



# Regional differences in movement behaviours of children and youth during the second wave of the COVID-19 pandemic in Canada: follow-up from a national study

Hilary A.T. Caldwell<sup>1</sup> · Guy Faulkner<sup>2</sup> · Mark S. Tremblay<sup>3,4</sup> · Ryan E. Rhodes<sup>5</sup> · Louise de Lannoy<sup>3</sup> · Sara F.L. Kirk<sup>1,6</sup> · Laurene Rehman<sup>6</sup> · Sarah A. Moore<sup>1,6</sup>

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## Abstract

**Objectives** Public health restrictions varied by region during the COVID-19 pandemic and reduced opportunities for children to be physically active. The purpose of this study was to assess regional differences in movement behaviours of Canadian children and youth during the second wave of the COVID-19 pandemic.

**Methods** A national sample of Canadian parents ( $n=1568$ ; 58% women) of children and youth (5–17 years of age) completed an online survey. Participants were classified based on region of residence (British Columbia, Prairies, Ontario, Quebec, or Atlantic Canada). Differences in movement and play behaviours (physical activity, outdoor play, sleep, screen time) between children and youth living in different regions were examined.

**Results** Compared to children and youth in Quebec (the region with the highest COVID-19 prevalence), children and youth in the Prairies ( $F_{(1,1563)}=9.0, p=0.01$ ) and Atlantic Canada ( $F_{(1,1563)}=17.1, p<0.001$ ) participated in more moderate-to-vigorous physical activity (MVPA). Compared to Quebec, living in Atlantic Canada increased the odds of meeting the MVPA guideline (odds ratio (OR)=2.1,  $p=0.02$ ), living in Ontario decreased the odds of meeting the sleep guideline (OR=0.6,  $p=0.01$ ), and living in Ontario (OR=0.7,  $p=0.04$ ) or Atlantic Canada (OR=0.6,  $p=0.049$ ) decreased the odds of meeting the screen time guideline. Children and youth in Atlantic Canada demonstrated smaller declines in outdoor play than their counterparts in Quebec.

**Conclusion** Movement and play behaviours varied between regions of Canada where the highest COVID-19 prevalence corresponded to lower odds of meeting the physical activity guidelines. Low compliance with 24-hour movement guidelines suggests that regional pandemic recovery plans need to prioritize opportunities for healthy movement.

## Résumé

**Objectifs** Les restrictions sanitaires ont varié d'une région à l'autre durant la pandémie de COVID-19, et elles ont réduit les possibilités pour les enfants d'être actifs. Notre étude visait à évaluer les différences régionales dans les comportements liés au mouvement des enfants et des jeunes canadiens au cours de la deuxième vague de la pandémie.

**Méthode** Un échantillon national de parents canadiens ( $n = 1\ 568$ ; 58 % de femmes) d'enfants et de jeunes (5–17 ans) ont répondu à un sondage en ligne. Les participants ont été classés selon leur région de résidence (Colombie-Britannique, Prairies, Ontario, Québec ou Canada atlantique). Les différences dans les comportements liés au mouvement et au jeu (activité physique, jeu à l'extérieur, sommeil, temps d'écran) entre les enfants et les jeunes de différentes régions ont été examinées.

✉ Sarah A. Moore  
sarah.moore@dal.ca

<sup>1</sup> Healthy Populations Institute, Dalhousie University, Halifax, NS, Canada

<sup>2</sup> School of Kinesiology, University of British Columbia, Vancouver, BC, Canada

<sup>3</sup> Children's Hospital of Eastern Ontario Research Institute, Ottawa, ON, Canada

<sup>4</sup> Department of Pediatrics, University of Ottawa, Ottawa, ON, Canada

<sup>5</sup> Behavioural Medicine Laboratory, School of Exercise Science, Physical and Health Education, University of Victoria, Victoria, BC, Canada

<sup>6</sup> School of Health and Human Performance, Dalhousie University, Stairs House, 6230 South Street, Halifax, NS B3H 1T8, Canada

**Résultats** Comparativement aux enfants et aux jeunes du Québec (la région qui présentait la plus forte prévalence de COVID-19), les enfants et les jeunes des Prairies ( $F_{(1,1563)} = 9,0, p = 0,01$ ) et du Canada atlantique ( $F_{(1,1563)} = 17,1, p < 0,001$ ) ont fait plus d'activité physique modérée à vigoureuse (APMV). Comparativement au Québec, le fait de vivre au Canada atlantique a accru la probabilité de respecter les lignes directrices sur l'APMV (rapport de cotes (RC) = 2,1,  $p = 0,02$ ), le fait de vivre en Ontario a réduit la probabilité de respecter les lignes directrices sur le sommeil (RC = 0,6,  $p = 0,01$ ), et le fait de vivre en Ontario (RC = 0,7,  $p = 0,04$ ) ou au Canada atlantique (RC = 0,6,  $p = 0,049$ ) a réduit la probabilité de respecter les lignes directrices sur le temps d'écran. Les enfants et les jeunes du Canada atlantique ont présenté des baisses moins importantes du jeu à l'extérieur que les enfants et les jeunes du Québec.

**Conclusion** Les comportements liés au mouvement et au jeu ont varié d'une région à l'autre du Canada; là où la prévalence de la COVID-19 était la plus élevée, la probabilité de respecter les lignes directrices sur l'activité physique était la plus faible. La faible conformité aux lignes directrices sur le mouvement sur une période de 24 heures donne à penser que les plans de rétablissement régionaux après la pandémie devront accorder la priorité aux possibilités de mouvement sain.

