the fourth year and beyond, 0.2 FTE is replaced with a volunteer School Health Champion from the school community to provide programming.

The study employed a repeated cross-sectional design. All school boards and principals that consented to implement the APPLE Schools program were approached to administer student, parent/guardian and principal surveys. Although we collected these data in 10 (2016), 15 (2018) and 20 (2020/21) APPLE Schools teaching Grade 4 to 6 students, the focus of this

paper is on the eight schools that participated in data collection at all three time points.

To ensure methodological rigour, student surveys were administered by research assistants in school during regular class time. The in-person mode of data collection in 2016 and 2018 (in which trained research assistants would travel to schools to administer surveys) was shifted to online in fall 2020/winter 2021 in accordance with the COVID-19 protocols.

Students' participation rates were 66%, 67% and 77% in 2016, 2018 and 2020/21, respectively. All students provided assent and their parents/guardians provided active-information passive permission consent. The Health Research Ethics Board of the University of Alberta (Pro00061528) and participating school boards approved all procedures.

Measures

One of the foci of the Comprehensive School Health intervention is improving knowledge and attitudes toward healthy lifestyle. To assess knowledge of current recommendations for engaging in at least 60 minutes of MVPA each day,¹¹ the children were asked to select the number of minutes a child their age should engage in MVPA each day (15, 30, 45, 60 or 90 minutes or a "don't know" response). Attitudes toward active and healthy living were assessed by asking the children how much they care about being physically active, eating healthy foods, going to sleep on time and being healthy.

To assess dietary consumption, students completed an interactive 24-hour dietary recall food behaviour questionnaire, previously validated in youth.¹² We computed the Diet Quality Index-International (DQI-I) score,¹³ a composite measure of diet quality ranging from 0 to 100, with higher scores indicating better diet quality. The DQI-I includes aspects of diet adequacy, variety, balance and moderation.

To assess physical activity, students were asked to wear a time-stamped pedometer (Omron HJ-720 ITC; OMRON Healthcare, Kyoto, Japan) for nine consecutive days on the right hip during all waking hours unless showering or swimming. These data are only available for 2016 and 2018; pedometers require in-person instructions

that could not be given during the COVID-19 public health measures put in place during the 2020/21 data collection period. In 2018 and 2020/21, student surveys included the Physical Activity Questionnaire for older Children (PAQ-C).¹⁴ The PAQ-C score ranges from 0 to 5 with higher scores indicating higher levels of physical activity. Students were asked to report how many hours per day they spend watching TV/DVDs/playing video games/using a cell-phone or similar device outside of school hours.

In 2016 and 2018, student standing height (with shoes off) was measured to the nearest 0.1 cm and body weight was measured to the nearest 0.1 kg on calibrated digital scales. To appreciate the sensitive nature of these measurements (particularly weight), students were invited to step behind a screen and research assistants recorded the results but did not comment on or discuss them with students. Overweight and obesity were defined using the International Obesity Task Force age- and sex-adjusted BMI cut-off points.¹⁵ Height and weight were not measured in 2020/21 because of COVID-19 protocols.

The student survey also included a series of 12 questions in the domain of mental health and well-being that were derived from population survey instruments¹⁶⁻¹⁹ and were suitable for school-based administration to Grade 4 to 6 students (details described in Wu et al.²⁰). Response options were “never or almost never,” “sometimes” and “often or almost always.” These were assigned scores of “-1,” “0” and “1” for positively stated items and reverse coded for negatively stated items so that high values indicate better mental health and well-being. The cumulative score was created by summing individual items, ranging from -12 to +12, with higher values indicating better mental health and well-being.

Statistical analyses

As part of descriptive analyses, we present the number and percentage of girls/boys and Grade 4/5/6 students across all data collection cycles, the prevalence of knowledge, attitudes, lifestyle behaviours and mental health and well-being in each of the measurement years as well as the absolute differences in prevalence over two-year intervals. For these differences in prevalence (2016 vs. 2018, and 2018 vs. 2020/21), we calculated 95% confidence

intervals using the Student's *t*-test for continuous variables and the Wald test for proportions. To examine temporal changes in knowledge, attitudes, lifestyle behaviours and mental health and well-being, we fitted multivariable linear and logistic regression models that were adjusted for grade level, student sex, region (rural, small population centre) and school social and material deprivation. Social and material deprivation indices were based on 2016 Canadian Census data. Given that the next cycle of these data (i.e. 2021 Canadian Census) was not available during data analyses, these indices remained unchanged.

