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Associations between parent and child 24-hour movement behaviours across the COVID-19 pandemic in Canada

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Abstract

Background Parents influence and support children's healthy movement behaviours (physical activity, sedentary time, sleep). During the COVID-19 pandemic, families spent even more time together. Thus, parents likely had greater influence on their child's movement behaviours than usual. This study assessed the associations between parent and child movement behaviours and compliance with movement behaviour guidelines at two time points during the COVID-19 pandemic.

Methods National samples of parents of children and adolescents (5–17 years) living in Canada completed online surveys about their own and their child's movement behaviours in October 2020 ($n=1,568$, 58% women) and April 2021 ($n=1,600$, 60% women). Associations between parent and child movement behaviours and compliance with 24-hour movement behaviour guidelines were examined.

Results We observed mostly positive, significant correlations between parent and child movement behaviours in October 2020 ($r=0.12–0.26$, $p<0.05$) and April 2021 ($r=0.12–0.20$, $p<0.05$). A parent meeting an individual movement behaviour guideline (e.g., physical activity) was associated with an overall higher incidence of their child meeting the same guideline in October 2020 (Incidence Rate Ratio (IRR):=1.10–3.06) and April 2021 (IRR: 1.19–2.26). The incidence of children meeting the 24-hour movement guidelines in October 2020 (IRR = 3.06, 95% CI: 1.55, 6.04) and in April 2021 (IRR = 2.26, 95% CI: 1.34, 3.83) was higher when parents met the 24-hour movement guidelines.

Conclusions Parent and child movement behaviours were associated with one another during the COVID-19 pandemic, particularly for children (compared with adolescents). In times of severe public health restrictions, health promotion efforts should target family units to promote healthy movement of families collectively.

Keywords Physical activity, Sedentary behaviour, Screen time, Sleep, Survey, Adolescents

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Background

Children, adolescents, and adults who meet the Canadian 24-Hour movement guideline tend to have improved physical and psychosocial health [1, 2]. Children and adolescents who engage in more desirable combinations of physical activity, sedentary behaviour (which includes recreational screen time), and sleep, have healthier measures of cardiometabolic health, fitness, adiposity, and health-related quality of life [3–5]. In adults, desirable combinations of physical activity, sedentary behaviour, and sleep are associated with reduced all-cause mortality, reduced adiposity, improved cardiometabolic health, and improved mental health [6]. In both children and adults, reallocating time to moderate-to-vigorous physical activity (MVPA) from any other movement behaviour is associated with improved health [6, 7]. Despite the known benefits of meeting 24-hour movement guidelines, recent findings from the Canadian Health Measures Survey reported that only 13.9% of children, 4.8% of adolescents, and 19.1% of adults were meeting the combined recommendations before the COVID-19 pandemic [5, 8].

Since the World Health Organization declared COVID-19 a pandemic in March 2020 [9], many studies have reported on its impact on movement behaviours. The Canadian Community Health Survey was completed at various time points during the pandemic and asked adolescents and adults about how much time they spent being physically active and engaging in screen time (as an indicator of sedentary behaviour) [10, 11]. Almost half of adolescents (12–17 years) met the physical activity recommendation before the pandemic; however, the percentage dropped to 37% in the first year of the pandemic before recovering to 44% in 2021. The percentage of adolescents meeting the screen time recommendation also dropped during the pandemic [10]. Among adults (18–64 years) during the pandemic, women maintained their physical activity levels while men slightly decreased compliance with the recommendation from 63 to 60%, and the percentage of adults in the lowest screen time category decreased [11]. These results were not unique to Canada; a scoping review exploring the impact of the COVID-19 pandemic on movement behaviours of adolescents worldwide determined that there were consistent declines in physical activity, and increases in screen time, sedentary behaviour, and sleep, and these changes were more detrimental for adolescents than children [12]. The declines in physical activity and increases in screen time and sedentary behaviour among children, adolescents, and adults are well documented across the pandemic; yet it is not entirely clear what features of the pandemic and related restrictions were harmful or protective against changes in movement behaviours. Given the increased time that families spent together due to social gathering restrictions, it is possible that families and parents, in particular, had an even greater influence on child and adolescent movement behaviours during this time.

The connection between parental and child movement behaviours can be attributed to Bandura's Social Cognitive Theory, and its application to engagement in health behaviours, health promotion, and disease prevention [13, 14]. Social Cognitive Theory identifies that health behaviours, such as movement behaviours, are influenced by personal, behavioural and environmental factors and their dynamic interactions [13]. Social support, which refers to how and to what extent others facilitate engagement in a specific behaviour, is one environmental factor to influence behaviour [15]. Barriers, another environmental factor, are personal, social or structural impediments to engaging in a specific behaviour [15]. Parents play key roles in both supporting child participation in and managing barriers to participation in healthy movement behaviours. The associations between parent and child movement behaviours were well documented in the *Consensus statement on the role of family in the physical activity, sedentary and sleep behaviours of children and youth* [16]. Families and parents can support children in healthy movement behaviours by encouraging, facilitating, modelling, setting expectations, and engaging in healthy movement behaviours together [17]. When Canadian parents were surveyed about regularly supporting their children in specific movement behaviours, the largest proportion of parents provided support for sleep (73%), followed by screen time (49%), light physical activity (LPA) (44%), and MVPA (23%) on most days of the week [18]. Parents provided greater support for all movement behaviours when children were younger and less as they entered adolescence [18], which is consistent with another study reporting greater associations between parent and child physical activity for children 4–8 years compared with older children [19]. Another study prior to the pandemic also showed positive relationships between parent and child physical activity and screen time, highlighting the potential for parental modelling of these behaviours to also impact their children's behaviours [20]. These associations between parent and child movement behaviours may have been further exaggerated during the COVID-19 pandemic, when families would have been expected to spend more time together due to pandemic related restrictions. Data from qualitative interviews with Canadian parents early in the pandemic revealed that children's physical activity opportunities were restricted with the cancellation of structured activities, like sports and the closure of recreation centres, and parents attempted to engage in unstructured activities with children, like walking or cycling, but opportunities were limited with the closure of parks and playgrounds [21]. These findings are supported by another study from Ontario, Canada that reported