**Keywords** Physical activity · Outdoor play · Sedentary behaviour · Sleep · Children and youth · Public health restrictions

**Mots-clés** Exercice physique · jeu à l'extérieur · mode de vie sédentaire · sommeil · enfants et jeunes · restrictions sanitaires

## Introduction

COVID-19 has greatly impacted the health, societal, and economic well-being of Canadians since it was declared a pandemic by the World Health Organization (WHO) on March 11, 2020 (World Health Organization, 2020). During the first wave of COVID-19, restrictive public health measures were implemented by federal, provincial/territorial, and local governments to slow the spread of the virus (Public Health Agency of Canada, 2020). In some provinces, these restrictions limited access to indoor recreation facilities, as well as outdoor fields, green spaces, and parks. As a result, opportunities for children and youth to engage in healthy movement behaviours (e.g., ample physical activity, low sedentary behaviour) were constrained in ways that were likely to vary across different jurisdictions. In April 2020, a national sample of Canadian parents reported declines in their children and youth's physical activity, particularly outdoor physical activity, sport, and play, and increased sedentary behaviour, particularly leisure screen time, and social media use (Moore et al., 2020). Because COVID-19 and the public health measures implemented to limit the spread have varied substantially between regions of Canada, so too have the movement and play behaviours of children and youth (de Lannoy et al., 2020; Mitra et al., 2020). For example, during the first wave of the pandemic, children in Ontario, the region with the second highest case load of COVID-19 at the time, exhibited the greatest declines in time spent outdoors and in outdoor play (de Lannoy et al., 2020). The declines in physical activity and outdoor play and increases in sedentary behaviour are worrisome given Canadian children and youth were participating in low levels of physical activity and high levels of screen time before the pandemic (Statistics Canada, 2019). In addition, there are established physical and mental health benefits of

increasing physical activity, limiting sedentary behaviours (including screen time), and meeting age-appropriate amounts of sleep for children and youth (Saunders et al., 2016; Tremblay et al., 2016).

In October 2020, COVID-19 cases were on the rise again in Canada and a second wave was declared (Tasker, 2020). Despite increasing case counts across the country, the fall lockdowns were not as strict as in the spring, and many parks, outdoor recreation spaces, and sport facilities remained open (albeit with new regulations and protocols) (Outdoor Play Canada, 2020). However, public health restrictions varied substantially according to region (Public Health Agency of Canada, 2020). For example, in October 2020, up to 50 people were permitted to gather for organized sports, without physical distancing, in Nova Scotia, while in certain regions of Ontario team sport games or scrimmages were prohibited (Government of Nova Scotia, 2020; Ontario Ministry of Heritage, Sport, Tourism and Culture, 2020). The loosening of COVID-19 public health restrictions in summer and fall 2020 in some regions of Canada may have facilitated greater opportunities for physical activity, movement, and play (e.g., playgrounds re-opened, sports returned to play, schools returned to in-person instruction). The public health restrictions imposed during Canada's second wave seemed to generally provide more opportunities for Canadian children and youth to be physically active and play outdoors compared to during the first wave.

Given the differences in COVID-19 case numbers and varied public health restrictions by region in Canada, the purpose of this study was to describe regional differences in parent-reported child and youth movement and play behaviours during the beginning of the second wave of COVID-19. We hypothesized that children and youth who lived in regions with fewer public health restrictions (i.e., Atlantic Canada)

would have engaged in more physical activity and outdoor play, and less sedentary time than their counterparts in regions with more severe public health restrictions (i.e., Ontario and Quebec). The secondary purpose was to explore differences in movement and play behaviours between children living in urban versus rural areas. For this purpose, we hypothesized that children and youth living in rural settings would experience smaller declines in outdoor play than children and youth living in urban settings.

## Methods

### Study design and population

ParticipACTION, a Canadian charitable not-for-profit organization promoting physical activity ([www.participaction.com](http://www.participaction.com)), conducted a survey assessing changes in children and youth movement behaviours during the COVID-19 outbreak in spring 2020 (Moore et al., 2020). In fall 2020, similar methods were used to again recruit a cross-sectional sample of 1568 parents of Canadian children and youth aged 5–17 years (Moore et al., 2021). This secondary data was conducted to assess regional differences in movement and play behaviours. This analysis was approved by the Dalhousie University Health Sciences Research Ethics Board (#2020-5351).

### Survey development

Healthy movement behaviours for children and youth were defined according to the Canadian 24-Hour Movement Guidelines for Children and Youth (Tremblay et al., 2016). Key content areas were developed by applying a socioecological framework which considers several areas of influence (e.g., interpersonal, parental, environmental) that interact to influence behaviours, such as physical activity (Stokols, 1996). The survey included parental and child demographics and information on geographic location, current movement behaviours (i.e., current levels of physical activity, outdoor play, sedentary behaviour, screen time, and sleep), and changes in children's movement and play behaviours from pre-pandemic, and parental support for their child's movement and play behaviours. The survey demonstrated good test-retest reliability (Moore et al., 2020, 2021). Selected items were used in this secondary analysis (Tables 2, 3, and 4).

### Survey content

Respondents provided parental and child demographic information (e.g., age, gender, ethnicity, geographic region by 6-digit postal code). Parents assessed their child's current movement behaviours (i.e., physical activity, sedentary behaviour,

sleep from the last week). The movement behaviour questions were adapted from the Canadian Health Measures Survey (Tremblay and Gorber, 2007). They were subsequently asked to compare their child's movement and outdoor play behaviours before and during the COVID-19 outbreak. Responses were reported using a 5-point Likert-type scale, ranging from "a lot less" (score = 1) to "no change" (score = 3) to "a lot more" (score = 5). If parents perceived their child to be doing the same amount of the behaviour as before the COVID-19 pandemic (i.e., that their child's behaviour had not changed due to the pandemic), the parent selected 3. If parents perceived their child to be doing more, or a lot more, of the behaviour during as compared with before the pandemic, the parent selected 4 or 5, respectively. Finally, if parents perceived their child to be doing less, or a lot less, of the behaviour during as compared with before the pandemic, the parent selected 2 or 1, respectively.

