Few Canadian children and youth were meeting the 24-hour movement behaviour guidelines 6-months into the COVID-19 pandemic: Follow-up from a national study

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Research Article

Keywords: pediatrics, physical activity, sedentary behaviour, sleep, outdoor play

DOI: https://doi.org/10.21203/rs.3.rs-757883/v1

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Abstract

Daily life has changed for families due to the COVID-19 pandemic. The aim of this repeated cross-sectional study was to describe movement behaviours in Canadian children and youth six months into the pandemic (T2; October 2020) compared with the start of the pandemic (T1, April 2020). An online survey was distributed to parents (N=1568) of children and/or youth (5–17 years; 58% girls) in October 2020. The survey assessed changes in movement behaviours (physical activity (PA) and play, sedentary behaviours (SB), and sleep) from before the pandemic to October 2020 (T2). We compared these data to spring data (T1; April 2020; Moore et al., 2020) collected using identical methodology (N=1472; 54% girls). We report correlations between movement behaviours and relevant parental factors and provide word frequency distributions for open-ended responses. During the second wave, 4.5% of children (4.6% girls; 4.3% boys) and 1.9% of youth (1.3% girls, 2.4% boys) met the movement guidelines (3.1% overall). Whereas, during the first wave, 4.8% (2.8% girls, 6.5% boys) of children and 0.6% (0.8% girls, 0.5% boys) of youth were meeting combined guidelines (2.6% overall). Parental support was correlated with their child’s movement behaviours (T1 and T2). Our study demonstrates the ongoing challenges for children and youth to engage in healthy movement during the pandemic.

Introduction

The COVID-19 pandemic, and the related public health restrictions imposed to curb the transmission of the virus, are having an unprecedented impact on the lives of children and youth (Moore et al., 2020; Guerrero et al., 2020; Paterson et al., 2021). While children, such as those 10 years of age and younger, appear to be less susceptible to experience severe illness due to COVID-19 and children represent proportionally lower reported cases (Ludvigsson 2020), there remain legitimate concerns for children and youth’s wellbeing during the pandemic. These concerns are heightened given the emergence of multiple variants of the virus, and reports that children or youth who are infected, may experience similar long-term effects to adults (Buonsenso et al., 2021). In Canada (and other nations globally), the initial public health response to reduce COVID-19 transmission resulted in immediate school and childcare closures, the cessation of sports and organized recreation activities, and limited access to outdoor places, such as playgrounds and parks (de Lannoy et al., 2020; Mitra et al., 2020). Such restrictions have ebbed and flowed in response to the ongoing nature of the pandemic with variation sometimes at local, provincial (or state), and national levels. With coordinated efforts to reduce COVID-19, these nationwide shut downs were extreme, with some suggesting shutdowns were akin to a global ‘medically induced coma’ (Lemieux et al., 2020).

Canadian Public Health Officers first implemented safety measures in response to the World Health Organization (WHO)’s declaration of COVID-19 as a global pandemic in March 2020 (WHO, 2020). Canada saw an initial spike in cases of the virus in April 2020 (i.e., first wave) when just over 2,000 Canadians were diagnosed daily with COVID-19 (Government of Canada, 2021). A decline in cases across the spring and summer months brought relaxed guidelines, and in the fall of 2020, most schools in Canada had resumed, sport and recreational activities restarted with new safety protocols in place, and there was increased availability of outdoor spaces with the implementation of physical distancing measures (Treble 2020). However, in October 2020, the number of new COVID-19 diagnoses was on the rise again in Canada (i.e., second wave), where again over 2,000 Canadians (including children and youth) were being diagnosed daily with the virus (Government of Canada, 2021).

The safety of children and youth during any global health crisis is of upmost concern. By the end of April 2020, an estimated 1.5 billion students around the world, including most Canadian children ages 5 to 17 years, transitioned to remote learning (Couzin-Frankel et al., 2020). While public health COVID-19 related restrictions were necessary to reduce virus transmission, the ‘stay-at-home’ measures put in place in Canada, and other nations globally, restricted opportunities for children and youth to engage in healthy movement and active play (Gostin & Wiley, 2020). Several studies, including our previous study of 1,472 Canadian parents of children and youth in April 2020 (Moore et al., 2020), indicated that most children and youth were not meeting the 24-hour movement behaviour guidelines (Tremblay et al., 2016; Carson et al., 2017) in the first wave of the COVID-19 pandemic. Notably, physical activity had declined (only 18.2% meeting guidelines), sedentary behaviour and screen time had increased (only 11.3% meeting guidelines), and sleep patterns were disrupted (only 71.1% meeting guidelines), with only 26% meeting the combined 24-hour movement behaviour guidelines (Moore et al., 2020). However, there is clear evidence that engaging in ample physical activity and time outdoors, reducing time being sedentary and using screens, and getting adequate sleep contributes to the overall health and development of children and youth (Tremblay et al., 2016). Given the significant and ongoing change to child and family lifestyles during the pandemic, there are growing concerns that young people and their families may experience substantial long-term physical and mental health consequences as a result of the COVID-19 virus outbreak and related restrictions.

At the time of this study, children, youth, and their families had lived with varying public health constraints for approximately six months. Public health policies in Canada evolved and relaxed into the fall of 2020, and many Canadian children and youth returned to school [in person, blended (i.e., a combination of in and out of classroom activities) and other recreation and sport activities. However, policies, such as physical distancing, still limited how children and youth engaged in healthy movement and outdoor play. Thus, the purpose of this 6-month repeated cross-sectional follow-up study was to describe the movement and play behaviours of a national sample of Canadian children and youth during the start of the second wave of the COVID-19 pandemic (T2; October 2020) and compare these findings to our initial results from the first wave (T1; April 2020). We hypothesized that, as children, youth, and their families settled into life during COVID-19 and returned to school, recreation, and sport, more children and youth would be meeting the physical activity recommendations, sedentary behaviour and screen time recommendations, and sleep recommendations. We hypothesized that more children and youth would be accessing outdoor play and recreation, and finding innovative ways to be active during the pandemic. Overall, we anticipate the findings of our studies will inform strategies to preserve and promote child health during the COVID-19 pandemic and recovery afterwards, and support preparation for future global health crises.