As per established recommendations, fixed effects regression models were chosen over mixed effects since the intraclass correlation was below 0.02.²¹ Analyses were conducted using statistical package R version 4.0.2 software (GNU General Public Licence; R Foundation for Statistical Computing, Vienna, AT).

Results

Table 1 shows the characteristics of participating students and schools. A total of 440, 352 and 384 students participated in the surveys in 2016, 2018 and 2020/21, respectively. Participants were approximately equally represented by girls and boys across three data cycles.

In terms of attitudes, fewer students in 2018, relative to 2016, reported caring about going to bed on time; relative to 2018, fewer students in 2020/21 reported caring about being healthy and healthy eating.

Students on average reported eating 3.1 servings of vegetables and fruit per day in 2016 (see Table 2). Vegetable and fruit consumption increased to 3.5 servings/day in 2018 but declined to 2.9 servings/day in 2020/21. Diet quality scores increased from 53.9 in 2016 to 56.4 in 2018 and remained at this level in 2020/21.

TABLE 1
Characteristics of APPLE Schools in rural and remote northern communities in Canada and participating students from these schools, 2016–2020/21

Schools characteristics, n (%)	2016–2020/21 (n = 8)		
Region of residence			
Rural	6 (75)		
Small population centre	2 (25)		
Material deprivation index quintile			
1 (least deprived)	0 (0)		
2	3 (37.5)		
3	2 (25)		
4	0 (0)		
5 (most deprived)	3 (37.5)		
Social deprivation index quintile			
1 (least deprived)	2 (25)		
2	2 (25)		
3	2 (25)		
4	2 (25)		
5 (most deprived)	0 (0)		
Student characteristics, n (%)	2016 (n = 440)	2018 (n = 352)	2020/21 (n = 384)
Sex			
Girls	215 (49)	175 (50)	206 (54)
Boys	225 (51)	177 (50)	178 (46)
Grade level			
Grade 4	144 (33)	121 (34)	124 (33)
Grade 5	139 (32)	128 (36)	128 (33)
Grade 6	153 (35)	103 (29)	132 (34)

TABLE 2
Knowledge of recommendations, attitudes toward healthy lifestyle, lifestyle behaviours, and mental health and well-being of students in 2016, 2018 and 2020/21 in eight APPLE Schools in rural and remote northern communities in Canada

