Original quantitative research

Private screen access in early adolescence predicts subsequent academic and social impairment at the end of high school for boys and girls

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This article has been peer reviewed.

Abstract

Introduction: Youth media guidelines in Canada and the United States recommend that bedrooms should remain screen-free zones. This study aims to verify whether bedroom screens at age 12 years prospectively predict academic and social impairment by age 17 years.

Methods: Participants were from the Quebec Longitudinal Study of Child Development birth cohort (661 girls and 686 boys). Linear regression analyses estimated associations between having a bedroom screen (television or computer) at age 12 years and self-reported overall grades, dropout risk, prosocial behaviour and likelihood of having experienced a dating relationship in the past 12 months at age 17 years, while adjusting for potential individual and family confounding factors.

Results: For both girls and boys, bedroom screens at age 12 years predicted lower overall grades ($B = -2.41$, $p \leq 0.001$ for boys; -1.61, $p \leq 0.05$ for girls), higher dropout risk ($B = 0.16$, $p \leq 0.001$ for boys; 0.17, $p \leq 0.001$ for girls) and lower likelihood of having experienced a dating relationship ($B = -0.13$, $p \leq 0.001$ for boys; -0.18, $p \leq 0.001$ for girls) at age 17. Bedroom screens also predicted lower levels of prosocial behaviour ($B = -0.52$, $p \leq 0.001$) at age 17 years for boys.

Conclusion: The bedroom as an early adolescent screen-based zone does not predict long-term positive health and well-being. Pediatric recommendations to parents and youth should be more resolute about bedrooms being screen-free zones and about unlimited access in private exposures in childhood.

Keywords: bedroom screens, private access, adolescent health, adolescent development, academic adjustment, social adjustment

Highlights

- Previous research has shown, and child and adolescent media guidelines recommend, that screens should be kept out of private zones. Early childhood bedroom screen exposure is associated with developmental and health risks, including slower language acquisition, lower sociability and emotional distress in later childhood.

- Using a prospective-longitudinal birth cohort of 661 girls and 686 boys born at a time when screen exposure was less complex, we found that having a bedroom television or computer in early adolescence predicted academic and social risks in later adolescence, likely from overexposure in terms of time and content.

Introduction

School-aged youth screen exposure has increased in recent years.[1] Technology is rapidly evolving, and with the burgeoning emergence of portable devices, the times and spaces in which youth can use screen media are multiplying. Most children and teens now spend more than twice the time recommended for daily exposure to leisure screen media.[2] Guidelines have been established by the American Academy of Pediatrics (AAP) and Canadian Pediatric Society (CPS). These commonly recommend no exposure prior to age 2 years, less than one hour before age 5 years and less than two hours for school-aged youth.[3,4] From middle school onward, the time spent on screens creates a time debt for other enriching developmental activities that shape human capital prospects for social and occupational functioning.[5]

AAP and CPS media-use guidelines also advise parents and youth to designate media-free zones at home.[3,4] Screen placement in a private space such as the bedroom creates solitary and unsupervised accessibility.[6] With private access, children are more likely to socialize in person less and to study less.[7]

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Previous studies have established associations between childhood bedroom screen access and increased overall screen time.[1,7,8] In fact, private screen access is associated with greater time spent in one's bedroom, and thus more isolation and greater screen use.[9] Recent studies and literature reviews of both cross-sectional and longitudinal studies of children and adolescents of varying ages highlight links between different types of screen exposure, lower levels of prosocial behaviour and less optimal academic performance.[10-12] Compared with those having no screens at all, children and adolescents who have a television, computer or video game system in their bedroom are at higher risk of adiposity and inadequate sleep.[6,13,14] However, not much is known about the link between bedroom media in adolescence and social and academic functioning.

Both the time spent viewing screens and the content viewed may have an impact on children's development and later lives. According to the time displacement hypothesis, time spent on screens represents time not invested in other, more enriching activities, such as in-person socializing and doing homework.[7,15,16] The content hypothesis states that exposure to violent and inappropriate content, which may increase with private screen access, impairs the development of prosocial behaviour.[7] The ability to empathize is a crucial socio-emotional skill that promotes creation of positive social ties.[17] Engaging in a dating relationship also represents an important developmental task of adolescence.[18] Finally, graduating from high school represents an important milestone as well, and thus represents a pillar for later social and economic success.[18-20]

Some of the existing literature on screen exposure and youth development contains some methodological challenges that weaken interpretations.[21] First, the risks associated with private screen access in early adolescence have scarcely been examined, and its relationship with social and academic functioning in later adolescence remains unclear. Private access emerges as a measure that potentially provides more information about the nature of content and experiences of teenagers with screens, in comparison to self-reported screen time measures, which are susceptible to methodological challenges.[21]

Second, many studies have been plagued by omitted variable bias. Given their limited control over pre-existing and potentially concurrent factors, cross-sectional designs, representing the majority of studies on risks associated with adolescent screen media exposure, fail to properly isolate the distinct contributions of screen exposure and private access.[21,22] Therefore, a study using a prospective-longitudinal design on bedroom screen access in early adolescence that would consider competing explanations for associations promises better confound control than cross-sectional designs.[21-22]

Third, because girls and boys uniquely experience risk and protective factors due to distinct biological and contextual influences, sex-stratified analysis represents a more revealing approach in comparison to controlling for sex. It allows us to highlight later gender-based differences in academic and social adjustment in relation to earlier private access experience, and can stimulate our understanding of the dynamics of such differences.[23]

Using data from the Quebec Longitudinal Study of Child Development (QLSCD; described later) birth cohort, we examined the association between bedroom screen access in later childhood and academic and social adjustment in the high school senior year. More specifically, we aimed to examine whether having a bedroom television or computer at age 12 years predicts subsequent self-reported academic and social adjustment by age 17 years. We controlled for pre-existing individual and family characteristics that could confound these prospective associations, especially overall screen media use at age 12. Boys and girls were treated separately in our analyses. We expected that having a screen-free bedroom would subsequently predict indicators of academic and social flourishment.

Methods

Participants

The QLSCD* is coordinated by the Institut de la statistique du Québec, and originates from a randomly selected, stratified sample of 2817 infants born between 1997 and 1998 in Quebec, Canada. The main objective of the QLSCD was to provide data on typical development in children.

Children were selected using the province's birth register. Of the original selection, 697 children were deemed ineligible for one of the following reasons: being a twin; having First Nations status; being untraceable at the time, mostly due to incorrect contact details; refusing to participate. The baseline sample, representing 75 % of the eligible target population, comprised 2120 infants followed up annually from age 5 months throughout childhood. Of these, 39 % were firstborn children.

For each follow-up, informed consent was obtained from parents, teachers and children when applicable. Participants were included in this study if they had completed child reports on having a bedroom television and computer in the 2010 survey, when they were aged 12 years (n = 1347 out of 2120). Predictor variable data were collected for 661 girls and 686 boys, thus creating our subsample for analysis. Outcome variables, based on quality and availability, were measured at age 17 years.

Measures

Predictor variable: early adolescence bedroom television and/or computer (age 12 years)

Participants were asked, in two distinct questions, if they had (1) a television and (2) a computer in their bedroom. Exploratory analysis revealed similar effects of both variables on psychosocial outcomes. Therefore, we combined answers to both questions to create a variable for which 0 = no to both questions (54.2 valid %), and 1 = yes to having a television and/or a computer in the bedroom (45.8 valid %).

Outcomes variables: academic achievement and positive relations indicators (age 17 years)
Overall grades
In the spring of the school year, participants were asked their overall average in all school subjects. This was a discrete variable, for which participant answers ranged from 0 to 100.

Dropout risk
We used a variable based on the typology of dropout risk as described by Fitzpatrick et al.,[19] comprising seven items; a higher

score corresponds to a higher risk of dropping out. Items assessed school delay, performance and engagement: (1) During this school year, what is your average mark in English Language?; (2) During this school year, what is your average mark in mathematics?; (3) Have you ever repeated an entire school year?; (4) Do you like school?; (5) In terms of your school marks, how would you rate yourself compared with other students of your age at your school?; (6) How important is it for you to get good marks?; and (7) Based on your own wishes, how far do you plan to go in school?

The original variable also includes a specific category for youth who did not attend school in the past school year (based on the age of the youth in the cohort, they could not be more advanced than the fifth and final year of high school in Quebec). We created from this variable one with 3 categories: 0 = below median; 1 = above median; 2 = actual dropout (did not attend school that year).

Prosocial behaviour

Results of the following seven items were summed: (1) When someone got hurt, I didn't hesitate to help them; (2) When someone made a mistake, I felt sorry for them; (3) When I witnessed an argument, I tried to stop it; (4) When someone spilled or broke something, I offered to help clean it up; (5) I helped people around me when they were having difficulty; (6) I readily shared my belongings with others; (7) I was kind to younger children. Each item explored the tendency to kindness, empathy, sharing and caring. Sums were then recoded to show a score from 0 to 10. Higher scores meant more reported prosocial behaviour.

Recent dating relationship

For this variable, we used answers to only one question; participants self-reported whether they had had at least one boyfriend or girlfriend in the past 12 months (0 = yes; 1 = no).

Childhood individual and family control variables (ages 5 months to 12 years, risk category = 1, no risk = 0)

"Individual characteristics" included temperament problems, early neurocognitive skills and self-reported screen time.

Temperament problems were assessed at age 1.5 years, reported by parents answering six questions regarding difficult and unpredictable temperament: (1) How easy or difficult is it for you to calm or appease [first name] when he/she is upset?; (2) On average, how many times per day does [first name] become restless and irritable, whether for a short or a long time?; (3) In general, to what extent does he/she cry or fidget?; (4) How easily is he/she upset?; (5) How changeable is [first name]'s mood?; (6) Please rate the general degree of difficulty that [first name] may present for the average parent. These six items were summed (above median = 1).

Early neurocognitive skills were evaluated at age 2 years, using an imitation sorting task that assesses attention and working memory, and is predictive of later academic achievement (below median = 1).[19]

Self-reported screen time was assessed at age 12 years, using weekly hours of television, internet, computer and video game exposure (above median = 1).

"Family background characteristics" included six measures. Maternal education was assessed when the child was aged 5 months (high school diploma or less = 1). Self-reported maternal depressive symptoms were assessed at age 5 months and scored on an abridged version of the Center for Epidemiologic Studies Depression Scale (13 items; above median = 1).[24] Parental antisocial behaviour during adolescence and adulthood was assessed at age 5 months using a composite score from mother and father responses to the National Institute of Mental Health Diagnostic Interview Schedule (higher scores correspond to more parental antisocial behaviour and correlate with social and occupational impairment; above median = 1). Parent-reported family dysfunction was assessed at age 1.5 years, using nine items from the McMaster Family Assessment Device (lower scores reveal that a family is functional; above median = 1).[25] Family configuration was assessed at age 2 years (nuclear = 0, non-nuclear = 1). Finally, family income was also assessed at age 2 years using Statistics Canada's low-income cut-off of that year (0 = not low income, 1 = low income).

Data analysis

In this study, we examined long-term prospective linear associations using ordinary least squares multiple regression in SPSS Statistics, version 26 (IBM Corp., Armonk, NY, US), stratified by sex. Indicators of academic achievement and positive relations at age 17 years were regressed on having a bedroom television and/or computer at age 12 years. To reduce the possibility of omitted variable bias and competing explanations, we controlled for pre-existing and concurrent child and family characteristics that could influence the predictor or outcome variables. As with any longitudinal study, incomplete data required an attrition analysis to compare the participants with varying incomplete data on control variables to participants with complete data on control variables from our sample.

With SPSS, using a stochastic algorithm, incomplete observations were imputed based on available complete data on control and outcome variables, generating multiple imputed datasets that are copies of the original complete data. The algorithm generates slightly different values for each imputed measure across the multiple datasets. The additional variance caused by differences in imputed values between the various copies reflects the uncertainty of the imputation and is added as a correction to the imputation. Our analyses were conducted with five imputed datasets, as is generally recommended.[26]

Results

Table 1 provides descriptive statistics for the predictor and all outcomes and control variables. Almost half of boys and girls, at age 12, had a television or a computer in their bedroom, or both. Thirty-nine percent of boys and 43.7% of girls were born to mothers with a high school diploma or less education. More than one-fifth of the sample (21.1% for boys and 22.8% for girls) lived in a non-nuclear family by age 2, and, at the same age, more than 15% (16.3% of boys and 19.8% of girls) were from low-income families.

As for the outcome variables, all measured at age 17, the average grades were in the upper seventies for both boys (78.73%) and girls (77.36%). Fewer boys (38.5% above median and 8.5% actual dropouts) than girls (42.8% above median and 9.2% actual dropouts) were in the risk categories for the dropout variable. Average scores for prosocial behaviour were lower for boys (6.99) than for girls (7.07), and more boys (76.1%) than girls (69.7%) declared they had not been in any dating relationship in the past 12 months.

