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Evidence synthesis

Benchmarking unhealthy food marketing to children and adolescents in Canada: a scoping review

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Abstract

Introduction: Unhealthy food and beverage marketing in various media and settings contributes to children's poor dietary intake. In 2019, the Canadian federal government recommended the introduction of new restrictions on food marketing to children. This scoping review aimed to provide an up-to-date assessment of the frequency of food marketing to children and youth in Canada as well as children's exposure to this marketing in various media and settings in order to determine where gaps exist in the research.

Methods: For this scoping review, detailed search strategies were used to identify relevant peer-reviewed and grey literature published between October 2016 and November 2021. Two reviewers screened all results.

Results: A total of 32 relevant and unique articles were identified; 28 were peer reviewed and 4 were from the grey literature. The majority of the studies ($n = 26$) examined the frequency of food marketing while 6 examined actual exposure to food marketing. Most research focussed on children from Ontario and Quebec and television and digital media. There was little research exploring food marketing to children by age, geographical location, sex/gender, race/ethnicity and/or socioeconomic status.

Conclusion: Our synthesis suggests that unhealthy food marketing to children and adolescents is extensive and that current self-regulatory policies are insufficient at reducing the presence of such marketing. Research assessing the frequency of food marketing and preschooler, child and adolescent exposure to this marketing is needed across a variety of media and settings to inform future government policies.

Keywords: *obesity, children, adolescents, food marketing, food environment, Canada, policy, self-regulation*

Introduction

Child obesity in Canada has increased significantly over the last four decades, with approximately 14% of Canadian children living with obesity.¹ This trend is mirrored globally, with the prevalence of child obesity increasing more than eight-fold over the last 40 years.² Poor dietary quality is a contributing factor to obesity, and Canadian children are struggling to meet

the dietary recommendations set by Canada's food guide.³ Recent studies have found that Canadian children's dietary intake is low in fruits and vegetables and high in sugar, sodium and saturated fats.^{3,4}

Children's poor dietary intake is associated with unhealthy food and beverage marketing (hereafter referred to as food marketing).⁵ Marketing is defined by the World Health Organization as "any form

Highlights

- The frequency of food marketing to children and adolescents in Canada is ubiquitous. Although children's actual exposure to unhealthy food marketing exists in different media, the evidence base is limited.
- Most research focusses on frequency of exposure, children from Ontario and Quebec, and television and digital media.
- Research is needed to examine the frequency of food marketing and pre-schoolers', children's and adolescents' exposure to the marketing by geographical location, media and target population.

of commercial communication or message that is designed to, or has the effect of, increasing the recognition, appeal and/or consumption of particular products and services."⁶ Children are exposed to food marketing in a variety of media, such as television, digital media and product packaging, and in schools and other spaces where they gather.⁷

The impact of food marketing is recognized as a function of both the exposure and power of the advertisements.⁶ Exposure refers to the reach, frequency (also known as potential exposure) and impact of the message, while power refers to the content, design and execution of the message.⁶ Frequency, or potential exposure, includes all advertisements on a specific medium that an individual may view,

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while actual exposure covers all advertisements actually viewed by an individual, as measured through self-reported methods or, more accurately, using measured media data or eye-tracking technology.⁸

Children are especially vulnerable to the persuasive marketing techniques used in food marketing because they often lack the cognitive skills needed to understand the intent of marketing.⁹ Furthermore, the products marketed to children are typically nutrient poor and energy dense.¹⁰

In Canada, food marketing is primarily self-regulated by Ad Standards and the food and beverage industry through the Canadian Children's Food and Beverage Advertising Initiative (CAI).¹¹ In the province of Quebec, food marketing to children less than 13 years old has been prohibited since 1980 under the *Consumer Protection Act* (CPA).¹² Previous scoping review evidence describing the impact of these food marketing regulations noted minimal improvement associated with the CPA in the power and frequency of food marketing to children in Quebec, and that loopholes in the CPA remain.⁷ Elsewhere in Canada, no positive changes to food marketing were observed as a result of the CAI.⁷

As a result of the ineffectiveness of current regulations in Canada, Bill S-228, designed to prohibit food marketing targeting children under 13 years old, was introduced into the Senate of Canada in 2016.¹³ Although this bill was passed by the House of Commons and the Senate, it did not receive final approval by the Senate before the dissolution of Parliament in 2019. In December 2019, the Prime Minister's Mandate Letter to the Minister of Health once again recommended the introduction of new restrictions on food marketing to children in Canada.⁷ Given that food marketing regulations are forthcoming, it is necessary to benchmark current levels of children's exposure to unhealthy food marketing in a variety of media and settings. Such research can serve as essential baseline data for any future policy evaluations.

The most recent review of the evidence regarding food marketing to children in Canada assessed English language research published between January 2000 and September 2016.⁷ Prowse⁷ found the evidence base for children's exposure to

unhealthy food marketing to be limited to television and product packaging. Moreover, the review concluded that Canadian regulations did not reduce children's exposure to or the power of food marketing.⁷ Although traditional media platforms such as television remain popular,¹⁴ the growth of digital media usage¹⁵ raises concerns over the various ways children may be exposed to food marketing.⁷ The observed increases in screen time during the COVID-19 pandemic also contribute to children's risk of exposure.¹⁶ As such, examining food marketing to children on digital media and other nontraditional settings, in addition to traditional media, has become a point of research focus.

The purpose of our review was to provide an up-to-date assessment of the English and French language research on Canadian children's exposure to food marketing in various media to determine where future research is needed. The objectives of this review are to explore the frequency (potential exposure) and actual exposure to food and beverage marketing by target population and its diversity, media and geographical distribution.

Methods

We conducted a scoping review of the peer-reviewed and grey literature published between October 2016 and November 2021. As described by Arksey and O'Malley¹⁷, the use of scoping reviews was determined to be the most appropriate approach to collate a wide range of evidence and identify research gaps in the literature. A detailed search strategy for both peer-reviewed and grey literature was developed prior to conducting any searches. The review protocol was designed and

conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) guidelines¹⁸ and was pre-registered with Open Science Framework (registration <https://doi.org/10.17605/OSF.IO/EG2CP>) to increase research transparency and prevent any duplication efforts.

Eligibility criteria

All peer-reviewed journal articles and grey literature related to food marketing to children aged 0 to 17 years and published in either English or French were included. This age group was selected as the development of food marketing restrictions aimed at protecting children originally applied to those under 18 years old in Canada and current Health Canada food marketing monitoring efforts focus on this age group.^{12,19}

We considered only grey literature reports that included primary research; compliance reports were excluded. A complete list of the eligibility criteria is shown in Table 1.

Information sources and search strategy

A systematic search of the following eight academic databases was conducted to identify relevant peer-reviewed results: Ovid MEDLINE/PubMed, Web of Science, Scopus, ProQuest ABI/INFORM, ProQuest Canadian Business & Current Affairs (CBCA), Ovid Embase, Ovid PsycINFO and EBSCO Cumulative Index to Nursing & Allied Health Literature (CINAHL). The search strings used for the academic databases (available on request from the authors) were developed with guidance from a

TABLE 1
Scoping review search methodology: eligibility criteria

Eligibility criteria	Exclusion criteria
Published between October 2016 and November 2021	Newspaper articles, working papers, conference papers or book chapters
Canadian data	Published outside of Canada
Original research	Did not describe original research
Evidence on the frequency (potential exposure) of food marketing or child/adolescent exposure to and power of food marketing to children (aged 0–17 years)	Compliance reports (e.g. Ad Standards' report evaluating the enforcement of the CAI among participating companies)
Available in English or French	In languages other than French or English

Abbreviation: CAI, Canadian Children's Food and Beverage Advertising Initiative.

university librarian with expertise in the health sciences. This search of electronic databases was conducted using only English search terms. All results retrieved by the search were imported into Covidence (Veritas Health Innovation, Melbourne, AU),²⁰ a web-based software for systematic reviews, and duplicates were automatically removed.

To identify relevant grey literature, a plan consisting of four different search strategies was developed: (1) grey literature databases; (2) Google searches; (3) targeted websites; and (4) consultation with experts. Grey literature strategies were adapted from those used by Godin et al.²¹ The first strategy encompassed a search of English and French grey literature databases (names of databases available on request from the authors). Neither English nor French language searches yielded any results that met the eligibility criteria.

The second search strategy for grey literature consisted of two advanced Google searches (“pdf only” and “any file format” filters). The specific English and French search terms used are outlined in Table 2. Only the first 10 pages of results were pre-screened for relevancy. We used the app Bookmark Manager to document any potentially relevant documents. The same process was repeated for the second Google search, this time using the “any file format” filter. The third grey literature search strategy involved searching the targeted websites that had been identified in the previous Google searches.

Next, we contacted experts in the topic area to identify any relevant documents that were missing and to confirm the

comprehensiveness of our grey literature search results; this did not yield any other results.

Study selection

Two reviewers (FH and DW) screened all peer-reviewed results using Covidence. The screening of search results from the electronic academic databases occurred in two phases. First, the title and abstract of each article was screened independently by the two reviewers (FH and DW) using the predefined eligibility criteria; any disagreements were resolved via consensus. Next, the full texts of potential articles were screened for eligibility by both reviewers. Disagreements were also resolved by discussion and/or consultation with a third reviewer (LR) when necessary. All articles that remained after full text screening were included in the study.

All English and French grey literature search results were screened by two independent reviewers (LR and MB) and any duplicates were removed. Figure 1 summarizes the study selection process for peer-reviewed and grey literature, based on the PRISMA-ScR reporting guidelines.¹⁸

Data extraction and synthesis of results

Following the screening of results, data were extracted from each article by one reviewer (FH). The extracted data included author and publication year, publication type, location, data collection period, population (preschoolers [0–5 years], children [6–12 years] and adolescents [13–17 years]) and key results related to the frequency of children and youth’s exposure to food marketing. Validation of the extracted data was completed by a second reviewer (DW).

The results were subsequently grouped by outcome measure, either the frequency of advertising or actual advertising exposure.

Results

A total of 32 relevant and unique articles were identified. Table 3 summarizes 35 studies extracted from the 32 unique publications by outcome measure (frequency or exposure to food marketing) and categorizes the studies by media and setting. Over half of the unique articles (n = 28) were peer reviewed and 4 were from the grey literature. Almost all articles described (n = 30) were cross-sectional studies, including one repeat cross-sectional study. A total of 27 studies examined the frequency of food marketing, while 8 examined actual exposure to food marketing in Canada.

The included literature examined the frequency or exposure to food marketing on television,^{10,22-27} in digital media²⁷⁻³³ and on packaging;³⁴⁻⁴¹ in schools,^{42,43} movie theatres,^{44,45} sports settings,⁴⁶⁻⁴⁸ restaurants^{49,50} and family-related festivals/events;^{45,51} outdoors (e.g. billboards, bus shelters, etc.)⁵² and in print.²⁷ Of all included studies, only 5 were conducted outside of Ontario or Quebec.

Figure 2 displays the number of included studies by target population and media/setting.

Frequency and exposure to food and beverage marketing in various media

Television

Three studies examined the frequency of television food marketing directed at youth, but differences in the methodology and

TABLE 2
English and French search terms used to conduct Google search

Topic	English search terms	French search terms
1: Food and beverages	“food,” “nutrition,” “beverage,” “drink” Search terms combined with the operator: ‘OR’	“alimentaire,” “nutrition,” “boisson” Search terms combined with the operator: ‘OU’
2: Marketing	“marketing,” “advertisement,” “advertising” Search terms combined with the operator: ‘OR’	“marketing,” “publicité” Search terms combined with the operator: ‘OU’
3: Children	“child,” “children,” “adolescent,” “teen,” “youth” Search terms combined with the operator: ‘OR’	“enfant” Search terms combined with the operator: ‘OU’
4: Canada	“Canada” Search terms combined with the operator: ‘OR’	“Canada” Search terms combined with the operator: ‘OU’

FIGURE 1
PRISMA flow diagram¹⁸ of systematic search of peer-reviewed and grey literature (n = 32)

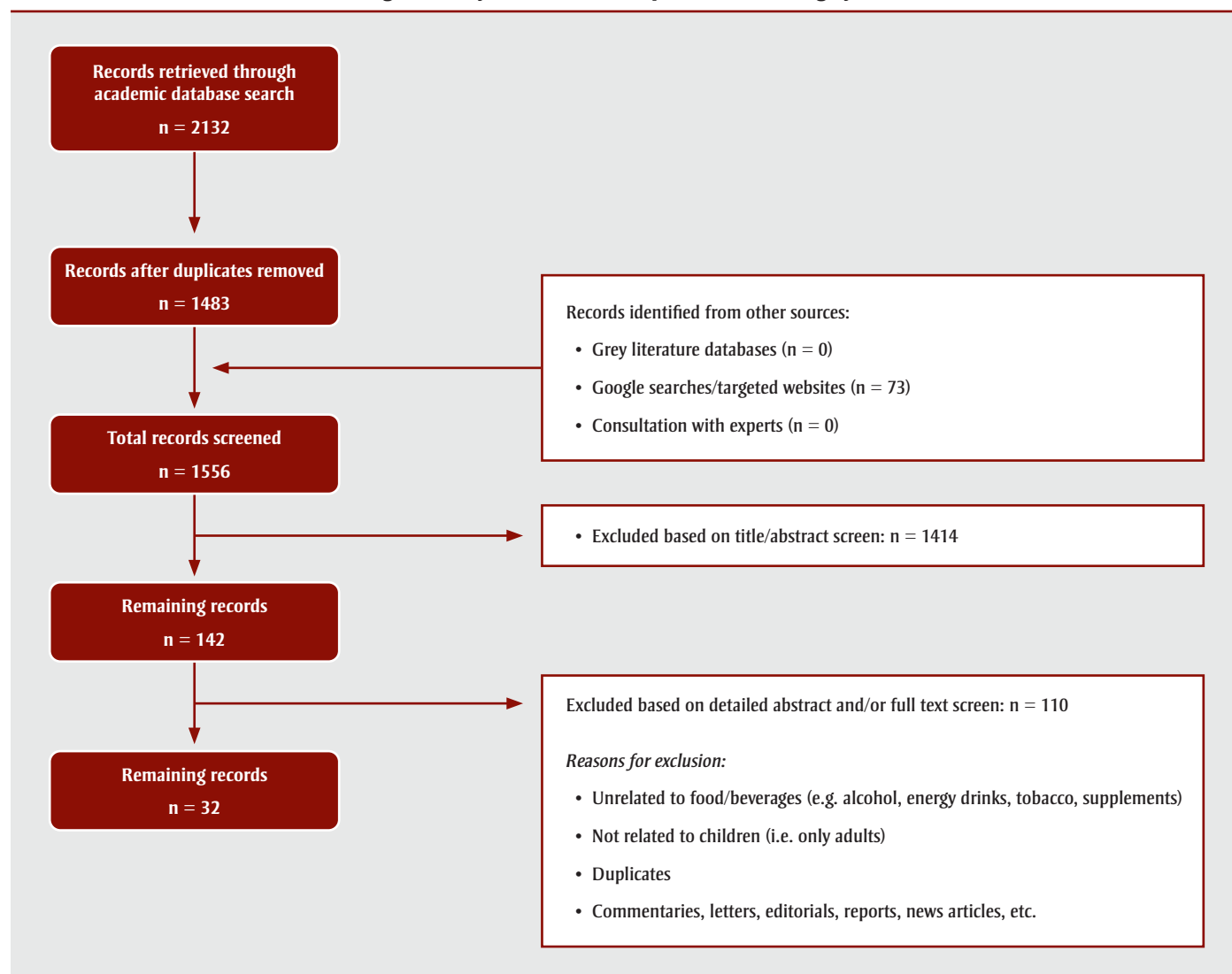


TABLE 3
Frequency of food marketing frequency and exposure studies according to media, setting, data collection location, population, and data collection periods, October 2016–November 2021