Materials And Methods

Study design and population
ParticipACTION is a national non-profit organization that promotes healthy movement behaviours among Canadians. In April 2020, ParticipACTION conducted the first national survey that assessed children and youth's movement and active play behaviours during the COVID-19 pandemic (Moore et al., 2020) to inform the 2020 Report Card of Physical Activity for Children and Youth (ParticipACTION, 2020). ParticipACTION conducted a follow-up study (6-months later; October 2020) to assess the continued impact of the COVID-19 virus outbreak on the same behaviours (Appendix A; Table A1). Using a repeated cross-sectional design (i.e., with new respondents at successive time points), a sample of parents of Canadian children (ages 5–11 years) and/or youth (ages 12–17 years) was recruited via Maru/Matchbox, a third-party market research company. Maru/Matchbox has an online consumer database of >120,000 Canadian panelists. Panelists are recruited via online and offline methods and receive small cash incentives ($0.50 to $3.00 CDN) for completing surveys. This sampling strategy is commonly used by ParticipACTION and other national organizations and researchers, given the ability to rapidly recruit large, representative samples (e.g., Moore et al., 2020; Rhodes et al., 2020a). Maru/Matchbox panelists consent to participate in research when they sign up for the panel.

Approximately six months after the WHO declared COVID-19 a global pandemic (World Health Organization, 2020) and at the beginning of the second wave of the virus in Canada (Morris & Mintz, 2021), ParticipACTION employed Maru/Matchbox to conduct a 6-month follow-up survey of the movement and play behaviours of Canadian children and youth. Panelists were recruited by Maru/Matchbox if they were a parent (or adult caregiver) of a child or youth (ages 5 to 17 years), could complete the survey in English or French during the survey timeline (T2; October 15–20, 2020), and had not completed the first survey (T1; April 15–20, 2020). Panelists were screened out by Maru/Matchbox if anyone in the household had been diagnosed with COVID-19 in the last month or if they were presently under self-isolation (i.e., quarantine) orders. Panelists were recruited so the sample would be similar demographically to the Canadian population, and were diverse in age, gender, region, income, employment, and language spoken (Statistics Canada, 2021). When these conditions were not met, Maru/Matchbox employed targeted recruitment to complete the sample.

Survey and survey administration

The survey (Appendix A; Table A1) was developed applying a socioecological framework to consider variables at the child, family, and community levels (Bronfenbrenner, 1977; Spence & Lee, 2003). Briefly, the survey included demographic variables (child age, gender, and disability status, parental age, gender, ethnicity, education, marital status, household income, housing type, and family dog ownership), movement behaviour variables (current levels of physical activity, sedentary behaviours, and sleep, parent perceived changes in physical activity, sedentary behaviours, and sleep due to COVID-19 and related restrictions), and parental support variables (parental encouragement and support of physical activity, sleep, and discouragement of sedentary behaviours). The survey also included a series of open-ended questions where respondents could note current activities, hobbies, and online resources, as well as innovative strategies that their families were using during the COVID-19 pandemic.

Movement behaviour questions were adapted from the Canadian Health Measures Survey (Tremblay & Goder, 2007), as well as questions related to parent perceived changes in their child's behaviours from before to during the COVID-19 pandemic. For change questions, responses were reported using a 5-point Likert 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 as a result of the pandemic) the parent selected 3. If parents perceived their child to be doing more, or a lot more, of the behaviour during the pandemic compared to 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 the pandemic compared to before the pandemic, the parent selected 2 or 1, respectively. Previous analysis demonstrated that the survey (Appendix A, Table A1) showed strong test-retest reliability (Moore et al., 2020).

Potential respondents were sent an email link to the survey. Participants passively consented to participate when they agreed to complete the survey; the survey took approximately 15-minutes to complete. If a parent had more than one child, they were asked to respond based on their child whose given first name came first alphabetically. They were also asked to use this same child as the referent child throughout the survey. Collected data were cleaned by Maru/Matchbox and received by ParticipACTION. Secondary use of data was approved by Dalhousie University's Research Ethics Board (#2020–5351). A data transfer agreement was completed between ParticipACTION and the study's primary investigators. October (T2; 6-month follow-up) and April (T1; first survey) data were provided by encrypted secure links to the study's primary investigators. Data verification was completed by the study's authors prior to data analysis.

Statistical analysis

For close-ended questions, data were analyzed in SPSS 26 (SPSS Inc., Chicago, IL, USA). Descriptive statistics and overall, age group, and gender specific means and standard deviations were calculated for all variables. The proportion of children and youth meeting the Canadian 24-Hour Movement Guidelines were also determined. Children and youth were deemed as meeting all movement behaviours for the previous week if they were active on six or seven days, spent two hours or less in daily recreational screen time, and accumulated 9–11 hours of sleep per night for 5-13-year-olds or 8–10 hours of sleep per night for 14-17-year-olds. The sleep age categories differ slightly in order to be consistent with the US National Sleep Foundation's recommendations (Hirshkowitz et al., 2015). Pearson correlations were conducted for associations between sociodemographic/social variables and behavioural outcomes (point-biserial correlations for those cases where one variable was dichotomous and one was continuous). Factorial analysis of variance (ANOVA) was conducted on all behavioral outcome variables by time (T1, April 2020; T2, October 2020), gender, and age group. Cross-tabulations $\chi^2$ analyses were conducted in a similar manner for the proportional analyses of meeting 24-hour, physical activity, sleep, and sedentary behaviour guidelines. Means (standard errors) were plotted for selected variables at both time points. Given the large sample size and number of statistical tests, a conservative alpha of $p < 0.01$ was adopted.