TABLE 1
Descriptive statistics for predictor, outcomes and control variables

	Boys			Girls		
	M (SD)	Categorical variables (%)	Range	M (SD)	Categorical variables (%)	Range
Predictor (age 12)						
Bedroom screens						
1 = yes	—	45.3	—	—	46.3	—
Outcomes (age 17)						
Overall grades	78.73 (6.78)	—	50–96	77.36 (7.65)	—	45–100
Dropout risk						
0 = below the median	—	53.1	—	—	48.0	—
1 = above the median	—	38.5	—	—	42.8	—
2 = actual dropout	—	8.5	—	—	9.2	—
Prosocial behaviour	6.99 (1.92)	—	0–10	7.07 (1.92)	—	0–10
Recent dating relationship						
1 = no	—	76.1	—	—	69.7	—
Control variables						
Temperament problems (age 1.5 y)						
1 = above the median	—	51.5	—	—	48.9	—
Early neurocognitive skills (age 2 y)						
1 = below the median	—	40.2	—	—	42.7	—
Screen time (age 12 y)						
1 = above the median	—	45.3	—	—	51.0	—
Maternal education (5 mo)						
1 = high school diploma or less	—	39.8	—	—	43.7	—
Maternal depressive symptoms (5 mo)						
1 = above the median	—	42.1	—	—	47.2	—
Parents' antisocial history (5 mo)						
1 = above the median	—	47.4	—	—	47.8	—
Family dysfunction (age 1.5 y)						
1 = above the median	—	56.1	—	—	59.3	—
Family configuration (age 2 y)						
1 = non-nuclear	—	21.1	—	—	22.8	—
Family income (age 2 y)						
1 = low	—	16.3	—	—	19.8	—

Abbreviations: M, mean; mo, months; SD, standard deviation; y, years.

Notes: Analyses corrected for attrition bias. Data were compiled from the final master file of the Quebec Longitudinal Study of Child Development (1998–2015), © Gouvernement du Québec, Institut de la statistique du Québec.

Table 2 documents the relationship between the pre-existing controls and having a bedroom television and/or computer at age 12 years. For boys, only maternal education when the child was aged 5 months ($B = 0.15$, $p \leq 0.001$) predicted a higher probability of having a screen in the bedroom at age 12 years. For girls, higher levels of temperament problems at age 1.5 years ($B = 0.08$, $p \leq 0.05$) predicted a higher probability of having a bedroom screen at age 12 years. Also, having a mother who did not have more than a high school diploma when the child was aged 5 months ($B = 0.16$, $p \leq 0.001$) and who showed higher levels of depressive symptoms ($B = 0.10$, $p \leq 0.01$) predicted a higher probability of having a television and/or computer in the bedroom at age 12 years. Non-nuclear family configuration ($B = 0.11$, $p \leq 0.05$) also predicted a higher probability of having a bedroom screen at age 12 years for girls.

Table 3 reports the relationship between having a bedroom screen in late childhood and subsequent academic and social indicators at the end of adolescence. For boys, having a bedroom television and/or computer at age 12 years predicted lower average grades ($B = -2.41$, $p \leq 0.001$), higher dropout risks ($B = 0.16$, $p \leq 0.001$), lower levels of prosocial behaviour ($B = -0.52$, $p \leq 0.001$) and lower chances of declaring having been in a dating relationship in the past 12 months ($B = -0.13$, $p \leq 0.001$) at age 17 years. For girls, it predicted lower average grades ($B = -1.61$, $p \leq 0.05$), higher dropout risks ($B = 0.17$, $p \leq 0.001$)

TABLE 2
Unstandardized regression coefficients (with standard errors) reflecting the adjusted relationship between baseline child and family characteristics between ages 5 months and 2 years and having a bedroom television and/or computer at age 12

	Bedroom screens (at age 12 years)	
	Boys (SE)	Girls (SE)
Temperament problems (age 1.5 y)	0.01 (0.04)	0.08 (0.04)*
Early neurocognitive skills (age 2 y)	0.04 (0.04)	0.003 (0.04)
Maternal education (5 mo)	0.15 (0.04)***	0.16 (0.04)***
Maternal depressive symptoms (5 mo)	0.03 (0.04)	0.10 (0.04)**
Parents' antisocial behaviour (5 mo)	0.003 (0.04)	0.002 (0.04)
Family dysfunction (age 1.5 y)	0.02 (0.04)	−0.01 (0.04)
Family configuration (age 2 y)	0.01 (0.05)	0.11 (0.05)*
Family income (age 2 y)	0.10 (0.06)	0.09 (0.05)
Adjusted R^2	0.03***	0.07***

Abbreviations: mo, months; SE, standard error; y, years.

Notes: Analyses corrected for attrition bias. Data were compiled from the final master file of the Québec Longitudinal Study of Child Development (1998-2015), © Gouvernement du Québec, Institut de la statistique du Québec.

*$p \leq 0.05$

**$p \leq 0.01$

***$p \leq 0.001$

and lower chances of declaring having been in a dating relationship in the past 12 months ($B = -0.18$, $p \leq 0.001$) at age 17 years.

Discussion

In the past decade, portable devices have invaded homes, making screen media more available than ever. In this context, pediatric societies have stated that there should be screen-free zones in homes, especially in bedrooms.[2,3] In our sample, almost half of boys and girls had a television or computer in their bedroom when they were aged 12 years, in 2009/10. This was prospectively associated with academic and social impairment five years later. Our study suggests that private access to screens in childhood forecasts lower human and social capital by the end of adolescence. This can have notable risks associated with access and control over health and wealth in later adulthood.[20,27]

More specifically, by age 17 years and compared with adolescents without bedroom screens at age 12 years, private access predicted decreases in self-reported overall grades, increases in dropout risk and lower likelihood of having dating experiences in the past 12 months. We also observed decreases in propensity toward kindness, empathy, sharing and caring behaviours among boys with bedroom screens. Considering that these findings were adjusted for potential individual and family confounders, the effect sizes can be considered clinically important. In fact, the relationships observed between bedroom screens and outcomes, five years later, mattered as much or more than those with our control variables, including maternal education, a well-known early-life factor for social trajectories across childhood and adolescence.[27,28] Such differences in experiences could point toward short- and long-term differences in psychosocial adjustment and well-being.[29]

Engaging in a dating relationship represents a typical developmental milestone of adolescence, which forecasts the ability to build intimate and serious relationships later in life.[30,31] Adolescence is also a sensitive period for the development of prosocial skills, which contribute to overall psychological stability. Our findings on the risks associated with bedroom screens on levels of prosocial behaviour for boys are therefore compelling. This association could forecast relationships of lesser quality and lower wages in later adulthood for boys with private screen access.[11] For girls, compared with their same-sex counterparts without bedroom screens at age 12 years, we found no relationship between bedroom screen access and kindness, empathy, sharing and caring characteristics. This may be due to neurobiological modelling factors, or to societal expectations for raising daughters, who tend therefore to be more focussed on empathy and caregiving.[32,33]

Our findings suggest bedroom screen access in childhood poses risks later on for important developmental milestones at a time when school readiness prior to postsecondary school transition is a concern. Unfettered and unsupervised access to screens may create a time debt for academic responsibilities and nonvirtual social interactions at a time when youth are typically honing their cognitive and interpersonal skills.[7,15,18] Such access could jeopardize the prospects of a successful life course for both sexes.[34,35] Lack of face-to-face contact combined with social isolation could potentially harm adolescent development and mental health.[36]

Remarkably, self-reported screen time at age 12 years was not associated with later youth outcomes. This suggests that it is not so much the time reported spent on screens, but more the private and unsupervised nature of screen access that predicts youth outcomes in this study.[37] We know as well that almost all discretionary screen time, for most children and adolescents, such as that which occurs in the bedroom, is devoted to recreational uses, and that very little is devoted to learning and school work.[5]

Strengths and limitations

The prospective-longitudinal design represents a chief strength of this study.[38] Repeated measures with population-based cohorts are akin to conducting a natural experiment of lifestyle habits on subsequent youth outcomes. In addition, controlling for potential confounders diminishes some bias from pre-existing influences on youth outcomes. Lastly, the gender-sensitive considerations of experiences by adolescent boys and girls represent another important strength of this study.

Using secondary data analysis, our study is not without limitations. First, its non-experimental nature precludes any causal inferences. Nevertheless, we have partially remedied this limitation by controlling for pre-existing individual and family confounding factors. Second, our database did not provide information on portable devices such as tablets and smartphones, which have proliferated in homes in recent years, and which further facilitate private access. But this is also a strength,

TABLE 3
Unstandardized regression coefficients (with standard errors) reflecting the adjusted relationship between having a bedroom television and/or computer at age 12 (including concurrent screen time at age 12) and well-being indicators at age 17

		Age 17 years			
		Overall grades (SE)	Dropout risk (SE)	Prosocial behaviour (SE)	Recent dating relationship (SE)
Boys	Bedroom screens (age 12 y)	−2.41 (0.50)***	0.16 (0.05)***	−0.52 (0.15)***	−0.13 (0.03)***
	Temperament problems (age 1.5 y)	−0.01 (0.50)	−0.01 (0.05)	−0.06 (0.15)	0.004 (0.03)
	Early neurocognitive skills (age 2 y)	−0.68 (0.49)	0.02 (0.05)	0.21 (0.15)	−0.03 (0.03)
	Screen time (age 12 y)	0.22 (0.49)	0.003 (0.05)	−0.04 (0.15)	0.03 (0.03)
	Maternal education (5 mo)	−2.13 (0.54)***	0.10 (0.05)*	−0.13 (0.16)	0.07 (0.04)*
	Maternal depressive symptoms (5 mo)	−0.73 (0.51)	0.06 (0.05)	0.20 (0.15)	0.03 (0.03)
	Parents' antisocial behaviour (5 mo)	−1.93 (0.50)***	0.16 (0.05)***	−0.11 (0.15)	−0.09 (0.03)**
	Family dysfunction (age 1.5 y)	0.12 (0.50)	0.02 (0.05)	−0.21 (0.15)	−0.04 (0.03)
	Family configuration (age 2 y)	−1.01 (0.64)	0.11 (0.06)	−0.42 (0.19)*	0.08 (0.04)
	Family income (age 2 y)	−1.35 (0.73)	0.32 (0.07)***	−0.26 (0.22)	−0.06 (0.05)
	Adjusted R^2	0.13***	0.11***	0.03***	0.03***
Girls	Bedroom screens (age 12 y)	−1.61 (0.67)*	0.17 (0.05)***	0.06 (0.16)	−0.18 (0.04)***
	Temperament problems (age 1.5 y)	1.69 (0.66)**	0.08 (0.05)	0.27 (0.15)	−0.01 (0.04)
	Early neurocognitive skills (age 2 y)	−1.02 (0.66)	0.04 (0.05)	0.10 (0.15)	−0.05 (0.04)
	Screen time (age 12 y)	0.68 (0.65)	−0.05 (0.05)	−0.05 (0.15)	0.07 (0.04)
	Maternal education (5 mo)	−2.46 (0.69)***	0.22 (0.05)***	−0.06 (0.16)	0.06 (0.04)
	Maternal depressive symptoms (5 mo)	−2.24 (0.68)***	0.05 (0.05)	0.17 (0.16)	0.01 (0.04)
	Parents' antisocial behaviour (5 mo)	−1.42 (0.65)*	0.01 (0.05)	−0.04 (0.15)	−0.16 (0.04)**
	Family dysfunction (age 1.5 y)	0.50 (0.69)	−0.01 (0.05)	−0.13 (0.16)	−0.04 (0.04)
	Family configuration (age 2 y)	−0.86 (0.82)	0.06 (0.06)	−0.16 (0.19)	0.001 (0.04)
	Family income (age 2 y)	−1.40 (0.89)	0.11 (0.07)	−0.04 (0.21)	0.05 (0.05)
	Adjusted R^2	0.09***	0.08***	−0.01	0.07***

Notes: Analyses corrected for attrition bias. Data were compiled from the final master file of the Quebec Longitudinal Study of Child Development (1998–2015), © Gouvernement du Québec, Institut de la statistique du Québec.

*$p \leq 0.05$
**$p \leq 0.01$
***$p \leq 0.001$

precisely because our study takes into account unsupervised access at a time when fixed devices facilitated the measurement of this dimension.

Conclusion

Our study supports recommendations to discourage screens from private spaces, given the associated academic and social risks. Opportunities to connect socially, interact with others and gain social competence—which are thwarted by solitary and sedentary time spent in private spaces in front of screens during adolescence—figure among the main components of optimal development and flourishment in emerging adulthood.[17] When projected over a lifespan and across an entire population, deficits in key development factors could translate into a general propensity for costly social, economic and health problems.[4,39,40] For these evidence-based reasons, pediatric guidelines should be more resolute about bedrooms, and other private spaces, remaining screen-free zones, especially at a time when portable devices are multiplying in homes, which may further enhance the propensity for solitary use. Limiting "anytime, anywhere" access to portable devices and mobile data before mid-adolescence could also be something for parents and policy makers to consider. Future studies, using data on smartphones and tablets, should replicate these findings during childhood and later developmental periods.

