Children, Youth and Environments 32(3), 2022

Parent-Perceived Changes in Active Transportation and Independent Mobility among Canadian Children in Relation to the COVID-19 Pandemic: Results from Two National Surveys

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Citation: Larouche, R., Moore, S. A., Bélanger, M., Brussoni, M., Faulkner, G., Gunnell, K., & Tremblay, M. S. (2022). Parent-perceived changes in active transportation and independent mobility among Canadian children in relation to the COVID-19 pandemic: Results from two national surveys. *Children, Youth and Environments, 32*(3), 25-52.
http://www.jstor.org/action/showPublication?journalCode=chilyoutenvi

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Abstract

Children's active transportation (AT) and independent mobility (IM) can provide benefits for health and social development. Using data from two national surveys, we assessed parent-perceived changes in AT and IM among 5- to 17-year-olds in Canada since the outbreak of COVID-19. About half of parents reported no changes, but two to three times more parents reported declines compared to

increases in AT and IM. We explored many potential correlates of changes in AT and IM. Changes in IM were the strongest correlate of changes in AT. Strategies to minimize unintended negative impacts on children's physical activity from policies to prevent infectious disease transmission should be developed.

Keywords: active travel, independent mobility, physical activity, coronavirus, Canada

Physical activity (PA) is associated with multiple benefits among children and youth such as higher cardiovascular fitness, lower cardiovascular disease risk factors, reduced risk of obesity, better cognitive functioning, and enhanced mental health (Dale et al., 2019; Donnelly et al., 2016; Poitras et al., 2016). Despite the known benefits, the majority of children and youth are not meeting the World Health Organization's PA guideline (Bull et al., 2020) of accumulating 60 minutes of daily moderate- to vigorous-intensity PA (Aubert et al., 2018; Hallal et al., 2012). In fact, only 23.1% of Canadian youth ages 12-17 met this guideline in 2014-2017 based on accelerometry data (Colley et al., 2019). This may have worsened as many studies observed declines in PA and increases in sedentary behavior since the onset of the COVID-19 pandemic (Moore et al., 2020, Moore et al., 2021; Paterson et al., 2021; Xiang et al., 2020). In Canada, survey-based data suggest that only 4.8% of children and 0.6% of youth were meeting movement behavior guidelines during the first wave of COVID-19 (Moore et al., 2020).

Pandemic-related restrictions have drastically reduced opportunities to engage in several types of PA, including organized sports, recreation, and fitness (Moore et al., 2020, Moore et al., 2021, Riazi et al., 2021). However, unstructured PA performed outdoors can typically be done in compliance with physical distancing orders. Among the various forms of outdoor PA, active transportation (AT) may represent an important form of PA to promote in the context of COVID-19. Evidence consistently shows that children and youth who engage in AT to/from school are more physically active than those who use motorized modes (Larouche et al., 2014; Larouche, 2018) and AT has consistently been shown to be associated with improvements of health markers (Mueller et al., 2015). Replacing motorized travel by AT would also have the added benefit of reducing greenhouse gas emissions that fuel climate change and particulate matter emissions that contribute to cardiovascular and respiratory diseases (Brand et al., 2021; Patz et al., 2014).

Despite its benefits, the prevalence of AT has decreased over the last few decades, in parallel with children's independent mobility (IM) (Fyhri et al., 2011; Larouche, 2018; Shaw et al., 2013). Although AT and IM can be interrelated, they represent distinct constructs: AT represents the use of human-powered modes, such as walking and cycling, to travel places (Sallis et al., 2004) and IM represents children's freedom to explore their neighborhood without adult supervision (Shaw et al., 2013). IM also contributes to children's social, cognitive, and motor development (Marzi & Reimers, 2018; Riazi & Faulkner, 2018). Researchers have shown that children who are granted more IM are more likely to engage in AT (Larouche et al., 2020; Page et al., 2010) and are more physically active (Larouche et al., 2020; Schoeppe et al., 2013).