significant associations between parent and child (≤ 12 years) physical activity levels across the pandemic from Fall 2020 to Fall 2021 [22].

Our research group has previously reported on the impact of the COVID-19 pandemic on Canadian children's movement behaviours and health behaviours through surveys administered in spring 2020, fall 2020, and spring 2021. The first iteration of the survey, administered in spring 2020, did not collect information about parent's movement behaviours [23]; however, these data were collected in fall 2020 and spring 2021 [24]. In fall 2020, older parental age, higher education, and greater time spent in outdoor play with a child were associated with greater likelihoods of parents meeting the MVPA recommendation or combined 24-hour movement guidelines [24]. In addition, greater levels of family physical activity were associated with a higher likelihood of meeting the screen time recommendation [24]. At all timepoints, we collected other key information about how families spent time together. For example, parental encouragement and parent co-participation were associated with higher child outdoor physical activity, time spent walking or biking, outdoor play, and family physical activity in Spring and fall 2020 [23, 25].

Given the evidence suggesting relationships between parent and child movement behaviours before and during the pandemic, it is important to further understand these relationships in a large, representative Canada-wide sample of parents of children and adolescents (aged 5–17 years) during periods of public health restrictions. The findings can be applied to the development and implementation of health promotion efforts to ensure children, youth, and adults maintain engagement in healthy movement behaviours during future public health emergencies. Therefore, the primary aim of this study was to determine the associations between parent and child movement behaviours (one parent and one child per household), and compliance with 24-hour movement behaviour guidelines at two timepoints (fall 2020 and spring 2021) during the COVID-19 pandemic. A secondary aim of this study is to examine the influence of gender and age on the associations between child and parent movement behaviours during the COVID-19 pandemic. It was hypothesized that parent and child movement behaviours would be positively associated during the COVID-19 pandemic, particularly early in the pandemic as families spent more time together due to public health-related gathering restrictions.

Methods

Study design

Data for this study were collected in Canada at two points during the COVID-19 pandemic: October 2020 and April 2021. This study was part of the follow-up to a large, national study that assessed child and adolescent movement behaviours during the COVID-19 pandemic, conducted in partnership with ParticipACTION (Canadian organization promoting healthy physical activity), starting in Spring 2020 [23]. The methods for this study have been described in detail previously [24, 25]. Briefly, using a repeated cross-sectional design, samples of approximately 1,500 parents of children (ages 5–11 years) and adolescents (ages 12–17 years) living in Canada were recruited via Maru/Matchbox, a third-party market research company, and independently completed the survey. Maru/Matchbox recruited participants from a panel that is comparable with the Canadian census in terms of child's age, gender, ethnicity, geographic location, and socioeconomic status [26]. All procedures involving research study participants were approved by Dalhousie University's Research Ethics Board (#2020–5351). Informed consent was obtained from all respondents.

Survey

The survey, described previously [23–25], included a series of questions related to participant demographics (parent and child) and parent and child movement behaviours. For this study, we included parent demographics (age, gender, marital status, education, annual household income, and employment status), child demographics (age, gender, disability status, household composition, and residence type), parent movement behaviours (minutes per week of MVPA, hours per day of screen time, hours per day of sedentary time, and hours per day of sleep), and child movement behaviours.

Statistical analyses

All analyses were performed using Stata SE 14.2 for Mac (StataCorp, College Station, TX, USA). Continuous variables were described as mean (M) and standard deviations (SD) and categorical variables were described as frequencies (*n*) and proportions (%). The proportion of children, adolescents, and parents meeting the Canadian 24-Hour movement guidelines and its component parts was determined. Children and adolescents were classified as meeting the movement behaviour guidelines if they participated in at least 60 min of MVPA on 6 or 7 days, if they spent 2 h or less in daily recreational screen time, and if they accumulated sufficient sleep; 9–11 h for 5–13 year-olds or 8–10 h for 14–17 year-olds daily [2]. Parents were classified as meeting the 24-hour movement behaviour guidelines if they participated in at least 150 min of MVPA per week, no more than 3 h of recreational screen time per day, and 7–9 h of sleep per day [1]. Given the study's focus on associations between parent and child movement behaviours, parental daily sedentary time is not reported and their sedentary behaviour is indicated

by recreational screen time to align with child and youth movement behaviours.