For open-ended questions, two independent assessors adopted a word frequency approach to review the data and elicit commonalities by respondents across each of the questions. A total of 13% of responses were in French and translated to English by one of the coders. Reliability and consistency across coders were previously assessed, averaging 98.3% (Moore et al., 2020). Reviewers studied each question separately, creating, identifying, and confirming codes,
tallying the recurrence of these codes in the responses, and then calculating total frequencies and percentages. As this was a 6-month follow-up study, overall shifts in activities, hobbies, and online resources over the pandemic were examined via visual inspection (reference point: T1, first survey; Moore et al., 2020).

Results

Participants

A total of 1,653 parents completed the survey in October 2020. Participants were excluded when child age was not entered and when parental age was implausible (n = 85; e.g., parental age 20 years, child age 15 years). The final T2 (October 2020) sample comprised of 1,568 parents (mean age = 42.9 years; SD = 8.4 years) of children and youth (mean age = 11.6 years; SD = 3.72 years). As anticipated given the recruitment strategy, the respondent’s geographic, ethnic, and age distributions were reflective of Canadian demographics. Results were compared with a similar sample of parents with data from T1 (April 2020). A complete T1 sample description is provided elsewhere (Moore et al., 2020); briefly, the final T1 (April 2020) sample comprised of 1,472 parents (mean age = 45.1 years; SD = 7.6 years) of children and youth (mean age = 11.5 years; SD = 3.7 years).

Table 1 includes descriptive statistics for T2 parent and child characteristics. At T2, respondents were primarily women (58.2%), married or cohabiting (79.6%), college or university graduates (72.0%), and working fulltime (68.2%). Type of home was predominantly a detached home (74.0%) and over one-third (40.1%) reported having a dog. Children and youth were primarily typically-developing (91.8%). While the majority of children and youth were meeting sleep recommendations for their age (59.3%), most were not meeting the physical activity or screen time guidelines (only 14.3% and 25.6% meeting the guidelines, respectively). Overall, only 3.1% of children and youth were meeting the 24-hour movement behaviour guidelines [physical activity, sedentary behaviour (screen time), sleep].
Table 1
Parent, child, and youth characteristics at T2\(^1\) (October 2020, N = 1568).

| Parental demographic profile |          |          |
|------------------------------|----------|----------|
| Age (years), M (SD)          | 42.9 (8.4) |          |
| Gender Women, N (%)          | 913 (58.2) |          |
| Ethnicity, N (%)             |          |          |
| European                     | 1087 (69.3) |          |
| Asian                        | 296 (18.9) |          |
| Indigenous                   | 66 (4.2) |          |
| Other                        | 119 (7.6) |          |
| Marital Status, N (%)        |          |          |
| Married or common-law        | 1248 (79.6) |          |
| Divorced or separated        | 132 (8.4) |          |
| Single                       | 176 (11.2) |          |
| Widowed                      | 12 (0.8) |          |
| Education, N (%)             |          |          |
| High school or less          | 439 (28.0) |          |
| College or technical school  | 386 (24.6) |          |
| University                   | 518 (37.9) |          |
| Advanced degree              | 225 (14.3) |          |
| Annual Household Income, N (%) |          |          |
| ≤$50,000                     | 274 (17.5) |          |
| $51,000 to $99,000           | 591 (37.7) |          |
| >$100,000                    | 594 (37.9) |          |
| Undisclosed                  | 109 (7.0) |          |
| Employment Status, N (%)     |          |          |
| Full-time (> 30 hours/week)  | 1069 (68.2) |          |
| Part-time                    | 192 (12.2) |          |
| Homemaker                    | 150 (9.6) |          |
| Student                      | 23 (1.5) |          |
| Other                        | 134 (8.6) |          |

| Child demographic profile |          |          |
|---------------------------|----------|----------|
| Age (years), M (SD)       | 11.62 (3.7) |          |
| Gender Girl, N (%)        | 759 (48.4) |          |
| Gender Boy, N (%)         | 793 (50.6) |          |
| Gender Other, N (%)       | 16 (1.0) |          |
| Disability, N (%)         | 145 (9.2) |          |
| Child’s Residence Type, N (%) |          |          |
| House                      | 1161 (74.0) |          |
| Apartment or townhome     | 390 (24.9) |          |
| Other                      | 17 (1.1) |          |
| Dog Ownership, N (%)      | 628 (40.1) |          |

\(^1\) T2 = time point 2, October 2020.

\(^2\) MVPA = moderate-to-vigorous intensity physical activity
### Movement behaviours in children and youth in October 2020

A description of movement behaviours, proportion of children meeting the guidelines, and changes in movement and play behaviours in October (T2) by age and gender are illustrated in Fig. 1 and presented in detail in Table 2. We found that, on average, 3.1% of children and youth (4.5% of children, and 1.9% of youth) were meeting the 24 hour movement behaviour guidelines. These data are described further by age and gender in Table 3 (children) and Table 4 (youth).
Table 2
Parent-reported movement and play behaviours of children and youth (5 to 17 years) during the COVID-19 pandemic (T2; October 2020) by age \(^1\) and gender.

| Current child movement behaviours, M (SD) | Children \(^2\) | Youth \(^2\) |
|-----------------------------------------|----------------|-------------|
| MVPA \(^3\) ≥ 60 minutes/day (days/week) | 3.5 (2.1) | 3.6 (2.1) |
| Sleep (hours/day) | 9.0 (1.6) | 8.8 (1.7) |
| Recreational screen time (hours/day) | 3.2 (2.6) | 3.3 (2.6) |

Proportion of children meeting guideline (%)

| MVPA | 17.5 | 11.6 |
| Sleep | 54.9 | 59.5 |
| Recreational screen time | 35.4 | 16.5 |
| 24-hour movement behaviours \(^2\) | 4.5 | 1.9 |