Measures	2016	2018	2020/21	2018–2016 difference (95% CI) ^a	2020/21–2018 difference (95% CI) ^a
Knowledge of recommendations, n (%)					
Know that she/he should take part in MVPA at least 60 minutes/day	136 (31)	98 (28)	69 (18)	–3 (–10, 3)	–10 (–17, –3)
Attitudes toward healthy lifestyle, n (%)					
Care about being healthy	409 (93)	320 (91)	334 (87)	–2 (–7, 1)	–4 (–8, 0)
Care about being physically active	383 (87)	299 (85)	307 (80)	–2 (–7, 3)	–5 (–10, 1)
Care about healthy eating	374 (85)	289 (82)	288 (75)	–3 (–9, 2)	–7 (–13, –1)
Care about going to bed on time	277 (63)	180 (51)	188 (49)	–12 (–18, –3)	–2 (–10, 5)
Healthy eating					
Vegetables and fruit, servings/day	3.1	3.5	2.9	0.3 (–0.1, 0.7)	–0.6 (–1, –0.2)
Milk and alternatives, servings/day	2.1	2.2	2.2	0.1 (–0.1, 0.4)	0.0 (–0.3, 0.3)
Grains and grain products, servings/day	6.0	6.5	7.2	0.5 (–0.1, 1.0)	0.7 (0.1, 1.3)
Meat and alternatives, servings/day	1.9	2.0	2.2	0.1 (–0.2, 0.3)	0.1 (–0.1, 0.4)
DQI-I	53.9	56.4	56.6	2.4 (1.2, 3.6)	0.3 (–0.8, 1.3)
Dietary variety	13.9	17.6	17.2	3.7 (3.1, 4.2)	0.4 (–0.9, 0.2)
Sugar-sweetened beverages, servings/day	1.1	1.0	2.4	–0.1 (–0.3, 0.1)	1.4 (1.0, 1.8)
Total sugar, g/day	96.9	106.2	107.6	9.3 (–1.2, 19.8)	1.4 (–11.3, 14.1)
Physical activity					
Step-count	9417	9418	–	1 (–508, 510)	–
PAQ-C	–	2.2	2.1	–	0 (–0.1, 0.1)
Screen time, hours/day					
Time watching TV	1.9	1.5	2.3	–0.4 (–0.7, –0.2)	0.8 (0.5, 1.2)
Time playing videogames	1.9	1.5	2.4	–0.5 (–0.9, –0.1)	0.9 (0.6, 1.3)
Time on cellphone	1.2	1.3	1.8	0.1 (–0.3, 0.4)	0.5 (0.2, 0.9)
Weight status, n (%)					
Overweight (excluding with obesity)	92 (21)	78 (22)	–	1 (–4.9, 7.4)	–
Obesity	79 (18)	63 (18)	–	0 (–5.7, 5.5)	–
Mental health and well-being					
Cumulative score ^b	5.4	4.7	4.3	–0.6 (–1.2, –0.1)	–0.4 (–1.1, 0.2)

Abbreviations: CI, confidence interval; DQI-I, Diet Quality Index – International; MVPA, moderate-to-vigorous physical activity; PAQ-C: Physical Activity Questionnaire for Older Children.

^a Positive values refer to higher values in 2018 vs. 2016 or higher values in 2020/21 vs. 2018. A difference is statistically significant if the 95% CI does not include zero.

^b Higher values of the cumulative score for mental health and well-being indicate better mental health and well-being.

Diet variety improved between 2016 (13.9) and 2018 (17.6) and remained at this level in 2020/21. The consumption of sugar increased between 2016 (96.9 g/day) and 2018 (106.2 g/day), although this increase was not statistically significant. Meanwhile the consumption of sugar-sweetened beverages was similar in 2016 and 2018, but more than doubled reaching, on average, 2.4 servings per day in 2020/21.

Our measures of physical activity (step-counts and PAQ-C scores) did not reveal any substantial or statistically significant changes between 2016 and 2020/21. Time spent watching TV and playing video games decreased by almost 30 minutes per day between 2016 and 2018 but then increased by almost an hour per day between 2018 and 2020/21. Time using cellphones also increased between 2018

and 2020/21 by approximately 30 minutes per day.

The proportion of overweight and obesity did not change substantially between 2016 and 2018. In terms of student health knowledge, fewer students in 2018 and 2020/21 than in 2016 correctly identified the recommendation for physical activity of at least 60 minutes daily. As for mental health and well-being, the cumulative score declined over time: from 5.4 in 2016 to 4.7 in 2018 and 4.3 in 2020/21.

Table 3 shows the observations in 2018 and 2020/21 relative to the pre-program level in 2016 adjusted for confounders. Students in 2020/21 were less likely to correctly answer the question about the recommended time for physical activity than in 2016. This decline was statistically

significant. Also, students were statistically significantly less likely to report favourable attitudes toward being healthy, being physically active, healthy eating and going to bed on time after four years of programming compared to pre-program levels.

The consumption of milk and alternatives and meat and alternatives declined by approximately 0.4 servings between 2016 and 2020/21, whereas the number of sugar-sweetened beverages increased in a statistically significant manner. Changes in the consumption of vegetables and fruits were not statistically significant. Relative to 2016, the DQI-I was 2.6 and 3.6 higher in 2018 and 2020/21 respectively. Similarly, diet variety was also higher in 2018 and 2020/21 than in 2016.