Media and settings	Frequency (potential exposure)				Exposure			
	No. of studies	Location	Population	Data collection period	No. of studies	Location	Population	Data collection period
Television	3	Canada ²²	Preschoolers, children, adolescents	12 months (2018)	4	Montréal, QC ²⁵	Preschoolers and children	1 month in 2011, 1 month in 2016 and 1 month in 2019
		Canada ²³	Preschoolers, children, adolescents	12 months (2018)		Toronto, ON ²⁴	Preschoolers and children	1 month in 2011, 1 month in 2013, 1 month in 2016 and 1 month in 2019
		Canada ¹⁰	Children	12 days (2017)		Toronto, ON ²⁶	Adolescents	1 month in 2011, 1 month in 2013 and 1 month in 2016
						Canada ²⁷	Adolescents	12 months (2014)

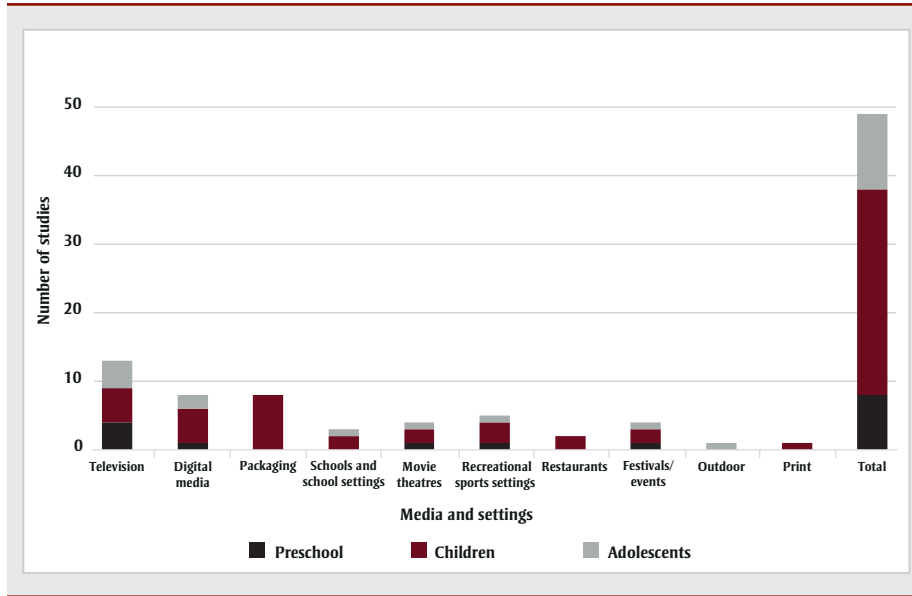
Continued on the following page

TABLE 3 (continued)
Frequency of food marketing frequency and exposure studies according to media, setting, data collection location, population, and data collection periods, October 2016–November 2021

Media and settings	Frequency (potential exposure)				Exposure			
	No. of studies	Location	Population	Data collection period	No. of studies	Location	Population	Data collection period
Digital	4	Canadian websites ³⁰	Children	12 months (2015)	3	Ottawa, ON ³²	Children and adolescents	2017
		Canadian websites ²⁸	Preschoolers and children	12 months (2015–2016)		Ottawa, ON ³³	Children and adolescents	2017
		Canadian websites ³¹	Children	6 months (2017)		Canada ²⁷	Adolescents	12 months (2014)
		Canadian websites ²⁹	Children	12 months (2015–2016)				
Packaging	8	Québec City and Montréal, QC ³⁴	Children	2016, 2018, 2019	0	–	–	–
		Canada ³⁵	Children	2013				
		Canadian websites ³⁶	Children	2 months (2018)				
		Nova Scotia ³⁷	Children	2 months (2015–2016)				
		Toronto, ON ³⁸	Children	2013				
		Calgary, AB ³⁹	Children	2009 and 2017				
		Ottawa, ON and Gatineau, QC ⁴⁰	Children	2015				
Quebec ⁴¹	Children	6 months (2018–2019)						
Schools and school settings	2	British Columbia, Ontario and Nova Scotia ⁴²	Primary and secondary school-aged	3 months (2016)	0	–	–	–
		Vancouver, BC ⁴³	Elementary and secondary school-aged children	1 day in June (2015)				
			1 day in Sept. (2015)					
Movie theatres	2	Ottawa, ON ⁴⁴	Preschoolers, children and adolescents	4 months (2019)	0	–	–	–
		Quebec ⁴⁵	Children	9 months (2018–2019)				
Sports clubs and recreational sports settings	3	Ottawa, ON ⁴⁸	Preschoolers, children and adolescents	4 months (2018)	0	–	–	–
		British Columbia, Alberta, Ontario and Nova Scotia ⁴⁷	Children	6 months (2015–2016), 4 months (2017)				
		British Columbia, Alberta, Ontario and Nova Scotia ⁴⁶	Children	6 months (2015–2016)				
Restaurants	2	Quebec ⁵⁰	Children	2 months (2019)	0	–	–	–
		Southwestern Ontario ⁴⁹	Children	3 months				
Festivals/ events	2	Quebec ⁴⁵	Children	6 months (2018–2019)	0	–	–	–
		Ottawa, ON ⁵¹	Children and adolescents	1 month (2019)				
Outdoor	1	London, ON ⁵²	Adolescents	3 months (2020)	0	–	–	–
Print	0	–	–	–	1	Canada ²⁷	Adolescents	12 months (2014)
Total number of studies	27	–	–	–	8	–	–	–

Note: The total number of studies is greater than 32 as some publications included multiple studies in the same publication.

FIGURE 2
Target population by media and settings of included studies



data collection periods make it challenging to compare the rates of advertising across these studies. Annual data drawn from television stations in 2018 revealed that the rate of food advertisements differed significantly between preschooler (0–5 years), child (6–12 years) and youth (13–17 years) age groups, from 0.6 to 3.3 advertisements/hour.²³ The same research team determined that more than half of the advertisements during children’s programming was produced by CAI-participating companies.²²

An international study establishing children’s potential exposure to television food advertising determined that 25% of advertisements sampled over a 12-day period on the top three children’s stations in Canada were for food and beverages, and that the rate of 10.9 food advertisements/hour on child-specific channels were among the highest globally.¹⁰

Child and adolescent actual exposure to television food marketing in Canada has been measured both objectively, through television viewership data (n = 3), and through self-report (n = 1). In Toronto (Ontario), children (2–11 years) and adolescents’ (13–17 years) exposure decreased over time despite increases in the frequency of food marketing on television.^{24,26} Similar exposure trends were also observed among children (2–11 years) in Montréal (Quebec).²⁵ Children and adolescents in Toronto and children in Montréal

appear to be exposed to similar, unhealthy food categories such as fast food and sugary drinks and snacks.^{24–26}

Hammond and Reid²⁷ conducted an online survey to assess self-reported exposure to energy drink advertisements on television. Of youth aged 12 to 14 years and 15 to 17 years, 59% (233/393) and 56.2% (348/620), respectively, reported ever having seen an energy drink advertisement on television.

Digital media

The frequency of food marketing on digital media has only been documented on websites. Two studies compared the presence of child-directed online content in companies participating in the CAI with companies that did not.^{30,31} Both studies found that participation in the CAI did not deter the companies from marketing child-directed products (as defined by the presence of child-oriented features) nor the inclusion and promotion of corporate social responsibility initiatives designed to target children through support of school food programs or children’s sports programs on company sites.^{30,31}

Other studies have documented varying levels of frequency of online food marketing. Two studies found that food marketing frequently appears on children’s (2–11 years) and adolescents’ (12–17 years) top 10 preferred websites, with an estimated 54 million and 14.4 million food

and beverage advertisements reported on children’s preferred and adolescent’s preferred websites respectively, from June 2015 to May 2016 alone.^{28,29} Most advertisements on both types of websites were for foods and beverages classified as excessive in fat, sodium or free sugars.^{28,29}

Three studies captured actual exposure to digital food marketing by youth.^{27,32,33} Two studies by Potvin Kent et al.^{32,33} measured child and adolescent exposure to food marketing over 10-minute periods on gaming applications (93 participants; aged 6–16 years) and on social media (101 participants; aged 7–16 years). Children and adolescents who used social media were exposed to food advertisements more frequently than those who used gaming apps (on average, 111 times/week versus 2.8 times/week, respectively).^{32,33} In both types of applications, children and adolescents were most exposed to marketing of fast food, sugary drinks and candy/chocolate.^{32,33}

Hammond and Reid²⁷ measured adolescent’s self-reported exposure to energy drink advertisements and found that more than one-third of youth aged 12 to 17 years viewed energy drink advertisements on social media. Between 35.6% (140/393) of youth aged 12 to 14 years and 39.3% (244/620) of youth aged 15 to 17 years reported seeing energy drink advertisements online.²⁷

Packaging

Eight studies assessed the proportion and types of food and beverage products commonly promoted in retail environments. Across most studies, the marketing of child-targeted products was apparent.^{34,35,39–41} For instance, in the University of Toronto’s Food Label Information Program 2013 (FLIP 2013) database, almost 5% of the 15 200 packaged supermarket products captured displayed at least one marketing technique considered to be directed to children.³⁵

Three studies identified breakfast cereals as a product that is frequently advertised to children.^{34,39,41} Elliott³⁹ noted an increase in volume of child-targeted cereal products in two supermarkets over an 8-year span (31/354 to 59/374). The prominence of marketing breakfast cereal over other food categories is supported by research specifically characterizing child-directed marketing of breakfast cereals. Findings

from one study revealed that almost one-fifth of 262 breakfast cereals sold in Ottawa (Ontario) and Gatineau (Quebec) supermarkets were considered child targeted.⁴⁰ These cereals were also three times more likely to be classified as “less healthy” than non-child-targeted cereals and were considerably higher in sodium and free sugar.⁴⁰

Similar findings on the healthfulness of frequently advertised child-targeted food and beverages are echoed elsewhere in Canada,^{36,38} including in Montréal and Québec City (Quebec).³⁴ Of the products featuring child-directed marketing techniques in FLIP 2013, Mulligan et al.³⁵ determined that the majority (727/747) were classified as restricted from marketing to children based on Health Canada’s nutrient criteria. In contrast, Kholina et al.³⁷ found that “less healthy” products, including snack foods and sugary drinks, but not breakfast cereals, were heavily promoted to children and more prominently displayed in 47 grocery stores and 59 convenience stores in Nova Scotia.

Frequency and exposure to food and beverage marketing in various settings

Schools

Evidence on food marketing both within and around schools in Canada is lacking. Only one recent study assessed the frequency of food marketing in schools, documenting that at least one type of food marketing was reported in 83.7% (129/154) of primary and secondary schools (n = 154) across British Columbia, Ontario and Nova Scotia.⁴² Primary schools were more likely to report selling branded food items such as pizza, chocolate and fast food compared to secondary schools. However, secondary schools were more likely to report food marketing on school property, food product displays and exclusive marketing agreements with food companies.