### Data collection

In the third week of October 2020, eligible participants were invited to complete an online survey (in English or French). Maru/Matchbox, a market research company, distributed the survey. Maru/Matchbox provides a small incentive (\$0.05 to \$3.00CDN) for completing the survey. This sampling strategy is commonly used by national organizations and researchers given the ability to recruit large, diverse samples from across Canada. During recruitment, the sample was stratified by gender and age of the child (families with a child aged 5–11 years and families with a youth aged 12–17 years), and region of Canada. Potential participants were screened out if they or their child had been diagnosed with COVID-19 or if the family was in self-isolation or quarantine due to COVID-19. Potential respondents were sent an email link to the survey, which required approximately 15 min to complete. Parents with more than one child were asked to think of the child whose given name came first alphabetically and to use that child as the referent for the survey (i.e., the index child). After data collection was complete, a cleaned dataset (.csv file) was received and further data cleaning and verification was completed by the study's primary investigators (e.g., data checking for implausible values).

### Regions

To address our primary aim and determine the regional differences in movement behaviours, participants were categorized into five Canadian regions based on their reported province of residence: British Columbia, Prairies (Alberta, Saskatchewan, Manitoba), Quebec, Ontario, and Atlantic Canada (New Brunswick, Nova Scotia, Prince Edward Island, and Newfoundland and Labrador), similar to our previous analysis (de Lannoy et al., 2020). Participants were recruited based on

geographical area and with proportional representation. Therefore, there were fewer participants from provinces with smaller populations (e.g., PEI) and more participants from provinces with larger populations (e.g., Ontario). The provinces within the Prairies and Atlantic Canada regions had similar public health restrictions related to physical activity, outdoor play, and sport. To address our secondary aim and determine differences in movement and play behaviours between children who live in urban versus rural environments, participants were categorized based on their reported postal code, where a postal code with a “0” in the second character is considered rural and all other postal codes are considered urban (Mechanda & Puderer, 2007). Similarly, participants were recruited with proportional representation. Therefore, there were fewer participants from rural areas and more participants from urban areas.

## Statistical analyses

All analyses were performed using Stata SE 14.2 for Mac (StataCorp, College Station, TX, USA). Region-specific continuous variables were described as means and standard deviations and categorical variables were described as frequencies (*n*) and proportions (%). Analysis of variance was used to determine differences in movement and play behaviours between children and youth living in five regions of Canada, and between children and youth living in rural or urban settings. A Sidak comparison was applied for multiple comparisons. Logistic regression was used to determine whether region predicted meeting or not meeting the physical activity, screen time, sleep, or all 24-hour movement guidelines (Tremblay et al., 2016). Regions were compared to Quebec as the reference variable as Quebec had the highest rate of COVID-19 cases as compared to other regions at time of data collection in October 2020 (see Table 1).

## Results

### COVID-19 policies and case numbers

Table 1 includes examples of policies that may have facilitated or restricted participation in physical activity during the second wave of the COVID-19 pandemic in different regions of Canada. At that time, British Columbia and most of Atlantic Canada were not restricting physical activity participation, but had policies in place to reduce the risk of spreading COVID-19, such as maintaining distance between participants or only restricting sports in regions with high case numbers. Organized sports were restricted in regions of Quebec,

Ontario, and New Brunswick, and recreation facilities were closed in Manitoba and parts of New Brunswick. The total and active COVID-19 cases as of October 30, 2020 were highest in Quebec, followed by Ontario, the Prairies, and British Columbia, and lowest in Atlantic Canada. At the time of data collection, weather was similar between regions based on historical climate data (Government of Canada, 2021) and schools were open in all regions (Canadian Institute for Health Information, 2021).

### Sample descriptive characteristics

Parent and child demographic characteristics are included in Table 2. In total, 1568 participants completed the study from British Columbia (*n*=175, 11.2%), the Prairies (*n*=301, 19.2%), Ontario (*n*=618, 39.4%), Quebec (*n*=251, 16.0%), and Atlantic Canada (*n*=223, 14.2%). Geographic, ethnic, and age distributions of the sample were reflective of Canadian demographics. Parent respondents were primarily female (58.2%), were married or cohabitating (78.8%), attended or completed undergraduate university (36.7%), and worked full-time (68.2%). Parents reported their ethnicities as European (38.5%), Indigenous (1.3%), other North American (21.6%), Asian (18.9%), Caribbean, Latin, Central or South American (2.2%), mixed (13.1%), or other (3.1%). Parents reported that children primarily resided in urban areas (89.7%) and lived in townhouses, semi-detached or detached homes (85.0%), their households included  $2.05 \pm 0.63$  adults and  $1.65 \pm 0.79$  children, the children were typically developing (90.8%), and 40.0% of families owned a dog. The majority of children attended school in-person (65.1%), though this ranged from 52.4% in Ontario to 78.9% in Atlantic Canada. Overall summary data (non-region specific) are presented in a subsequent publication (Moore et al., 2021).

### Regional differences in physical activity

There was a statistically significant difference in MVPA ( $F_{(4,1563)}=4.9, p=0.01$ ) and LPA ( $F_{(4,1563)}=6.4, p<0.001$ ) between regions. Parents living in the Prairies and in Atlantic Canada reported more MVPA for their children ( $F_{(1,1563)}=9.0, p=0.011$ ;  $F_{(1,1563)}=17.1, p<0.001$ , respectively) than those living in Quebec. Parents in British Columbia ( $F_{(1,1563)}=12.4, p=0.002$ ), the Prairies ( $F_{(1,1563)}=12.0, p=0.002$ ), Ontario ( $F_{(1,1563)}=13.9, p=0.001$ ), and Atlantic Canada ( $F_{(1,1563)}=822.1, p<0.001$ ) reported more LPA for their children than those living in Quebec. Compared to Quebec, living in Atlantic Canada was associated with increased odds of meeting the MVPA guideline (OR=2.1,  $p=0.02$ ) (see Table 3, Fig. 1 and Fig. 3).