Conflicts of interest

None. The study sponsors had no role in study design; the collection, analysis or

interpretation of data; the writing; the report; or the decision to submit the paper for publication.

Authors' contributions and statement

BG—conceptualization, data curation, format analysis, writing—original draft.

BG, LSP—methodology, writing—review & editing.

LSP—funding acquisition, validation.

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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Original quantitative research

Physical activity, organized sport participation and active transportation to school among Canadian youth by gender identity and sexual attraction

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This article has been peer reviewed.

Abstract

Introduction: Regular physical activity is associated with a wide range of health benefits in youth. While previous studies have identified disparities in physical activity among youth by gender identity and sexual attraction, these have seldom been explored in Canadian youth.

Methods: Data from the 2019 Canadian Health Survey on Children and Youth were used to assess prevalence of and time spent in organized sports participation, total physical activity and active transportation by gender identity (non-cisgender vs. cisgender) among youth aged 12 to 17, and by sexual attraction (nonheterosexual attraction vs. heterosexual attraction) among youth aged 15 to 17.

Results: There was no difference in average minutes of total physical activity per week between non-cisgender and cisgender Canadian youth. Non-cisgender youth (which represent 0.5% of the population) averaged significantly fewer minutes of organized sports per week than their cisgender counterparts. There was some evidence of increased active transportation to school among non-cisgender youth, but insufficient power to detect significant differences. Canadian youth reporting any nonheterosexual attraction (which represent 21.2% of the population, including mostly heterosexual youth) were less likely to be regularly physically active and participate in organized sports than youth reporting exclusive heterosexual attraction. Differences were larger among males than females. Males reporting nonheterosexual attraction were more likely to use active transportation to get to school than their heterosexual counterparts.

Conclusion: Non-cisgender youth and youth reporting nonheterosexual attraction tended to participate less in organized sports than their counterparts, but may have engaged in more active transportation. Mitigating the barriers associated with sport participation could increase physical activity among these groups.

Keywords: gender identity, sexual orientation, sexual and gender minorities, youth sports, exercise, physical activity, active transportation

Introduction

Regular physical activity is associated with a wide range of health benefits, including prevention of chronic diseases and improved well-being.[1] The *Canadian 24-Hour Movement Guidelines for Children and Youth (ages 5–17 years)* recommend that children and youth obtain an average of at least 60 minutes of moderate-to-vigorous physical activity (MVPA) per day involving a variety of aerobic activities for optimal health benefits.[2] The most recent device-measured national data from the 2018 to 2019 Canadian Health Measures Survey show that 35.6% of youth aged 12 to 17 years meet this recommendation.[3] Lower intensities of physical activity (i.e. light physical activity; LPA) may also be beneficial for health. Research has shown strong, consistent associations between total physical activity (MVPA and LPA) and improved cardiovascular health, physical

Highlights

- Non-cisgender youth in Canada had lower levels of participation in organized sports than cisgender youth; however, they engaged in similar levels of total physical activity.
- Nonheterosexual-attracted youth in Canada had lower levels of participation in organized sports and total physical activity than heterosexual-attracted youth.
- Efforts are needed to minimize barriers associated with organized sport participation for non-cisgender and nonheterosexual-attracted youth.

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fitness and bone health, as well as lower adiposity.[4]

Identifying subpopulations that are less physically active can inform strategies and policies for health promotion. Gender identity and sexual attraction are important determinants of health. Various health and social inequities have been found for non-cisgender (i.e. identifying as a gender different from their sex at birth) and non-heterosexual (i.e. not exclusively attracted to the opposite gender) individuals compared to their cisgender (i.e. identifying as the same gender as their sex at birth) and heterosexual (i.e. exclusively attracted to the opposite gender) counterparts, respectively.[5] Studies conducted in the US, UK, New Zealand and Spain have identified lower levels of physical activity and participation in organized sports among non-cisgender versus cisgender youth,[6-9] as well as among nonheterosexual versus heterosexual youth.[9-17] The magnitude of these differences varies by sex, with larger differences in physical activity and sports participation among cisgender and non-cisgender males than between cisgender and non-cisgender females.[10]

To the best of our knowledge, the only representative study assessing physical activity and sports participation by gender identity or sexual attraction among Canadian youth was based on the 1998 to 2013 British Columbia Adolescent Health Surveys. It found that males identifying as "mostly" heterosexual, bisexual or "mostly" or "completely" homosexual were consistently less likely to participate in both organized and nonorganized sports and physical activity compared to "completely" heterosexual males.[18] Meanwhile, bisexual and "mostly" or "completely" homosexual females were less likely to participate in nonorganized sports and physical activity than heterosexual females, and bisexual females were less likely to participate in organized sports than heterosexual females.[18]

The objective of our study was to present current evidence by using nationally representative data from the 2019 Canadian Health Survey on Children and Youth to assess total physical activity, organized sports participation and active transportation use among Canadian youth (i.e. adolescents aged 12 to 17 years) by gender identity and sexual attraction.

Methods

Data source

The data source for this study was the 2019 Canadian Health Survey on Children and Youth (CHSCY), a cross-sectional survey conducted by Statistics Canada. Data collection occurred between 11 February and 2 August 2019. The CHSCY surveyed a nationally representative sample of children and youth aged 1 to 17 years. Those living on First Nation reserves and other Indigenous settlements, those living in foster homes and the institutionalized population were excluded. The sampling frame consisted of beneficiaries of the Canadian Child Benefit, which covers 98% of the Canadian population aged 1 to 17 years in all provinces and 96% in all territories.

This study was limited to youth aged 12 to 17 years, which is a restricted age range in comparison to other (e.g. World Health Organization) definitions of youth. The survey was administered using electronic questionnaires or telephone interviews. All youth were asked about their gender and physical activity behaviours. Only youth aged 15 to 17 were asked about sexual attraction.

There were 11 077 respondents aged 12 to 17 in the 2019 CHSCY (5301 aged 15 to 17). The response rate was 41.3%. Survey weights were provided by Statistics Canada to account for sampling and non-response and generate nationally representative estimates. Briefly, each respondent is assigned a weight based on design and adjustment factors that corresponds to the number of persons in the entire population that are represented by that respondent. Further details regarding weighting are provided online by Statistics Canada.[19,20] Each analysis was restricted to those with complete data for physical activity behaviours, leaving 11 064 respondents (99.9% of respondents aged 12 to 17) for gender identity, and 5254 respondents aged 15 to 17 (98.1% of respondents aged 15 to 17) for sexual attraction.

Measures

The exact wording for each survey question is provided online by Statistics Canada.[21] The measures related to sex, gender and sexual attraction used in this study were based on available data and current statistical standards.[22] Definitions and available measures are continually

evolving and may not necessarily align with previous or future research.

Sex
Youth aged 12 to 17 were asked, "What was your sex at birth? Sex refers to sex assigned at birth." The response options were "male" and "female."

Gender identity
Youth aged 12 to 17 were asked, "Gender refers to current gender which may be different from sex assigned at birth and may be different from what is indicated on legal documents. What is your gender?" The response options were "male," "female" and "or please specify." Youth who identified as a gender other than male or female were classified as "nonbinary."

Cisgender/non-cisgender
Youth who identified as the same gender as their sex at birth were classified as "cisgender." Youth who identified as a gender other than their sex at birth, including those considered "nonbinary," were classified as "non-cisgender."

Sexual attraction
Youth aged 15 to 17 were asked whether they were "only attracted to males"; "mostly attracted to males"; "equally attracted to females and males"; "mostly attracted to females"; "only attracted to females"; or "not sure." Youth were classified as having "heterosexual attraction" if they identified as male gender and were attracted only to females or identified as female gender and were only attracted to males; or as having "nonheterosexual attraction" if they were attracted to the same gender, attracted to both males and females, or not sure, or if they identified as nonbinary gender. These classifications have been used in other studies.[23,24]

Physical activity
Individuals were asked for the total amount of time they spent participating in physical activity in which they sweated at least a little or breathed harder, as well as the amount of time they actually spent sweating or breathing harder for each of the past 7 days. Response options were in 15-minute increments (no time, 15 minutes or less, 30 minutes, 45 minutes, 1 hour, etc., up to 7 hours or more). Those who answered 15 minutes or less or 7 hours or more were assigned a time of 15 minutes or 7 hours, respectively, for that day. The total time across all 7 days was used to calculate the average minutes of physical activity per day, since sensitivity analyses

showed that these estimates were more in line with device-measured MVPA for Canadian youth than the time spent sweating or breathing harder, although they may include both MVPA and LPA.[3] Individuals were categorized as averaging ≥ 60 minutes of physical activity per day versus averaging < 60 minutes per day, which is the threshold used in the *Canadian 24-Hour Movement Guidelines for Children and Youth (ages 5–17 years)*.[2]

Sports participation

Individuals were asked whether they participated in sport or physical activity with a coach or instructor in the past year and past 7 days. Individuals were also asked for the total amount of time they spent participating in sport or physical activity in the past 7 days, which was divided by 7 to obtain an average sport participation time per day.

Active transportation

Individuals were asked whether they walked, biked or used another active way to get to school in the past 7 days, and the amount of time they spent using each of these modes of transportation. The amount of time spent using each mode was summed and divided by 7 to obtain an average active transportation time per day.

Statistical analyses

Descriptive statistics were used to calculate percentages, means and 95% confidence intervals (95% CIs) for gender identity (cisgender/non-cisgender) and sexual attraction overall, stratified by gender, and for physical activity, sports participation and active transportation indicators, stratified by cisgender/non-cisgender and heterosexual attraction/nonheterosexual attraction. Distributions were also calculated excluding those reporting "not sure" attraction as a sensitivity analysis. All percentages and means were calculated using survey weights to be nationally representative; 95% CIs were calculated using bootstrap weights. Two-tailed Wald chi-square tests were used to assess differences in means and percentages between groups under a statistical significance level of 0.05. Analyses were conducted in SAS Enterprise Guide version 7.1 (SAS Institute Inc., Cary, NC, US).

Results

Gender identity and physical activity

Based on self-reported sex at birth and gender, 0.3% of youth aged 12 to 17 were classified as nonbinary and 0.5% as non-cisgender (Table 1). All estimates for non-binary and non-cisgender youth should be interpreted with caution due to their small sample size.

Physical activity measures by gender identity are presented in Table 2. Average minutes of physical activity per week did not differ between non-cisgender and cisgender youth. The percentages of non-cisgender youth who averaged 60 minutes or more of physical activity per day and who participated in organized sports in the past week were unreportable due to high sampling variability. Among non-cisgender youth, 48.5% participated in organized sports in the past year, compared to 67.3% of cisgender youth. Non-cisgender youth also averaged significantly fewer minutes of organized sport participation per week (96 minutes vs. 214 minutes). Finally, 48.0% of non-cisgender youth used active transportation to get to school, averaging 335 minutes per week, compared to 29.2% of cisgender youth, averaging 164 minutes per week. These differences were not significant.

Sexual attraction and physical activity

Among youth aged 15 to 17, 78.8% reported heterosexual attraction while 21.2% reported nonheterosexual attraction (17.4% attracted to the same or both genders and 3.8% not sure of their attraction; Table 3). Females were more likely to report nonheterosexual attraction than males.

Physical activity measures by heterosexual/nonheterosexual attraction are presented in Table 4. Overall, youth reporting nonheterosexual attraction were less likely to average 60 minutes or more of physical activity per day (16.8% vs. 27.3%) and less likely to participate in organized sports in the past week (33.1% vs. 45.1%) and year (49.2% vs. 62.8%) than youth reporting heterosexual attraction. Youth reporting nonheterosexual attraction spent fewer weekly minutes being physically active (225 minutes vs. 284 minutes) and participating in organized sports (130 minutes vs. 216 minutes) than youth reporting heterosexual attraction; however, they spent more weekly minutes using active transportation to get to school (169 minutes vs. 126 minutes) than their heterosexual counterparts. While there was no difference in the overall percentage of youth using active transportation to get to school by sexual attraction, males reporting nonheterosexual attraction were more likely to use active transportation than those reporting heterosexual attraction. Males reporting nonheterosexual attraction also spent more time in active transportation to get to school per week, while achieving fewer minutes of organized sport participation. These differences were not apparent among females. There were no differences in trends when youth reporting "not sure" were excluded as a sensitivity analysis (data not shown).

Discussion

Gender identity and physical activity

To our knowledge, this was the first study to explore differences in measures of physical activity by gender identity among Canadian youth aged 12 to 17 years. Non-cisgender individuals made up a small

TABLE 1
Gender identity of study participants, youth aged 12 to 17 years, 2019 Canadian Health Survey on Children and Youth (N = 8418)

	Weighted frequency[a]	Percentage (%)	95% CI
Self-reported gender			
Male	884 934	50.5	49.4–51.6
Female	862 592	49.2	48.2–50.3
Nonbinary	4 472	0.3[D]	0.1–0.4
Cisgender/non-cisgender			
Cisgender	1 743 799	99.5	99.3–99.7
Non-cisgender	8 199	0.5[c]	0.3–0.7

Abbreviation: CI, confidence interval.