Shapiro-Wilk Test of Normality was conducted for all child and parent movement behaviours, and the results indicated that all movement behaviours were not normally distributed ($p < 0.001$). To assess the relationships between child and parent movement behaviours, Spearman correlations were used given samples were not normally distributed and data were ordinal. Once Spearman correlation coefficients were determined, we assessed if there was a difference between the October 2020 and April 2021 correlation coefficients using Fisher's Z-test. Poisson regression analyses, with robust error variance, were used to calculate incidence rate ratios (IRR) for a child meeting a movement behaviour guideline if their parent met the matching movement behaviour guideline. Age and gender adjusted models were also computed.

Results

Sample characteristics

Parent, child, and adolescent descriptive characteristics for October 2020 and April 2021 are included in Table 1. In October 2020, 1,568 parents participated, and 1,600 parents participated in April 2021 (two independent samples). Geographic and ethnic distributions of the samples were reflective of Canadian demographics. At both timepoints, parent respondents were predominantly women, married or co-habiting, attended or completed university, worked full-time, and had annual household incomes over $51,000. Almost all parents (85–90%) reported that their child or adolescent lived in houses or townhouses, and households were reported to have an average of 2.1 adults and 1.7–1.9 children, at both timepoints. In October 2020, 9.3% and in April 2021, 9.8% reported that their child or adolescent had a diagnosed disability or chronic condition.

Parent movement behaviours and the proportion of parents meeting guidelines are also included in Table 1. October 2020 results for children and adolescents were published previously [25]. Movement behaviours and the proportion meeting movement behaviour guidelines are included in Table 2 for the entire child and adolescent sample, and separately for children and adolescents, and boys and girls.

Figure 1 shows the proportion of children, adolescents, and parents who met the MVPA, screen time, sleep, and 24-hour combined movement behaviour guidelines in October 2020 and April 2021. In October 2020, most parents met the screen time (52%) and sleep (66%) recommendations, while most reported not meeting the MVPA recommendation (20%), and only 8% met the combined 24-hour movement behaviour guidelines. In April 2021, most parents again met the screen time (57%) and sleep (68%) recommendations, while 30% reported meeting the MVPA guideline and 10% met the 24-hour movement behaviour guideline. Child and adolescent movement behaviours and proportions meeting the guidelines are included in Table 2. As reported previously, only 4% of children and adolescents met the 24-hour combined movement behaviour guidelines in October 2020. In spring 2021, most children and adolescents (71%) met the sleep recommendation, 29% met the screen time recommendation, 17% met the MVPA recommendation, and 5% met the 24-hour movement behaviour guidelines.

Movement behaviour associations between parents and children

We observed associations between parent and child movement behaviours in both October 2020 and April 2021 (Table 3). In October 2020, statistically significant associations where $r > 0.10$, $p < 0.05$ included: child MVPA and child sleep ($r = 0.158$), child MVPA and parent MVPA ($r = 0.171$), child screen time and child sleep (r=-0.155), child screen time and parent screen time ($r = 0.255$), and child sleep and parent sleep ($r = 0.124$). In April 2021, we observed the following statistically significant associations: child MVPA and child screen time (r=-0.151), child MVPA and child sleep ($r = 0.141$), child MVPA and parent MVPA ($r = 0.165$), child screen time and parent screen time ($r = 0.204$), child sleep and parent sleep ($r = 0.124$). The correlation coefficients for associations between parents and child MVPA ($z = 0.174$, $p = 0.431$), screen time ($z = 1.514$, $p = 0.065$), and sleep ($z = 0.32$, $p = 0.366$) were similar between timepoints (October 2020 and April 2021).

Table 4 includes the unadjusted IRR to describe the likelihood of a child meeting a movement behaviour guideline if their parent met that guideline in October 2020 and April 2021. In October 2020, a parent meeting the individual or combined movement behaviour guidelines was associated with an overall higher incidence of their child or adolescent meeting the guidelines. However, the relationships varied when analyzed by age or gender groups. By gender in October 2020, a parent meeting the individual or combined movement behaviour guidelines was associated with girls meeting any of the guidelines and boys meeting the screen time guideline. In October 2020, parents meeting guidelines was associated with higher incidence of children meeting the MVPA, screen time, or 24-hour combined guideline, but not the sleep guideline. For adolescents (12–17 years) in October 2020, a parent meeting the guidelines was associated with higher incidence of adolescents meeting the sleep or screen time guideline, but not MVPA or 24-hour movement behaviour guidelines. When October 2020 models were adjusted for gender and age, child gender was not a significant predictor of children meeting the MVPA, Sleep, Screen Time or 24-Hour Combined

Table 1 Description of parent, child, and adolescent characteristics and parent movement behaviours in October 2020 and April 20,201 of the COVID-19 pandemic