**Table 1** Policies facilitating or restricting participation in physical activity during the COVID-19 second wave in Canada and COVID-19 case numbers as of October 30, 2020

Region	Policies facilitating physical activity participation	Policies restricting physical activity participation	Total COVID-19 cases (Total (/100,000))	Active COVID-19 cases (Total (/100,000))
British Columbia	School sports can occur if physical distancing can be maintained between members of different learning groups (Province of British Columbia, 2021a) Walking outdoors encouraged provided it does not turn into a group of people meeting outside. Outdoor public skating permitted (Province of British Columbia, 2021b)		14,381 (284)	2189.2 (43)
Prairies	Alberta allows group outdoor sport/fitness activities for 10 or fewer people (Government of Alberta, 2021a) Socializing outdoors (as opposed to indoors) encouraged (Oct 2020) (Government of Alberta, 2021b)	All indoor and outdoor facilities closed in Manitoba Red level regions as of September 28, 2020 (CBC News, 2020b) Playgrounds and winter recreation areas in Manitoba Provincial Parks closed (Nov 10, 2020)	36,104 (429)	6929 (101)
Ontario	Ontario's New Framework permits team and individual sports in green to orange zones with modifications to avoid physical contact. Outdoor recreational amenities open with restrictions in all zones (Nov 7, 2020) (Government of Ontario, 2021)	Team sports in Toronto, Ottawa, Peel, York closed (Oct 10, 2020) (Government of Ontario, 2021)	74,715 (513)	7018 (48.2)
Quebec	Gym classes and in-school sports allowed within class cohorts (CBC News, 2020a) Outdoor activities permitted with physical distancing across all alert levels, with more strict gathering limits in alert level zones 3–4 (Gouvernement du Québec, 2021)	Organized sports prohibited in red zones (Gouvernement du Québec, 2021)	104,952 (1237)	9107 (107)
Atlantic Canada	Up to 50 people can gather for organized sports, without physical distancing, in Nova Scotia (Oct 1, 2020) (Government of Nova Scotia, 2020) Sports and recreational activities permitted in New Brunswick yellow and orange zones. Parks remained open in all zones (Oct 9, 2020) (Government of New Brunswick, 2020) Under the 'New Normal' guidelines in PEI, sport and recreation, overnight camps, public spaces open with precautions (Oct 1, 2020) (Government of Prince Edward Island, 2020) Newfoundland introduced holiday events and gathering guidelines (Nov 12, 2020), encouraging activities to be done outdoors (Government of Newfoundland and Labrador, 2020)	Organized sports and recreational facilities closed in New Brunswick red zones (Government of New Brunswick, 2020)	1801 (64)	69 (1)
Canada			231,999 (617)	25,326.3 (67)

Note: COVID-19 total and active cases are as of October 30, 2020, as reported by the Government of Canada

### Regional differences in sedentary behaviour

Child screen time was similar between all regions ( $F_{(4,1251)}=0.8$ ,  $p=0.54$ ). Compared to Quebec, living in Ontario (OR=0.68,  $p=0.04$ ) or Atlantic Canada (OR=0.6,  $p=0.049$ ) was associated with decreased odds of meeting the sedentary behaviour guideline (see Table 3, Fig. 2 and Fig. 3).

### Regional differences in sleep

While there was a significant overall effect of region on sleep ( $F_{(4, 1412)}=3.1$ ,  $p=0.02$ ), there were no differences between regions compared to Quebec ( $p>0.05$ ). Compared to Quebec, living in Ontario was associated with decreased odds of meeting the sleep guideline (OR=0.6,  $p=0.01$ ) (see Table 3, Fig. 2 and Fig. 3).