[a] Frequencies are weighted to be representative of the Canadian population.

[c] Estimate should be interpreted with caution due to high sampling variability (0.15 < coefficient of variation ≤ 0.25).

[D] Estimate should be interpreted with caution due to high sampling variability (0.25 < coefficient of variation ≤ 0.35).

TABLE 2
**Physical activity measures for cisgender and non-cisgender youth aged 12 to 17 years,
2019 Canadian Health Survey on Children and Youth (N = 8418)**

	Cisgender		Non-cisgender		
	Estimate	95% CI	Estimate	95% CI	*p* value
Percentage of youth (%)					
Averaged ≥ 60 min of physical activity per day	27.4	26.1–28.7	E	N/A	N/A
Participated in organized sports in the past year	67.3	65.9–68.7	48.5D	29.2–68.1	0.0576
Participated in organized sports in the past week	50.8	49.3–52.3	E	N/A	N/A
Used active transportation to get to school	29.2	27.9–30.5	48.0D	27.7–68.7	0.0691
Average minutes per week					
Physical activity in which one sweated or breathed harder	296	287–304	270C	140–400	0.7020
Participation in organized sports	214	199–228	96D	41–151	< 0.0001*
Active transportation to get to school	164	154–175	335D	124–547	0.1135

Abbreviations: CI, confidence interval; min, minutes; N/A, not available.

C Estimate should be interpreted with caution due to high sampling variability (0.15 < coefficient of variation ≤ 0.25).

D Estimate should be interpreted with caution due to high sampling variability (0.25 < coefficient of variation ≤ 0.35).

E Estimate unreportable due to high sampling variability (coefficient of variation > 0.35).

* Statistically significant difference between gender identities, *p* < 0.05.

percentage (0.5%) of the study population. There was no difference in the average weekly minutes of physical activity between non-cisgender and cisgender youth. The percentage of youth averaging 60 minutes or more per day of physical activity could not be compared in the two groups due to high sampling variability.

TABLE 3
**Sexual attraction of study participants, youth aged 15 to 17,
2019 Canadian Health Survey on Children and Youth (N = 3963)**

	Weighted frequency[a]	Percentage (%)	95% CI
Overall (male, female, nonbinary gender)			
Heterosexual attraction	659 609	78.8	77.1–80.4
Nonheterosexual attraction	177 699	21.2	19.6–22.9
Attracted to same or both genders	146 106	17.4	15.9–19.1
Not sure	31 593	3.8	3.0–4.7
Male gender (n = 1907)			
Heterosexual attraction	356 798	85.2	82.8–87.3
Nonheterosexual attraction	61 990	14.8	12.7–17.2
Attracted to same or both genders	51 886	12.4	10.4–14.6
Not sure	10 104	2.4C	1.6–3.4
Female gender (n = 2040)			
Heterosexual attraction	302 811	72.7	70.0–75.2
Nonheterosexual attraction	113 754	27.3	24.8–30.0
Attracted to same or both genders	92 776	22.3	19.9–24.8
Not sure	20 978	5.0	3.7–6.7
Nonbinary gender (n = 16)			
Heterosexual attraction	0	0.0	N/A
Nonheterosexual attraction	1 955	100.0	N/A
Attracted to same or both genders	1 444	73.8C	44.5–92.9
Not sure	E	E	N/A

Abbreviations: CI, confidence interval; N/A, not available.

a Frequencies are weighted to be representative of the Canadian population.

C Estimate should be interpreted with caution due to high sampling variability (0.15 < coefficient of variation ≤ 0.25).

E Estimate unreportable due to high sampling variability (coefficient of variation > 0.35).

This finding contrasts with existing research that found non-cisgender US high school students were less likely to be physically active for 60 minutes or more per day than cisgender students.[6]

Non-cisgender youth achieved significantly fewer minutes of organized sports participation per week than cisgender youth. Further, only half of non-cisgender youth participated in organized sports in the past year, compared to two-thirds of cisgender youth. This finding is in line with existing research from the United States[6,7] and Spain;[8] however, there was no difference in the likelihood to play sports between non-cisgender and cisgender youth in a 2014 survey of US high school students.[16]

Disparities in organized sport participation may be attributed to structural discrimination, such as policies that exclude transgender athletes from competitive sports.[25-27] They may also be attributed to non-cisgender youth feeling uncomfortable or unsafe in organized sport environments, particularly in gender-segregated spaces (e.g. locker rooms).[10,16,27-29] Non-cisgender youth may find ways to be physically active outside of organized sports. For instance, some non-cisgender respondents in a study of American youth noted that they preferred individual sports and physical activities (e.g. biking, rock climbing) to team sports.[27] Nonetheless, participation in organized sports during adolescence contributes to health, not

TABLE 4
Physical activity measures by sexual attraction, youth aged 15 to 17 years, 2019 Canadian Health Survey on Children and Youth (N = 3963)

	Heterosexual attraction		Nonheterosexual attraction		*p* value
	Estimate	95% CI	Estimate	95% CI	
Overall (male, female, nonbinary gender)					
Percentage of youth (%)					
Averaged ≥ 60 min of physical activity per day	27.3	25.3–29.4	16.8	13.3–20.8	< 0.0001*
Participated in organized sports in the past year	62.8	60.5–65.1	49.2	44.5–53.9	< 0.0001*
Participated in organized sports in the past week	45.1	42.7–47.5	33.1	28.8–37.4	< 0.0001*
Used active transportation to get to school	24.8	22.8–26.8	28.4	24.2–32.6	0.1252
Average minutes per week					
Physical activity in which one sweated or breathed harder	284	270–297	225	191–259	0.0013*
Participation in organized sports	216	191–240	130	99–160	< 0.0001*
Active transportation to get to school	126	111–141	169	135–203	0.0248*
Male gender (n = 1907)					
Percentage of youth (%)					
Averaged ≥ 60 min of physical activity per day	30.3	27.5–33.0	18.6[c]	11.8–25.5	0.0022*
Participated in organized sports in the past year	66.0	62.9–69.1	47.6	39.5–55.6	< 0.0001*
Participated in organized sports in the past week	48.6	45.4–51.8	35.1	27.0–43.2	0.0023*
Used active transportation to get to school	26.7	24.0–29.4	36.0	28.1–43.9	0.0250*
Average minutes per week					
Participation in organized sports	244	205–284	95	71–119	0.0697
Physical activity in which one sweated or breathed harder	315	296–334	247	176–318	< 0.0001*
Active transportation to get to school	138	117–159	218[c]	154–283	0.0204*
Female gender (n = 2040)					
Percentage of youth (%)					
Averaged ≥ 60 min of physical activity per day	23.8	20.8–26.8	15.8	11.6–20.0	< 0.0001*
Participated in organized sports in the past year	59.0	55.6–62.5	50.1	44.4–55.8	0.0077*
Participated in organized sports in the past week	41.0	37.5–44.5	32.0	27.0–37.1	0.0036*
Used active transportation to get to school	22.5	19.6–25.4	24.3	19.5–29.1	0.5264
Average minutes per week					
Physical activity in which one sweated or breathed harder	284	270–297	225	191–259	0.0869
Participation in organized sports	182	158–206	148	104–192	0.1798
Active transportation to get to school	126	111–141	169	135–203	0.1716

Abbreviations: CI, confidence interval; min, minutes.

[c] Estimate should be interpreted with caution due to high sampling variability (0.15 < coefficient of variation ≤ 0.25).

* Statistically significant difference between attraction groups, *p* < 0.05.

only through the benefits associated with regular physical activity, but through improved well-being and social development.[30] Further efforts should be made to understand and mitigate the barriers associated with participation in organized sports.

Nearly half of non-cisgender youth used active transportation to get to school, compared to one-third of cisgender youth. Further, the average weekly minutes in active transportation to get to school among non-cisgender youth was over double that of cisgender youth. However,

findings were not significant due to the small sample size.

Previous studies on active transportation use by gender identity were limited to adults. A US study found that non-cisgender college students engaged in active transportation more frequently than their cisgender counterparts, although findings were similarly limited by sample size.[31] A study conducted in US adults suggested discomfort among non-cisgender individuals using public transit due to discrimination or abuse.[32] Non-cisgender youth may similarly experience discomfort using

public transit or school buses, and engage in active transportation to school as an alternative.[33] Alternatively, non-cisgender youth may prefer active transportation as a way to be physically active over organized sports.[27] Regardless of the reasons behind the observed differences between non-cisgender and cisgender youth, active transportation should be promoted for all youth as a way to be physically active and obtain the related health benefits.[34]

Overall, these results show different modes of attaining physical activity for non-cisgender and cisgender youth aged 12 to

17. However, the small number of noncisgender youth in the study sample impacted our ability to identify differences between these groups where they might exist, especially where absolute percentages suggest differences between groups.

Sexual attraction and physical activity

One-fifth of youth aged 15 to 17 reported nonheterosexual attraction (attracted to the same or both genders, or not sure of their attraction). Youth reporting nonheterosexual attraction were less likely to average 60 minutes or more of physical activity per day, regardless of gender. They also averaged 60 fewer minutes of physical activity per week than their heterosexual counterparts. These findings are in line with existing Canadian research demonstrating lower levels of physical activity (organized or non-organized) among nonheterosexual youth in British Columbia,[18] as well as research from the UK[13] and US.[11,12,14,15,17]

Youth reporting nonheterosexual attraction were less likely to participate in organized sports in the past week and year than youth reporting heterosexual attraction. These differences were larger among males than females. This finding is consistent with those of the BC Adolescent Health Surveys, which have consistently shown lower participation in sports and physical activity with a coach among nonheterosexual youth compared to heterosexual youth, with larger differences among males.[18] Studies from the US have found lower levels of participation in team sports and school sports among nonheterosexual youth, particularly among males.[14,16,17] Many nonheterosexual youth avoid organized sports due to bullying and discrimination from peers and staff, and because they feel unsafe or uncomfortable in sport settings (e.g. physical education class, locker rooms).[10,16,27,29,35]

The differences between males and females may be partially attributed to the perception of nonheterosexual females as more masculine and therefore more competent in sport than their heterosexual counterparts.[10] In addition, nonheterosexual male youth tend to experience greater bullying victimization than their female counterparts across sport and other environments.[25,36,37]

However, differences in total physical activity were smaller than differences in organized sport participation between nonheterosexual- and heterosexual-attracted males, suggesting that nonheterosexual-attracted males make up for lower levels of organized sport participation with other physical activity (e.g. nonorganized sports, active transportation). For instance, a study in the US found that lesbian, gay, bisexual, transgender and queer youth generally prefer individual sports (which are often nonorganized) to team sports.[27]

Males reporting nonheterosexual attraction were more likely to use active transportation to get to school and spent more time doing so than males reporting heterosexual attraction. There was no difference in active transportation use among females. Active transportation to school may be an important coping mechanism to avoid bullying behaviour on public transit or school buses.[38] Studies have shown that nonheterosexual male youth are more likely to be bullied than their female counterparts,[36,37] which may explain the gender difference in the uptake of active transportation. Otherwise, a US study found that youth with nonheterosexual attraction were less likely to have a driver's license upon reaching young adulthood, which may be due to lower parental support in obtaining a license.[39] Given that practising driving on routine trips to school is common among youth,[40] the higher rates of active transportation to school among nonheterosexual males may also be attributed to lower likelihood of parental support for driving. Finally, males with nonheterosexual attraction may simply prefer active transportation as a way to be physically active over organized sports.[27]

Overall, these results point to lower levels of physical activity and organized sport participation among nonheterosexual-attracted youth compared to heterosexual-attracted youth aged 15 to 17. These discrepancies were larger among males than females. Our results were in line with Canadian and international studies demonstrating decreased physical activity and sport participation among nonheterosexual youth. Efforts should be made to decrease the barriers associated with physical activity and sport participation. This might be done by implementing anti-bullying programs in sport, promoting nonheterosexual athletes as role models, encouraging peer and familial support and introducing youth to a wider range of physical activities in school.[14,41]

Strengths and limitations

This study assessed multiple measures of physical activity (total physical activity, organized sport participation and active transportation to school) by gender identity and sexual attraction among Canadian youth. It was the first study, to our knowledge, to examine differences in each physical activity measure by gender identity among Canadian youth, and in active transportation to school by sexual attraction. Future studies would benefit from examining additional measures of physical activity, such as participation in nonorganized sports, participation in different sport settings (i.e. group vs. individual, types of sports) and the meeting of muscle- and bone-strengthening recommendations in the *Canadian 24-Hour Movement Guidelines*, among these subpopulations.[2]

This study had several limitations. Despite the use of a large sample of Canadian youth, the low prevalence of non-cisgender individuals meant there was insufficient power to detect significant differences for most measures and to examine behaviours of nonbinary and transgender youth separately. Several estimates could not be reported due to high sampling variability. There was insufficient sample size to report estimates for detailed sexual attraction categories (e.g. males attracted only to males; nonbinary attracted only to males). The sample size was also insufficient to explore how other socioeconomic characteristics (e.g. ethnocultural background, household income) intersect with gender identity and sexual attraction in the assessment of physical activity. These findings are important to note for future surveys; researchers may wish to increase sample sizes or oversample non-cisgender and nonheterosexual-attracted youth in order to report more detailed breakdowns.