Change in child movement and play behaviours during COVID-19 outbreak, M (SD) \(^4\)

| | Children | Youth |
|-------------------------------|---------|-------|
| Walks or cycles in neighbourhood | 2.82 (1.00) | 2.80 (1.03) |
| Physical activity or sport outdoor | 2.64 (1.01) | 2.58 (1.03) |
| Physical activity or sport inside | 2.64 (0.99) | 2.63 (1.01) |
| Household chores | 3.15 (0.70) | 3.08 (0.79) |
| Plays outdoor | 2.88 (1.00) | 2.59 (0.97) |
| Plays inside | 3.33 (0.89) | 3.26 (0.92) |
| Watches TV or screens | 3.54 (0.93) | 3.66 (0.91) |
| Uses social media | 3.07 (0.86) | 3.07 (0.88) |
| Sleep quantity | 3.05 (0.50) | 3.20 (0.69) |
| Sleep quality | 3.02 (0.51) | 2.98 (0.67) |
| Overall 24-hour movement behaviours | 2.86 (0.67) | 2.84 (0.67) |
| Overall time spent outdoor | 2.84 (0.97) | 2.55 (0.99) |
| Family time in physical activity | 2.94 (0.92) | 2.80 (0.94) |
| Family time in sedentary behaviours | 3.43 (0.82) | 3.45 (0.80) |

\(^1\) = significant age effect; \(^2\) = significant gender effect

\(^3\) MVPA = moderate-to-vigorous physical activity

\(^4\) Ranges from 1 to 5, where 1 = a lot less, 3 = no change, and 5 = a lot more

Movement behaviours in children in April 2020 and October 2020

A summary of the movement behaviours of children (ages 5 to 11 years) in April 2020 (T1, approximately 1 month after the WHO declaration of COVID-19 as a global pandemic) and October 2020 (T2, approximately 6 months after the WHO declaration, second wave of the COVID-19 virus outbreak) is presented in Table 3. The parents of girls and boys in April and October 2020 reported similar amounts of days per week of physical activity (MVPA, moderate to vigorous physical activity) and hours of sleep per day; however, parents reported significantly more hours per day of recreational screen time in April compared with parental reports in October \(p < 0.01\). The proportion of children meeting the 24-hour movement behaviours (physical activity, sleep, and screen time) also differed between April and October 2020. Fewer boys and girls were meeting screen time guidelines (i.e., ≤ 2 hours of recreational screen time per day) in April compared with October, whereas more children were meeting the age-specific sleep recommendations in April compared with October \(p < 0.01\). The proportion of boys meeting the physical activity recommendations was higher in April compared with October \(p = 0.01\), however, there was no significant difference in MVPA between the two time points in girls \(p = 0.03\). Overall, only 4.5% of children (4.6% of girls and 4.3% of boys) were meeting the 24-hour movement behaviour guidelines in October 2020, compared with 4.8% of children (2.8% of girls and 6.5% of boys) in April 2020 (Moore et al., 2020).
We also assessed parent perceived changes in their child’s movement and play behaviours compared to before the pandemic at both timepoints (T2 v T1). Parents of girls reported that their daughter’s movement behaviours were now the same as pre-pandemic levels. Parents of boys also assessed their son’s movement behaviours as the same as pre-pandemic; however, this was only significant for four types of activities (physical activity and sport outdoor, overall time spent outdoors, family time in sedentary behaviour, and watching TV or screens; \( p < 0.01 \)).

Table 3
Parent-reported movement and play behaviours of children (ages 5 to 11 years) during the COVID-19 virus outbreak between April (T1; Moore et al., 2020) and October 2020 (T2).

|               | Girls          | Boys           |
|---------------|----------------|----------------|
|               | April          | October        |               | April          | October        |               |
| Current child movement behaviours. M (SD) |               |               |               |               |               |               |
| MVPA \( ^1 \geq \) 60 minutes/day (days/week) | 3.4 (2.3)      | 3.5 (2.0)      | 1.07 (0.30)  | 3.7 (2.4)      | 3.6 (2.1)      | 1.16 (0.28)  |
| Sleep (hours/day)       | 9.3 (2.2)      | 9.2 (1.6)      | 0.70 (0.40)  | 9.1 (2.5)      | 8.8 (1.7)      | 3.29 (0.07)  |
| Recreational screen time (hours/day) | 5.1 (3.3)      | 3.1 (2.5)      | 66.55 (0.00) | 5.2 (3.8)      | 3.3 (2.6)      | 54.71 (0.00) |
| Proportion of children meeting guideline (%) | \( \chi^2 (p) \) |               | \( \chi^2 (p) \) |               |               |               |
| MVPA          | 19.0           | 15.3           | 1.64 (0.20)  | 27.9           | 19.7           | 6.92 (0.01)  |
| Sleep         | 72.6           | 58.5           | 14.59 (0.00) | 67.5           | 51.5           | 19.64 (0.00) |
| Recreational screen time | 16.2           | 38.3           | 37.61 (0.00) | 16.8           | 32.8           | 23.25 (0.00) |
| 24-hour movement behaviours \( ^2 \) | 2.8            | 4.6            | 1.39 (0.24)  | 6.5            | 4.3            | 1.54 (0.21)  |
| Change in child movement and play behaviours during COVID-19 outbreak. M (SD)\(^3\) |               |               |               |               |               |               |
| Walks or cycles in neighbourhood | 2.54 (1.36)    | 2.84 (0.96)    | 11.20 (0.01) | 2.61 (1.34)    | 2.80 (1.03)    | 4.98 (0.03)  |
| Physical activity or sport outdoor | 2.26 (1.25)    | 2.70 (0.98)    | 25.87 (0.00) | 2.30 (1.34)    | 2.58 (1.03)    | 11.88 (0.01) |
| Plays outdoor | 2.57 (1.30)    | 2.99 (1.01)    | 22.00 (0.00) | 2.59 (1.31)    | 2.77 (0.99)    | 4.61 (0.03)  |
| Watches TV or screens | 4.10 (0.92)    | 3.48 (0.91)    | 76.68 (0.00) | 4.11 (0.84)    | 3.59 (0.95)    | 61.20 (0.00) |
| Uses social media | 3.46 (0.91)    | 3.08 (0.84)    | 31.94 (0.00) | 3.16 (0.85)    | 3.07 (0.88)    | 1.88 (0.17)  |
| Overall time spent outdoor | 2.35 (1.25)    | 2.93 (0.97)    | 45.29 (0.00) | 2.41 (1.28)    | 2.75 (0.96)    | 17.62 (0.00) |
| Family time spent in physical activity | 2.70 (1.17)    | 3.04 (0.92)    | 18.25 (0.00) | 2.74 (1.16)    | 2.84 (0.92)    | 1.56 (0.21)  |
| Family time spent in sedentary behaviours | 3.90 (0.83)    | 3.45 (0.80)    | 50.40 (0.00) | 3.85 (0.79)    | 3.42 (0.84)    | 52.23 (0.00) |