TABLE 3
Knowledge of recommendations, attitudes toward healthy lifestyle, lifestyle behaviours, and mental health and well-being of students in 2018 and 2020/21 relative to 2016 in eight APPLE Schools in rural and remote northern communities in Canada

Measures	2 years of intervention (2018) ^a		4 years of intervention (2020/21) ^a	
	OR (95% CI) ^b	β (95% CI) ^b	OR (95% CI) ^b	β (95% CI) ^b
Knowledge of recommendations				
Know that she/he should take part in MVPA at least 60 minutes/day	0.9 (0.7, 1.2)	–	0.5 (0.3, 0.7)	–
Attitudes toward healthy lifestyle				
Care about being healthy	0.7 (0.4, 1.2)	–	0.4 (0.3, 0.7)	–
Care about being physically active	0.8 (0.6, 1.3)	–	0.6 (0.4, 0.9)	–
Care about healthy eating	0.8 (0.6, 1.2)	–	0.5 (0.4, 0.7)	–
Care about going to bed on time	0.6 (0.5, 0.8)	–	0.6 (0.4, 0.8)	–
Healthy eating				
Vegetables and fruit	–	0.3 (–0.1, 0.7)	–	0.1 (–0.4, 0.6)
Milk and alternatives	–	0.1 (–0.1, 0.4)	–	–0.4 (–0.7, –0.1)
Grains and grain products	–	0.6 (–0.1, 1.2)	–	0.2 (–0.6, 1)
Meat and alternatives	–	0.1 (–0.2, 0.4)	–	–0.4 (–0.7, –0.1)
DQI-I	–	2.6 (1.4, 3.7)	–	3.6 (2.2, 5.1)
Dietary variety	–	3.7 (3.2, 4.3)	–	3.1 (2.3, 3.8)
Sugar-sweetened beverages	–	–0.1 (–0.4, 0.2)	–	1.2 (0.8, 1.6)
Total sugar	–	9.2 (–2.1, 20.5)	–	0.1 (–14.4, 14.6)
Physical activity				
Step-count	–	8.9 (–251.6, 269.5)	–	–
PAQ-C	–	–	–	–0.0 (–0.1, 0.1)
Screen time				
Time watching TV	–	–0.4 (–0.8, –0.1)	–	0.4 (0.1, 0.7)
Time playing videogames	–	–0.3 (–0.8, 0.1)	–	0.6 (0.2, 1.0)
Time on cellphone	–	0.1 (–0.3, 0.5)	–	0.6 (0.2, 1.0)
Weight status				
% with overweight (excluding with obesity)	1.0 (0.8, 1.2)	–	–	–
% with obesity	1.0 (0.8, 1.2)	–	–	–
Mental health and well-being				
Cumulative score	–0.7 (–1.3, –0.1)	–	–1.0 (–1.6, –0.4)	–

Abbreviations: CI, confidence interval; DQI-I, Diet Quality Index - International; MVPA, moderate-to-vigorous physical activity; OR, odds ratio; PAQ-C, Physical Activity Questionnaire for Older Children.

^a Changes are in relation to 2016, i.e. before the start of the program.

^b Beta coefficient or odds ratios were derived from linear or logistic regression, respectively, adjusted for grade level, sex, region (rural, small population centre), and social and material deprivation quintiles.

Relative to 2016, students in 2018 were less likely and in 2020/21 were more likely to spend time watching TV, playing video games and using their cellphones. No changes in physical activity and weight status were observed across the four years where observations were made.

Mental health and well-being in 2018 and 2020/21 were statistically significantly lower than pre-program levels.

Discussion

In the first two years of APPLE Schools implemented in rural and remote northern communities, we observed modest increases in vegetable and fruit consumption and declines in screen time (time spent watching TV, playing video games, using a cellphone). However, these positive changes

were not sustained during the subsequent years of implementation, which coincided with the COVID-19 pandemic. Between 2016 and 2020/21, we saw a gradual decrease in knowledge of the physical activity recommendations, in attitudes toward healthy lifestyle, and in mental health and well-being.