Additionally, the wording of certain questions limited our reporting. Data on gender were collected using biological terms ("female" and "male"), and all youth who reported a gender other than female or male were classified as nonbinary. It was not possible to determine breakdowns for specific gender identities, such as Two-Spirit or queer. Further, the questionnaire did not specify whether sexual attraction towards males and/or females was based on gender or sex. In this study, we assumed that attraction was based on gender rather than sex, which may not be the case for all respondents.

Conclusion

Gender identity and sexual attraction are important predictors of physical activity among Canadian youth. Our findings demonstrate different modes of engaging in physical activity between non-cisgender and cisgender youth aged 12 to 17 years, with similar total physical activity yet lower organized sport participation and some evidence of higher active transportation use among non-cisgender youth. We also found lower levels of organized sport participation and total physical activity among Canadian youth aged 15 to 17 years reporting nonheterosexual attraction compared to those reporting heterosexual attraction, particularly among males, but increased active transportation only among males. Mitigating the barriers associated with participation in organized sports while additionally promoting active transportation could increase physical activity among all youth.

Conflicts of interest

The authors have no conflicts of interest to disclose.

Authors' contributions and statement

CW, GB, MTB, KCR—conceptualization.

CW—methodology, formal analysis, writing—original draft.

CW, GB, MRJS, MTB, KCR—writing—review & editing.

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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Original quantitative research

Associations between negative COVID-19 experiences and symptoms of anxiety and depression: a study based on a representative Canadian national sample

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This article has been peer reviewed.

Abstract

Introduction: Amid the widespread impact of the COVID-19 pandemic, a notable increase in symptoms of anxiety and depression has become a pressing concern. This study examined the prevalence of anxiety and depression symptoms in Canada from September to December 2020, assessing demographic and socioeconomic influences, as well as the potential role of COVID-19 diagnoses and related negative experiences.

Methods: Data were drawn from the Survey on COVID-19 and Mental Health by Statistics Canada, which used a two-stage sample design to gather responses from 14 689 adults across ten provinces and three territorial capitals, excluding less than 2% of the population. Data were collected through self-administered electronic questionnaires or phone interviews. Analytical techniques, such as frequencies, cross-tabulation and logistic regression, were used to assess the prevalence of anxiety and depression symptoms, the demographic characteristics of Canadians with increased anxiety and depression symptoms and the association of these symptoms with COVID-19 diagnoses and negative experiences during the pandemic.

Results: The study found that 14.62% (95% CI: 13.72%–15.51%) of respondents exhibited symptoms of depression, while 12.89% (95% CI: 12.04%–13.74%) reported anxiety symptoms. No clear differences in symptom prevalence were observed between those infected by COVID-19, or those close to someone infected, compared to those without these experiences. However, there were strong associations between traditional risk factors for depressive and anxiety symptoms and negative experiences during the pandemic, such as physical health problems, loneliness and personal relationship challenges in the household.

Conclusion: This study provides insight into the relationship between COVID-19 and Canadians' mental health, demonstrating an increased prevalence of anxiety and depression symptoms associated with COVID-19-related adversities and common prepandemic determinants of these symptoms. The findings suggest that mental health during the pandemic was primarily shaped by traditional determinants of depression and anxiety symptoms and also by negative experiences during the pandemic.

Keywords: COVID-19, anxiety, depression, mental health, loneliness

Highlights

- This study investigated the effects of negative experiences during the COVID-19 pandemic on mental health in Canada.
- The study found that 15% of Canadians screened positive for symptoms of depression and 13% for symptoms of anxiety from September to December 2020.
- Negative experiences related to COVID-19, such as physical health difficulties, loneliness and challenges in personal relationships, were associated with elevated depression and anxiety symptoms.
- Future research should investigate mental health needs among groups not included in the dataset, such as children, 2SLGBTQI+ communities, First Nations individuals on reserve and individuals who are precariously housed.

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Introduction

On 4 May 2023, the World Health Organization recategorized COVID-19 from a global public health emergency to an established and ongoing health issue.[1] Despite this shift, the mental health repercussions of the pandemic remain paramount in the Canadian health discourse. Although extant literature recognizes heightened substance use,[2] increased suicide ideation[3] and deteriorated self-rated mental health[4] during the pandemic, crucial research gaps remain. Specifically, the direct and indirect associations between anxiety and depression symptoms and individual COVID-19 experiences, including being diagnosed with COVID-19 oneself or the diagnosis of one's family members, friends or other close acquaintances, remain understudied.[5] Moreover, much attention has been focussed on specialized populations, inadvertently overlooking the broader general population.[6]

Despite the overarching stresses attributed to the pandemic, the precise facets of the specific, negative COVID-19 experiences contributing to this stress remain a knowledge gap. By emphasizing symptoms of anxiety and depression over clinical diagnoses, this study adopts an upstream approach, proactively identifying burgeoning mental health challenges that, if unaddressed, may evolve into formal mental illnesses. We sought to advance our understanding of the effects of COVID-19 and associated experiences on the mental health of Canadians. We employed a nationally representative sample to estimate the prevalence of anxiety and depression symptoms and identify associated factors that may have increased the risk of symptoms during this period of heightened stress.

COVID-19 national datasets such as the one we used provide symptom rating scales, serving as validated tools for tracking mental health trends. These datasets allow for the examination of depression and anxiety symptom ratings via self-report screening instruments, thereby monitoring the prevalence of mental health–related symptoms. Although these ratings do not confirm clinical diagnoses, they possess validated cut-points clinicians interpret as signals for further assessment.[7-9] Importantly, even without a formal diagnosis, these symptoms may cause significant distress, compromise well-being and quality of life and thus highlight the potential value of mental health assessment for those with elevated symptoms.

The study had three primary objectives: (1) to estimate the prevalence of anxiety and depression symptoms in the Canadian population between 11 September 2020 and 4 December 2020; (2) to explore the characteristics of this subgroup, including having been diagnosed with or having been in contact with someone diagnosed with COVID-19; and (3) to identify negative COVID-19-related factors associated with positive screens for anxiety and depression symptoms.

Methods

Data source

This study used data from the Survey on COVID-19 and Mental Health (SCMH) conducted by Statistics Canada and made available to researchers through the Canadian Research Data Centre Network.[10] Therefore, no additional ethics review is required under Article 2.2 of the Tri-Council Policy Statement 2, 2022.[11] The purpose of the SCMH was to collect data to assess the experiences of COVID-19 on Canadians' mental health and well-being. Detailed methodological information on the SCMH is available from the Statistics Canada archive.[12] Briefly, the target demographic of the survey comprised Canadian residents aged 18 years and older, living across all 10 provinces and the territorial capitals of Canada, and excluded less than 2% of the population (those living on-reserve, those in institutions and members of collectives).

The survey used a two-stage, cross-sectional design, with dwellings as the first stage sampling unit and individuals as the second stage. Stratified by geographic region, a simple random sample of dwellings was selected within each province and three territorial capitals. Data collection occurred between 11 September 2020 and 4 December 2020. Data were collected directly from survey respondents through a self-administered electronic questionnaire or computer-assisted telephone interview. With a response rate of 53.3%, the survey gathered data from 14 689 respondents.

Measures

Demographic variables

Demographic variables included sex (male, female); age (18–24, 25–44, 45–64, 65+ years); household composition (family and/or others, live alone); income—total annual household (less than CAD 40 000, 40 000–79 999, 80 000–99 999, 100 000–149 999, 150 000+); education (high school or less, bachelor degree or less, above a bachelor degree); place of residence (urban, rural); employment—during that week, (did not work, did work); province of residence (British Columbia, Alberta, Saskatchewan/Manitoba, Ontario, Quebec, Eastern [New Brunswick, Nova Scotia, Prince Edward Island, Newfoundland and Labrador], Northern [Yukon, Northwest Territories, Nunavut]); and minoritized (yes, no).

The minoritized variable is a derived variable from the SCMH. Respondents were first self-selected into predefined categories representing various ethnic groups. Thereafter, a second related variable was established in the SCMH as a binary indicator of whether respondents identified themselves as minoritized. We avoided using the terms "visible minority" and "marginalized" because they can perpetuate stereotypes and imply that certain groups are inherently less capable or in need of protection. Instead, we used the terms "minoritized" and "minoritization" to acknowledge that systemic inequalities and oppression place individuals into a "minority" status rather than their characteristics.[13]

COVID-19 occupational variables were also included in this study. Respondents were asked if they were considered a COVID-19 frontline worker or COVID-19 essential worker during the past week (yes, no).

Mental health outcomes

The Patient Health Questionnaire-9 (PHQ-9) and General Anxiety Disorder-7 (GAD-7) were used to assess current (past two weeks) symptoms associated with major depressive disorder (did not meet cut-point, met cut-point) and generalized anxiety disorder (did not meet cut-point, met cut-point). A positive screen on these scales occurs at a cut-point of 10, which would typically justify further assessment in clinical practice.[7-9]

Diagnosis with COVID-19

Respondents to the 2020 SCMH were asked, "Have you or anyone you know been diagnosed with COVID-19?" Response options were yes or no. If the respondent answered yes, the question stem would include, "Who has been diagnosed with COVID-19?" Response options included:

yourself (yes, no); another household member (yes, no); a close friend or family member outside of your household (yes, no); a co-worker or colleague (yes, no); someone else with whom you interact with in your community, e.g. neighbour, grocery store worker, babysitter (yes, no); or other (yes, no). Respondents could select multiple categories.

COVID-19 negative experiences

Respondents to the 2020 SCMH were asked, "Have you experienced any of the following impacts due to the COVID-19 pandemic?" Response options were: loss of job or income (yes, no); difficulty meeting financial obligations or essential needs, e.g. rent or mortgage payments, utilities, groceries (yes, no); death of a family member, friend or colleague (yes, no); feelings of loneliness or isolation (yes, no); emotional distress, e.g. grief, anger, worry (yes, no); physical health problems, e.g. weight gain or loss, high blood pressure, headaches, sleep problems (yes, no); challenges in personal relationships with members of your household, e.g. children, spouse, parent, grandparents (yes, no). Respondents could select multiple categories.

Data analysis

Data analysis was carried out at the Prairie Regional Research Data Centre at the University of Calgary using the statistical software Stata, version 16.0 (StataCorp, College Station, TX, US). To account for the survey design and to provide results that are representative at the national level, estimates were weighted using a set of replicate sampling weights provided by Statistics Canada.[12] Standard errors, coefficients of variation and 95% confidence intervals were estimated using a master weight and replicate bootstrap weights.[14] The calculation of replicate bootstrap weights includes adjustments for nonresponse.

Descriptive techniques were used for the cross-sectional data, including estimating frequencies, to understand the basic distributions of our variables of interest, including the prevalence of anxiety and depression symptoms. Logistic regression models were employed to explore associations between symptoms of anxiety or depression and demographic variables, various COVID-19 diagnosis categories and negative experiences related to COVID-19, such as job loss or the death of a family member. Each COVID-19 diagnosis category and negative COVID-19 experience

was considered a separate exposure variable. Statistical significance for the associations was assessed using Wald tests for coefficients from logistic regression analysis using the replicate bootstrap weights. *P* values of less than 0.05 were considered significant.

For COVID-19 diagnosis categories, individuals not diagnosed or who did not know someone diagnosed with COVID-19 constituted the reference group. Unadjusted odds ratios (ORs) and 95% confidence intervals (CIs) were initially estimated. Age- and sex-adjusted logistic regression models were then fit to compare the prevalence of symptoms in COVID-19 diagnosis categories.

For negative COVID-19 experiences, individuals who did not have those experiences constituted the reference group. Following the derivation of unadjusted ORs, interaction effects of negative experiences with sex and age as determinants of depression and anxiety symptoms were examined. For "physical health problems" and "death of family/friend/colleague," stratification by age groups (18–44 and 45 + years) was performed due to interactions of these experiences with age. In the absence of age and sex interactions, the COVID-19 experiences exposure variables were adjusted for age and sex.

Additional statistical modelling was performed to evaluate the effect of covariates on the age- and sex-adjusted odds ratios. A series of logistic regression models were used to generate adjusted ORs and their 95% CIs. These models included covariates identified a priori, including sex, age, household composition, place of residence, employment and minoritization—these covariates were coded as outlined above, except that income, education and province of residence were included after dummy coding, with "CAD 150 000 or more," "greater than bachelor's degree" and "Quebec" set as the baseline categories. The mode of data collection (self-administered electronic questionnaire, computer-assisted telephone interviewing) was found to have a significant association with symptoms of depression ($p < 0.001$). Therefore, it was added to the models with self-administered electronic questionnaire as the referent group.

Although emotional distress was included in the SCMH as a negative COVID-19 experience, it was not incorporated into the analysis of anxiety or depression

symptoms because it is a component of anxiety and depression assessments. There were minimal missing data (less than 10% for any variable), and regression models included only complete cases, forgoing imputation.