	October 2020 (*n* = 1,568)	**April 2021 (*n* = 1,600)**
Parent Demographic Profile		
Age (years), M (SD)	42.9 (8.4)	44.35 (7.9)
Gender, women, n (%)	913 (58.2%)	958 (59.9%)
Marital status, *n* (%)		
Single	176 (11.2%)	105 (6.6%)
Married or common-law	1,248 (79.6%)	1,344 (84.0%)
Separated or divorced	132 (8.4%)	142 (8.9%)
Widowed	12 (0.8%)	9 (0.6%)
Education, *n* (%)		
Elementary or high school	212 (13.5%)	200 (12.5%)
College	507 (32.3%)	517 (32.3%)
University undergraduate	575 (36.7%)	610 (38.1%)
University postgraduate	274 (17.5%)	273 (17.1%)
Annual household income (CAD), *n* (%)		
≤$50,000	274 (17.5%)	215 (13.4%)
$51,000 to $99,000	591 (37.7%)	555 (34.7%)
$100,000+	594 (37.9%)	650 (40.6%)
Undisclosed	109 (7.0%)	180 (11.3%)
Employment status		
Full-time (> 30 h/week)	1,069 (68.2%)	1,070 (66.9%)
Part-time	192 (12.2%)	182 (11.4%)
Homemaker	150 (9.6%)	180 (11.3%)
Other	157 (10.0%)	168 (10.5%)
Child and Adolescent Demographic Profile		
Age (years), M (SD) / *n* (%)		
5–11 years	8.2 (2.1), 726 (46.3%)	8.4 (2.0), 810 (50.6%)
12–17 years	14.6 (1.7), 842 (53.7%)	14.7 (1.6), 790 (49.4%)
Gender, girls, *n* (%)	759 (48.4%)	763 (47.7%)
Disability, *n* (%)	145 (9.3%)	157 (9.8%)
Household makeup, M (SD)		
Adults	2.1 (0.7)	2.1 (0.7)
Children	1.7 (0.8)	1.9 (0.9)
Child's residence type, *n* (%)		
House/townhouse	1,332 (84.5%)	1,436 (89.8%)
Apartment/condominium	219 (14.0%)	142 (8.9%)
Other	17 (1.1%)	22 (1.4%)
Parent Movement Behaviours, M (SD)		
MVPA (min/week)	91.1 (152.5)	125.9 (177.5)
Screen Time (hours/day)	4.4 (3.3)	4.0 (2.9)
Sedentary Time (hours/day)	5.8 (3.6)	6.7 (3.8)
Sleep (hours/day)	7.2 (1.5)	7.2 (1.4)
Proportion of Parents Meeting Guidelines, n (%)		
MVPA	309 (19.9%)	475 (29.8%)
Screen Time	799 (52.1%)	919 (57.4%)
Sleep	989 (66.2%)	1,090 (68.1%)
24 h Combined	117 (8.2%)	163 (10.2%)

CAD: Canadian dollars; MVPA: moderate-to-vigorous physical activity

Table 2 Summary of the movement and play behaviours in children and adolescents in October 2020 and April 2021 of the COVID-19 pandemic

	All (*n* = 1,568)	Children			Adolescents		
		Total (*n* = 726)	Boys (*n* = 371)	Girls (*n* = 347)	Total (*n* = 842)	Boys (*n* = 422)	Girls (*n* = 412)
October 2020							
Movement behaviours, M (SD)							
MVPA ≥ 60 min (days/week)	3.1 (2.1)	3.5 (2.1)	3.6 (2.1)	3.5 (2.0)	2.8 (2.1)	2.8 (2.0)	2.8 (2.1)
LPA ≥ 120 min (days/week)	2.9 (2.2)	3.3 (2.3)	3.4 (2.3)	3.3 (2.3)	2.6 (2.1)	2.6 (2.1)	2.6 (2.2)
Sleep (hours/day)	9.1 (2.8)	9.4 (3.0)	9.3 (3.0)	9.5 (2.9)	8.9 (2.6)	8.7 (2.7)	9.1 (2.6)
Screen time (hours/day)	3.9 (2.9)	3.2 (2.6)	3.3 (2.6)	3.1 (2.2)	4.5 (3.1)	4.6 (3.1)	4.4 (3.0)
Proportion of children meeting guidelines, n (%)							
MVPA**	224 (14.3%)	127 (17.5%)	73 (19.7%)	52 (15.3%)	97 (11.5%)	50 (11.9%)	47 (11.4%)
Sleep	898 (63.4%)	397 (61.4%)	191 (57.8%)	203 (65.1%)	559 (70.8%)	242 (64.0%)	254 (66.0%)
Screen time	345 (27.8%)	226 (38.6%)	110 (36.4%)	115 (40.8%)	119 (18.2%)	54 (16.4%)	64 (20.2%)
24 h combined	44 (3.9%)	27 (5.1%)	13 (4.7%)	14 (5.4%)	17 (2.8%)	8 (2.7%)	9 (3.0%)
April 2021							
Movement behaviours, M (SD)							
MVPA ≥ 60 min (days/week)	3.2 (2.2)	3.9 (2.2)	3.8 (2.2)	3.9 (2.1)	2.5 (2.1)	2.7 (2.1)	2.4 (2.0)
LPA ≥ 120 min (days/week)	3.1 (2.4)	3.7 (2.4)	3.7 (2.4)	3.8 (2.4)	2.4 (2.2)	2.4 (2.2)	2.4 (2.2)
Sleep (hours/day)	10.0 (1.5)	10.2 (1.5)	10.2 (1.6)	10.3 (1.4)	9.7 (1.5)	9.7 (1.5)	9.6 (1.5)
Screen time (hours/day)	4.1 (3.4)	3.5 (2.8)	3.6 (2.9)	3.4 (2.8)	4.7 (3.8)	4.8 (3.8)	4.5 (3.7)
Proportion of children meeting guidelines, n (%)							
MVPA**	268 (16.8%)	193 (23.8%)	101 (24.6%)	92 (23.4%)	75 (9.5%)	49 (12.0%)	26 (7.1%)
Sleep	1131 (70.7%)	572 (70.6%)	286 (69.6%)	285 (72.3%)	559 (70.8%)	302 (73.7%)	249 (67.5%)
Screen time	471 (29.4%)	280 (34.6%)	140 (34.1%)	137 (34.8%)	191 (24.2%)	96 (23.4%)	94 (25.5%)
24 h combined	78 (4.9%)	61 (7.5%)	36 (8.8%)	25 (6.4%)	17 (2.2%)	11 (2.7%)	6 (1.6%)