In 2012, we reported that an effective Comprehensive School Health program (i.e. “a best practice”) in a rural setting in one eastern Canadian province (Nova Scotia) was transferable to a mostly urban setting in a western province (Alberta).^{6,8} In this new setting, we demonstrated the “next practice” (newly named APPLE Schools) to be effective in increasing vegetable and fruit consumption,⁸ increasing physical activity levels,^{8,9} preventing childhood obesity⁸ and reducing health

inequalities²² while being cost-effective and yielding a favourable return on investment.²³

In the present study, we examined whether this “best practice” could also be transferred to rural and remote northern communities. Although we are aware of several studies that considered differential effects of the Comprehensive School Health interventions in rural (“It’s Your Move!” project²⁴) and disadvantaged (Prevention of Overweight among Pre-school and School Children project²⁵) communities in their analyses, we are not aware of studies that fully took into account very distinct features of these communities. These rural and remote northern communities comprise Indigenous peoples who are grappling with the trauma inflicted by colonization and the residential school system,²⁶ which likely contributes to

existing skepticism toward externally run schools and programs. Some communities are “fly-in” or otherwise so remote (up to 200 km away from the nearest population centre) that access to food and particularly fresh produce is severely limited. The prevalence of unhealthy lifestyle behaviours and poor mental health and well-being in these communities is significantly higher than in other settings,^{27,28} and high teacher turnover makes it particularly challenging to change the school culture in a sustainable way.²⁹ Some of these communities were also affected by the Horse River wildfire and resulting evacuation in May 2016³⁰ and by economic downturns caused by sharp declines in oil prices in 2018 and again in early 2020.³¹ In addition, the COVID-19 pandemic that started in March 2020 disproportionately affected these communities.³²

Despite these challenges, APPLE Schools had been successful in improving some of the lifestyle behaviours of students. Dietary variety, promoted in the newest Canada’s Food Guide³³, improved. Diet quality and vegetable and fruit consumption improved in the first two years of program implementation, with the number of servings of vegetables and fruit, notably low at 3.1 servings/day (the 2007 Eating Well with Canada’s Food Guide recommended 5 to 6 servings/day for this age group³⁴) in 2016, increasing by 0.3 to 3.4 servings/day in 2018. This modest increase was not statistically significant and smaller than what we previously reported for APPLE Schools program in mostly urban schools (an increase of 0.5 servings/day, from 4.6 at baseline to 5.1 servings/day two years later⁸). Average diet quality scores increased from 53.9 in 2016 to 56.4 in 2018, which is still substantially less than the average scores of 62 and higher in socioeconomically disadvantaged city neighbourhoods.⁸ Total sugar consumption increased by 9.3 g/day, or from 96.9 in 2016 to 106.2 g/day in 2018. This increase could not be explained by the increase in naturally occurring sugar from vegetables and fruit: even if an additional 0.3 servings/day constitute fruits that are high in sugar, this would have only accounted for approximately 35% of the increase in total sugar consumption. Thus, an increase in added rather than naturally occurring sugar was the main driver of the total sugar increase.

The high burden of unhealthy eating among children in these communities, and the limited success at improving this,

point to the need for further adaptation of program delivery, for example, by partnering with stakeholders to improve the accessibility and affordability of a variety of healthy foods options.³⁵ The COVID-19 pandemic-related impact on food security, coupled with decreased access to fresh produce due to inter-provincial travel and transportation restrictions, may have led to reliance on processed and ultra-processed foods,^{36,37} the likely drivers of the changes observed between 2018 and 2020/21. The pronounced decrease in vegetable and fruit consumption and the increase in the consumption of sugar-sweetened beverages observed during the pandemic illustrate the volatility of not yet firmly established healthy behaviours and the vulnerability of these northern communities to external stressors as evidenced by the COVID-19 pandemic.