**Table 2** Description of parent, child, and youth characteristics by region ( $n=1568$ )

	British Columbia ( $n=175$ )	The Prairies ( $n=301$ )	Ontario ( $n=618$ )	Quebec ( $n=251$ )	Atlantic Canada ( $n=223$ )
<b>Respondent characteristics</b>					
Age (years), <i>M</i> ( <i>SD</i> )	43.3 (8.1)	41.9 (8.22)	43.4 (8.5)	43.4 (7.8)	41.8 (9.0)
Gender female, <i>n</i> (%)	100 (57.1)	162 (53.8)	358 (57.9)	151 (60.2)	142 (63.7)
<b>Marital status</b>					
Single, never married	19 (10.9)	33 (11.0)	57 (9.2)	35 (13.9)	32 (14.4)
Common-law, civil partnership, or married	135 (77.1)	242 (80.4)	510 (85.5)	183 (72.9)	166 (74.4)
Separated or divorced	18 (10.3)	24 (8.0)	43 (7.0)	27 (1.1)	20 (9.0)
Other	3 (1.7)	2 (0.7)	8 (1.3)	6 (2.4)	5 (2.2)
<b>Respondent education</b>					
Elementary or high school	25 (14.3)	40 (13.3)	71 (11.5)	40 (15.9)	36 (16.1)
College	52 (29.7)	104 (34.6)	185 (29.9)	81 (32.3)	85 (38.1)
University undergraduate	70 (40.0)	115 (38.2)	239 (38.7)	81 (32.3)	70 (31.4)
University postgraduate	28 (16.0)	42 (14.0)	123 (19.9)	49 (19.5)	32 (14.4)
<b>Respondent employment status</b>					
Employed/self-employed full-time (30 or more h per week)	115 (65.7)	192 (63.8)	431 (69.7)	194 (77.3)	137 (61.4)
Employed/self-employed part-time (fewer than 30 h per week)	28 (16.0)	48 (15.0)	76 (12.3)	15 (6.0)	25 (11.2)
Homemaker	12 (6.9)	37 (12.3)	57 (9.2)	16 (6.4)	28 (12.6)
Other	20 (11.4)	24 (8.0)	54 (8.7)	26 (10.4)	33 (14.8)
<b>Respondent household income</b>					
< \$50,000	25 (14.3)	55 (18.3)	95 (15.4)	46 (18.3)	53 (23.8)
\$50,000–\$99,999	77 (44.0)	102 (33.9)	216 (35.0)	104 (41.4)	92 (41.3)
≥ \$100,000	59 (33.7)	115 (38.2)	266 (43.0)	89 (35.5)	65 (29.2)
Undisclosed	14 (8.0)	29 (9.6)	41 (6.6)	12 (4.8)	13 (5.8)
<b>Child/youth characteristics</b>					
Child (5–11 years)	7.9 (2.0)	8.0 (2.0)	8.5 (2.1)	8.1 (2.0)	8.0 (2.1)
Youth (12–17 years)	14.9 (1.7)	14.7 (1.8)	14.4 (1.7)	14.7 (1.7)	14.7 (1.8)
Gender female, <i>n</i> (%)	79 (45.1)	158 (52.5)	285 (46.1)	134 (53.4)	103 (46.2)
Disability, <i>n</i> (%)	15 (8.6)	19 (6.3)	60 (9.7)	17 (6.8)	34 (15.3)
Adults living in home	2.0 (0.6)	2.1 (0.6)	2.1 (0.7)	2.0 (0.6)	2.0 (0.6)
Children living in home	1.6 (0.7)	1.7 (0.8)	1.6 (0.8)	1.7 (0.9)	1.7 (0.9)
<b>Residential characteristics</b>					
Community rural, <i>n</i> (%)	12 (6.9)	39 (13.0)	42 (6.8)	31 (12.4)	38 (17.0)
Low- or high-rise apartment/condo	16 (9.1)	24 (8.0)	91 (14.7)	59 (23.5)	29 (13.0)
Townhouse, semi-detached or detached house	158 (90.3)	271 (90.0)	524 (84.8)	188 (74.9)	191 (85.7)
Something else	1 (0.6)	6 (2.0)	3 (0.5)	4 (1.6)	3 (1.4)
Dog ownership, <i>n</i> (%)	65 (37.1)	127 (42.2)	246 (39.8)	92 (36.7)	98 (44.0)
<b>School attendance, <i>n</i> (%)</b>					
In-person	122 (69.7)	212 (70.4)	324 (52.4)	187 (74.5)	176 (78.9)
Blended learning (mixture of in-person and online)	26 (14.9)	31 (10.3)	119 (19.3)	43 (17.1)	26 (11.7)
Online/virtual learning	22 (12.6)	49 (16.3)	159 (25.7)	17 (6.8)	10 (4.5)
Not currently attending school	5 (2.9)	9 (3.0)	16 (2.6)	4 (1.6)	11 (4.9)

Note: *M*, mean; *SD*, standard deviation

**Table 3** Movement behaviours (physical activity, screen time, and sleep) and adherence to Canadian physical activity, sedentary behaviour, sleep, and 24-hour combined movement guidelines in children and youth by region

	British Columbia	The Prairies	Ontario	Quebec	Atlantic Canada
Movement behaviours (mean (SD))					
MVPA ≥ 60 min (days/week)	3.1 (2.1)	3.3 (2.1)*	3.1 (2.1)	2.8 (2.0)	3.6 (2.1)*
LPA ≥ 2 h (days/week)	3.1 (2.2)*	3.0 (2.2)*	3.0 (2.2)*	2.3 (2.1)	3.3 (2.3)*
Screen time (h/day)	3.5 (2.8)	4.0 (3.0)	4.0 (2.9)	3.8 (3.1)	3.8 (2.6)
Sleep (h/day)	8.9 (1.4)	8.8 (1.6)	8.5 (1.6)	8.7 (1.47)	8.5 (1.3)
Guideline adherence (n(%))					
MVPA	14 (8.0)	25 (8.3)	47 (7.6)	16 (6.37)	28 (12.6)*
Screen time	48 (35.3)	66 (27.7)	133 (25.9)*	68 (33.83)	41 (24.4)*
Sleep	122 (74.4)	171 (62.6)	324 (58.5)*	153 (68.92)	126 (61.8)
24-h combined	8 (6.2)*	5 (2.3)	6 (1.3)	2 (1.12)	5 (3.2)

Note: MVPA, moderate-to-vigorous physical activity; LPA, light physical activity; 24-h, 24-hour; SD, standard deviation

\*Significantly different from Quebec ( $p < 0.05$ )

### Regional differences in 24-hour movement guidelines compliance

Compliance with the 24-hour movement guidelines was low across regions (1.3–6.2%). Compared to Quebec, living in British Columbia was associated with increased odds (OR=5.9,  $p=0.03$ ) of meeting the 24-hour movement guidelines (Table 3 and Fig. 3).

### Regional differences in outdoor play

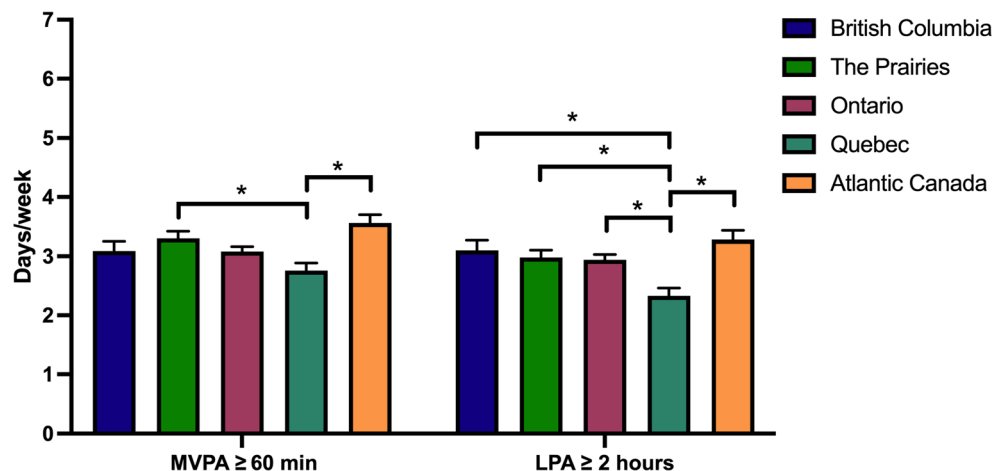
Parents reported that children and youth participated in a little less of all outdoor physical activities as compared with before the COVID-19 outbreak and related restrictions (Table 4). There were no differences in neighbourhood walks or bike rides between children and youth living in different regions. Children and youth living in Ontario had smaller declines in actively transporting to school compared with their