MVPA: moderate-to-vigorous physical activity; LPA: light physical activity; **Meeting MVPA guideline defined as ≥ 60 min on 6 or 7 days/week

Movement Behaviour Guidelines (IRR = 0.83–1.17, $p = 0.11$–0.66). Child age was a significant predictor for children meeting the MVPA (IRR = 0.94, 95% CI: 0.91, 0.97), Screen Time (IRR = 0.90, 95% CI: 0.88, 0.92) and 24-Hour Combined Movement Behaviour Guidelines (IRR = 0.89, 95% CI: 0.81, 0.96), but not sleep (IRR = 1.00, 95% CI: 0.99, 1.02).

In April 2021, a parent meeting the individual or 24-hour movement guidelines was associated with higher incidence of children (5–11 years) meeting the individual or 24-hour movement guidelines and adolescents meeting the MVPA or sleep guidelines, but not screen time or 24-hour movement guidelines. It was also observed that a parent meeting an individual guideline was associated with higher incidence of boys meeting the individual guidelines, but not the combined 24-hour movement guidelines. A parent meeting the sleep, screen time, or 24-hour movement guidelines was associated with higher incidence of girls meeting those guidelines, but not MVPA. When April 2021 models were adjusted for gender and age, child gender (girl) was a significant predictor of children meeting the MVPA (IRR = 0.76, 95% CI: 0.63, 0.94) and 24-Hour Combined (IRR: 0.65, 0.43, 0.98) Movement Behaviour Guidelines, but not the Sleep (IRR: 0.96, 95% CI: 0.91, 1.03) or Screen Time (IRR: 1.04, 95% CI: 0.91, 1.19) Guidelines. Child age was a significant predictor of children meeting the MVPA (IRR: 0.87, 95% CI: 0.85, 0.90), Screen Time (IRR: 0.94, 95% CI: 0.92, 0.96) and 24-Hour Combined (IRR: 0.84, 95% CI: 0.79, 0.89) Movement Behaviours Guidelines, but not the Sleep Guideline (IRR: 1.00, 95% CI: 0.99, 1.01).

Discussion

Summary of findings

This study aimed to describe the relationships between parent and child and adolescents' movement behaviours in October 2020 and April 2021 of the COVID-19 pandemic using data collected from a large sample of Canadian parents, following up on our previous work about children's movement behaviours at the beginning of the COVID-19 pandemic [23]. We observed significant but weak, correlations between child and parent MVPA, sleep, and screen time volumes in both October 2020 and April 2021. Having a parent meet an individual or the combined 24-hour movement guidelines was associated with higher incidence rates of children and adolescents meeting guidelines, and relationships were strongest for the 24-hour movement guidelines compared to individual guidelines. In October 2020, parents meeting the individual or combined 24-hour movement guidelines was generally associated with higher incidence of children and adolescents meeting guidelines, particularly for children (5–12 years-old) and girls, but not adolescents or boys. In April 2021, parents meeting guidelines was generally