Pre-pandemic, only 37.6%, 70.7% and 28.5% of Canadian children were meeting recommendations for physical activity, sleep and screen time, respectively,³⁸ outlined in the Canada’s 24-hour movement guidelines. Emerging reports show the toll of the COVID-19 pandemic on these lifestyle behaviours.³⁹⁻⁴² In the northern communities, after the initial success of declines in screen time, gains between 2018 and 2020/21 were likely negated by the COVID-19 pandemic, consistent with these reports.^{39,40} Closure of schools, playgrounds and recreational facilities during the lockdown left children with few or no alternatives to be physically active, to entertain themselves and to interact with peers.⁴³ Adverse outcomes of screen time were to be expected, albeit we argue that if used for socializing in general and in the context of the pandemic specifically, screen time should not necessarily be considered a negative lifestyle behaviour. Indeed, it can be used to encourage physical activity (e.g. exergaming⁴⁴), particularly when coupled with the opportunity for social interaction with peers.

Although improving both students’ knowledge of and attitudes toward healthy lifestyle are key elements of the APPLE Schools approach, we did not reveal any positive changes in the present evaluation. This observation is not supported by existing literature. Two recent studies confirmed an increase in knowledge and positive attitudes among students attending schools exposed to health promotion programs.^{45,46} The absence of improvements in knowledge and attitudes of students

does raise concerns to do with the program’s reach and the scope of the cultural and logistical adaptation essential to successful implementation.⁴⁷ Adaptations to the program to accommodate issues related to high school staff turnover may be particularly challenging as continuity in leadership and teaching staff are critical to change the school culture in a sustainable way. The limited reach may have accounted for the absence of improvements in mental health and well-being, and the coinciding economic downturns and the COVID-19 pandemic,^{48,49} may have pushed this into a negative trend in mental health and well-being. The program’s reach is further affected by “programming dose.” A recent systematic review on the effectiveness of Comprehensive School Health approach drew attention to the importance of “intervention dose” by showing that low dose interventions were less likely to be effective.⁵⁰ The implementation of the APPLE Schools program in the northern communities, facilitated by a School Health Facilitator 0.5 FTE for the first two years and 0.2 FTE for the third year due to budgetary limitations, showed limited effectiveness. In contrast, APPLE Schools program implementation in urban settings, facilitated by full-time Facilitator for the first two years was effective.^{8,9} The “programming dose” may have been too low, particularly in light of the disproportionately higher needs and challenges in the northern communities.

Strengths and limitations

Strengths of the current study are that it achieved relatively high participation rates despite being conducted in hard-to-reach settings and that it used survey instruments validated for this age group.

Several limitations warrant consideration. The eight APPLE Schools were selected by school jurisdictions rather than randomly, which limits the generalizability of the results. The absence of “control” schools limits our ability to allocate the observed changes to the program and any of the coinciding events, including the pandemic. It should be noted that the concept of “control” schools, which would require three waves of data collection in hard-to-reach settings without offering any program, is perceived by many stakeholders as neither acceptable nor ethical. In addition, because of the pandemic, surveys were administered during winter months in 2020/21, while data were collected as scheduled during spring months in 2016

and 2018, which may have introduced seasonal variation in lifestyle behaviours.

Conclusion

Selected positive changes in health behaviours (diet variety, vegetables and fruit consumption, screen time) were noted in the first two years following implementation of the APPLE Schools program in eight schools in rural and remote northern communities, but these changes were not sustained after the start of COVID-19 public health response measures, illustrating the volatility of the newly adopted healthy behaviour changes and the vulnerability of these communities to external stressors. In light of the multiple challenges of health promotion in rural and remote northern communities, attention to systematic and proactive adaptation,⁴⁷ increased intensity and longer duration of program delivery are likely essential to facilitate sustainable improvements in healthy lifestyle behaviours and mental health and well-being.

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Conflict of interest

The authors have no real or perceived conflicts of interest relevant to this article to disclose.

Authors' contributions and statement

All listed authors contributed to study design, drafted and revised the article, and gave their final approval of the version submitted for publication.

KM and PV conceptualized the study and methodology and secured funding and resources.

MK, KM and PV developed a statistical analysis plan, and MK conducted all data analyses.

TT validated and analyzed dietary data and contributed to the interpretation of the findings that pertain to dietary factors.

JF informed study conceptualization and interpretation from a practice perspective.

JD and PV accessed and verified the data and wrote the original draft. All authors reviewed and approved the final manuscript.

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