counterparts in Quebec ( $F_{(1,1261)}=8.0, p=0.02$ ). Children and youth living in Atlantic Canada had smaller declines in physical activity or sports outside ( $F_{(1,1563)}=9.7, p=0.01$ ), outdoor play ( $F_{(1,1563)}=9.0, p=0.01$ ), and overall time spent outside ( $F_{(1,1563)}=6.8, p=0.01$ ) compared with children and youth living in Quebec.

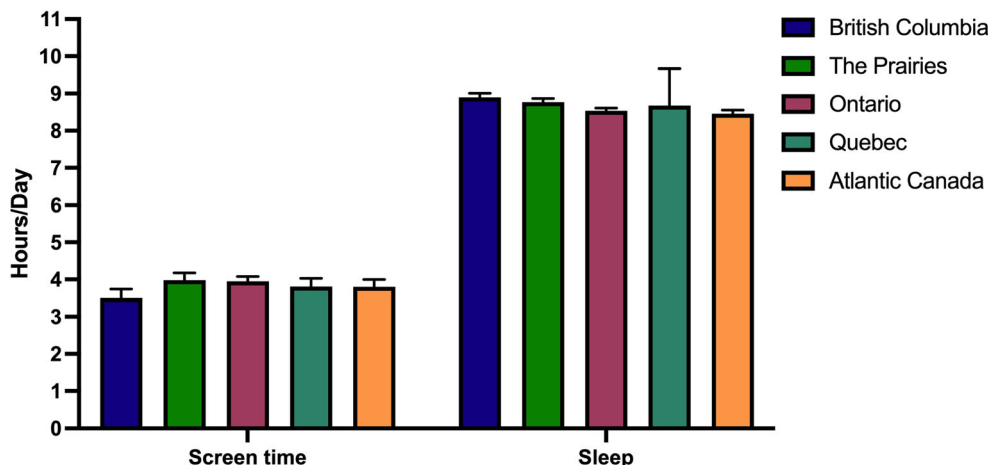
### Urban/rural differences in movement behaviours

The urban/rural differences are for all regions aggregated together. There were no differences between children and youth living in urban versus rural settings in days/week of MVPA ≥ 60 min ( $F_{(1,1566)}=2.1, p=0.15$ ), hours per day of sleep ( $F_{(1,1415)}=0.6, p=0.43$ ), or hours per day of screen time ( $F_{(1,1254)}=0.02, p=0.8$ ). Children living in rural settings reported a higher number of days/week of LPA ≥ 2 h ( $3.3 \pm 2.4$  days/week) versus children living in urban settings ( $2.9 \pm 2.2$  days/week;  $F_{(1,1566)}=5.1, p=0.02$ ). There were no differences

**Fig. 1** MVPA and LPA of children and youth across Canada during the second wave of COVID-19. \* indicates significantly different from Quebec at  $p < 0.05$ ; MVPA, moderate-to-vigorous physical activity; LPA, light physical activity. Error bars represent standard error of the mean



**Fig. 2** Sleep and screen time of children and youth across Canada during the second wave of COVID-19. Error bars represent standard error of the mean



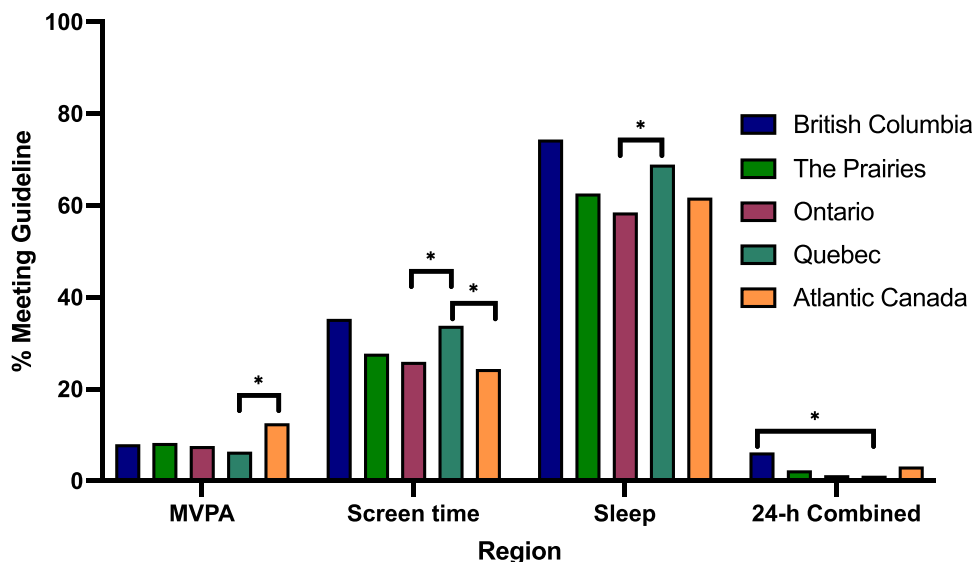
in actively transports to school ( $F_{(1,1264)}=2.2, p=0.14$ ), walks or bikes in neighbourhood ( $F_{(1,1566)}=2.7, p=0.10$ ), and physical activity or sports outside ( $F_{(1,1566)}=3.2, p=0.07$ ) between children living in urban versus rural neighbourhoods. Parents reported small declines in plays outside for children living in rural ( $2.9 \pm 0.8$ ) versus urban ( $2.7 \pm 1.0$ ) settings ( $F_{(1,1566)}=9.2, p=0.003$ ). Parents also reported small declines in overall time spent outside for children living in rural ( $2.9 \pm 0.8$ ) versus urban ( $2.7 \pm 1.0$ ) settings ( $F_{(1,1566)}=6.4, p=0.01$ ).