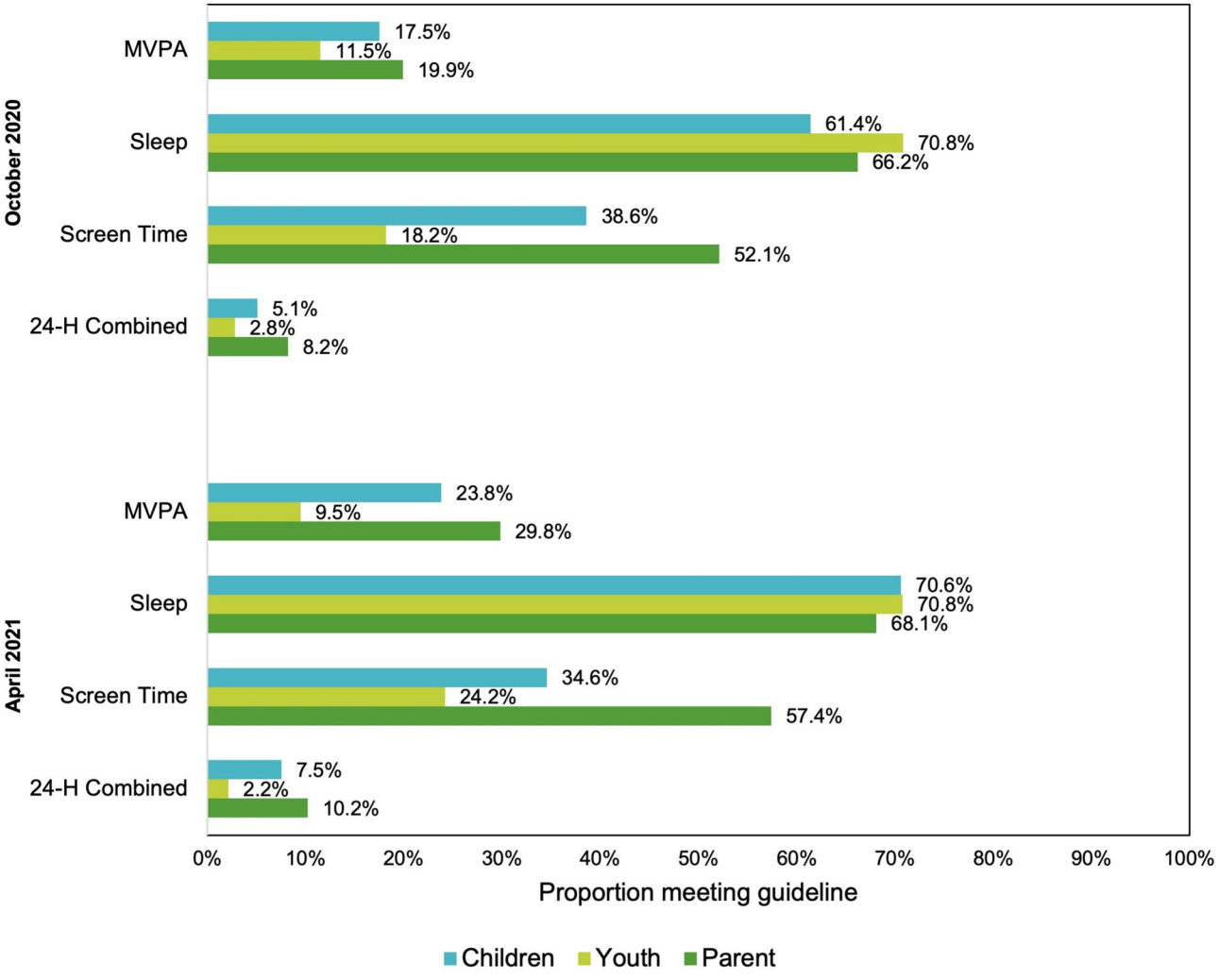

Fig. 1 Proportion of participants meeting the movement behaviour guidelines in October 2020 and April 2021

Table 3 Associations between parent and child movement behaviours in October 2020 and April 2021

	Child MVPA	Child Screen Time	Child Sleep	Parent MVPA	Parent Screen Time	Parent Sleep
October 2020						
Child MVPA	1.00					
Child Screen	-0.059*	1.00				
Child Sleep	0.158*	-0.155*	1.00			
Parent MVPA	0.171*	0.057*	0.099*	1.00		
Parent Screen Time	-0.010	0.255*	-0.097*	-0.007	1.00	
Parent Sleep	-0.046	-0.036	0.124*	-0.000	0.045	1.00
April 2021						
Child MVPA	1.00					
Child Screen Time	-0.151*	1.00				
Child Sleep	0.141*	-0.041	1.00			
Parent MVPA	0.165*	0.001	0.079*	1.00		
Parent Screen Time	-0.121*	0.204*	-0.025	-0.026*	1.00	
Parent Sleep	-0.008	0.080*	0.112*	-0.018	0.024	1.00

MVPA: moderate-to-vigorous physical activity; *$p < 0.05$

Table 4 Incidence rate ratios of children or adolescents meeting the guideline if a parent Meets the guideline in October 2020 and April 2021

October 2020					
Movement Behaviour Guideline	**All (*n* = 1,568)**	**Age Group**		**Child/Adolescents Gender**	
		Children (*n* = 726)	**Adolescents (*n* = 842)**	**Boys (*n* = 809)**	**Girls (*n* = 759)**
MVPA	1.66 (1.28, 2.28)*	1.90 (1.36, 2.66)*	1.48 (0.98, 2.22)	1.41 (0.98, 2.03)	2.02 (1.39, 2.95)*
Sleep	1.10 (1.01, 1.20)*	0.96 (0.85, 1.09)	1.23 (1.09, 1.39)*	0.97 (0.86, 1.10)	1.25 (1.10, 1.43)*
Screen Time	1.69 (1.39, 2.06)*	1.42 (1.38, 1.77)*	2.05 (1.44, 2.93)*	1.64 (1.24, 2.18)*	1.69 (1.29, 2.21)*
24-H Combined	3.06 (1.55, 6.04)*	4.08 (1.82, 9.14)*	2.05 (0.60, 6.99)	2.00 (0.60, 6.62)	3.96 (1.71, 9.19)*
April 2021					
Movement Behaviour Guideline		**Age Group**		**Child/Adolescents Gender**	
	All (*n* = 1600)	**Children (*n* = 726)**	**Adolescents (*n* = 842)**	**Boys (*n* = 837)**	**Girls (*n* = 763)**
MVPA	1.45 (1.16, 1.82)*	1.50 (1.17, 1.93)*	1.63 (1.06, 2.50)*	1.65 (1.24, 2.21)*	1.26 (0.90, 1.78)
Sleep	1.19 (1.04, 1.28_*	1.21 (1.09, 1.34)*	1.17 (1.05, 1.31)*	1.22 (1.11, 1.36)*	1.15 (1.02, 1.28)*
Screen Time	1.43 (1.21, 1.68)*	1.54 (1.24, 1.91)*	1.22 (0.95, 1.57)	1.36 (1.08, 1.71)*	1.47 (1.16, 1.86)*
24-H Combined	2.26 (1.34, 3.83)*	2.19 (1.22, 3.95)*	2.64 (0.88, 7.92)	1.71 (0.79, 3.68)	3.20 (1.52, 6.73)*