One study examined the food marketing environment in schools. Findings from the Velazquez et al.⁴³ study support the prevalence of food marketing for minimally nutritious foods around schools in Vancouver (British Columbia). Almost all (22/26) of the schools participating in the study had at least one food and/or beverage advertisement within 400 metres, and 5 of the 26 schools had 50 or more advertisements in their immediate vicinity.⁴³ The majority of the food marketing promoted products that failed to fall within provincial school food guidelines.⁴³

Movie theatres

Two studies reported food marketing from multiple sources within movie theatres, including advertisements in the movie theatre environment and those screened prior to children’s movies.^{44,45} The results of these two studies indicate that a large volume of food advertisements, particularly for traditionally unhealthy movie theatre foods such as popcorn, soft drinks and candy/chocolate, are promoted both in the common spaces of movie theatres and before the start of children’s movies.^{44,45} For example, a total of 1999 food advertisements were identified in movie theatre environments across seven movie theatres in Ottawa (Ontario) and 241 advertisements were observed prior to the screening of 28 children’s movies over a 4-month period.⁴⁴ All of these advertisements were considered to be restricted from marketing to children based on the World Health Organization’s Nutrient Profile Model.⁴⁴ Product placements in movies may also account for a small share of children’s potential exposure to food advertising.⁴⁵

Sports clubs

This review identified three studies that focussed on food marketing in sports clubs and recreational sports settings. Two studies confirmed that food and beverage marketing is frequent in sports and recreational facilities, most commonly occurring in sites with food concessions, sports areas and other areas.^{46,47} The median number of food advertisements across 16 recreational facilities in Ontario over 6 months was about 29.⁴⁷ In such settings, food marketing takes many forms including posters, signs and product placement.⁴⁶ Out of 51 recreational sports settings in Alberta, Ontario and Nova Scotia, food marketing was present in 98% (49/50) of all sites and over half of all food marketing instances were considered “least healthy.”⁴⁶

Children’s sports clubs also present opportunity for food marketing to children. One study found that 40% (27/67) of 67 children’s sports clubs in Ottawa (Ontario) obtained some form of food company sponsorship, with fast food restaurants accounting for 41% of these sponsorships.⁴⁸

Restaurants

Two articles reviewed food marketing in restaurants. Findings from these studies indicate a mix of strategies used to market to children in restaurants; one study of

20 restaurants in Quebec noted the frequent use of meal and food packaging as well as in-restaurant promotions (e.g. posters, toy displays, etc.) as a marketing tool among fast food restaurants.⁵⁰ Food marketing in family restaurants was predominantly present on children’s menus and included the use of branded marketing.^{49,50} Neither study was designed to measure children’s actual exposure to these types of food marketing.

Festivals/Events

Of all the studies included in this review, only two described food marketing at family events. The Quebec Coalition on Weight-Related Problems examined marketing across 18 family festivals, amusement parks and ski facilities over 6 months; while findings suggested an overall improvement in the frequency of food advertising at family festivals, unhealthy foods were heavily promoted at amusement parks and child-directed advertising remained apparent at all three types of family venues.⁴⁵ One study examined the extent of food marketing-related content associated with social media; individual users were responsible for most marketing-related instances associated with a family-event compared to corporate or other post sources, and children were frequently featured in these types of social media posts.⁵¹

Outdoor

One study used Global Positioning System (GPS) points collected from a mobile application to monitor 154 adolescents’ (13–18 years old) proximity to outdoor advertising, such as in bus shelters, street-level posters and billboards (n = 97) over 3 months. The data collected revealed that most adolescents were exposed to at least one advertisement during this period.⁵²

Print

There is a paucity of literature investigating print media food marketing. Hammond and Reid’s²⁷ online survey revealed that 22.4% (88/393) and 28.6% (177/620) of adolescents aged 12 to 14 years and 15 to 17 years, respectively, reported having ever seen a food or beverage advertisement in magazines or newspapers.

Discussion

This scoping review reveals that food marketing to children and adolescents is prevalent in Canada across a wide variety of media and settings. While the studies

included in this review suggest digital media and television to be important sources of children's actual exposure to unhealthy advertisements, the evidence base is limited. The results of this review also highlight that less healthy food products, such as snack foods, sugary drinks and fast food, are commonly promoted in the array of settings and media, consistent with previous Canadian research.⁷ Despite these findings, this review emphasizes the dearth of research exploring food marketing to children by age, geographical location, sex/gender, race/ethnicity and socioeconomic status.

Media examined

Television, digital media and packaging collectively dominated the food marketing research focus, with over half of the identified studies focussing exclusively on these types of media. The levels of food marketing observed on television and in digital media are of particular concern given the high levels of screen time youth in Canada report, with 47% of youth aged 5 to 17 years spend over 2 hours per day on screens.⁵³ This is compounded by an exponential increase in social media and Internet usage among youth, providing even greater opportunity for the food industry to target children and adolescents.¹⁵ Research also suggests that social media influencers are an increasingly popular promotional source for food products targeting youth.^{15,53} Despite these findings, no research has examined children's exposure to unhealthy food marketing through digital media influencers.

This review also highlights a lack of exploration beyond traditional and digital media. This is consistent with the previous scoping review conducted by Prowse⁷; this review also cited a need for evidence of food marketing in other media frequently used by children to contribute to a more comprehensive understanding of sources of youth exposure to food and beverage marketing. Though one study in this review documented exposure to food marketing in gaming apps, exposure on other child and adolescent gaming platforms, such as computer games or arcade games, is less understood. This is an important area given that Canadian youth, on average, spend 0.75 hours per day playing video games.¹⁵

This review found some evidence on print and outdoor food marketing. While the

inclusion of such media in the recent literature differs to that prior to 2016,⁷ the limited evidence base precludes interpretations on the extent of food marketing in these categories. Research from New Zealand also identified public spaces, including street signs and shop fronts, as a substantial source of children's exposure to unhealthy food advertising.^{54,55} Future research should also address print, out-of-home (e.g. billboards, street furniture ads, bus "wraps") and radio marketing—platforms that may promote child-targeted products.

Settings examined

The settings-based evidence presented in this review demonstrate that unhealthy foods and beverages are often promoted in settings frequented by children, such as schools and movie theatres. The emphasis on these settings is valuable and warrants further research to document children's actual exposure to food marketing in these environments. The paucity of literature on food marketing in other settings that impact children, including recreational centres, sports clubs or convenience stores, highlights a considerable knowledge gap that needs to be filled to inform policy design in this area.

Target population examined

Children were assessed in all of the settings as part of this review (television, digital media, packaging, schools, movie theatres, sports clubs, restaurants and festivals/events). However, settings-based evidence is lacking for preschoolers and adolescents in schools, restaurants and festivals/events.

The research presented in this review focussed on children, with adolescents included in only 25% (9/32) of all publications. Preschoolers were rarely included (<15% of all studies), and almost no studies examined food marketing to either of these age groups. The majority of recent television studies examined adolescents while most digital marketing and food packaging research centred around children. The lack of emphasis on child populations outside the 6- to 12-year age range has been noted in the Canadian food marketing literature; Prowse⁷ found a notable absence of preschooler- and adolescent-specific research prior to 2016. Younger children and adolescents represent critical stages in the development of dietary

habits.⁵ Adolescents are frequently excluded from regulatory action against food marketing to children. A recent scoping review specifically on food marketing to adolescents also emphasized the dearth of studies focussing exclusively on adolescent populations and an existing focus on television advertising to youth.⁵⁶ Research benchmarking adolescent exposure to food marketing in a variety of media and settings will help justify their protection and inclusion in future marketing restrictions.

Geographical distribution examined

Research on food marketing to children in Canada has primarily been conducted in Ontario and Quebec. Of the studies included, only four focussed on the province of Quebec. More research estimating the frequency and actual exposure to this marketing is needed in Quebec, particularly in digital media, in out-of-home marketing and in settings such as schools. Such research is especially important as the *Consumer Protection Act* (CPA) is being considered as a regulatory model for unhealthy food marketing restrictions nationally and internationally.

It is essential to benchmark food marketing to children and adolescents across many different provinces, given Canada's unique regulatory landscape. Previous evidence indicates that food marketing varies across regions in Canada, particularly television marketing.⁷ To date, no studies have assessed food marketing to children in Saskatchewan, Manitoba, New Brunswick, Prince Edward Island or Newfoundland and Labrador or in any of the three Canadian territories.

Diversity in food marketing research

Despite a growing evidence base of food marketing to children in Canada, there is a strong need to produce more nuanced research that considers exposure by language, sex/gender, race/ethnicity and socioeconomic status to enable the development of policies to protect these groups. Similarly, food marketing to Indigenous children in Canada remains an area severely underrepresented in the literature. While no studies in this review focussed on diversity in any of these aforementioned capacities, international research suggests that boys, as well as Black and Hispanic youth, may be disproportionately exposed to food marketing.^{57,58}

Research directions and policy implications

The evidence synthesized in this review elucidates several critical gaps in the food marketing literature in Canada. Food marketing to children is a complex issue, shaped by a myriad of sociological and physical factors. However, other than media and settings, the current literature lacks recognition and exploration of underlying sociodemographic factors, such as age, race/ethnicity, socioeconomic status, geographical location and language spoken in the home, which may contribute to differences in the type and frequency of food advertisements viewed by Canadian children. The results of several studies across multiple media platforms and settings between 2016 to 2021 illustrate the extensive state of food marketing to children and adolescents in Canada. The advent of new media, such as television streaming or online gaming platforms, as well as the impact of COVID-19 on the frequency and children's exposure to food marketing also necessitates further inquiry. Other settings contributing to unhealthy food marketing in children's daily lives, including recreational centres and convenience stores, should also be explored. Further research is needed to fully quantify children and adolescent's actual exposure across all research gaps identified in this review. With regard to policy, funding to support continued monitoring of food marketing to children and adolescents across a variety of media and settings needs to be provided by government. Such monitoring will inform future policy action that would aim to protect all youth in Canada from the harms of unhealthy food and beverage marketing.

Strengths and limitations

This review captures the breadth of English and French peer-reviewed and grey literature examining the frequency of and children's exposure to unhealthy food marketing in Canada. This range highlights multiple potential research avenues for future research. However, this study did not evaluate the risk of bias or methodological quality of the research included. Furthermore, although data collection periods used to determine the frequency of food marketing or exposure to food marketing ranged from 1 day to 12 months, few studies examined marketing to children over a full year²³ and only four studies compared data over multiple different

years.^{24-26,39} Marketing is a field that is constantly changing and evolving; the current research studies in Canada may not capture these changes.²³

Conclusion

This scoping review benchmarks current levels of food marketing to youth in Canada by media, target population and geographical location. The findings of this review demonstrate that unhealthy food marketing is prevalent in an increasing range of media platforms and settings frequented by children and adolescents. Although more nuanced research is needed to address food marketing in specific youth demographic segments, our evidence synthesis suggests that food and beverage marketing persists despite current self-regulatory and statutory policies within Canada. Further monitoring guided by the research gaps identified in this review may help inform future food marketing policies to protect children in Canada.

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Conflicts of interest

None.

Authors' contributions and statement

MPK conceived this study, developed the methodology, interpreted the results and revised the final manuscript.

FH collected data and wrote the draft manuscript.

DW collected the data and helped write the draft manuscript.

LR collected the data and revised the manuscript.

MB collected the data and helped interpret the results.

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Study protocol

The Royal Canadian Mounted Police (RCMP) Study: protocol for a prospective investigation of mental health risk and resilience factors

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Abstract

The Royal Canadian Mounted Police (RCMP), like all public safety personnel (PSP), are frequently exposed to potentially psychologically traumatic events that contribute to posttraumatic stress injuries (PTSI). Addressing PTSI is impeded by the limited available research. In this protocol paper, we describe the RCMP Study, part of the concerted efforts by the RCMP to reduce PTSI by improving access to evidence-based assessments, treatments and training as well as participant recruitment and RCMP Study developments to date.

The RCMP Study has been designed to (1) develop, deploy and assess the impact of a system for ongoing annual, monthly and daily evidence-based assessments; (2) evaluate associations between demographic variables and PTSI; (3) longitudinally assess individual differences associated with PTSI; (4) augment the RCMP Cadet Training Program with skills to proactively mitigate PTSI; and (5) assess the impact of the augmented training condition (ATC) versus the standard training condition (STC). Participants in the STC (n = 480) and ATC (n = 480) are assessed before and after training and annually for 5 years on their deployment date; they also complete brief monthly and daily surveys.

The RCMP Study results are expected to benefit the mental health of all participants, RCMP and PSP by reducing PTSI among all who serve.

Keywords: PTSD, posttraumatic stress injuries, longitudinal, risk, resilience, transdiagnostic, Unified Protocol, police, public safety personnel

Highlights

- Research is limited on how to mitigate posttraumatic stress injuries (PTSI) among Royal Canadian Mounted Police (RCMP) who are exposed to potentially psychologically traumatic events.
- The RCMP Study has been designed to develop, deploy and assess the impact of skills taught to proactively mitigate PTSI.
- RCMP cadets recruited into the study to receive the augmented training are assessed before and after training and annually for 5 years on their deployment date.
- The RCMP Study results are expected to benefit the mental health of study participants, RCMP and other public safety personnel by mitigating PTSI among all who serve.