Results

Prevalence of anxiety and depression symptoms (study objectives 1 and 2)

The descriptive characteristics of the 14 689 Canadians eligible for this analysis are summarized in Table 1. The study found that 12.89% of Canadians screened positive for anxiety symptoms, and 14.62% screened positive for symptoms of depression. The prevalence of anxiety symptoms was found to be elevated in females (15.79%) compared to males (9.86%); in individuals aged 18 to 24 years (20.52%) compared to older age groups (Table 1); in households with family or others living together (13.15%) compared to those living alone (11.40%); in those reporting household income less than CAD 40 000 (14.90%) and CAD 40 000 to CAD 79 999 (14.15%) compared to individuals with a household income of CAD 150 000 or more (11.38%); in individuals that were unemployed (14.87%) compared to employed individuals (12.62%); and in frontline workers (17.48%) compared to individuals not working on the front line (11.81%).

Similarly, the frequency of elevated depression symptoms was highest in females (16.78%) compared to males (12.23%); in individuals aged 18 to 24 (26.90%) compared to older adults (Table 1); in those reporting household income less than CAD 40 000 (17.33%) and between CAD 80 000 and CAD 99 999 (16.04%) compared to individuals with a household income of CAD 150 000 (12.51%); in individuals with less than a bachelor's degree (15.89%) compared to individuals with greater than a bachelor's degree (13.04%); in individuals living in urban centres (15.45%) compared to individuals living in rural areas (10.85%); in unemployed individuals (16.68%) compared to employed individuals (14.55%); and among frontline workers (19.08%) compared to individuals not working on the frontline (13.75%).

Notably, residents of Quebec had the lowest prevalence of anxiety symptoms (9.00%) and depression symptoms (10.75%) compared to all other Canadian provinces and territorial capitals (Table 1).

National prevalence of anxiety and depression symptoms by demographic and socioeconomic variables in the context of COVID-19 (September to December 2020), Canada

Variable	Total proportion of variables		Anxiety symptoms		Depression symptoms	
	%	95% CI	Prevalence (%)	95% CI	Prevalence (%)	95% CI
Overall population prevalence			12.89	12.04–13.74	14.62	13.72–15.51
Sex						
Male	49.24	49.17–49.32	9.86[r]	8.71–11.00	12.23[r]	10.97–13.48
Female	50.76	50.68–50.83	15.79[***]	14.54–17.04	16.78[***]	15.47–18.09
Age (y)						
18–24	9.47	8.67–10.27	20.52[r]	15.99–25.05	26.90[r]	21.96–31.84
25–44	35.58	34.78–36.38	15.22[*]	13.66–16.78	17.84[***]	16.13–19.55
45–64	32.78	32.78–32.78	11.93[***]	10.65–13.21	12.92[***]	11.66–14.17
65+	22.17	22.17–22.17	7.24[***]	6.16–8.33	6.60[***]	5.57–7.62
Household living arrangements						
Family and/or others	85.59	85.34–85.83	13.15[r]	12.18–14.11	14.54[r]	13.52–15.56
Living alone	14.41	14.17–14.66	11.40[*]	10.02–12.77	15.11	13.63–16.60
Total household income (CAD)						
< 40 000	17.28	16.39–18.17	14.90[**]	12.87–16.93	17.33[**]	15.19–19.48
40 000–79 999	27.69	26.58–28.80	14.15[*]	12.38–15.91	15.05	13.24–16.86
80 000–99 999	11.66	10.81–12.50	12.25	9.53–14.97	16.04[*]	13.07–19.00
100 000–149 999	20.76	19.67–21.85	13.02	11.13–14.90	14.69	12.53–16.84
150 000+	22.61	21.50–23.73	11.38[r]	9.48–13.28	12.51[r]	10.56–14.45
Education						
Less than high school	7.56	6.97–8.15	14.31[*]	10.90–17.72	12.99	9.94–16.04
Bachelor's degree or less	56.30	55.10–57.49	14.05[**]	12.88–15.22	15.89[**]	14.61–17.16
Greater than bachelor's degree	35.78	34.59–36.96	10.81[r]	9.51–12.10	13.04[r]	11.67–14.42
Place of residence						
Rural	17.51	16.79–18.23	11.55[r]	9.92–13.17	10.85[r]	9.30–12.40
Urban	82.49	81.77–83.21	13.20	12.23–14.17	15.45[***]	14.42–16.48
Employment						
Employed	62.75	61.58–63.92	12.62[r]	11.49–13.76	14.55[r]	13.34–15.76
Unemployed	37.25	36.08–38.42	14.87[*]	13.40–16.35	16.68[*]	15.08–18.27
Province of residence						
British Columbia	13.41	12.64–14.21	14.33	12.10–16.57	15.94	13.50–18.37
Alberta	11.41	10.73–12.13	15.20	12.72–17.69	17.58	15.06–20.10
Saskatchewan and Manitoba	6.17	5.85–6.50	13.81	12.04–15.58	16.48	14.63–18.33
Ontario	39.48	38.10–40.80	13.42	11.82–15.02	15.10	13.39–16.82
Quebec	22.88	21.80–23.90	9.00[***]	7.60–10.41	10.75[***]	9.21–12.30
Eastern[a]	6.49	6.20–6.79	15.50[r]	13.81–17.18	15.57[r]	13.87–17.27
Northern[b]	0.15	0.15–0.15	14.83	12.19–17.47	16.53	13.87–19.19
Minoritized[c]						
Yes	25.12	24.08–26.16	11.59	9.60–13.59	15.11	12.89–17.33
No	74.88	73.84–75.92	13.27[r]	12.35–14.18	14.48[r]	13.51–15.45

TABLE 1 (continued)

National prevalence of anxiety and depression symptoms by demographic and socioeconomic variables in the context of COVID-19 (September to December 2020), Canada

Variable	Total proportion of variables		Anxiety symptoms		Depression symptoms	
	%	95% CI	Prevalence (%)	95% CI	Prevalence (%)	95% CI
COVID-19 occupation: essential and frontline workers						
Considered essential worker						
Yes	50.04	48.45–51.63	12.61	10.96–14.26	13.85	12.09–15.61
No	49.96	48.37–51.55	12.14[r]	10.56–13.72	14.69[r]	12.98–16.41
Considered frontline (health care) worker						
Yes	11.63	10.58–12.68	17.48**	13.73–21.24	19.08**	15.25–22.92
No	88.37	87.32–89.42	11.81[r]	10.62–13.00	13.75[r]	12.48–15.02

Data source: Survey on COVID-19 and Mental Health 2020.

Abbreviations: CAD, Canadian dollars; CI, confidence interval; y, years.

Note: The PHQ-9 and GAD-7 were used to assess current (past two weeks) symptoms associated with major depressive disorder and generalized anxiety disorder. A positive screen on these scales occurs at a cut-point of 10.

[a] New Brunswick, Nova Scotia, Prince Edward Island, Newfoundland and Labrador.

[b] Yukon, Northwest Territories and Nunavut capital cities.

[c] The term "minoritized" is used to describe individuals whom systemic inequalities and oppression have placed in a "minority" status, rather than their own characteristics or numbers.

[r] Reference group.

* $p < 0.05$

** $p < 0.01$

*** $p < 0.001$

COVID-19 diagnosis categories and associations with anxiety and depression symptoms (study objective 2)

We examined the association between COVID-19 diagnosis categories (yes, no) and the presence of symptoms of anxiety and depression (met cut-point/did not meet cut-point) using odds ratios as shown in Table 2. There was not a statistically significant association between having received a COVID-19 diagnosis oneself, or any of the subsequent categories, and symptoms of anxiety and depression ($p > 0.05$).

COVID-19-related factors and association with positive screens for anxiety and depression symptoms (study objective 3)

Table 3 presents the prevalence and associated CIs of anxiety and depression symptoms corresponding to different negative COVID-19 experiences. Among Canadians that reported negative COVID-19 experiences, the experience associated with the highest prevalence of anxiety (71.08%; 95% CI: 67.84–74.32) and depression (74.14%; 71.19–77.10) symptoms was feelings of loneliness and isolation. Physical health problems related to COVID-19 had the next highest prevalence of anxiety (56.71%; 53.26–60.15) and depression (60.51%; 57.26–63.76) symptoms. The death

of a family member, friend or colleague had the least prevalence of anxiety (10.98%; 8.66–13.30) and depression (10.88%; 8.66–13.10) symptoms.

Table 4 presents the adjusted ORs for anxiety and depression symptoms, controlling for all covariates simultaneously. Unadjusted ORs are also included for comparison. The ORs are presented in relation to different negative COVID-19 experiences. In both unadjusted and adjusted analyses, each of the listed COVID-19 experiences demonstrated a statistically significant relationship with symptoms of anxiety and depression ($p < 0.05$). For both symptoms of anxiety and depression, physical health problems, loneliness and challenges in personal relationships with members of one's household had the largest ORs.

Discussion

In this study, we investigated the prevalence of anxiety and depression symptoms amid the COVID-19 pandemic, focussing on the specific characteristics of Canadians with elevated symptoms, including COVID-19 diagnosis and COVID-19-related adverse experiences, from September to December 2020. Our findings reinforce that there is a substantial mental health burden associated with the pandemic,[4,15,16] underlining the necessity to formulate comprehensive and strategic mental health interventions.

The results highlight variations in the prevalence of anxiety and depression symptoms across gender, age and socioeconomic strata, consistent with other pandemic-related studies.[17,18] Notably, an elevated prevalence of symptoms was detected among women and younger cohorts (aged 18–24 years). The literature suggests an increased gender-based susceptibility to adverse psychological outcomes, observable during the pandemic's periods of both elevated stress and recovery.[18,19] This may be due to a convergence of stressors such as traditional gender roles, parental responsibilities, labour disparities and a societal environment conducive to violence against women. The shift to home-schooling and the need to care for older individuals exacerbated the burden of care, borne predominantly by women.[20] Coupled with reduced support systems, these stressors likely worsened poor mental health outcomes in women. Additionally, the tendency of women to report symptoms more than men underscores the need for additional research to identify and address the factors contributing to these gender disparities.

The literature supports the notion that there has been an outsized impact of mental health challenges on young adults during the pandemic.[4,21] Complications unique to this group include educational and

TABLE 2

ORs, adjusted ORs, *p* values and 95% CIs for the associations between COVID-19 diagnosis categories and anxiety and depression symptoms

| | Anxiety symptoms[a] | | | | | | Depression symptoms[a] | | | | | |
| | Unadjusted | | | Age- and sex-adjusted | | | Unadjusted | | | Age- and sex-adjusted | | |
	OR	*p* value	95% CI	OR	*p* value	95% CI	OR	*p* value	95% CI	OR	*p* value	95% CI
You or anyone you know diagnosed with COVID-19	1.13	0.25	(0.92–1.38)	1.00	0.99	(0.81–1.23)	1.18	0.10	(0.97–1.43)	1.00	0.97	(0.82–1.23)
Yourself	0.83	0.77	(0.24–2.85)	0.86	0.81	(0.26–2.86)	1.37	0.48	(0.57–3.28)	1.44	0.40	(0.62–3.35)
Another household member	1.07	0.91	(0.36–3.15)	1.13	0.83	(0.38–3.33)	1.13	0.79	(0.45–2.82)	1.21	0.68	(0.48–3.07)
Close friend/family member outside household	1.03	0.87	(0.72–1.48)	1.00	1.00	(0.69–1.44)	1.26	0.20	(0.89–1.80)	1.22	0.28	(0.85–1.74)
Co-worker or colleague	1.22	0.35	(0.80–1.87)	1.23	0.34	(0.80–1.89)	1.43	0.08	(0.96–2.12)	1.35	0.14	(0.90–2.03)
Someone else interacted with in community	1.46	0.09	(0.94–2.28)	1.46	0.10	(0.94–2.27)	0.84	0.46	(0.52–1.34)	0.85	0.52	(0.53–1.37)
Other	0.93	0.77	(0.59–1.48)	0.92	0.72	(0.58–1.46)	0.85	0.44	(0.56–1.29)	0.88	0.55	(0.57–1.35)

Data source: Survey on COVID-19 and Mental Health, September to December 2020.

Abbreviations: CI, confidence interval; OR, odds ratio.

Notes: The first row in the table represents the global category "You or anyone you know diagnosed with COVID-19." Only respondents who answered "yes" to this question were subsequently asked about the specific categories of COVID-19 diagnosis listed in the remaining rows. The subcategories, therefore, overlap with the main category. Reference category is no diagnosis.