MVPA: moderate-to-vigorous physical activity; *$p < 0.05$

associated with higher incidence of children and adolescents meeting guidelines, particularly for the child age group and for the 24-hour movement guidelines. Parents meeting the sleep guideline was associated with higher incidence of children and adolescents meeting the sleep guideline across age and gender groups. When overall models were adjusted for age and sex, results were variable. In October 2020, child gender was not a significant predictor and age contributed to the models, such that being younger was associated with a higher incidence of children meeting the MVPA, Screen Time of 24-Hour Combined Movement Behaviour Guideline. In April 2021, being a girl was associated with a higher incidence of a child meeting the MVPA or 24-Hour Combined Movement Behaviour Guidelines, but not the Sleep or Screen Time Guidelines. Being younger was associated with a higher incidence of meeting the MVPA, Screen Time or 24-Hour Combined Movement Behaviour Guidelines, but not the Sleep Guideline in April 2021.

Guideline compliance between timepoints

In this study, we observed that compliance with the MVPA guideline was higher for children and parents in April 2021 than in October 2020, and that compliance for adolescents was similar between October 2020 and in April 2021. Previous analyses with these data have shown that 12–17 year-olds were less likely than younger children to meet the movement guidelines throughout the first six months of the pandemic [25, 27]; this study indicates that this trend continued into the first year. In spring 2020, more parents reported their children meeting the guideline, with 23.8% of children and 13.2% of adolescents meeting the MVPA guideline [23]. It is interesting that compliance for children dipped in fall 2020 compared to spring 2020 before increasing again in spring 2021, and could be reflective of differences in public health restrictions at those timepoints [28, 29]. For example, organized sport physical activity participation decreased for children and youth across the pandemic, but not in-school or non-organized physical activity, likely due to stricter gathering limits on organized sports across Canada in Fall 2020 [12, 28].

Across both timepoints, we saw good compliance with the sleep guideline for children, adolescents, and parents, similar to data collected about Canadian children [5] and parents [30] pre-pandemic. Compliance with the screen time guideline was similar between October 2020 and April 2021 for parents and their children, a promising finding giving the initial increases in recreational screen time reported earlier in the pandemic [23]. Separate analyses of the same dataset revealed that parental screen time in October 2020 was associated with children's age and family physical activity [24]. Compared to October 2020, compliance with the 24-hour movement behaviour guidelines in April 2021 was higher in children (driven by higher MVPA and sleep compliance), slightly lower in adolescents, and higher in parents (driven by higher MVPA, sleep and screen time compliance). Despite compliance being higher or similar between timepoints, overall compliance was still quite low in October 2020 and April 2021 for all three behaviours, suggesting health promotion efforts to collectively address all movement behaviours are needed to promote health in children, adolescents, and adults.

Associations between parent and child movement behaviours

We observed that the volumes of parent and child movement behaviours were generally positively associated with one another, and the strengths of those associations were similar between timepoints. The associations were not unsurprising given the proposed link between Social Cognitive Theory and healthy behaviours that suggests health behaviours are influenced by environmental factors, such as support from others, including parents [13]. It has been reported that family and friend encouragement and co-participation are associated with children's physical activity and sedentary behaviour participation [31]. Interactions with friends and peers were limited due to public health restrictions during the COVID-19, suggesting that family encouragement and co-participation may have played a bigger role in children's engagement in healthy movement behaviours. We previously reported that parents meeting the MVPA guideline in October 2020 was associated with family hobbies and outdoor play, activities that may have been enjoyed between parents and children alike and together [24]. The positive associations between parent and child movement behaviours are not specific to the COVID-19 era. For example, Sigmundová et al. (2020) reported positive relationships between parent and child physical activity levels using pedometer data. More specifically, the strength of the mother-child relationships decreased with the children's age, while father-child relationships were relatively stable across age groups [19]. Data from a representative sample of Canadian parents in 2017 revealed that parental support for 24-hour movement behaviours was higher for younger children than older children [18].

We also observed that parents meeting individual or combined 24-hour movement guidelines was associated with their children and adolescents meeting guidelines, but not across all age groups, gender groups, or behaviours. In October 2020, we observed higher incidence of children, but not adolescents, meeting the MVPA guideline if their parents did. The parallel patterns of MVPA compliance over time between parents and children, but not adolescents, mirrors other research conducted during COVID-19 that observed positive associations between parental movement behaviours and young children's (toddlers/preschoolers) movement behaviours [32]. Similar research from 250 parents of children under 12 in Ontario, Canada also found that parental physical activity levels were positively associated with children's physical activity levels early in the COVID-19 pandemic [22]. Although those studies only assessed younger children, parents often have more influence and contact with their younger children than older children. The discrepancy in associations found in our work between children and adolescents may be explained by the growing independence of adolescents to spend more time with, and be influenced by, peers [33], rather than parents and families. As children get older, parents also report feeling less perceived control over their adolescents' screen time and physical activity [27]. Alternatively, other studies found that younger children engaged in more unstructured, outdoor activities than adolescents throughout the early periods of the pandemic [34, 35], potentially allowing for more time spent together with parents doing these activities, and adolescents' MVPA levels remaining stable with their more preferred or commonly used structured activities still being restricted.