\(^1\) MVPA = moderate-to-vigorous physical activity
\(^2\) Includes physical activity, sleep, and screen time
\(^3\) Ranges from 1 to 5, where 1 = a lot less, 3 = no change, and 5 = a lot more

Movement behaviours in youth in April 2020 and October 2020

A summary of the movement behaviours of youth (ages 12 to 17 years) in April and October 2020 is presented in Table 4. The parents of youth in April and October 2020 reported similar amounts of days per week of MVPA; however, parents of youth reported significantly more hours per day of screen time in April compared with parental reports in October across gender (\( p < 0.01 \)). Parents of youth also reported fewer hours of sleep in October compared with April (\( p < 0.01 \)). The proportion of youth meeting screen time and sleep guidelines also differed between April and October 2020. In April, fewer boys and girls were meeting screen time guidelines (i.e., \( \leq 2 \) hours of recreational screen time per day), whereas in April compared with October (\( p < 0.01 \)). The proportion of youth meeting the MVPA guideline did not differ between April and October. Overall, parents of youth reported their child’s behaviours to be more similar to pre-pandemic levels in October compared with April for all activities. Only 1.9% of youth (1.3% of girls and 2.4% of boys) were meeting the 24-hour movement behaviour guidelines in October 2020, compared with 0.6% of children (0.8% of girls and 0.5% of boys) in April 2020 (Moore et al., 2020).
We provide a summary of the associations between perceived changes in child movement behaviours, and demographic factors and parental support factors in Table 5. Briefly, related to parent demographic factors, for those associations where \( r > 0.1; p < 0.01 \): Children and youth of younger parents had more time outdoors \( (r = -0.12) \) and better parent-reported sleep quality \( (r = -0.14) \). Children and youth who lived in detached homes spent more time outdoors \( (r = 0.12) \), walking and cycling outdoors \( (r = 0.14) \), more playtime outdoors \( (r = 0.16) \) and overall time outdoors \( (r = 0.13) \).

There were a number of associations noted between movement and play behaviours and parental support factors. For those associations where \( r > 0.1; p < 0.01 \): Parental encouragement of physical activity was associated with more outdoor physical activity \( (r = 0.17) \), time spent walking and cycling \( (r = 0.17) \), time outdoors playing \( (r = 0.15) \), and overall time spent outdoors \( (r = 0.13) \). These children and youth also had more indoor activity \( (r = 0.14) \), more activity through chores \( (r = 0.19) \), more family time physical activities \( (r = 0.22) \) and more sleep \( (r = 0.15) \). Parent co-play (i.e., when parents engaged in play with their child) was associated with more child outdoor physical activity \( (r = 0.29) \), more walking and cycling \( (r = 0.32) \), more outdoor play \( (r = 0.40) \), and overall time spent outdoors \( (r = 0.36) \). Additionally, these children and youth had more activity through chores \( (r = 0.28) \), family time physical activity \( (r = 0.42) \), and better sleep quality \( (r = 0.14) \). Parents logistical support for physical activity (e.g., driving a child to an activity) was associated with more outdoor physical activity \( (r = 0.20) \), more walking and cycling \( (r = 0.11) \), more outdoor play \( (r = 0.13) \), more overall time spent outdoors \( (r = 0.17) \), more family physical activity \( (r = 0.20) \), as well as more time spent being active inside \( (r = 0.18) \). When parents discouraged screen time, this was associated with more time being active through chores \( (r = 0.11) \), more inside play \( (r = 0.14) \), more family sedentary behaviours \( (r = 0.20) \), and more sleep \( (r = 0.14) \), but was also associated with more screen time \( (r = 0.21) \) and more time spent on social media \( (r = 0.21) \). Finally, parents’ encouragement of sleep was associated with the child sleeping more \( (r = 0.20) \) and better sleep quality \( (r = 0.16) \), as well as more time being active through chores \( (r = 0.15) \), inside play \( (r = 0.13) \), and family physical activity \( (r = 0.12) \), as well as screen time \( (r = 0.13) \).
Table 5
Associations between parent perceived changes in movement behaviours and demographic, social, and environmental factors in October 2020.