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Introduction

Public safety personnel (PSP), including border services personnel, correctional workers, firefighters, operational and intelligence personnel, paramedics, police officers, public safety communicators, and search and rescue personnel, “ensure the safety and security of Canadians.”¹ Of all Canadian PSP, Royal Canadian Mounted Police (RCMP) report the highest average number of exposures to potentially psychologically traumatic events (PPTes), often more than 11 exposures to each type of PPTe.²

Using self-reported symptoms (based on validated measures, but not structured clinical interviews) of surveyed Canadian PSP, Carleton et al.³ determined that a very high percentage of RCMP officers screened positive for posttraumatic stress disorder (PTSD) or other posttraumatic stress injuries (PTSI; e.g. major depressive disorder, panic disorder); half (50.2%) screened positive for one or more mental health conditions.³ Many have reported suicidal behaviours during the past year (i.e. ideation [9.9%], planning [4.1%], attempts [0.2%]) or during their lifetimes (i.e. ideation [25.7%], planning [11.2%], attempts [4.2%]).⁴

Despite commitments to support PSP mental health and widespread efforts involving implementations of different interventions, evidence for effective programs designed to support PSP mental health remains extremely limited.⁵⁻¹¹

Contemporary programs designed to support PSP mental health focus on increasing knowledge, reducing stigma and increasing help-seeking behaviours.¹² Most studies of PTSI among PSP use cross-sectional data with short follow-up periods and assess very small subsets of variables posited as important.^{6,13} The limited research suggests the extant programs produce small, time-limited, highly variable benefits,^{7,8,10,14,15} likely due to low fidelity of delivery¹⁶ and limited specification of the mechanisms of action for mitigating PTSI.^{6,10} A particularly large, robustly designed trial with serving PSP compared psychoeducation to resilience training focussed on stress reduction and mindfulness,¹⁷ but

found no statistically significant differences between the treatment groups. The researchers recommended future programs target specific modifiable individual differences.¹⁷

Individual differences that have been posited as resilience factors for psychopathology include some personality traits (i.e. extroversion, conscientiousness),¹⁸ hope,¹⁹ distress tolerance,²⁰ optimism,²¹ interpersonal supports²² and positive life activities (e.g. exercise).²³ Environmental factors, individual differences in psychological variables and individual differences in physiological variables have also been posited as risk factors for psychopathology.²⁴ Environmental risk factors for psychopathology include PPTe and stressors (e.g. adverse childhood experiences, difficult socioeconomic status),²⁵ family history of psychopathology,²⁶ pre-existing psychopathology²⁷ and peritraumatic experiences.^{28,29} Individual psychological difference risk factors for psychopathology include some personality traits (e.g. neuroticism, world view),²⁹ anxiety sensitivity,³⁰ fear of negative evaluation,³¹ illness/injury sensitivity,³² pain-related anxiety/fear,³³ intolerance of uncertainty,³⁴ rumination,²⁷ maladaptive self-appraisal,³⁵ dissociation³⁶ and anger.³⁷ Individual physiological difference risk factors for psychopathology include autonomic nervous system dysregulation.^{38-41,*}

Aversive avoidant reactions to emotions are particularly critical risk factors for developing PTSI.^{30,34} Greater acceptance of emotions reduces reliance on avoidant coping strategies (e.g. alcohol use, avoiding reminders of the event) that exacerbate PTSI symptoms and, paradoxically, lead to more frequent negative emotions.⁴²⁻⁴⁴ The Unified Protocol^{43,44} is an evidence-based cognitive behaviour intervention designed to help individuals cultivate an approach-oriented stance towards emotions. The Unified Protocol was designed to reduce symptoms of diverse anxiety- and mood-related disorders.⁴² The Unified Protocol is supported by considerable evidence demonstrating transdiagnostic effectiveness across several delivery formats (e.g. individual, group, self).⁴⁵⁻⁵⁹

There is preliminary support for the Unified Protocol as a proactive intervention

to mitigate PTSI based on a randomized trial assessing participants with elevated nonclinical symptoms of depression and anxiety.⁶⁰ Participants found the proactive Unified Protocol training to be highly acceptable and satisfying; at 1-month follow-up, they reported using the new skills “some” to “most” of the time, and statistically significant improvements were observed from baseline to 1-month follow-up. The Unified Protocol appears to have potential as a proactive intervention that can be efficiently and effectively delivered to PSP to use to protect their mental health^{13,47,61-65} and enhance job satisfaction.⁶⁶

The current paper describes the RCMP Study[†] (i.e. design, measures, materials, hypotheses, planned analyses, expected implications, limitations). The RCMP Study is part of the concerted efforts the RCMP is making to address PTSI by improving access to evidence-based assessments, treatments and training. The overarching objectives for the RCMP Study are as follows:

- (1) to develop, deploy and assess the impact of a system for ongoing (i.e. annual, monthly, daily) evidence-based assessments of environmental factors and individual differences (i.e. measurements of biometrics, mental health, social experiences);
- (2) to evaluate associations between demographic variables and symptoms of PTSD and other PTSI;
- (3) to longitudinally assess environmental factors and individual differences associated with PTSI;
- (4) to integrate the adapted Unified Protocol training into the RCMP Depot Division (“Depot”) Cadet Training Program,^{63,67,68} to create the augmented training condition (ATC); and
- (5) to assess for differences in participants receiving the ATC relative to those receiving the standard training condition (STC) (e.g. ATC participants should report better mental health).

The current paper details the RCMP Study design, protocols, measures, materials and

* Additional details about individual differences of interest for the RCMP Study are available in the supplemental materials (see <http://hdl.handle.net/10294/14680>).

† On 28 June 2017, the RCMP posted the public request for proposals, “Longitudinal Study of Operational Stress Injuries / Étude longitudinale sur les traumatismes liés au stress opérationnel” (Solicitation Number M7594-171491/C). On 30 November 2017, the research team led by R. Nicholas Carleton was notified that they were the successful applicant. The project is now referred to by stakeholders as the “RCMP Study.”

hypotheses, planned analyses, expected implications and limitations; and describes participant recruitment and study progress to date.

Methods

Study design

The RCMP Study necessarily uses a longitudinal prospective sequential experimental cohort design to create a clustered randomized trial⁶⁹⁻⁷¹ that engages individual participants for 5.5 years. The structure of the Cadet Training Program does not allow for randomizing individual participants or individual groups of participants; nevertheless, meta-analytic evidence suggests that results from studies using this design and results from true randomized controlled trials do not typically differ meaningfully or statistically significantly, and both methods produce comparable groups at baseline.^{72,73}

The RCMP have provided continuous coordinated feedback, through co-authors GPK and KSH, on the study design and measurement tools.

RCMP cadets are recruited into training cohorts called troops, each of which typically includes 32 cadets. Between 30 and 50 troops are trained per year (i.e. 800-1200 cadets).

Ethics approvals

The University of Regina Ethics Board provided initial approval on 10 April 2019 (File #2019-055), and the RCMP Research Ethics Board followed with approval on 12 April 2019 (File #SKM_C30818021312580). The study was also approved through a Privacy Impact Assessment as part of the overall National Administrative Records Management System approval (20161123286) and Public Services and Procurement Canada approval (201701491/M7594174191).

The project is bound by the *Privacy Act*, R.S., 1985, c. P-21 and the *Personal Information Protection and Electronic Documents Act*, SC. 2000, c.5 and approved by Public Services and Procurement Canada (PSPC) M7594-171491/001/SS.

All interested people were provided with printed and electronic copies of the study

information at several points, and all participants were required to explicitly indicate consent before proceeding. Consent was explicitly reaffirmed at several points during the data collections.

Participant information

Potential participants include RCMP cadets starting the Cadet Training Program—Canadian citizens or permanent residents, aged 19 to 57 years, who read, write and speak either English or French fluently.⁷⁴ Cadets must meet several recruiting requirements, including security clearances, medical examinations, a polygraph test and minimum physical standards. There are no conditions that would exclude any cadet from participating in the RCMP Study. There is no reason to expect that the demographic representation of participants will differ from the demographic representation of cadets overall.

All RCMP constables are trained at Depot. The training program is a rigorous and highly structured 26-week program during which cadets study and practise well beyond 8 hours of scheduled classroom time per day.^{75,†} The average age of recruits is 29 years and about 25% self-identify as female. All cadets attending the Cadet Training Program after the ATC launches will receive the augmented training; RCMP Study participation remains voluntary.

Sample size requirements and power analyses

We performed power analyses for a cluster randomized trial using SAS version 9.3 (SAS Institute Inc., Cary, NC, US) and RMASS web application (Center for Health Statistics, University of Chicago, IL, US). Based on these analyses, a sample of 480 participants per condition (i.e. STC and ATC) at T2 (pre-deployment, at about 24 weeks after recruitment) will provide adequate power (i.e. >80%).^{76,77} Power analyses assumptions were (1) clustering of participants into RCMP troops; (2) repeated measures among participants over time (i.e. clustering within participants); and (3) attrition (i.e. loss to follow-up) ranging from 5% to 20%. Our goal in conducting the power analyses was to assess the sample size requirements under several

different scenarios and to assess the multiple outcomes of interest.

Analyses

Continuous (e.g. symptoms) and cross-sectional (single time point) analyses

We assumed power of 80%, a significance level (α) of 0.05 and standardized effect size estimates from 0.2 to 0.5. Intraclass correlation coefficients for clustering of participants into troops were assessed from weak (0.01) to strong (0.20), with troop cluster size set at 24 to account for non-graduating cadets.

Binary (e.g. diagnostic status) and cross-sectional (single time point) analyses

We assumed power of 80%, a significance level (α) of 0.05 and cumulative incidence rates of 10% to 20% for the ATC and 25% to 35% for the STC. Intraclass correlation coefficients for clustering of participants into troops were assessed from weak (0.01) to strong (0.20), with troop cluster size set at 24 to account for non-graduating cadets.

Longitudinal continuous analyses

We assumed power of 90% and 95%, with 40 troop clusters, balanced condition allocation and a significance level (α) of 0.05. The attrition rate across six measurement occasions was set to 0% (at T2), 5%, 5%, 10%, 15% and 20%. The intraclass correlation coefficient between study participants (i.e. across repeated measurements) was set as 0.2 and within troops as 0.1. We assumed a linear trend across measurement occasions with a first-order autoregressive within-participant correlation structure with an estimated coefficient of 0.40. The study will be adequately powered if the effect size is greater than 0.25.

Participant recruitment and retention

The website describing the RCMP Study in detail is publicly available (www.rcmpstudy.ca) and is actively used by stakeholders, but that accessibility makes it impossible to know when potential participants first learn about the study. Recruitment for the STC concluded on March 2022 and recruitment for the ATC began on June 6, 2022.

The research team introduces the RCMP Study to potential participants with an

† The Cadet Training Program has evolved considerably since 1885. A problem-based learning model is currently used to acquire police driving, firearms and self-defence skills; emphasis is placed on communication skills for de-escalation and crisis management.

email sent from the RCMP National Recruiting Program[§] before cadets arrive at Depot. RCMP Study advertisements (e.g. posters, tent cards, pop-up banners) are also distributed throughout Depot.

After potential participants arrive at Depot, each troop attends a recruitment session delivered by members of the research team. The session includes video content from serving RCMP members (~10 minutes), introductions to the research team, a didactic lecture with a slide show presentation (~35 minutes long) and an opportunity for potential participants to ask questions (~15 minutes). The presentation outlines the RCMP Study rationale, design, requirements, expected outcomes and the potential benefits to the RCMP, the broader PSP community and all Canadians.

The presentation also explains potential benefits to individual participants (e.g. monitoring individual mental health, potentiating earlier access to mental health support). Potential participants are given a paper copy of the full participant information sheet and consent form and invited to consider participating. The formal participation decision occurs a few days later during a dedicated on-boarding session.

The on-boarding session begins with a brief video testimonial from an RCMP officer with lived experience (~10 minutes). The research team then provides a highly detailed and interactive tutorial (~45 minutes) explaining, for example, the technology set-up and using the study software and hardware. The on-boarding session includes an opportunity to ask questions (~10 minutes).

Although participants are encouraged to complete all assessments, because of the size, scale and length of the RCMP Study very few participants manage to complete all assessments and missing data are expected. Cadets who choose not to participate are invited to provide anonymous feedback about their decision. Participants who leave the research project are also invited to provide anonymous feedback about their decision. Participants who leave the RCMP during the research project will be invited to complete the assessment phase following their departure.

Cumulative attrition from longitudinal police studies without the employer paying for participation time typically ranges from 3% at 1 year to 43% at 3 years.⁷⁸⁻⁸² A similar research design with military participants has reported cumulative attrition rates of less than 10% and overall rates of missing data of less than 30%, with anecdotal reports that participants appreciate being able to track their own activities and symptoms.^{83,84} All RCMP Study participants can participate during paid time and the RCMP have demonstrated a high affinity for research participation (G. Krätzig, personal communication, 12 February 2019). That affinity, coupled with plans for recruitment and retention, and intrinsic motivation (i.e. the prospect of improved mental health), suggests attrition rates consistent with the military research.^{83,84} Based on previous research,^{27,83,84} anticipated participation recruitment was expected to take about 24 months.

Gender and sex

Gender structures implicitly and explicitly influence how PSP experience occupational stressors and interact with mental health. Policing culture emphasizes hegemonically masculine traits,⁸⁵ creating specific difficulties for women including stereotyping, discrimination and sexual harassment on duty.^{30,86} Masculinized work patterns⁸⁷ create challenges for women accessing parental leave and balancing work with care obligations.^{30,87} Perhaps due to such stressors, women police officers more frequently report mental health challenges than men police officers,³ but with substantial variability associated with potential causes.^{30,34} The RCMP Study will support sex- and gender-disaggregated analyses across various topics (see the supplemental tables at <http://hdl.handle.net/10294/14680>). Data are primarily quantitative and self-reported; still, participants can provide open-ended responses. Gender and sex will be treated as variables for all analyses. Qualitative analyses will include open-ended responses where possible. The results will provide insight into gendered structures affecting PSP mental health.

Data collection timeframe

Participants will be assessed for at least 66 months, via full assessments conducted

at T1 and T2, and annually thereafter (i.e. T3, T4, T5, T6, T7), as well as monthly assessments, daily assessments and biometric assessments (see the section “Assessments, surveys and interviews” for details), to allow for sufficient time to potentially develop PTSI symptoms after deployment. The data collection time-period uses seven broad milestones (see Table 1 for a summary and the supplemental tables at <http://hdl.handle.net/10294/14680> for details): pre-training (T1); pre-deployment (T2; ~24 weeks after recruitment); and on or about each of five deployment anniversaries (T3 to T7), the first (T3) being about 12 months after deployment. Each milestone involves a full assessment (FA1 to FA7). Recruitment will continue until 480 ATC participants have completed FA2. Unless extended by the RCMP, FA7 concludes data collection from each participant.

Participants complete their first monthly assessment (i.e. MA1) about 4 weeks after completing FA1 and do not complete a monthly assessment concordant with completion of a full assessment (i.e. maximum number of monthly assessments per participant is 65). Participants can complete their first daily assessment (i.e. DA1) on the same day as FA1 (i.e. maximum number of daily assessments per participant ~2008). Cadets cannot be enrolled into the ATC until all STC participants have deployed, creating, by necessity, a 26-week gap that will be used to prepare to transition the Cadet Training Program to the ATC (see supplemental tables at <http://hdl.handle.net/10294/14680>).

Unified Protocol adaptation and training details

A 13-week protocol based on the Unified Protocol and called Emotional Resilience Skills Training (ERST) was developed for seamless integration with the Cadet Training Program. The ERST includes an instructor guide, didactic PowerPoint slides and a cadet workbook, all conforming to the extant Cadet Training Program formats.