The highest incidence rates were for the combined 24-hour movement behaviour guidelines, suggesting parental modelling or co-participation in each of the movement behaviours may have the biggest impact across a child's entire 24-hour day. In a previous parent-child dyad study that was able to assess mother and young children's co-participation in movement behaviours using proximity tagging features with Bluetooth accelerometers, it was found that the pairs only spent about two hours in shared activities together, which were largely sedentary in nature; however, more shared time spent in MVPA led to a higher likelihood of the child to engage in MVPA when away from their mother [36]. This points to the importance of parents both modelling the activity and co-participating at least for some time, to influence independent behaviours for their children. However, that study was conducted with children younger than those involved in the current study, and was prior to the pandemic, when parents may have spent less time with their children, with more time spent in childcare or school.

In relation to differences in associations between child gender, we did not observe an influence of gender on the associations between child and parent movement behaviours in October 2020, but did observe that being a girl was associated with a higher incidence of meeting MVPA and 24-Hour Combined Movement Behaviour Guidelines in April 2021. In unadjusted models, we reported a higher incidence of girls meeting the 24-Hour Combined Movement Behaviour Guidelines when their parents did versus boys. Previous work has also reported similar associations between parents and daughters and sons [20]; however, there is often found to be stronger relationships between same gender dyads [19, 37]. The emotional connection and influential nature of the relationship between mothers and daughters may explain this association [38]. In the context of this work, our sample is mostly parents identifying as women, potentially leading to stronger connections, more co-participation in behaviours, and greater support between these parents and girls.

The influence of the COVID-19 pandemic was hypothesized to have a greater impact on the association of

parent and child movement behaviours due to the experience of public health restrictions and families spending more time together, especially earlier in the pandemic (October 2020). Although this was true for many, our study did not find substantial differences in strengths of associations between their movement behaviours at two timepoints. Given our study was conducted in Canada during two timepoints with different levels of restrictions, it is unclear if our results can be generalized to other jurisdictions. As shown by Carroll et al. (2020), parent's and children's movement behaviours were mostly unfavourably affected by the pandemic, and increased and decreased in the same patterns [32], contributing to similar levels of association. It is recommended that health promotion efforts during similar public health emergencies focus on family co-participation in healthy movement behaviours given the increased time spent together, associations between parent and child movement behaviours, and reported unfavourable changes in movement behaviours during the pandemic.

Strengths and limitations

Our study has several strengths and limitations to note. This study builds on the findings from our previous work on childrens' [23, 25] and parents' [24] movement behaviours during the COVID-19 pandemic by expanding the reporting on both child and parent movement behaviours one year into the pandemic, in a large Canadian sample, and determining associations between these groups. The addition of parental movement behaviours allows us to better understand the impact of the pandemic and related public health restrictions on family units, particularly in a time when parents previously reported less family time in physical activities and more family time in sedentary behaviours [25], and when parent and child co-play was associated with more child outdoor and indoor physical activity, and more family physical activity [23]. In terms of limitations, data on parental movement behaviours were not collected in our initial survey in spring 2020, so we cannot compare or track trends in parent movement behaviours across the entire pandemic. Children's MVPA was reported as days per week of ≥60 min and parents reported as minutes per week, allowing us to draw conclusions about guideline compliance but limiting how the volumes could be compared statistically. While our sample of children and adolescents included similar proportions of boys and girls, our parent sample was made up predominantly of women, so we cannot decipher if relationships between parent and child movement behaviours looked different for mothers versus fathers. The movement behaviours of our sample were not normally distributed, and this limited the statistical tests we could do, and may be attributed to the social desirability or recall bias that is common with self-reports of movement behaviours.

Conclusions

Parent and child 24-hour movement behaviours were associated at each of the two timepoints during the pandemic; however, the associations varied between child gender and age groups and between pandemic time points. Generally, associations were stronger for children compared with adolescents and for 24-hour movement guidelines versus individual component guidelines. We also observed that compliance with all guidelines was low for parents and children. Health promotion efforts, particularly during times of public health restrictions, should promote family-based healthy movement behaviours to support more parents and children to engage in healthy habits together. In addition, efforts should target physical activity, screen time, and sleep in combination, rather than in isolation.

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Author contributions

Conceptualization, SAM, GF, MST; methodology, SAM, GF, MST; analysis, HATC; writing—original draft preparation, HATC, JEC, SAM; writing—review and editing, all authors (HAT, JEC, AP, SB, SFLK, GF, MST, SAM); supervision, SAM; project administration, SAM, GF, MST; funding acquisition, SAM, GF, MST. All authors (HAT, JEC, AP, SB, SFLK, GF, MST, SAM) have read and agreed to the published version of the manuscript.

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Data availability

The quantitative data for this study are available upon reasonable request to the corresponding author and upon the signing of a data transfer agreement.

Declarations

Ethics approval and consent to participate

The study was conducted in accordance with the Declaration of Helsinki and approved by Dalhousie University's Research Ethics Board (#2020–5351). Maru/Matchbox participants passively consented to participate when they agreed to complete the survey. Maru/Matchbox panelists consent to participate in survey-based research when they sign-up for the panel.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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