| Parent's age | Outdoor physical activity | Walking and cycling | Outdoor play | Overall time outdoors | Inside physical activity | Household chores | Inside play | Family physical activity | Family sedentary behaviour | Screen time | Social media use | Sleep | Sleep quality |
|--------------|---------------------------|---------------------|--------------|----------------------|-------------------------|-------------------|-------------|-------------------------|---------------------------|------------|------------------|-------|---------------|
| -0.05        | -0.02                     | -0.09*              | -0.12*       | -0.09*               | -0.05                   | -0.02            | -0.07*      | 0.03                    | 0.07*                     | 0.12*      | -0.03            | -0.14 |
| Parent's gender 1 | 0.00                     | -0.04               | 0.03         | 0.02                 | -0.03                   | 0.06             | -0.01       | 0.10*                   | 0.08*                     | 0.04       | 0.04             | -0.01 |
| Parent's education | -0.02                    | 0.02                | 0.00         | -0.02                | -0.03                   | 0.06             | -0.01       | 0.05                    | 0.05                     | 0.10*      | 0.05             | -0.01 |
| Household income | 0.00                     | 0.04                | 0.09*        | 0.02                 | -0.13                   | 0.00             | -0.01       | 0.02                    | 0.04                     | 0.08*      | 0.02             | -0.04 |
| Marital status 2 | 0.07*                    | 0.05                | 0.09*        | 0.05                 | 0.01                    | 0.04             | 0.00        | -0.01                  | 0.00                     | -0.02      | -0.01            | 0.02 |
| Household (dwelling) type 3 | 0.12*                    | 0.14*               | 0.16*        | 0.13*                | -0.01                   | 0.08*            | -0.05       | 0.06                    | 0.02                     | 0.01       | 0.05             | 0.02 |
| Dog ownership 4 | 0.05                     | 0.04                | 0.08*        | 0.03                 | 0.00                    | 0.06             | -0.05       | 0.04                    | 0.02                     | -0.04      | 0.03             | -0.03 |
| Parent encourages physical activity | 0.17*                    | 0.17*               | 0.15*        | 0.13*                | 0.14*                   | 0.19*            | 0.05        | 0.22*                   | 0.08*                     | 0.09*      | 0.07*            | 0.15* |
| Parent participates in physical activity | 0.29*                    | 0.32*               | 0.40*        | 0.36*                | 0.14*                   | 0.28*            | 0.01        | 0.42*                   | 0.01                     | -0.03      | -0.03            | 0.04 |
| Parent logistical support of physical activity | 0.20*                    | 0.11*               | 0.13*        | 0.17*                | 0.18*                   | 0.09*            | -0.03       | 0.20*                   | -0.09*                    | -0.06      | 0.04             | 0.06 |
| Parent discourages screen time | -0.03                    | 0.02                | 0.00         | -0.03                | 0.00                    | 0.11*            | 0.14*       | 0.05                    | 0.20*                     | 0.21*      | 0.14*            | 0.14* |
| Parent encourages sleep | 0.04                     | 0.06                | 0.06         | 0.04                 | 0.06                    | 0.15*            | 0.13*       | 0.12*                   | 0.12*                     | 0.13*      | 0.06             | 0.20* |

1 1 = man; 2 = women
2 1-single; 2 = cohabited
3 1 = apartment; 2 = detached home
4 1 = no; 2 = yes
*p < 0.01

Discussion

Ways families were approaching movement in October 2020 compared with April 2020

A summary of parents’ responses to open-ended questions are presented in Appendix B. Forty-nine percent (49.4%) of parents indicated an increased adoption of inside hobbies or activities, and 53.1% reported increased outdoor hobbies or activities. Among respondents, the most cited inside activities (see Appendix B; Table B1) were arts & crafts (11.0%), video games (10.3%), and puzzles & games (8.2%). Among the reported increased inside activities, 8.4% were screen-based (e.g., computer, phone, tablet, television) and 4.2% were active hobbies (e.g., dancing, physical education exercises, treadmill, running around). The top three referenced outdoor activities (see Appendix B; Table B2) were cycling (6.1%), walking and hiking as a family (5.8%), and running (1.7%); and sports (1.7%; e.g., basketball on driveway, playing catch, soccer). New family hobbies as a result of COVID-19 and related restrictions were also reported (194 responses; see Appendix B; Table B3), with the most commonly mentioned activities being physical activity (4.4%), puzzles and games (3.2%), and arts and crafts (1.2%). Overall, 1.2% of new family hobbies were screen-based. Among respondents, 9.3% reported using online resources or apps to support healthy movement behaviours (see Appendix B; Table B4). Following YouTube (2.1%), home workout videos (1.3%) and online workouts (1.3%) were the most frequently reported online resources families accessed to support healthy movement behaviours. Compared to 6 months previous, there appeared to be a general shift to more active and less sedentary activity options. A greater dispersion in coded activities was observed (as indicated by the addition of new codes), revealing few ‘peaks’ in popular activities. Over a 6-month period, an increased range or diversity in online resources were noted.
Summary of findings

The purpose of this 6-month follow-up study was to describe the movement and play behaviours of a large national sample of Canadian children and youth during the start of the second wave of the COVID-19 pandemic (T2; October 2020), and compare these findings to our initial results from the first wave (T1; April 2020). Given the changing landscape of the pandemic and varying public health recommendations across the first and second waves of COVID-19, this study aimed to extend the findings of our April 2020 study (Moore et al., 2020) and evaluate the continuing impacts of the virus outbreak on children and youth's movement and play. Our hypothesis that children, youth, and their families would be settling into life during COVID-19 and returning to sport and recreation with loosened restrictions, and that a larger proportion of children and youth would be meeting the 24-hour movement recommendations, was not fully supported in October 2020. Overall, fewer children and youth were meeting the physical activity and sleep recommendations for their ages in October compared with April 2020. However, more children and youth were meeting the screen time recommendations for their ages in October compared with April 2020. Not surprisingly, children and youth who had parents who encouraged and supported healthy behaviours were more likely to meet the recommendations for physical activity, sedentary behaviour (screen time), and sleep. Children and youth who lived in detached homes were also more likely to play and be physically active outdoors.