The ERST leader for the research team (SSZ, a co-developer of the Unified Protocol) will train and certify several Cadet Training Program instructors as master trainers to provide the ERST to other training program instructors, RCMP

[§] The RCMP does not release email addresses of new recruits to any external group.

TABLE 1
RCMP Study recruitment and data collection timeframe overview for STC and ATC

Approximate times	Milestone	Assessment	Activity
2 weeks prior to arrival	–	N/A	Initial RCMP Study email
Week 1 (early)	–	N/A	Recruitment presentation and on-boarding session
Weeks 1–2, Day 6	T1	FA1	Pre-training assessment
Week 5	–	MA1	
Week 24–25	T2	FA2	Pre-deployment assessment
Weeks 76–80	T3	FA3	
Weeks 128–132	T4	FA4	
Weeks 180–184	T5	FA5	Deployment anniversary assessments
Weeks 232–236	T6	FA6	
Weeks 284–288	T7	FA7	

Abbreviations: ATC, augmented training condition; FA, full assessment; MA, monthly assessment; N/A, not applicable; RCMP, Royal Canadian Mounted Police; STC, standard training condition.

Note: FA1–FA7, first to seventh full assessments, which will include full surveys and clinical interviews during the timeframe indicated.

officers and ATC cadets. The RCMP selects which instructors (n = 6–8) are to receive the week-long interactive workshop and then provide ongoing quality control for the ATC implementation.

Master trainers will each train two to three trainers (instructors selected to provide the ERST to ATC cadets; n = 18) by presenting the ERST material as if the trainers were cadets. Master trainer training fidelity will be assessed and supported by having their training sessions audiorecorded and rated by a member of the research team (SSZ). The trainers will then provide the ERST to all 200 Depot team members, including other instructors. The training sessions for the 200 Depot team members will also be audiorecorded for review by the master trainers to support fidelity.

The master trainers will work with all Cadet Training Program instructors and the research team to integrate the ERST—and testing of ERST skill use—into every other aspect of the program, therein creating a high-fidelity ATC with didactic training supplemented by substantial experiential practice. Cadets should have sufficient practice that the ERST skills become as automatic as any other skill set, facilitating ongoing use after deployment and protecting their mental health. Participants will also have ongoing access to ERST to support skill retention after deployment.

The integration should overcome challenges of previous mental health training program deployments related to fidelity¹⁶ and skill development.^{6,7,14,15}

Communication tools – Moodle and Qualtrics

All communications between the research team and participants, administration of surveys, feedback for participants (including their clinical assessment reports) and distribution of the ERST materials will be coordinated through a tailored and dedicated instance of the online learning platform Moodle (i.e. the Portal) paired with a software application (i.e. the App) downloadable onto compliant smart phones. Surveys are administered in English or French through a secured Qualtrics account. Clinical interviews are supported by electronic administration of the Mini-International Neuropsychiatric Interview (MINI).⁸⁸⁻⁹⁰

Assessments, surveys and interviews

Full assessments – full surveys

Details of the full surveys (e.g. questionnaire titles, details, psychometric information, references) are in the “Supplemental Psychometrics and References for Self-Report Measures (Alphabetically)” (see <http://hdl.handle.net/10294/14680>).

The initial full survey assesses stable demographics (i.e. sex, date of birth, height, ethnicity, gender, sexual orientation, adverse childhood experiences) and reference characteristics (i.e. pre-recruitment education, employment, language(s) spoken, religion, work history, living location and mental health history). All remaining full surveys assess demographics expected to change more (i.e. physical health conditions, body mass, work and

living locations, socioeconomic status, marital status, rank, work hours, education, household composition).

Average completion time for each full survey is 72 minutes. Participants can access their full survey results in a dedicated report containing context and academic references through the Portal. All full surveys also assess for the following:

(1) symptoms of PTSI including generalized anxiety disorder, major depressive disorder, panic disorder, PTSD and social anxiety disorder as well as PTSI correlates (e.g. substance use, chronic pain, insomnia, relationship dissatisfaction);

(2) environmental factors and individual differences positively or negatively associated with PTSI:

- PPTE exposures;
- personality;
- anxiety sensitivity, fear of negative evaluation, illness/injury sensitivity, intolerance of uncertainty, pain-related anxiety, resilience, anger, beliefs about emotions, experiential avoidance, emotion regulation, and mindfulness;
- mental health care knowledge, access and use;
- occupational stressors, work fulfilment, institutional betrayal, stigma, family stressors, posttraumatic growth, social support and self-care; and

3) ERST retention and use for ATC participants.

Responses consistent with one or more mental disorders are flagged for participants and include recommendations for accessing additional mental health supports.

Full assessments – clinical interviews

Each full assessment includes a semistructured MINI clinical interview⁸⁸⁻⁹⁰ conducted by a registered clinical psychologist or by supervised trainees. The MINI provides a standardized diagnostic approach consistent with DSM-5 criteria.⁹¹ The interviewer reviews the full survey results before MINI administration in either English or French, whichever the participant prefers.

The published MINI interrater reliability exceeds 75%.^{88,89} Current interrater reliability will be assessed with the κ (kappa)

statistic and “observed agreement” (i.e. a second interviewer observes 15% of all clinical interviews). Average completion for each clinical interview is 45 minutes.

Participants receive verbal (from the interviewer) and written (through the Portal) summaries of their full assessment and are advised of responses consistent with one or more mental disorders and referred for mental health support as indicated (e.g. to registered psychological services available, through the RCMP and independent of the RCMP); however, a diagnosis is not provided.

Monthly assessments

Details of the monthly assessments (e.g. questionnaire titles, details, psychometric information, references) are in the “Supplemental Psychometrics and References for Self-Report Measures” (see <http://hdl.handle.net/10294/14680>). The maximum number of monthly assessment questions is 271, determined by participant responses to header questions. Average completion time for each monthly survey is 15 minutes. All monthly surveys assess for the following:

- (1) symptoms of PTSI including generalized anxiety disorder, major depressive disorder, panic disorder, PTSD and social anxiety disorder as well as PTSI correlates (e.g. substance use, chronic pain, insomnia);
- (2) individual differences associated with PTSI: PPTE exposures; resilience; mental health care knowledge, access and use; occupational stressors, social support and self-care; and
- (3) ERST retention and use for ATC participants.

Participants receive written (through the Portal) summaries of their monthly assessment including timeline charts for participants to monitor fluctuations, facilitating participation healthy habits.⁹²⁻⁹⁴ Responses consistent with one or more mental disorders are flagged for participants and include recommendations for accessing additional mental health supports.

Daily assessments

The daily assessments are very brief self-report questionnaires that allow participants to reflect and report on their mood, attitude and performance; physical wellness;

emotional state; work hours; sleep hours; sleep quality; eating; physical activity; social activity; substance use and gambling; and ERST use (ATC participants only).

Mood, attitude and performance and physical wellness are rated on 100-point visual analog scales with anchors of ill (0-25), injured (26-50), reacting (51-75) and healthy (76-100). A 24-point rating scale is used for emotional state, work hours and sleep hours. Sleep quality, eating, physical activity, social activity and substance use are reported dichotomously (i.e. yes/no responses), with discretionary options for participants to record details.

The daily assessments also allow participants to log PPTE or other significant emotional events, creating a record of exposures to stressors. Average completion time for each Daily Survey is about 1 minute. Completing the daily assessments supports regular self-reflection and provides participants with graphical feedback to encourage healthy habits.⁹²⁻⁹⁴

Biometric assessments

The original RCMP Study design used electrocardiography to measure heart rate variability through beat-to-beat intervals in consecutive QRS complexes (i.e. R-R intervals) of sinus origin.⁹⁵⁻⁹⁷ The process provides a relative assessment of health based on information about the autonomic nervous system⁹⁷ using the method of choice for valid assessments of heart rate variability.^{98,99} R-R intervals from electrocardiography are robustly related to other collection methods;^{99,100} however, heart rate variability analyses for autonomic nervous system changes reflecting psychopathology require knowing the sinus, supraventricular or ventricular origin,¹⁰¹ inspecting all heartbeats and using complete physiological recordings,⁹⁷ instead of mathematically mediated estimations.^{98,100,102-104}

Hexoskin wearable biosensor garments (Carré Technologies Inc., Montréal, QC) were modified for policing operational requirements and used for heart rate variability measurements. Initial plans required participants to wear the garment upon waking for a 5-minute resting period to establish baseline metrics.⁹⁷ The garment was worn during training and work shifts, producing 3 to 5 days of recordings per week. Participants were also equipped with an Apple Watch (series 4 and then

series 5; Apple Inc., Cupertino, CA), to supplement the biometric data collection with sleep and metabolic data, supported by a dedicated Apple iPhone (Apple Inc., Cupertino, CA). Participants use the iPhones with Wi-Fi at no cost and could use the iPhones as personal phones, but they were not provided with voice or data plans. Biometric recordings were downloaded for offline processing and analyses.

Participants found using the Hexoskin garments challenging, and in 2021, data collection transitioned to the Recordis cardiac sensor device (LLA Technologies Inc., Vancouver, BC) to collect M-mode echocardiography timing events (i.e. systole, diastole, isovolumic contraction and relaxation periods, rapid ejection) as well as twist forces of the ventricle (a surrogate for contractility), heart rate variability and Myocardial Performance Index variant.¹⁰⁵

The Recordis is applied to the sternum base (~1 cm above the xiphoid process) with a single electrocardiography electrode or heart belt strap, and uses a smartphone application providing immediate and ongoing user feedback. The current protocol requires a daily 1-minute recording upon waking, with data downloaded for offline processing and analyses. This equipment is expected to better support participant compliance without compromising data collections to address hypotheses.

Data management and confidentiality

Data transfers from participant devices to secured research servers in Canada are protected using Transport Layer Security. The RCMP Study also employs a PKI Class 3 SSL Certificate, with a 2048-bit digital signature and 256-bit encryption. Data stored on the servers are automatically encrypted using server-side Advanced Encryption Standard-256 before being saved to disk and decrypted prior to downloading. The data are also “salted” (i.e. they include false participants) to further protect participant privacy. The data are stored separately from the data dictionary and the codes necessary for interpretation.

Participants log into the Portal using a unique randomly generated Participant Identification Code (PIC) and a password of their choosing. A PIC is created for each RCMP cadet, irrespective of their decision to participate in the study. The PIC is used for storing participant data

and linking responses over time because the research team does not have access to participant names. The RCMP stores the list pairing cadet names with PICs in a secured file at Depot that is accessible by only two employees; the organization never has access to individual participant RCMP Study data. The file is only opened under two circumstances: to add new participants; and if a participant discloses an imminent intent to die by suicide, a registered clinical psychologist from the research team may contact the RCMP to provide the PIC—but no other information—to try to save the participant’s life.

Hypotheses

The RCMP Study hypotheses were pre-registered.** Hypotheses specific to individual difference variables are provided in supplemental tables (see <http://hdl.handle.net/10294/14680>; i.e. “Posttraumatic Stress Injury Symptom Measures”; “Primary Differences Associated with Posttraumatic Stress Injuries”; and “Secondary Individual Differences Associated with Posttraumatic Stress Injuries”). Overarching RCMP Study hypotheses are shown in Table 2.

Planned analyses

We will initially describe study data using frequencies, means and standard deviations. We will test differences in baseline demographic characteristics of STC and ATC participants using a χ^2 (chi-square) test for independence. Missing data will be described within and across times when data are measured. Multiple imputation will be adopted assuming a missing-at-random mechanism¹¹¹ and completed based on the clustering of individuals into troops and on a thorough examination of variables associated with missing values and response distributions.¹¹² We will adopt strategies to control the familywise error rate (i.e. the probability of at least one Type I error in a family of tests),¹¹³ while accounting for Type II errors.¹¹⁴

Analyses will include mixed-effects multiple linear and non-linear regression models including covariates (i.e. sex, age, marital status, education, province of residence) and trend analyses as needed. To test for differences between troops in the cross-sectional analyses, we will use a

TABLE 2
RCMP Study hypotheses

Baseline comparisons	<ol style="list-style-type: none"> 1) Mental health disorder prevalence rates at T1 for both groups based on clinical interviews or screening tools based on self-reported symptoms, will be comparable to the mental health disorder prevalence rates of the general population (i.e. 10.1%;¹⁰⁶). 2) At T1, both groups will report individual difference scores comparable to the general population.
Positive impacts of STC and ATC, enhanced benefits of ATC	<ol style="list-style-type: none"> 3) From T1 to T2, both groups will show reductions in variables associated with risk (e.g. anxiety sensitivity), increases in variables associated with resilience (e.g. distress tolerance), improvements in mental health (e.g. absolute, statistically significant or clinically significant reductions in self-reported symptoms of PTSD, reductions in proportions of participants meeting diagnostic criteria using either standardized cut-off scores, clinical interview results), as a function of the Cadet Training Program.^{107,108} <ol style="list-style-type: none"> a. The ATC group will, but the STC participants will not, show statistically significant changes associated with more than small effect sizes. b. Relative to the STC group, the ATC group at T2 will report statistically significantly lower risk, greater resilience and better mental health. 4) Both groups will show statistically significant predictive relationships between completing assessments, changes to individual differences over time (i.e. inversely with risk [e.g. anxiety sensitivity], positively with resilience [e.g. hope], inversely with mental health symptoms [e.g. symptoms of major depressive disorder]) and successful completion of the Cadet Training Program.^{92,94} 5) Both groups will evidence statistically significant sequential predictive relationships for environmental factors or individual differences reported during the daily, monthly and full assessments.
Mitigating factors	<ol style="list-style-type: none"> 6) Both groups will show increases in risk, decreases in resilience and reductions in mental health at T3, T4, T5, T6 and T7, relative to T2; however, the ATC group will show slower increases in risk, slower decreases in resilience and slower reductions in mental health. 7) Both groups will show a statistically significant relationship between changes in environmental factors or individual differences over time, frequency of exercise¹⁰⁹ and other self-reported indicators of physical health.¹¹⁰ 8) Relative to the STC group, the ATC group will report fewer symptoms of and instances of mental health disorders after T1. 9) The ATC group will show a statistically significant relationship between changes in environmental factors or individual differences over time and engagement with ATC content. 10) Relative to men, women will report more difficulties with mental disorder symptoms and occupational stressors. 11) Changes in biological variables (i.e. autonomic nervous system reactivity, heart rate variability, cardiac mechanical changes) will be associated with environmental factors or individual differences.