[a] The PHQ-9 and GAD-7 were used to assess current (past two weeks) symptoms associated with major depressive disorder and generalized anxiety disorder. A positive screen on these scales occurs at a cut-point of 10.

employment disruptions,[22] as is also highlighted in research focussed on youth.[23,24] However, how pandemic-related stressors exacerbate normative stressors associated with academic and professional transitions remains unclear. Nevertheless, a subset of young adults reported enhanced well-being in the initial phase of the pandemic, indicating an appreciation for decelerated lifestyles, increased leisure time for hobbies and personal growth and temporary relief from academic and climate change concerns.[25]

Despite these positives, emerging adulthood remains a period of vulnerability for the onset of mental health disorders. In the pandemic context, academic disruptions, economic hardships, social isolation, misinformation on social media and restricted access to physical activities have likely intensified the mental health challenges faced by young adults.[24,25]

Individuals with lower income or who were unemployed reported a higher prevalence of anxiety and depression symptoms, potentially linked to financial insecurities related to the pandemic. This is in contrast to some research that suggests interventions such as financial support and rent bans may have mitigated some mental

health impacts.[17] Geographical variations in symptom prevalence were also noted; Quebec experienced the fewest anxiety and depression symptoms, indicating potential regional differences in stressors or mental health resources availability.[26,27] Despite there being no significant difference in symptom prevalence between minoritized and nonminoritized groups, the influence of systemic disparities on mental health outcomes cannot be discounted.[28]

Our study highlighted occupational disparities related to the pandemic, revealing a higher prevalence of depressive and anxiety symptoms among frontline workers.

TABLE 3

Frequency of negative COVID-19 experiences in the general population, and with and without symptoms of anxiety[a] and depression[a]

| Negative COVID-19 experience factors | Total proportion | | No anxiety symptoms | | Anxiety symptoms | | No depression symptoms | | Depression symptoms | |
	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI
Physical health problems	23.94	(22.86–25.01)	19.07	(17.98–20.17)	56.71	(53.26–60.15)	17.60	(16.55–18.64)	60.51	(57.26–63.76)
Feelings of loneliness/isolation	37.67	(36.49–38.85)	32.63	(31.40–33.87)	71.08	(67.84–74.32)	31.34	(30.13–32.55)	74.14	(71.19–77.10)
Challenges in personal relationships with members of your household	17.86	(16.92–18.80)	13.83	(12.91–14.75)	45.02	(41.57–48.46)	13.55	(12.66–14.44)	42.70	(39.30–46.10)
Difficulty with financial obligations/essential needs	15.42	(14.49–16.34)	12.52	(11.62–13.42)	34.23	(30.96–37.49)	12.20	(11.29–13.10)	33.67	(30.46–36.88)
Death of family/friend/colleague	6.04	(5.46–6.62)	5.26	(4.69–5.82)	10.98	(8.66–13.30)	5.22	(4.65–5.79)	10.88	(8.66–13.10)
Loss of job/income	25.49	(24.38–26.59)	23.75	(22.58–24.93)	36.85	(33.45–40.26)	23.38	(22.19–24.56)	37.43	(34.06–40.80)

Data source: Survey on COVID-19 and Mental Health, September to December 2020.

Abbreviation: CI, confidence interval.

[a] The PHQ-9 and GAD-7 were used to assess current (past two weeks) symptoms associated with major depressive disorder and generalized anxiety disorder. A positive screen on these scales occurs at a cut-point of 10.

TABLE 4
Unadjusted and adjusted[a] ORs for a positive screen of anxiety and depression symptoms, by negative COVID-19 experience factor, with 95% CIs

Negative COVID-19 experience factors	Anxiety symptoms		Depression symptoms	
	Unadjusted OR (95% CI)	Adjusted[a] OR (95% CI)	Unadjusted OR (95% CI)	Adjusted[a] OR (95% CI)
Physical health problems	**5.55 (4.74–6.50)**	**5.19 (4.34–6.19)**	**7.17 (6.16–8.35)**	**6.77 (5.72–8.01)**
Age 18–44[b]	n/a	**4.66 (3.60–6.04)**	n/a	**5.45 (4.21–7.06)**
Age 45+ [b]	n/a	**6.16 (4.86–7.80)**	n/a	**8.57 (6.74–10.88)**
Feelings of loneliness/isolation	**5.07 (4.29–5.99)**	**4.43 (3.67–5.35)**	**6.28 (5.32–7.40)**	**6.49 (5.41–7.79)**
Challenges in personal relationships with members of your household	**5.10 (4.34–5.99)**	**4.60 (3.81–5.55)**	**4.75 (4.05–5.57)**	**4.46 (3.71–5.36)**
Difficulty with financial obligations/essential needs	**3.63 (3.08–4.28)**	**3.10 (2.53– 3.80)**	**3.65 (3.10–4.30)**	**3.52 (2.91–4.26)**
Death of family/friend/colleague	**2.22 (1.71–2.88)**	**1.98 (1.47–2.66)**	**2.21 (1.71–2.86)**	**2.03 (1.52–2.72)**
Age 18–44[b]	n/a	**2.19 (1.36–3.54)**	n/a	n/a
Age 45+ [b]	n/a	**1.80 (1.22–2.66)**	n/a	n/a
Loss of job/income	**1.87 (1.59–2.19)**	**1.53 (1.27–1.83)**	**1.96 (1.67–2.29)**	**1.80 (1.51–2.14)**

Data source: Survey on COVID-19 and Mental Health, September to December 2020.

Abbreviations: CI, confidence interval; n/a, not applicable; OR, odds ratio.

Notes: Reference group is those who answered "no" to having had these experiences. Bold font indicates statistical significance ($p < 0.05$).

[a] Adjusted for sex, household living arrangements, place of residence, employment, minoritization, income, education, province of residence and collection method.

[b] In cases where there were interactions, the models are stratified by age rather than adjusted for age.

However, counterintuitively, health care workers who directly engaged with COVID-19 patients reported lower stress levels than those in non-COVID-19 units.[29] This may suggest that the uncertainty surrounding the pandemic induced greater stress than direct disease exposure, the latter possibly fostering better coping strategies through increased awareness. Increased anxiety symptoms were also noted among individuals in contact with people diagnosed with COVID-19. Theories of crisis, personal construct and adult models of anxiety provide a lens to interpret these findings, pointing to a perceived threat response triggered by the lack of control and predictability in the pandemic's early stage.[30-32]

Moreover, we found that respondents with physical health problems were significantly more likely to report depressive and anxiety symptoms. This is in line with the disruptions in health care delivery during the pandemic, potentially exacerbating pre-existing chronic conditions.

We further observed intriguing trends, whereby loneliness was strongly associated with symptoms of depression and anxiety, but solitary living was not (for anxiety symptoms). The data underscore the importance of distinguishing between objective social isolation and subjective feelings of loneliness when formulating interventions to improve mental health outcomes. Programs aimed at mitigating feelings of loneliness through social skills training and fostering meaningful connections may offer more benefit than simply increasing the number of social interactions during crisis periods.[33,34]

Strengths and limitations

This study utilized a nationally representative dataset, capturing a broad demographic range across Canada. This approach allowed for an exhaustive examination of the relationship between COVID-19-related experiences and the national prevalence of anxiety and depression symptoms. Overcoming the limitations of prior research, which was encumbered by varied sampling frames, inconsistent data collection methods and a reliance on public opinion data, this study provides insights into patterns of prevalence of anxiety and depression symptoms during the COVID-19 pandemic.[35]

Despite these strengths, it is essential to acknowledge inherent limitations. For instance, the cross-sectional survey design restricted our ability to formulate definitive conclusions about the pandemic's mental health impacts, and cannot support causal inference. Measurement errors may have arisen due to the study's reliance on self-reported data and retrospective recall.

Although the study's framework allows for the identification of associations, it falls short in drawing causal inferences. Therefore, we suggest that future longitudinal investigations be pursued to provide more nuanced insights into the temporal patterns and causal relationships between experiences during public health emergencies and mental health outcomes. Additionally, the study excludes subpopulations, including those experiencing homelessness, residents of First Nations reserves and individuals residing in institutions, that may endorse the highest prevalence of anxiety and depression symptoms.

The study's design also did not account for the potential influence of multiple exposures to COVID-19 diagnoses, or the severity of the disease experienced by diagnosed individuals. It overlooked the effect of overlapping personal diagnosis experiences and knowledge of others' diagnoses. These factors could alter the psychological response to the pandemic, limiting an accurate assessment of its mental health impacts. The study did not incorporate respondents' pre-existing mental health status, a key component in understanding their mental health responses to the pandemic. And, despite both being linked to negative COVID-19 experiences,

the concepts of loneliness and social isolation—commonly understood as the subjective feeling of being alone and the objective state of an individual's social environment, respectively—are not equivalent; however, they were grouped in the SCMH data, which may complicate interpretation.

Finally, it must be noted that the findings of this study are specific to the general population during the early stages of the pandemic and do not include subsequent significant developments, such as the emergence of new variants and the introduction of vaccines. This context must be considered when considering the applicability and implications of the study's findings.

Conclusion

The aim of this study was to explore the prevalence and characteristics of reported anxiety and depression symptoms among Canadians from September to December 2020, focussing on those with COVID-19 diagnoses and COVID-19-related adversities. Using the SCMH, the study suggests important mental health implications arising from the pandemic and points to disparities across various demographic subgroups.

The findings suggest a potential mental health burden from the pandemic, with signs of increased vulnerabilities indicated among women, younger individuals (aged 18–24 years) and lower-income groups. Regional differences may also suggest local stressors or potential gaps in mental health resources. While a direct association between COVID-19 diagnosis and heightened anxiety or depression symptoms was not clearly established, the data do suggest a strong relationship with negative COVID-19 experiences, highlighting the need for more comprehensive mental health approaches. Variations across age groups, professional sectors and diverse communities offer insight into the heterogeneous influence of the pandemic.

Though resilience is often observed following disasters, with many individuals avoiding psychopathology and some even discovering new strengths, this study suggests the need for a more nuanced and targeted approach to mental health that extends beyond the immediate physical health impacts of the pandemic. It emphasizes the importance of continued research and monitoring to better understand the enduring mental health implications of the COVID-19 pandemic as a persisting health concern.

Conflicts of interest

The authors have no conflicts of interest to declare.

Authors' contributions and statement

AM, SR, JVAW, SBP—conceptualization.

AM, JVAW, AGMB, SBP, SR—methodology.

SR, JVAW, SBP—data curation.

GD, SBP—supervision.

SR, GD, JVAW, VS, MF, AM, AGMB, SBP—formal analysis.

SR, VS, MF, GD, AGMB, SBP—verification.

SR, SBP, GD—writing—original draft.

SR, GD, JVAW, VS, MF, AM, AGMB, SBP—writing—review and editing.

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

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Commentary

Defining the role of digital public health in the evolving digital health landscape: policy and practice implications in Canada

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Abstract

In this article, we argue that current digital health strategies across Canada do not appropriately consider the implications of digital technologies (DTs) for public health functions because they adopt a primarily clinical focus. We highlight differences between clinical medicine and public health, suggesting that conceptualizing digital public health (DPH) as a field distinct from, but related to, digital health is essential for the development of DTs in public health. Focussing on DPH may allow for DTs that deeply consider fundamental public health principles of health equity, social justice and action on the social and ecological determinants of health. Moreover, the digital transformation of health services catalyzed by the COVID-19 pandemic and changing public expectations about the speed and convenience of public health services necessitate a specific DPH focus. This imperative is reinforced by the need to address the growing role of DTs as determinants of health that influence health behaviours and outcomes. Making the distinction between DPH and digital health will require more specific DPH strategies that are aligned with emergent digital strategies across Canada, development of intersectoral transdisciplinary partnerships and updated competencies of the public health workforce to ensure that DTs in public health can improve health outcomes for all Canadians.

Keywords: digital public health, digital transformation, digitalization, public health, health equity

Introduction

The World Health Organization (WHO) defines digital health as "a broad umbrella term encompassing eHealth (which includes mHealth), as well as emerging areas, such as the use of advanced computing sciences in 'big data,' genomics and artificial intelligence".[1,p.1] In Canada, digital health is considered a broad field leveraging digital technologies (DTs) across clinical and community care, to optimize health outcomes and ensure connected, convenient, efficient and cost-effective person-centred care. With the expansion of digital health during the COVID-19 pandemic, many Canadian jurisdictions launched digital health strategies covering various health specialties, including public health.[2] Most strategies emphasized the patient-provider-health systems

interface, giving patients greater access to and control of their health data, while addressing longstanding issues such as access to primary care and wait times for specialist care.[2,3] The Pan-Canadian Health Data Strategy was also launched to address requirements for common data policy frameworks and interoperability standards to allow data sharing.[3] However, these strategies adopt overtly clinical perspectives, with none explicitly considering the role of DTs in public health.

Since 2017, when Public Health England launched its "digital first" strategy, the term "digital public health" (DPH) has been used to describe a distinct practice involving the application of DTs in public health functions.[4,5] During the pandemic, this practice gained popularity, with utilization

of DTs such as data analytics and dashboards for real-time disease surveillance, social media for health promotion and communication and apps such as Canada's COVID Alert for infectious disease exposure notification and contact tracing.[6,7]

In our team's scoping review of DPH, we found inconsistencies in its conceptualization and definition.[8] Practitioners and researchers have either considered DPH as a tool to achieve existing public health

Highlights

- Current and emergent digital health strategies in Canada have not fully accounted for the application of digital technologies in achieving public health goals.
- A digital public health framing as a practice distinct from, but related to, digital health allows the public health workforce to develop digital technologies that will achieve public health goals while addressing contemporary challenges facing the field.
- The emergence of digital technologies as a determinant of health and health behaviours strengthens the argument for a digital public health framing and requires the public health workforce to develop new expertise to address both new and longstanding determinants of health.