Change in movement behaviours before and across the COVID-19 pandemic

Given its health consequences, physical inactivity was itself declared a pandemic in a 2012 Lancet series, where the authors urged public health officials to adopt a life course approach to encourage children and youth to participate in ample activity (Kohl et al., 2012). The proportion of Canadian children and youth meeting physical activity recommendations before the COVID-19 pandemic was relatively low, having previously been reported to be 12.7% and 17.1% using parent-report and device-based measures, respectively (Rhodes et al., 2019; Carson et al., 2017). Children and youth are commonly physically active at school, as well as through sport, outdoor play, and recreation (Kneseshaw-Price et al., 2013; Corder et al., 2011; Colabianchi et al., 2016). Therefore, it is not surprising that we found a decline in parent-reported child's physical activity levels across the pandemic. In a recent study, Canadian parents of children ages 5 to 11 years noted the decline in their child's physical activity levels was due to, in part, their reliance on pre-programmed, structured activities to keep their child active. Parents felt tasked with the challenge of reimagining ways to increase physical activity and decrease sedentary behaviours during the pandemic (Riazi et al., 2021). Further, parents had expressed the challenge of controlling their child's screen time, stating this as a way for their child to connect with friends and complete schoolwork (Riazi et al., 2021). In the present study, and as anticipated, we found that fewer children and youth were meeting the screen time guidelines during the pandemic compared with before the pandemic. Before the pandemic, the proportion of Canadian children meeting screen time guidelines (i.e., ≤ 2 hours per day of recreation screen time) was 25.8% (Rhodes et al., 2019). In April 2020 (during the first wave of the pandemic), we reported that only 11.3% of Canadian children and youth were meeting screen time guidelines (Moore et al., 2020), however 6-months later, 25.6% of children and youth were meeting the guidelines. We attribute this difference to many children and youth returning to school in fall 2020 and fewer communities having strict lockdown policies. Overall, there were dramatically low proportions of children and youth meeting the combined 24-hour movement behaviour guidelines during the first and second waves of the COVID-19 pandemic. We found that, despite many children and youth returning to in-person instruction and some organized activities during the second wave of COVID-19, only 3.1% were meeting the combined 24-hour movement behaviour guidelines (compared with 2.6% during the first wave of COVID-19). The COVID-19 pandemic, and the public health restrictions that have been put in place to reduce virus transmission, may be having negative consequences on child and youth health. This is indicated by our findings that show dramatic changes in Canadian children and youth physical activity, sedentary behaviours, and sleep during the first and second waves of COVID-19.

Concerns for child and youth health across the pandemic

There are rising pediatric cases of COVID-19 globally, though proportionately the virus tends to infect children and youth at relatively lower rates compared with adults (Song et al., 2020; Cooper et al., 2021). For many, it is the collateral mental and physical health consequences on children and youth that are of prime concern (Golberstein et al., 2020; Guan et al., 2020). For example, early data indicates that COVID-19 related closures, cancellations, and restrictions are associated with decreased cardiovascular fitness (Dayton et al., 2021) and increased rates of obesity (Rundle et al., 2020) in children and youth. Reduced time spent in physical activity and increased time on screens during the COVID-19 pandemic have also been associated with greater risk of anxiety and depressive symptoms (Alves et al., 2021), and insomnia in children and youth (Lu et al., 2020). With most children and youth engaging in too much sedentary behaviour and screen time, and too little physical activity and sleep during the pandemic, it is speculated that this global health crisis could lead to future health consequences for this young generation. There is evidence indicating that children and youth who engage in optimal levels of physical activity and sleep, and spend less time being sedentary and on screens, demonstrate better physical and mental health (Carson et al., 2016). Further, movement behaviours learned and adopted in the early years tend to track moderately from adolescence into young adulthood (Hayes et al., 2019). Consequently, childhood and adolescence are often considered ‘windows of opportunity’ to foster healthy behavioural patterns (Dorn et al., 2019). Childhood and adolescence may be the opportune time for the promotion of healthy movement behaviours and interventions tailored to improve physical activity, sleep, and reduce sedentary behaviours and screen time. Thus, comprehensive plans to address the post-pandemic mental and physical health of this generation of pandemic children and youth are warranted.

Reintroducing outdoor play and family activities during and after the pandemic

In the present study, many parents noted that their children and youth were relying more on self-directed and unstructured activities for their activity and play during the COVID-19 pandemic. Indeed, parents in a previous study also noted that they were addressing the lack of their child’s structured activities with nature walks, cycling, and hikes (Riazi et al., 2021). Perhaps the pandemic offers a unique opportunity for children, youth, and their families to reimagine their leisure time. Six months into the pandemic, through our open-ended questions, parents indicated that their children or youth took to cycling, walking, and hiking in nature. Given the known benefit of being outdoors (Herrington & Brussoni, 2015; Tremblay et al., 2015), and the relatively lower risk of transmission of COVID-19 in outdoor spaces when physical distancing is also employed (Weed & Foad, 2020), playing outdoors should be considered an important tool to contribute towards childhood health and well-being. Many Canadian Public Health Officials have continued to emphasize the importance of outdoor activities...
throughout the pandemic. For example, Dr. Bonnie Henry, British Columbia’s Provincial Health Officer has urged children and their families to “Please, go outside. Go outdoors with your family.” Child-led free play outdoors is especially important for childhood and adolescent health and wellbeing. Thus, public health officials should continue to promote time outdoors, restoring child-led play. Access to outdoor spaces should be viewed as a necessity during and beyond the COVID-19 pandemic.