Abbreviations: ATC, augmented training condition; PTSD, posttraumatic stress injuries; RCMP, Royal Canadian Mounted Police; STC, standard training condition.

Note: T1–T7, first to seventh milestones, from pre-training, pre-deployment (at ~24 weeks after recruitment) and on or about each of five deployment anniversaries (T3 to T7), the first (T3) being about 12 months after deployment.

mixed-effects model that accounts for clustering within troops, while to test for changes over time and to test for differences between troops in the longitudinal analyses, we will use a mixed-effects model that accounts for clustering within troops as well as within individuals (i.e. repeated measurements for each individual). We will use recursive Bayesian algorithm and ecological momentary analyses to analyze the daily assessments and biometric data. Sex and gender analyses will be conducted. Open-ended data will be

coded using conventional qualitative content approaches before analyses.¹¹⁵

Knowledge translation

We plan to share main results with the research community via publication in peer-reviewed journals. Results will be of interest to RCMP leadership and members and their families, other PSP stakeholders, clinicians and policymakers. Knowledge translation will be tailored for the different audiences. Technical reports and lay

** Pre-registration with aspredicted.org for the RCMP Study and associated hypotheses occurred on 7 November 2019 with the name, “Risk and resiliency factors in the RCMP: A prospective investigation” (#30654).

summaries will be available through the study website (www.rcmpstudy.ca), in English and French, and provided to senior RCMP officials and the Department of Public Safety and Emergency Preparedness. Results will also be communicated to PSP stakeholders through the Canadian Institute for Public Safety Research and Treatment (www.cipsrt-icrtsp.ca). The University of Regina Communications Department will issue press releases as appropriate.

Current study status and impacts of COVID-19

STC recruitment and data collection began on 22 April 2019 and continued for 27 troops until 9 December 2019. There were 25 on-boarding sessions from 25 April 2019 to 12 December 2019. Depot closed in response to COVID-19 containment restrictions on 19 March 2020, and all participants still in the Cadet Training Program were discharged from the RCMP Study. Many participants had completed the full assessment at T1 (n = 496) and T2 (n = 167). STC recruitment restarted on 16 November 2020 and continued until more than 480 participants had completed their full assessments at T2, which occurred on 21 March 2022. The ATC recruitment began on 6 June 2022.

The COVID-19 pandemic inconvenienced RCMP Study participants, delayed the study timeline, increased study costs and led to the creation of pre- and post-COVID-19 groups within the STC, adding a new covariate for analyses.

The data collection timeframe was on track until Depot closed on 19 March 2020. Depot did not reopen to new cadets until 2 November 2020. Cadets attending the training program after 2 November 2020 started with 2 weeks in mandatory isolation to offset COVID-19 risks. The closure and reopening resulted in: all RCMP Study participants at Depot at the time of shutdown (n = 130) being removed from the RCMP Study; substantially increased recruitment time for the STC due to removal of existing participants; the ad hoc creation of pre- and post-COVID-19 STC participant groups (i.e. STC-PREC19 and STC-POSTC19); and the need to assess for and control for the impact of COVID-19 on the STC by statistically comparing the STC-PREC19 and STC-POSTC19, and by adding the COVID-19 STC group status in subsequent analyses.

Discussion

The RCMP Study was designed to develop, deploy and assess the impact of a system for ongoing (i.e. annual, monthly, daily) evidence-based assessments of environmental factors, individual differences in psychological variables and individual differences in physiological variables (i.e. measurements of biometrics, mental health, social experiences). The implemented system is now referred to as the RCMP Study Protocol. The RCMP Study was also designed to prospectively assess for interactions between demographic variables, environmental factors, individual differences and PTSI symptoms. Data collection is well under way and initial results will be reported in peer-reviewed publications. The RCMP Study has developed and will integrate and test the impact of integrating ERST into the Cadet Training Program. ATC participants are expected to report significant and substantive mental health benefits relative to STC participants.

Expected implications for clinical practice, policy and research

The RCMP Study was designed to benefit all participants: through evidence-based assessments that encourage self-monitoring and earlier access to care^{92-94,116-118}; through reductions in mental health stigma through increased discourse¹¹⁹⁻¹²² and social supports^{22,119,123}; with tangible evidence of organizational commitment to improve evidence-based mental health supports^{119,124,125}; by creating independent electronic mental health records; and through shared altruistic engagement in improving mental health for all PSP^{126,127}.

Participants in the ATC are expected to receive substantial additional benefits from receiving the ERST, a set of skills that may also help RCMP to support civilians who are experiencing distress. Integrating the ERST to create the ATC appears to be unique among contemporary efforts to proactively support PSP mental health. The ATC includes specific and regular fidelity checks for the ERST, assessments of ERST engagement and use, and ongoing ERST access. In effect, the “dose” of the intervention will be larger, more rigorously applied and more rigorously assessed than previous efforts,^{6,128} and will provide critical information about the potentially positive proactive impact of any PSP mental health training program.

The RCMP Study was also designed to benefit the RCMP as an organization, by providing evidence-based information for ongoing enhancements to training and assessments and by deploying and testing a set of tools to support RCMP mental health. The RCMP Study results and the RCMP Study Protocol are expected to also inform assessments, treatments and programming for diverse PSP, military, veterans and other people at risk for PPTE exposures (e.g. nurses).^{129,130} For example, a project funded by the Canadian Institutes of Health Research is now testing an adaptation of the RCMP Study Protocol with samples of firefighters, paramedics, municipal police and public safety communicators.

Strengths and limitations

The RCMP Study has several strengths: longitudinal design elements that can inform causal relationships; prospective design elements that can inform predictive and proactive discussions associated with PPTE; large STC and ATC sample sizes at milestone T2; ongoing multimodal assessments of environmental factors and individual differences, including PPTE exposures, occupational stressors and social stressors; and interrater reliability assessments for clinical interviews. The sequential experimental cohort design elements required creating an exceptionally tailored and structured training program (i.e. the ATC) from the ERST adaptation of the rigorously well-supported Unified Protocol.^{42,43} The ATC is an inherent study strength, and the ERST is a tangible deliverable for the RCMP.

The RCMP Study also has several necessary limitations. The sequential experimental cohort design was necessary to accommodate Cadet Training Program ecological realities. Cadets interact within and across troops while in the training program and, as such, cannot be truly randomized to the STC or ATC.

Relatedly, Depot trainers could not feasibly provide two separate training conditions, simultaneously or in parallel, prohibiting a truly randomized design. The study design strengths coupled with founding the ATC on the Unified Protocol should sufficiently offset the randomization design limitation.^{72,73} There is no obfuscation of participant condition and no true “sham” training condition, creating unknowable influence from expectancy effects. Direct research on such

impacts remains relatively nascent,¹³¹ but the available results suggest little or no difference between open and closed label designs where participants are provided with a sufficient rationale for the study design (e.g. Locher et al.¹³²).

The assessments are uncommonly detailed, which may produce intermittent response fatigue among participants; however, participation occurs on paid time and the RCMP actively support participant morale and engagement with the RCMP Study.

Despite the detailed assessments, there may be important unassessed variables. If the interim analyses or participant feedback evidence are missing variables, the research study team will work to accommodate additional data collection.

The detailed assessments also increase Type I error risks from spurious correlations.¹³³ The pre-registration of hypotheses, as well as the a priori provision of expected results in the current protocol paper, are expected to mitigate Type I error risks and protect against equally problematic Type II error risks.¹³³ The voluntary nature of cadet participation in the RCMP Study creates an unknowable influence from self-selection biases. The sample size and analytic plan are designed to offset attrition, but protecting participant privacy prohibits definitively assessing for systematic biases based on attrition. The lengthy time spans associated with data collection and results increase attrition risk, so the research team is working to regularly disseminate meaningful interim results.

Conclusion

The RCMP Study has been designed as an applied longitudinal prospective sequential experimental cohort research project. Participants, the RCMP as an organization, past, present and future RCMP and all PSP should benefit directly and indirectly from the RCMP Study. The benefits should occur irrespective of any specific RCMP Study component (i.e. risk variables, resilience variables, biological variables, the relative impact of the ATC). Through the RCMP Study, the RCMP have become global leaders in the international efforts to better support the mental health of all PSP. The current protocol paper provides details to inform and support similar efforts by other researchers.

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Authors' contributions and statement

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Original quantitative research

A person-centred approach to COVID-19 pandemic-related stressors

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Abstract

Introduction: The COVID-19 pandemic and resultant containment effects has had a detrimental effect on individuals' social, occupational and financial circumstances. Taking a person-centred approach to inquiry and data analysis, we sought to identify classes (or segments) of employees with distinct configurations of responses across several pandemic-related stressors. We also investigated purported risk and resilience factors of membership in these classes.

Methods: We analyzed data from 4277 employees who completed a pulse survey in August 2020, using latent class analysis to identify classes of employees with unique patterns of responses across six pandemic-related stressors. We also conducted a multinomial logistic regression analysis to explore the associations between several risk and resilience factors (e.g. age, gender, perceived organizational support) and class membership, and we compared the emergent classes' levels of self-reported mental health.

Results: The data revealed four unique classes of employees: "adapting," "conflicted," "insecure" and "stressed" (30%, 35%, 21% and 14% of the sample, respectively). All of the risk and resilience factors were associated with being in the adapting class versus the other classes. The adapting employees also showed the most positive self-reported mental health relative to their counterparts.

Conclusion: By identifying classes of employees with distinct configurations of pandemic-related stressors, as well as differential risk factors and levels of self-reported mental health, the present study offers a starting point for informing work-related interventions with the goal of helping employees most vulnerable to pandemic-related stressors effectively cope with these stressors.

Keywords: *latent class analysis, mental health, risk factors, resilience, perceived organizational support, adapting, stress*

Introduction

The COVID-19 pandemic has had a pivotal impact on individuals, organizations and governments around the world.^{1,2} Many individuals had to quickly transition to a fully remote work environment, with little time to adapt to the new tools and processes of their work, all while learning to navigate an entirely novel social landscape.³ Arguably, increased demands in

both personal and professional domains likely had a largely negative influence on working individuals' psychological health and safety related to work.

In the Canadian population, anxiety has quadrupled and depression more than doubled since the onset of the pandemic.⁴ Furthermore, one-third of Canadians with depression and anxiety have reported an increase in alcohol and cannabis use

Highlights

- Only 30% of employees reported low levels of stress in response to six pandemic-related stressors, whereas 70% reported at least moderate levels of stress in response to one or more of these stressors.
- Several risk factors (i.e. being younger, being a woman, being a visible minority) were related to employee's responses to stressors.
- Conversely, perceived organizational support emerged as a reliable promotive factor that appears to counteract exposure to risk.
- These results can help guide work-related interventions to support employees most vulnerable to pandemic-related stressors cope with these stressors and improve their mental health.

during this time.⁴ These findings demonstrate that the pandemic is likely to have lasting effects on Canadians' mental health. As for working professionals, literature reviews of the impact of COVID-19 on employee mental health have revealed that main pandemic-related stressors include self-threat (defined as threat to one's well-being), financial insecurity, occupational insecurity, social isolation and work-life imbalance.^{1,5-8}

Risk factors: socioeconomic and sociocultural considerations

Although these findings demonstrate a clear need for organizations to support

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their employees in coping with the realities (and aftermath) of the pandemic, COVID-19 stressors may not affect all employees in the same way.^{9,10} In order for organizations to successfully support a diverse workforce, it is important to explore how these stressors relate to the sociocultural and socioeconomic (e.g. employment equity groups, age, income, job characteristics) implications of the pandemic.⁸ For example, longitudinal studies examining the mental health impact of stressors during the pandemic in a North American context showed that, relative to their older counterparts, younger adults are more likely to develop psychological distress, depressive symptoms and negative health behaviours, as well as to suffer financial impacts (perhaps in part because of their greater likelihood of working precarious jobs).^{8,11,12}

Recent studies have also found that, compared to men, women report increased family demands and work–family conflict, job loss, depression and psychological distress as a result of the pandemic.^{8,11,12} Furthermore, sharing a household with a larger number of dependents is related to poorer mental health—and this is especially true for women.¹³ Similarly, visible minorities expressed greater socioeconomic concerns relative to their White counterparts.^{11,14,15} Finally, persons living with a disability experience greater financial insecurity, loneliness, fear of contracting COVID-19 and sleep disturbances as well as decreased feelings of belonging and overall mental health than their counterparts without disabilities.^{16–18}

Resilience factor: perceived organizational support

Resilience factors can have direct positive effects on mental health, independently of the levels of exposure to risk factors such as the socioeconomic and sociocultural characteristics described above, or they can buffer the negative effects of these risk factors on mental health.¹⁹ In particular, research has shown that perceived organizational support, defined as employees' perceptions that their employer cares for their well-being and recognizes their contributions,^{20,21} is one of the most consistent resilience factors among working professionals.^{2,5,22–29} Organizations can bolster these perceptions by, for instance, providing their employees with resources to cope with work-related demands.^{25,30} Research has also demonstrated that

perceived organizational support constitutes a protective factor for burnout,^{25,31} and that it is positively associated with performance and negatively associated with absenteeism and turnover.^{20,27,32}

Research questions

The potential associations of risk and resilience factors with COVID-19-related stressors, and the relationships between these stressors and employee mental health are unclear. The situation is still evolving, and the long-term or sustained psychological effects of the current crisis remain unknown. To gain a more precise understanding of these phenomena, we first sought to identify configurations, or patterns, of responses across several COVID-related stressors through a person-centred strategy. Then, we examined the relationships between these nascent configurations of responses, the risk and resilience factors, and self-reported mental health. To our knowledge, this study is the first to apply a person-centred lens to pandemic-related stressors in general and in a work setting more specifically.