**Discussion**

In this study, we aimed to describe regional differences in physical activity, screen time, sleep, and outdoor play among children and youth across Canada during the second wave of the COVID-19 pandemic. We hypothesized that children and youth who live in regions with fewer public health restrictions (i.e., Atlantic Canada) would engage in more physical activity

and less sedentary time compared with children and youth who live in regions with more severe public health restrictions (i.e., Ontario and Quebec). Similar to our findings in April 2020 (de Lannoy et al., 2020), the main finding of the current study was that the movement behaviours of children and youth in Central, Western, and Eastern Canada were healthier as per the 24-Hour Movement Guidelines compared with those of children and youth in Quebec. Second, we aimed to describe differences in movement and play behaviours between children living in urban versus rural settings. We found that children and youth living in rural settings engaged in more LPA and experienced smaller declines in plays outside and overall time outside compared to those living in urban settings. At the time of data collection (October 2020), COVID-19 case numbers and public health restrictions varied greatly between regions in Canada (Table 1) and so we hypothesized that these restrictions would parallel the movement behaviours of children and youth. Consistent with this hypothesis, MVPA and LPA levels were highest among children and

**Fig. 3** Adherence to Canadian MVPA, sleep, screen time and 24-hour combined movement guidelines in children and youth by region during the second wave of COVID-19. MVPA, moderate-to-vigorous physical activity; 24-h, 24-hour





**Table 4** Summary of parent-reported changes in outdoor play by region of Canadian children and youth during the second wave of the COVID-19 pandemic. Changes based on responses to a 5-point scale ranging from “a lot less” (scored 1) to “about the same” (scored 3) to “a lot more” (scored 5)

	British Columbia	The Prairies	Ontario	Quebec	Atlantic Canada
Actively transports (i.e., walks, bikes, scoots) to or from school	2.7 (0.9)	2.7 (0.8)	2.6 (0.9)*	2.8 (1.0)	2.7 (0.8)
Walks or bikes in neighbourhood	2.9 (1.0)	2.7 (1.0)	2.7 (1.1)	2.8 (1.1)	2.8 (0.8)
Physical activity or sports outside	2.6 (0.9)	2.6 (1.0)	2.4 (1.0)	2.5 (1.1)	2.8 (0.9)*
Plays outside	2.8 (1.0)	2.8 (1.0)	2.6 (1.1)	2.7 (1.0)	3.0 (0.8)*
Overall time spent outside	2.7 (1.0)	2.8 (0.9)	2.6 (1.1)	2.6 (1.0)	2.9 (0.8)*

Note: Actively transports to and from school only applies to children and youth attending in-person learning

\*Significantly different from Quebec ( $p < 0.05$ )

youth in Atlantic Canada, which coincided with the fewest restrictions on sports and recreation compared to the rest of the country. However, what is surprising is that MVPA and LPA levels were higher in the Prairies, despite the fact that restrictions on group sports were similar to those in Quebec. Moreover, Manitoba was the only province to reinstate restrictions on access to provincial parks in the fall of 2020; all other provinces opened provincial parks over the summer of 2020 and kept them open in the face of the second COVID-19 wave. Investigation into school recess practices, and single household sports and outdoor activities may shed greater light on this surprising observation. Given the importance of appropriate amounts of physical activity, screen time, and sleep for physical and mental health, a pandemic recovery plan must prioritize safe opportunities for physical activity and outdoor play in all regions.

Differences in outdoor play of children and youth across Canada were initially examined during the first wave of COVID-19 in spring 2020. Parents from all regions reported that their children decreased their time spent outdoors and in outdoor play, with the greatest declines reported respectively by parents in Ontario followed by those in Quebec (de Lannoy et al., 2020). Similarly, we observed decreases in time spent outdoors, outdoor play, physical activity or sports outdoors, and walking or biking among children and youth in all regions. This is somewhat surprising considering the public health restrictions on outdoor activities and recreation were much less strict in fall 2020 versus spring 2020. In a study conducted in summer 2020, parents from British Columbia and Ontario reported a loss of physical activity opportunities, such as cancellations of structured activities and limited access to outdoor spaces like parks and playgrounds (Riazi et al., 2021). By the fall, some organized sports and physical activities were restricted, but most outdoor spaces, such as parks, were available for unstructured play (Outdoor Play Canada, 2020). This suggests that Canadian children are highly reliant on structured sport for physical activity, and less inclined to go to public outdoor spaces for unstructured active play. The other major factor limiting

outdoor play may also be equitable access; in a recent study by Mitra et al. (2020), the authors showed that proximity to outdoor green spaces was an important determinant of time spent in outdoor play in densely populated urban areas. In a report from Canada’s Chief Public Health Officer, it was recommended that a pandemic recovery plan improve the built environments to promote outdoor social and physical activities while maintaining physical distancing, with a particular focus on improving equitable access to outdoor spaces in underserved communities (Public Health Agency of Canada, 2020). For example, street reallocations during COVID-19 in Victoria, Kelowna, and Halifax were intended to support mobility, recreation, and physical distancing in dense areas and support COVID-19 recovery for businesses (such as temporary patios on streets) (Fischer & Winters, 2021). Similar efforts occurred in almost all other Canadian cities as an initial reaction to physical distancing concerns in the spring of 2020 (de Lannoy et al., 2020). Whether these measures translate into long-term decisions to redesign cities to prioritize walking, cycling, or wheeling over driving remains to be seen.