Our study also reiterates the importance of parent support for, and encouragement of, healthy movement behaviours. Similar to previous research (Rhodes et al., 2019), parent involvement in their child’s physical activity was a significant correlate of children and youth movement behaviours. At the time of this study, many children and youth had returned to school; as such, there may be fewer opportunities for children and youth to engage with play and physical activity with their parents. In our open-ended questions, parents indicated their families taking up outdoor family walks and hikes. Parents also indicated that, when indoors, their children and youth were engaging in non-screen based family sedentary behaviours, like arts and crafts, puzzles and board games. The evidence on the role of the family in children and youth physical activity, sedentary, and sleep behaviours is sufficiently compelling that last year a consensus statement was published (Rhodes et al., 2020a). The statement, published as part of the 2020 ParticipACTION Report Card on Physical Activity for Children and Youth (ParticipACTION, 2020), recommended parental support for healthy movement behaviours, parental modeling of healthy behaviours, parental responsibility for healthy expectation in the family, and opportunities for the entire family to be active and play together (Rhodes et al., 2020a). This may be difficult, given that adults are also indicating that their activity levels have decreased as a result of COVID-19 lockdowns and restrictions (Stockwell et al., 2021). Still, we found that during the pandemic parents showed excellent creativity and found innovative ways to keep their children and youth engaged in physical activities. This included more outdoor activities as a family, as well as indoor activities, such as active Apps and games. As we emerge out of the COVID-19 pandemic, public health officials, and policies, should consider physical activity and outdoor play promotion by targeting opportunities for the parent and child to move and play together. Families may consider ways in which they can carve out time for physically active family pursuits. Interventions based on key determinants of parental supports are warranted (Rhodes et al., 2020b; Rhodes et al., 2020c).

**Recommendations to preserve and promote healthy movement behaviours in child and youth**

Six months into the pandemic, many shifts and changes continued to be observed in movement behaviours among children and youth. While this global health crisis is long-lasting and has had significant health and economic consequences, it may also be conceivable that this pandemic will shape new ways of engaging in movement and play. To preserve and promote child and youth health as we emerge from this pandemic, we recommend that:

- Public health officials support children, youth, and their families by encouraging physical activity, providing easy access to (and not closing of) outdoor spaces that allow everyone to walk, cycle, wheel or scoot and providing sufficient space for physical distancing;
- Children and youth aim to meet the 24-hour movement behaviour guidelines; accumulating 60-minutes or more of MVPA, watching screens in their leisure time no more than 2 hours per day, and getting adequate sleep for their age (i.e., 9 to 11 hours per night for those aged 5 to 13 years, and 8 to 10 hours per night for those age 14 to 17 years); and
- Parents and families consider ways to engage together in healthy movement behaviours, to encourage children and youth to get outdoors, to continue to support and encourage more physical activity, less sedentary and screen time, and good quality, uninterrupted sleep.

**Strengths and limitations**

We have extended the findings from our first study (Moore et al., 2020), and showed the continued implications of the pandemic and related public health restrictions on the movement and play behaviours of a large sample of nationally representative parents of children and youth. Using identical methodology, we conducted a 6-month follow-up survey and we compared findings from this follow-up (T2, October 2020) to baseline findings from earlier in the pandemic (T1, April 2020). Our study utilized a repeated cross-sectional study design, rather than longitudinal; however, this approach was deemed appropriate given our study aims. We acknowledge that a number of analyses were conducted in this study, enhancing the likelihood of a false positive test. We used a smaller p-value (0.01) to reduce this possibility. Further, children and youth’s movement behaviour data were collected via parent-report. This may have biased our findings due to challenges in recall or a parent’s preference to provide socially desirable responses. We also acknowledge that there were regional differences in COVID-19 cases and geographical and social disparities may disproportionately affect some children and youth more than others. We also acknowledge that there were differences in public health restrictions and weather between April (first wave) and October (second wave) surveys; however, some factors were similar during these two time points (e.g., new cases per day in Canada were 2,019 and 2,580 in mid-April and mid-October, respectively).

**Conclusions**

This 6-month follow-up study provides evidence of the continued collateral consequences of the COVID-19 virus outbreak and related public health restrictions on children and youth health. The results demonstrate that most children and youth were not engaging in sufficient healthy movement behaviours several months into the pandemic, despite the re-opening of many schools, playgrounds, parks, and organized sporting activities. Given the number of COVID-19 infections in different regions and the variation in re-opening policies across the country, future studies should consider analysis by region. Future studies may also consider investigating factors of adherence and non-adherence to the 24-hour movement behaviour guidelines, and investigate the long-term consequences of the pandemic on children and youth’s health. Collectively, we anticipate our study’s findings can guide efforts to mitigate potential health risks to children, youth, and their families during future pandemics.

**Declarations**

**Acknowledgments**
We would like to thank the survey participants for their support of this project. The survey was distributed by ParticipACTION, a national non-profit organization with a mission to help Canadians sit less and move more (Toronto, Canada).

Competing interest statement

SAM, MDG, MB, RM have no conflicts of interest to declare. GF, RER, LJF, NO, JCS, and MST 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 provides meeting expenses for the RAG to meet but does not provide any additional compensation. LMV and TCB are employed by ParticipACTION in the roles of Knowledge Translation Manager and Behavioural Insights Manager, respectively.

Contributors’ statement

Conceptualization, SAM, GF, MST.; methodology, SAM, GF, MB, RM; formal analysis, SAM, RER, LMV, LJF; data validation, SAM, RER, MDG, writing—original draft preparation, SAM; writing—review and editing, SAM, GF, RER, LMV, LJF, MDG, MB, RM, NO, JCS, TCB, MST; visualization, SAM, RER, LMV, JJF; project administration, SAM, GF, MST.; funding acquisition, SAM, GF, MST, LMV. All authors have read and agreed to the published version of the manuscript.

Funding statement

The study was funded by Dalhousie University, ParticipACTION, and the Province of Nova Scotia. LMV was supported by a Canadian Institutes of Health Research Fellowship Award.

Data availability statement

This dataset is available from ParticipACTION upon reasonable request and completion of a data transfer agreement.

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**Figures**

Figure 1

Parent-reported changes in 24-hour movement behaviours in Canadian children and youth (5 to 17 years) during the first [April (●) 2020] and second wave [October (*) 2020] of the COVID-19 pandemic. Scores are based on a 5-point scale range from ‘a lot less’ (score 1) to ‘about the same’ (score 3) to a lot more (score 5). Green arrows represent when April 2020 scores ranked less compared with October 2020 within the same variable. Red arrows represent when April 2020 scores ranked higher compared with October 2020 within the same variable. See Table 2 for more details. Data points are means with standard error bars (too small to be seen).

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