Marketing researchers often use person-centred techniques to reduce several variables to a few easily interpretable classes, or segments, of individuals.³³ Of these techniques (e.g. median split, cluster analysis), methodologists have identified latent class analysis as the most flexible and, arguably, the most psychometrically robust.³⁴ Examining the complex interplay of multiple stressors in an organization can offer a more detailed picture of the environment than that afforded by studying these dimensions in isolation.^{35,36} Not only are employee classes easy to communicate to managers, through the use of personas, for example,³⁷ but they can also guide the development of differential intervention strategies targeting specific subgroups.³⁸ In turn, matching appropriate strategies to the different employee segments or dedicating resources to the most exposed subgroups will likely yield the greatest benefit to both employees and the organization.³⁹

In summary, we posed the following research questions:

1. How many distinct configurations of pandemic-related stressors exist for employees, and what form do they take?

2. Are the aforementioned risk and resilience factors related to membership in these emergent employee classes?
3. Do the employee classes differ in their levels of self-reported mental health?

Methods

Participants

We conducted secondary analyses on data collected via a pulse survey on COVID-19 and its impacts on the work and well-being in a public service organization. This medium-to-large-size organization, with a little less than 7500 employees at the time of data collection, is in the science and professional services domain of the public service. Employees are distributed across occupational groups and levels with pay and benefit structures commensurate with the work performed in the organization, from entry level to senior executive positions, and from clerical and general administrative positions to highly specialized technical positions.

The majority of the respondents worked at the organization's headquarters in Canada's National Capital Region (71.1%; 95% confidence interval [CI]: 69.7–72.4) and the remainder were scattered across the country. The respondents engaged in research and analytical activities, clerical and administrative activities, project and program management activities, and a variety of corporate services (such as human resources and finance). Many were economics and social science professionals (42.7%; 95% CI: 41.2–44.2). Almost all were teleworking at the time of the study (93.9%; 95% CI: 93.1–94.6).

Data collection

The survey covered topics such as employee engagement, leadership, workforce, workplace, compensation and workplace well-being. Data collection took place from 10 to 28 August 2020. The data were collected anonymously, with access to the electronic survey made available to all staff via email; the response rate was approximately 57%, for a total of 4277 respondents.

In an attempt to reduce sampling bias,⁴⁰ the collected data were benchmarked to known population totals. We applied this benchmark factor to all subsequent analyses.

Measures

Pandemic-related stressors

We focussed on six pandemic-related stressors, each assessed with a single survey item beginning with the stem “Thinking of right now, to what extent do the following factors cause you stress?” These stressors were “being sick”; “financial hardships”; “lack of job security”; “impact on my workload”; “being isolated from my family and friends;” and “balancing work and personal life.” Respondents rated all items on 5-point scales from 1 (“Not at all”) to 5 (“To a very large extent”).

Risk and resilience factors

We selected the following risk factors for analysis in the present study: a younger age (we included age as a continuous variable in the multinomial logistic regression analysis; see Table 1); a larger household size (also a continuous variable and a proxy for a larger number of dependents in the household; with a median of 3, ranging from 1 to 20); self-identifying as female, a visible minority or living with a disability (all binary variables recoded as 1 [“yes”] or 0 [“no”]); and employment status (also a binary variable recoded as 1 [“contract”] or 0 [“indeterminate”]).

We included having a supervisory role (another binary variable recoded as 1 [“yes”] or 0 [“no”]) for exploratory purposes because the relationship between having a supervisory role and pandemic-related stressors was unclear.

We assessed perceived organizational support by averaging respondents’ ratings across three items: “My department or agency regularly shares accurate information with employees about COVID-19 and its impact on the organization”; “I have the materials and equipment I need to do my job;” and “My department or agency shares support services, resources, and information on mental health such as the Employee Assistance Program regularly, and encourages employees to get help if they need it” (4.31; 95% CI: 4.29–4.33; $\alpha = 0.62$). Respondents rated these items on 5-point scales from 1 (“Strongly agree”) to 5 (“Strongly disagree”; reverse coded).

Self-reported mental health

We created a self-reported mental health score by averaging respondents’ ratings across three items: “In general, how is

TABLE 1
Characteristics of survey sample^a

Characteristic	%	95% CI
Age group (years)		
≤ 24	3.14	2.66–3.71
25–29	9.52	8.65–10.45
30–34	8.64	7.80–9.55
35–39	12.95	11.94–14.03
40–44	14.88	13.80–16.02
45–49	15.33	14.23–16.50
50–54	15.46	14.35–16.64
55–59	10.49	9.56–11.50
≥ 60	9.60	8.70–10.58
Gender^b		
Female	57.73	56.19–59.25
Male	42.27	40.75–43.81
Living with a disability		
Yes	6.92	6.17–7.76
No	93.08	92.24–93.83
Visible minority		
Yes	19.34	18.15–20.58
No	80.66	79.42–81.85
Contract employee		
Yes	13.73	12.70–14.83
No	86.27	85.17–87.30
Non-supervisory role		
Yes	66.65	65.20–68.07
No	33.35	31.93–34.80

^a The collected data were benchmarked to known population totals.

^b The survey questionnaire asked for respondents’ gender, with the response options being “female” or “male.”

your mental health?”; “Compared to the pre-COVID period, how has your mental health been affected?”; and “Overall, my level of work-related stress is...” (3.02; 95% CI: 2.99–3.04; $\alpha = 0.71$). Respondents rated these items (reverse coded where necessary) on 5-point scales from 1 (e.g. “Poor”) to 5 (e.g. “Excellent”).

Analytical approach

Stressor classes

We estimated latent class solutions including one to eight classes with Mplus software version 7.4 (Muthen & Muthen, Los Angeles, CA, US) by means of its robust maximum likelihood estimator and complex survey design functionalities to account for the benchmarking factor.^{41,42}

To handle the small amount of missing data present at the item level (mean = 7.8%; range: 1.4% to 14.2%), we relied on full information maximum likelihood,⁴³ the default option with maximum likelihood estimator in Mplus.⁴¹ Each model used 10 000 sets of starting values, with the best 500 sets retained for final stage optimization.⁴⁴

We used the Bayesian information criterion (BIC),⁴⁵ the sample-size adjusted BIC⁴⁶ and the consistent Akaike information criterion (CAIC)⁴⁷ as primary indicators of model fit, with lower values signifying a better fit to the data. For completeness, we also report the Akaike information criterion (AIC),⁴⁸ the adjusted

Lo–Mendell–Rubin likelihood ratio test (aLMR)⁴⁹ and the entropy, which ranges from 0 to 1, with a higher value reflecting a greater model classification accuracy.⁵⁰ The aLMR test provides a *p* value to compare models with a model with one less class.

To aid in interpretation and establish the gains in fit for each additional class estimated, we relied on a scree plot of the BIC, adjusted BIC and CAIC values, inspecting the point at which the slope of the plot flattens (Figure 1).⁵¹ Finally, we also paid attention to the parsimony and stability (i.e. including the relative sizes of the emergent classes) of the different solutions prior to choosing a final model.^{52,53}

Risk and resilience factors and self-reported mental health

We added the risk and resilience variables and the self-reported mental health score to the final model with the automatic three-step procedure and the R3STEP and BCH commands, respectively.⁵⁴ The R3STEP command uses multinomial logistic regression to evaluate if, for example, being a woman increases the likelihood of an employee belonging to one class relative to another class, whereas the BCH command tests the estimated mean differences between the classes on the self-reported mental health score. R3STEP and BCH analyses handle missing data via listwise

deletion (*n* = 3849) and full information maximum likelihood estimation (*n* = 4262), respectively.

Results

Stressor classes

For the BIC, the five-class solution exhibited the best fit compared to all other solutions, with the BIC reaching its lowest value at five classes (Table 2 and Figure 1). The adjusted BIC and CAIC, on the other end, attained their lowest value at seven and four classes, respectively. Because the four-class solution was associated with both the lowest CAIC value and the first non-significant aLMR test, and because the relative sizes of the emergent classes were all greater than 8%, we used it as the basis for further modelling.⁵³

Configurations of pandemic-related stressors and their forms

Employees in the “adapting” class, with a prevalence of 30%, had very low probabilities of choosing “to a large extent” or “to a very large extent” when evaluating the extent to which the pandemic-related stressors caused them stress (Table 3). In contrast, employees in the smallest class (“stressed,” making up 14% of the sample) had consistently moderate probabilities of endorsing “to a large extent” or “to

a very large extent” in reaction to the stressors.

The most frequent class of employees (“conflicted,” 35%) showed very low probabilities of selecting “to a large extent” or “to a very large extent” in response to self-threat, financial and job insecurity and workload, but a higher probability of these responses in reaction to work–life imbalance (with social isolation a close second). The third-largest class (“insecure”; 21%) had fairly low probabilities of choosing “to a large extent” or “to a very large extent” in response to five of the stressors, but a higher probability of selecting these options in reaction to job insecurity (with self-threat as a close second).

Risk and resilience factors

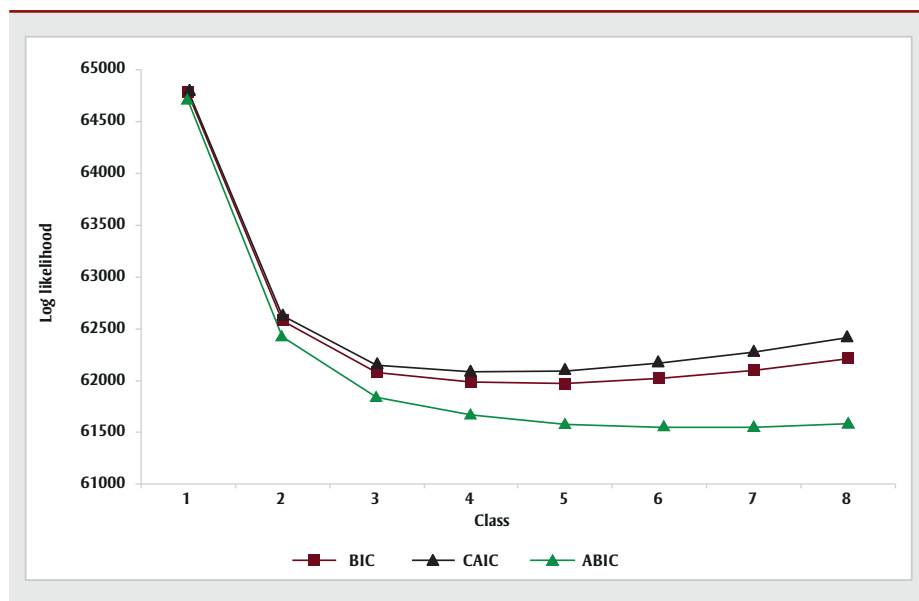
A logical target for workplace interventions would be to transition those employees who are most vulnerable to pandemic-related stressors (“stressed”) into the most favourable configuration of these stressors. To aid in interpretation, we used the adapting class as the referent (Table 4). In terms of the resilience factor specifically, lower perceived organizational support was related to belonging in the conflicted, insecure or stressed class relative to the adapting class (Table 4).

In terms of risk factors, women and supervisors were more likely to belong to the conflicted class than the adapting class, whereas the opposite was true for contract employees. Age was negatively associated with membership in the conflicted class compared to the adapting class.

Visible minorities, persons living with a disability and contract employees had a higher likelihood of belonging to the insecure class than the adapting class, whereas the opposite was true for supervisors. Age was positively associated with membership in the insecure class versus the adapting class.

Women, visible minorities, persons living with a disability and contract employees were more likely to belong to the stressed class than the adapting class. Age was negatively associated with belonging in the stressed class relative to the adapting class, whereas the opposite was true for household size.

FIGURE 1
Scree plot of the fit indices of the latent class analyses^a



Abbreviations: ABIC, adjusted BIC; BIC, Bayesian information criterion; CAIC, consistent Akaike information criterion.

^a The collected data were benchmarked to known population totals; after deleting cases with missing data on all variables, unweighted *n* = 4262.

TABLE 2
Latent class enumeration fit indicators^a

Number of classes	LL	FP	AIC	BIC	Adjusted BIC	CAIC	aLMR	Entropy
1	-32 290.139	24	64 628.279	64 780.858	64 704.596	64 804.858	–	–
2	-31 085.250	49	62 268.500	62 580.017	62 424.315	62 629.017	< 0.001	0.622
3	-30 728.692	74	61 605.384	62 075.839	61 840.697	62 149.839	< 0.001	0.636
4	-30 579.668	99	61 357.336	61 986.728	61 672.147	62 085.728	0.558	0.609
5	-30 467.652	124	61 183.303	61 971.632	61 577.612	62 095.632	0.591	0.604
6	-30 388.191	149	61 074.383	62 021.650	61 548.189	62 170.650	0.703	0.617
7	-30 323.355	174	60 994.711	62 100.915	61 548.015	62 274.915	0.764	0.637
8	-30 275.892	199	60 949.783	62 214.925	61 582.585	62 413.925	0.784	0.651

Abbreviations: AIC, Akaike information criterion; aLMR, adjusted Lo–Mendell–Rubin likelihood ratio test; BIC, Bayesian information criterion; CAIC, consistent Akaike information criterion; FP, free parameters; LL, log likelihood.

^a The collected data were benchmarked to known population totals; after deleting cases with missing data on all variables, unweighted n = 4262.