Interestingly, we did not observe differences in MVPA between children and youth living in rural versus urban areas; however, we did find that those living in rural areas engaged in LPA ( $\geq 2$  h/day) on more days per week and experienced smaller declines in outdoor play or overall time spent outside than those in urban areas. Our group showed that in spring 2020, children and youth in Canada who increased outdoor activity were likely to live in houses versus apartments, live further from a major road, live in low-density neighbourhoods, and live within 1 km of parks (Mitra et al., 2020), which may explain why LPA was higher in rural areas. Similar observations were found during the pandemic lockdown in France, where access to a large outdoor area was a predictor of higher physical activity during the COVID-19 lockdown (Chambonniere et al., 2021). Access to more outdoor space in rural settings may have mitigated declines in unstructured outdoor play.

Similar to the spring 2020 survey (Moore et al., 2020), the majority of participants in our study met the sleep guideline,

but living in Ontario compared to Quebec was associated with decreased odds of meeting the guideline. Almost 30% of children and youth met the screen time guideline, and this compliance was much higher than the 11% who met the guideline in spring 2020 (Moore et al., 2020), and may be attributable to students' return to in-person learning at school. While living in Ontario or Atlantic Canada was associated with decreased odds of meeting the screen time guideline compared to living in Quebec, the rates of compliance across all regions were low (24–34%). Overall, 2.3% of participants met the 24-hour movement guidelines and children and youth living in British Columbia were more likely to meet the 24-hour movement guidelines than their counterparts in Quebec; however, compliance across Canada was similar to early pandemic levels (Guerrero et al., 2020; Moore et al., 2020).

A key strength of this study was the inclusion of a nationally representative sample of 1500 children from all Canadian provinces. In addition, the timing of the study allowed us to capture movement behaviours as Canada entered its second wave of COVID-19 and assess the impacts of different restrictions in different regions on movement behaviours in children and youth. A limitation of this study is that data on the movement behaviours of children and youth from the Canadian territories (Yukon, Nunavut, and Northwest Territories) were not captured. In addition, the movement behaviours were assessed through self-report (parental-report) rather than being directly measured (e.g., accelerometers). Self- and parent-reported movement behaviours may be subject to overestimates of physical activity or underestimates of sedentary behaviours. Future studies may wish to use device-based measures (e.g., accelerometers) to assess movement behaviours. However, using a validated questionnaire did allow us to capture movement behaviour data from a large group of parents from across Canada rapidly, something that would not have been feasible using device-based measures.

## Conclusion

This study provides an examination of regional differences in movement and play behaviours among Canadian children and youth during the second wave of the COVID-19 pandemic. We showed that the movement and play behaviours of children and youth across Canada continued to be impacted by COVID-19 in fall 2020 as we still observed very low compliance with the MVPA and 24-hour movement guidelines, and declines in outdoor play and physical activity. We observed some regional differences in physical activity when compared to Quebec, including higher MVPA in Atlantic Canada and higher LPA in all other regions. As we continue to live with the COVID-19 pandemic and while public health restrictions continue to change in response to the virus transmission, future work should continue to track the effects of public health

restrictions on the movement behaviours of children and youth as part of a pandemic recovery plan. Given the declines in physical activity across Canada and benefits of physical activity participation, public policies and educational campaigns should prioritize and encourage opportunities for physical activity, sport, and play that can be performed safely with minimal risk of COVID-19 transmission and in ways that promote equitable access and participation.

## Contributions to knowledge

What does this study add to existing knowledge?

- Our study highlights that movement behaviours (physical activity, screen time, and sleep) of Canadian children and youth continue to be negatively impacted by the COVID-19 pandemic.
- Our study notes that children and youth who live in regions that restrict outdoor play and movement during the pandemic may experience more barriers to engaging in healthy behaviours.

What are the key implications for public health interventions, practice or policy?

- We conclude that pandemic-related recovery plans should prioritize opportunities for physical activity and play that can be done safely and in alignment with current public health restrictions.
- We recommend, in the case of future pandemics or times when stay-at-home orders are put in place, that public health restrictions balance the need to control virus transmission and opportunities for children and youth to support their mental and physical health through movement and play (e.g., keeping parks and playgrounds open where possible).

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**Author contributions** SAM conducted the data preparation and cleaning. HATC and SAM conducted the data analysis, populated data tables, created figures, interpreted the data, and drafted the initial draft of the manuscript. SAM, GF, and MST conceptualized the study design, drafted the survey, oversaw the acquisition, analysis, and interpretation of data, and reviewed the final manuscript. LD, RR, SFLK, and LR reviewed and approved the final version of the manuscript.

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**Data availability** The dataset supporting the conclusion of this article is available from the study's corresponding author upon reasonable request and the completion of a data transfer agreement.

**Code availability** Analyses were conducted in Stata SE 14.2 for Mac (StataCorp, College Station, TX, USA). Code is available from the study's corresponding author upon reasonable request.

## Declarations

**Ethics approval and consent to participate** Participants consented to participate in survey-based research when they signed up for the panel from which the sample was drawn. Subsequently, participants passively consented to participate when they agreed to complete the survey. The secondary data analysis was approved by the Dalhousie University Health Sciences Research Ethics Board (REB #: 2020-5351).

**Consent for publication** Not applicable.

**Conflict of interest** HATC, LD, SFLK, LR, and SAM have no conflicts of interest to declare. GF, MST, and RR are members of the ParticipACTION Research Advisory Group (RAG). The RAG provides advice to ParticipACTION about the direction that should be pursued with respect to its research, evaluation, and knowledge translation. ParticipACTION does not compensate members of the RAG.

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