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goals, or as a response to wider societal digital transformation that demands a more fundamental integration of DTs with public health functions centred on the needs of communities and populations.[8,9] However, DPH's relevance to supporting public health efforts while upholding fundamental public health principles remains uncontested.[4,7] While DPH is subsumed within digital health discourse in Canada despite its increasing prominence, we must consider the policy and practice benefits to be accrued from focussing on DPH as a distinct field alongside digital health.

The current vague distinction between DPH and digital health reflects similar ambiguities between clinical medicine and public health.[10] Clinical medicine emphasizes diagnosis and treatment of individuals, with responsibility to patients, albeit tempered by an awareness of their social contexts and health conditions.[11] In contrast, public health focusses on the health of communities (at a population level), emphasizing health promotion, protection and prevention.[11,12] Clinical medicine and public health are complementary fields with overlapping functions such as immunization, lifestyle modification (especially for chronic diseases) and disease screening.[10] These overlaps may explain the current subsuming of DPH within digital health.[1,2] Practitioners and researchers have also struggled to distinguish digital health from digital public health interventions.[13]

The case for a distinction between digital health and DPH

Differentiating DPH from digital health can help public health practitioners articulate and operationalize fundamental public health principles of health equity, social justice, ethics and action to address social and ecological determinants of health within their digital interventions.[7,14] Many COVID-19 digital interventions were created using solely digital health perspectives in their design, implementation and evaluation, with public health principles being applied as an afterthought.[14] While digital health interventions may be beneficial at the individual level, these benefits do not necessarily translate to equitable improvements in population-level health outcomes. Moreover, differences in digital access and literacy often determine the population subgroups that benefit from generically designed digital health technologies. We appreciate recent pivots in the digital health discourse to include health equity.[14] However, the inherent

responsibility to the patient underscored in the digital health (clinical) approach suggests health equity remains a secondary focus.

Further, "digital transformation" is a process accompanied by widespread societal adoption of DTs that influence health behaviours, access to health resources and health outcomes.[9] These influences are recognized as "digital determinants of health," and affect individual lifestyle, social, cultural and environmental determinants of health.[15] This recognition expands previous, narrower views of digital determinants as being restricted to inequities in access to digital health interventions (i.e. differences in digital literacy and access) to include an understanding of how DTs are inequitably distributed in other facets of life, with direct and indirect effects on public health outcomes. The 2022 "NyQuil chicken challenge" (a popular trend in which social media users cooked and ingested chicken bathed in over-the-counter cold and flu medication) also demonstrates the public health risks DTs can pose and highlights the added health protection functions they require.[16] Focussing on DPH can help public health researchers and practitioners develop the methods, skills and competencies required to understand the ramifications of digital determinants of health, while addressing them using fundamental public health principles. Such framings can also contribute to wider digital health interventions, especially interventions that consider health equity and social justice in their design, implementation and uptake, as universal interventions have been demonstrated to widen inequities.[7]

Moreover, widespread digital transformation has resulted in changing public expectations of public health services, which must ensure fast, responsive and convenient access to health information and services that are centred on their needs. These changing expectations are accompanied by new approaches to public health surveillance, with increased availability of new and diverse big datasets both within and outside of public health systems. Therefore, early and active participation of public health practitioners in the development of DPH can support resource allocation and development of nimble organizational processes to ensure that digital transformation of public health services appropriately optimizes public health outcomes.[9] In our scoping review, we also found that conceptualizing DPH

as a product of digital transformation requires practitioners and decision makers to embrace goals for interoperable, scalable and sustainable people-centred digital systems.[8]

Some may argue that distinguishing between digital health and DPH may be impractical and potentially perpetuates siloed programs and interoperability challenges limiting the potential impacts of DTs on health outcomes.[3] DTs may also help transition health care from curative to preventive medicine, obscuring the demarcations between digital health and DPH.[4] This transition towards preventive medicine through digital health might imply significantly greater contributions of public health practitioners to health interventions, with better resource allocation to achieve public health objectives. However, given inherent differences between DPH and digital health (Table 1), we anticipate that a broad view would result in inadequate attention to public health goals and functions.

Policy and practice implications

Distinguishing between digital health and DPH has policy and practice implications, especially in Canada. Most emerging digital health strategies have a mainly clinical focus, only implicitly acknowledging the public health implications of DTs. Perhaps due to the provincial and territorial organization of health care, Canada has yet to develop a national digital health strategy—a key recommendation of the WHO global strategy for digital health.[1] A DPH focus may inform strategies that advance the digital agenda in public health, applying systems thinking and approaches that ensure holism and perhaps a national strategy not only for harnessing health data but also for applying DTs to public health functions. Public health practitioners can also develop intersectoral and transdisciplinary partnerships (including partnerships with private sector organizations) to design and implement such strategies.[3] Such strategies must consider public health perspectives in creating standardized ethical, regulatory and legal frameworks that are required not only to improve health equitably, but also to protect privacy and ensure the ethical use of available data.

While distinct, DPH strategies should be aligned and integrated with broader digital health strategies to fill gaps identified from a public health perspective. Such

TABLE 1
Differences between digital health and digital public health

Dimension	Digital health	Digital public health
Perspective	Individual health with a focus on more efficient and effective care, while empowering individuals to participate more actively in person-centred care.	Population and public health perspective, focussing on improving health outcomes for populations through targeted interventions that are efficient, effective and people-centred.
Context	Mainly clinical context but may follow patients outside clinical contexts and into the community.	Mainly community context but may rely on data from clinical services to track and optimize health outcomes for specific populations.
Interventions	Individual and systems-level interventions including web-based apps, mobile apps, electronic health records (including personal health records) that enable easy and cost-effective access to health services.	Mainly community and systems-level interventions using similar technologies that aim to speed up (or automate) collection, collation and analysis of data for surveillance and public health assessments and facilitate targeted health promotion at a community/population level. May draw on clinical data to achieve these goals. Also includes community-informed interventions including apps tracking environmental exposures and geographic systems tracking disease incidence/prevalence rates.
Prioritization of health equity	Focus is on improving patients' health outcomes. Although health equity is prioritized, interventions are effective on a case-by-case basis. Equity discourse may focus on ensuring accessibility through adaptations where necessary, but interventions are not necessarily considered unsuccessful if these adaptations are not implemented or do not work.	Focus is on improving health outcomes for **all**. This implies that equity is a central goal of these interventions, which may be considered unsuccessful if they fail to facilitate this goal.

alignment might reduce the risk of siloed, vertical digital interventions that characteristically fail to meet public health goals. We must also evaluate the use of DTs within communities and populations, exploring and addressing their influence on public health behaviours as a health protection function. This perspective is largely missing from current discourse within digital health. Finally, the public health workforce must be better prepared to harness opportunities and address threats that DTs pose to public health. Competency frameworks must be updated to ensure the ever-expanding digital health and non-health data necessary for decision making for public health are better used to improve public health outcomes.[3,9]

Conclusion

Distinctions between digital health and DPH are needed. Digital transformation spurred by the COVID-19 pandemic, changing public expectations about the delivery of health services, the increasing role of DTs in the determination of health and the threats they pose to population and public health in specific circumstances provide additional impetus for practitioners and decision makers to consider a specific focus on DPH. Explicit DPH strategies are needed to harness largely untapped potentials for DTs in public health. These strategies must be aligned with existing digital health strategies, drawing on cross-sectoral and interdisciplinary partnerships that emphasize evidence-based approaches to ensure health for all.

Acknowledgements

Conflicts of interest

The authors declare no competing interests.

Authors' contributions and statement

II, MG—conceptualization and literature review.

II—writing—original draft.

II, GM, DH, MG—formal analyses, writing—review & editing.

MG—supervision.

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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Release notice

Suicide Surveillance Indicator Framework Quick Stats and Data Tool, cycles 3 and 4

Gabriela Williams, MSc; Hongbo Liang, MD, PhD

The Suicide Surveillance Team of the Public Health Agency of Canada (PHAC) is pleased to announce the release of the third and fourth cycles of the Suicide Surveillance Indicator Framework (SSIF) Quick Stats and its Data Tool.

The SSIF update follows government objectives and legislation under the Federal Framework for Suicide Prevention, which requires making statistics publicly available every two years about suicide and related risk factors.

The SSIF Quick Stats includes overall rates and estimates for outcomes and risk and protective factors of suicide. The SSIF Data Tool contains disaggregated data for the four cycles of the SSIF (2017, 2019, 2021 and 2023) by socioeconomic and demographic factors.

These data are derived from administrative sources—such as the Canadian Vital Statistics - Death database (CVS-D), the Discharge Abstract Database (DAD) and the Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP)—and from survey data—such as the Canadian Community Health Survey (CCHS), the General Social Survey (GSS) and the Health Behaviour in School-aged Children (HBSC) study.

Crisis lines are an important indicator of current need of vulnerable populations for access to help. As such, three new sources of data from crisis lines were incorporated into this update of the SSIF: Kids Help Phone, Talk Suicide Canada and the Canadian Surveillance System for Poison Information (CSSPI).

The SSIF Quick Stats and Data Tool can be accessed on the PHAC Infobase website (https://health-infobase.canada.ca/ssif).

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Call for papers: Generating stronger evidence to inform policy and practice: natural experiments on built environments, health behaviours and chronic diseases

Guest editors: Dr. Stephanie Prince Ware (Public Health Agency of Canada), Dr. Gavin McCormack (University of Calgary)

HPCDP Journal Editors: Robert Geneau and Margaret de Groh (Public Health Agency of Canada)

Where we work, learn, play, eat and live has important implications for health. The built environment has been associated with the development of chronic disease, and with health behaviours often seen as critical pathways for this relationship.[1,2] Built environments refer to components of the physical environment that are human-made or human-modified and include structures and buildings, recreation facilities, green spaces and parks, transportation systems and community design.

Natural experiments are interventions that occur without a researcher's ability to manipulate the intervention or exposure to the intervention.[3,4] Natural experiments offer the opportunity to evaluate the effects of "naturally occurring" interventions such as changes to the built environment (e.g. creation of a new bike path, park improvements, infrastructure changes to schools or workplaces, construction of a new recreation facility or grocery store) on health behaviours and chronic disease risk. Natural experiments are often more practical for investigating the health impacts of environmental interventions when compared to traditional experimental studies (e.g. randomized controlled trials). Compared to cross-sectional studies, natural experiments provide a means to generate rigorous evidence to better establish causality, as well as to understand the implementation of interventions in "real-world" scenarios.

This special issue answers the 2017 Canadian Public Health Officer annual report's call to further evaluate the health impacts of community design features in Canada.[5] This special issue resonates with the expanding scholarly and policy-oriented interest in the utility of natural experiments as a critical tool in advancing the body of evidence and for informing interventions to improve public and population health.[6,7] Specifically, the objective of this special issue on natural experiments is to provide timely evidence to further understand the effectiveness of built environment interventions on health behaviours and chronic disease prevention in a Canadian context.

Health Promotion and Chronic Disease Prevention in Canada: Research, Policy and Practice is seeking relevant topical research articles that present new findings or synthesize/review existing evidence on natural experiments of the built environment (or related policies) that influence health behaviours with implications for chronic disease prevention in Canada.

Relevant topic areas include, but are not limited to:

- Built environments, including community or neighbourhoods, workplaces, schools, transportation infrastructure, home environments, recreation environments, parks, playgrounds, green spaces, public open spaces, natural environments and seniors' residences.

- All health-related behaviours, including physical activity, sedentary behaviour, sleep, food consumption, smoking and substance use.

- Chronic diseases and health-related outcomes, including body mass index, fitness, blood pressure, blood lipids, blood sugar, injuries, falls, mental health, stress, depression, anxiety, Alzheimer's disease, dementia, obesity, metabolic syndrome, cardiovascular disease, cancer, diabetes and lung disease.

International submissions will be considered if they include Canadian data, results (e.g. as part of multi-country studies or global comparisons) and/or evidence-based discussion of implications for community or population health in Canada.

Consult the Journal's website for information on article types and detailed submission guidelines for authors. Kindly refer to this call for papers in your cover letter.

All manuscripts should be submitted using the Journal's ScholarOne Manuscripts online system. Pre-submission inquiries and questions about suitability or scope can be directed to HPCDP.Journal-Revue.PSPMC@phac-aspc.gc.ca.

Submission deadline: November 30, 2024

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Other PHAC publications

Researchers from the Public Health Agency of Canada also contribute to work published in other journals and books. Look for the following articles published in 2023:

Bird M, Barnett TA, Fuller D, et al. Multidimensional school features associated with physical activity among youth at risk of obesity: an exploratory principal component and generalized estimating equation analysis. BMC Public Health. 2023;23(1):2010. https://doi .org/10.1186/s12889-023-16889-w

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