TABLE 3
Pandemic-related stressors and item-response probabilities^a

Latent class indicator	Item-response probability				
	Not at all	To a small extent	To a moderate extent	To a large extent	To a very large extent
Adapting class (30%)					
Self-threat	.845	.094	.037	.014	.010
Financial insecurity	.843	.111	.028	.015	.002
Job insecurity	.750	.146	.069	.013	.022
Workload	.814	.129	.042	.013	.003
Social isolation	.521	.325	.123	.031	.000
Work–life imbalance	.468	.277	.155	.058	.041
Conflicted class (35%)					
Self-threat	.489	.275	.138	.062	.036
Financial insecurity	.685	.240	.064	.011	.000
Job insecurity	.638	.280	.074	.008	.000
Workload	.434	.341	.169	.042	.013
Social isolation	.052	.369	.371	.133	.075
Work–life imbalance	.090	.325	.322	.169	.094
Insecure class (21%)					
Self-threat	.224	.354	.218	.145	.058
Financial insecurity	.117	.462	.296	.090	.035
Job insecurity	.000	.411	.318	.157	.114
Workload	.146	.445	.324	.079	.005
Social isolation	.110	.405	.322	.117	.046
Work–life imbalance	.095	.366	.384	.141	.014
Stressed class (14%)					
Self-threat	.373	.149	.136	.109	.233
Financial insecurity	.219	.208	.180	.142	.251
Job insecurity	.200	.151	.143	.136	.371
Workload	.193	.117	.221	.179	.289
Social isolation	.179	.151	.177	.231	.263
Work–life imbalance	.098	.089	.164	.191	.458

^a The collected data were benchmarked to known population totals; after deleting cases with missing data on all variables, unweighted n = 4262.

TABLE 4
Three-step results for risk and resilience covariates^{a,b}

Factor	Adapting vs. conflicted			Adapting vs. insecure			Adapting vs. stressed			Conflicted vs. insecure			Conflicted vs. stressed			Insecure vs. stressed		
	Coef.	SE	OR	Coef.	SE	OR	Coef.	SE	OR	Coef.	SE	OR	Coef.	SE	OR	Coef.	SE	OR
Age	-0.185***	0.037	0.831	0.060*	0.030	1.062	-0.146***	0.037	0.864	0.245***	0.037	1.278	0.039	0.036	1.040	-0.207***	0.038	0.813
Female gender ^c	0.305*	0.144	1.357	0.232	0.137	1.261	0.452*	0.174	1.571	-0.073	0.162	0.930	0.147	0.170	1.158	0.220	0.191	1.246
Living with a disability	0.651	0.339	1.917	0.723*	0.303	2.061	1.589***	0.318	4.899	0.072	0.321	1.075	0.939**	0.277	2.557	0.866**	0.303	2.377
Visible minority	-0.060	0.184	0.942	0.677***	0.158	1.968	0.585**	0.197	1.795	0.737***	0.201	2.090	0.645**	0.211	1.906	-0.092	0.211	0.912
No. of people in the household	-0.067	0.054	0.935	0.008	0.052	1.008	0.167**	0.063	1.182	0.075	0.060	1.078	0.234***	0.061	1.264	0.159*	0.068	1.172
Contract employee	-1.698***	0.368	0.183	0.712***	0.160	2.038	0.567*	0.227	1.763	2.410***	0.353	11.134	2.265***	0.363	9.631	-0.145	0.228	0.865
Non-supervisory role	-0.747***	0.152	0.474	0.880***	0.195	2.411	0.174	0.202	1.190	1.627***	0.220	5.089	0.921***	0.191	2.512	-0.706**	0.260	0.494
POS	-1.317***	0.198	0.268	-1.440***	0.172	0.237	-2.237***	0.200	0.107	-0.123	0.122	0.884	-0.921***	0.116	0.398	-0.797***	0.125	0.451

Abbreviations: Coef., coefficient; OR, odds ratio; POS, perceived organizational support; SE, standard error (of the coefficient).

^a The collected data were benchmarked to known population totals; after listwise deletion, unweighted n = 3848.

^b Coefficient (coef.) is the estimate from the R3STEP multinomial logistic regression analysis, which uses listwise deletion. The coefficient and OR reflect the effects of the covariates on the likelihood of membership into the second listed profile relative to the first listed profile.

^c The survey questionnaire asked for respondents' gender, with the response options being "female" or "male."

* p < 0.05.

** p < 0.01.

*** p < 0.001.

Self-reported mental health

Employees self-reported the most positive mental health when they belonged to the adapting class (mean [SE] = 3.734 [0.028]), followed by the conflicted (3.034 [0.035]), insecure (2.712 [0.028]) and stressed (2.197 [0.049]) classes (all at $p < 0.05$, based on a modified Bonferroni adjustment).

Discussion

The results of the present study shed light on the ways COVID-19-related stressors combine, particularly in a work setting. We identified four classes of employees from a medium-to-large public service organization, each with a distinct configuration of stressors. Adapting employees conveyed low probability of response to the six studied stressors, whereas stressed employees reported consistently high levels of stress in reaction to these stressors. Reinforcing the notion that the adapting class was the most resilient, employees in this class reported the most positive mental health of all employees. Two additional classes—the conflicted and insecure classes—highlighted the fact that one or two stressor(s) (i.e. work-family imbalance and job insecurity, respectively) can be a driving force(s) in the current COVID-19 crisis situation. Thus, the present study illustrates the advantages of taking a person-centred approach to exploring patterns of stressors in this context rather than looking at these stressors in isolation.

Perceived organizational support emerged as a reliable promotive factor for being in the adapting class compared to each of the other classes. Although we recognize that testing for the presence of buffering effects would be a valuable next step in future studies, at the very least this finding provides preliminary support for a compensatory model, that is, a process in which perceived organizational support appears to counteract exposure to risk.⁵⁵ This result also aligns with research findings on the direct effects of social support on post-disaster psychological distress.⁵⁶

The first class comparison identified being younger, a woman, a supervisor and a permanent employee as risk factors for membership in the conflicted class versus the adapting class. That supervisors were more likely to belong to the conflicted class than the adapting class is not surprising in light of the evidence linking job authority to work-related pressures and

strains in the work–family interface.⁵⁷ Future research could further explore these links.

The second comparison distinguished being a visible minority, living with a disability and being a contract employee as risk factors for membership in the insecure class compared to the adapting class, substantiating topical research recognizing these characteristics as risk factors for adverse pandemic-related outcomes.^{11,14–18} Being older and occupying a non-supervisory role also emerged as risk factors when comparing these groupings of employees, factors future research could delve into. For example, older employees may be rethinking their retirement as a result of the current COVID-19 crisis situation.⁵⁸

Last, being younger, a woman or a visible minority, living with a disability, having precarious employment and living in larger households all emerged as risk factors when comparing the stressed to the adapting employees. These results align with recent work identifying these socioeconomic and sociocultural characteristics as risk factors for detrimental outcomes during the ongoing COVID-19 pandemic.^{8,11–18}

Limitations and future directions

A drawback of the present study is that the findings rely exclusively on self-reported data and a cross-sectional design. This kind of study design makes it impossible to reach clear conclusions regarding the probable causal links between the risk and resilience factors, class membership and self-reported mental health. Future research would benefit from examining the directionality of these relationships through a longitudinal design. Furthermore, because consistency is an important criterion in evaluating the validity of classes emerging from person-centred research, future work should demonstrate that our nascent class structure remains consistent across samples drawn from the same population of employees.^{38,59} In addition, because our findings resulted from crowd-sourced data, they do not generalize to the entire population of employees. Nonetheless, given the large number of respondents, they should offer valuable insights on the employees' attitudes and perceptions.

Another limitation of the present study lies in its limited investigation of the notion of work-related social support.

Sources of support can include an employee's organization, but it can also comprise their supervisor or co-workers.⁶⁰ Research has identified different types of support (i.e. emotional, instrumental, appraisal and informational),⁶¹ a dimension we were unable to explore in this study because the survey items pertaining to perceived organizational support only reflected instrumental and informational forms of support. Future research could investigate whether certain types of organizational support are most beneficial in lessening specific kinds of stressors among employees. For instance, Cutrona and Russell⁶² identified emotional support as one of the best predictors of positive outcomes in the context of uncontrollable events.

Future work could also give meaningful consideration to supervisor mental health, an area of inquiry that remains largely unexplored.⁶³ Supervisors are not impervious to mental health problems,⁶⁴ and there are several reasons (e.g. cognitive complexity, responsibility, social isolation and loneliness) why high-quality leadership might come at a high cost.⁶³ Future research could explore how supervisors experience stressors such as work–life imbalance in order to inform workplace interventions tailored to their specific needs.

Practical implications

Organizational policies and interventions are often based on the average-population approach.⁶⁵ However, identifying the stressors specific to distinct segments of employees can greatly help in designing and implementing effective workplace interventions for employees most vulnerable to these stressors. The present study shows that a one-size-fits-all approach cannot accurately cater to gender differences, sociocultural practices, employment status and cultural backgrounds, among others. Adopting a person-centered lens is essential in order to effectively support diverse groups of employees through the use of targeted and adapted information, engagement efforts and interventions.

Our findings suggest that all employees would probably benefit from increased provision of instrumental and informational organizational support during the COVID-19 pandemic crisis, irrespective of their configurations of pandemic-related stressors. However, offering the type(s) of

organizational support that best address specific employees' challenges would likely be most effective. Such an undertaking would also go a long way in showing employees that their organization values their unique circumstances. For instance, employees who are particularly concerned about work–life imbalance might best profit from the implementation of adaptive organizational practices such as flexible work-hours, telework and paid pandemic leave.⁶⁶ In contrast, such practices might not be as helpful to precarious workers who might best benefit from transparent communication about personnel decisions pertinent to their job security.⁶⁶

Conclusion

The COVID-19 pandemic has bolstered, and at times created, important risk factors for the mental health of working professionals. By applying a person-centred approach to inquiry and data analysis, the present study gives credence to the notion that employees experience pandemic-related stressors in unique ways. By identifying classes or segments of employees with distinct configurations of stressors, as well as differential risk factors and levels of self-reported mental health, the present study makes novel and important contributions to the organizational health literature. Furthermore, it also offers a starting point for informing work-related interventions with the goal of helping vulnerable employees effectively cope with these stressors.

Conflicts of interest

The authors declare that there are no known conflicts of interest.

Authors' contributions and statement

ARB conceived this work, conducted the analyses and drafted the methods and results sections as well as parts of the introduction and discussion.

EMBH supported ARB in conceptualizing this project and drafting the manuscript, including parts of the introduction and discussion.

ML provided ideas and thoughts for discussion and revised the manuscript for important intellectual content.

All authors read and approved the final manuscript.

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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

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.

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,

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.

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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 later⁶). 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.

The content and views expressed in this article are those of the authors and do not necessarily reflect those of the Government of Canada.

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Corrigendum

Vaping-associated lung illness (VALI) in Canada: a descriptive analysis of VALI cases reported from September 2019 to December 2020

This corrigendum is being published to correct a calculation error on pages 37 and 41 of the following article:

Baker MM, Procter TD, Belzak L, Ogunnaike-Cooke S. Vaping-associated lung illness (VALI) in Canada: a descriptive analysis of VALI cases reported from September 2019 to December 2020. *Health Promot Chronic Dis Prev Can.* 2022;42(1):37-44. doi: [10.24095/hpcdp.42.1.06](https://doi.org/10.24095/hpcdp.42.1.06).

1. p. 37 (*Abstract, Results*)

Before correction

VALI cases were reported at a lower prevalence (0.9 per million) than EVALI (8.5 per million).

After correction

VALI cases were reported at a lower prevalence (0.63 per million) than EVALI (8.5 per million).

2. p. 41 (*Discussion*)

Before correction

From September 2019 to December 2020, 20 VALI cases were reported in Canada, representing a prevalence of 0.9 cases per 1 million population.*

After correction

From September 2019 to December 2020, 20 VALI cases were reported in Canada, representing a prevalence of 0.63 cases per 1 million population.*

3. p. 41 (*Footnote*)

Before correction

* Population estimates were calculated based on Statistics Canada Table 17-10-0009-01, Population estimates, quarterly (2020 Q1). Prevalence is presented per population per year.

After correction

* Population estimates were calculated using the date of symptom onset to establish the date range and 15+ years as the age range, to best describe the population at risk. Source: Statistics Canada Table 17-10-0009-01 (formerly CANSIM 051-0005). Release date: 2022-03-17. The prevalence is presented per population per year (May 2019–April 2020 (inclusive)).

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Mirza AI, Zhu F, **Knox N**, [...] **Bonner C**, **Van Domselaar G**, [...] **Graham M**, et al. The metabolic potential of the paediatric-onset multiple sclerosis gut microbiome. *Mult Scler Relat Disord*. 2022;63:103829. <https://doi.org/10.1016/j.msard.2022.103829>

Paul LA, Li Y, Leece P, Gomes T, [...] **Murray R**, et al. Identifying the changing age distribution of opioid-related mortality with high-frequency data. *PLoS ONE*. 2022;17(4):e0265509. <https://doi.org/10.1371/journal.pone.0265509>

Rohden F, Nelson CJ, Yost CK, **Anderson C**, et al. Proceedings of the Dual Use Research of Concern Panel Discussion: challenges and perspectives. *Can J Microbiol*. 2022;68(5):377-82. <https://doi.org/10.1139/cjm-2021-0343>

Rollo S, **Roberts KC**, **Bang F**, et al. Sociodemographic factors associated with meeting the Canadian 24-Hour Movement Guidelines among adults: findings from the Canadian Health Measures Survey. *J Phys Act Health*. 2022;19(3):194-202. <https://doi.org/10.1123/jpah.2021-0542>

Way KL, Birnie D, Blanchard C, [...] **Prince SA**, et al. The physical activity levels and sitting time of adults living with atrial fibrillation: the CHAMPLAIN-AF study. *CJC Open*. 2022;4(5):449-65. <https://doi.org/10.1016/j.cjco.2022.01.004>

Zhao J, **Smith T**, **Lavigne M**, Aenishaenslin C, Cox R, **Fazil A**, [...] **Hermant B**. A rapid literature review of multi-criteria decision support methods in the context of One Health for all-hazards threat prioritization. *Front Public Health*. 2022;10:861594. <https://doi.org/10.3389/fpubh.2022.861594>