During the COVID-19 pandemic, many cities invested in walking and cycling infrastructure and/or temporarily closed streets to car travel (Fischer & Winters, 2021). In a period characterized by a large decline in public transit use associated with concerns about propagation of the virus (Savage & Turcotte, 2020; Zhang et al., 2021), this might have created favorable conditions for the promotion of AT and IM. However, it is unclear how children's AT and IM changed since the pandemic was also associated with a reduction in access to outdoor PA infrastructure (de

Lannoy et al., 2020). In a qualitative study from two large Canadian urban centers (Toronto, Ontario and Vancouver, British Columbia), parents attributed a reduction in children's IM to closures of parks, playgrounds, and other outdoor facilities (Riazi et al., 2021). Simply, if there is nowhere to go to play, and no one with whom to play once there, then a child's interest in going places independently is likely weakened. Yet, another qualitative study with families in Prince George, a small community in Northern British Columbia, suggested that the pandemic led to a shift from organized activities towards unstructured outdoor activities, including cycling (Pelletier et al., 2021). To our knowledge, no previous quantitative studies have examined changes in AT and IM associated with the COVID-19 pandemic in national samples of Canadian children and youth.

Therefore, our primary objective was to examine changes in AT and IM among children and youth since COVID-19 was declared a pandemic (i.e., March 2020). To this end, we combined data from two national surveys of parents across Canada conducted by different market survey firms in October and December 2020. We also explored the correlates of changes in AT and IM since COVID-19 and how they vary by gender. Potential correlates explored in this study included many variables identified as correlates of AT or IM in pre-pandemic studies, including household income (D'Agostino et al., 2021), employment (D'Agostino et al., 2021), dog ownership (Christian et al., 2014), type of home (Johansson et al., 2012), age (D'Agostino et al., 2021; Pabayo et al., 2011), number of children in the household (Pabayo et al., 2011), vehicle ownership (McDonald et al., 2008), immigration status (Te Velde et al., 2017), and health/disability status (Wheeler et al., 2009). Region of residence was also considered given variation in pandemic-related restrictions across provincial and territorial jurisdictions in Canada. The analyses were stratified by gender because of known differences between boys and girls' level of AT and IM and their determinants (Egli et al., 2018).

Methods

Participants and Setting

The study targeted 5- to 17-year-olds since Canadian movement guidelines for children and youth are specifically designed for this age group. Survey 1 consisted of baseline data from a national longitudinal study conducted by Léger (leger360.com). Léger maintains an online panel that includes over 450,000 Canadians who volunteer to participate in online studies. Baseline data were collected in December 2020 from 2,291 parents of 7- to 12-year-old children. Only parents able to complete the online survey in English or French were included. Parents provided consent electronically after reviewing an information letter. The survey was self-administered online, using a computer-aided web interviewing method. Prior to beginning the survey, parents had to answer *yes* to the following screening questions: 1) Do you have a child aged 7 to 12 years?; and 2) Do you agree to be invited again to participate in this study in 6, 12, and 18 months? Parents are provided with $3 compensation for each completed survey, which corresponds to Léger's usual practice. Survey 1 was approved by the University of Lethbridge's Human Participant Research Committee (#2020-097).

Survey 2 was a cross-sectional study conducted by ParticipACTION (a Canadian non-profit organization promoting physical activity), and data were collected by Maru/Matchbox (www.marugroup.net), a third-party market research company with an online consumer database of >120,000 Canadian panelists, in October 2020. The sample included 1,622 parents of 5- to 17-year-olds. Third-party market research companies (like Léger and Maru/Matchbox) are commonly hired by researchers and organizations conducting national studies given their ability to recruit large, representative panels and their robust quality control procedures (e.g., Dubé et al., 2021). Such panels are designed to be demographically representative of the target populations (Göritz, 2007). Parents completed the survey in English or French, and households under COVID-19 isolation at the time of the survey or who had a COVID-19 case in the last month were excluded. Similar consent methods were used as in Survey 1, and modest compensation ($0.50–$3.00 CDN) was provided to respondents. Secondary use of the survey 2 data was approved by Dalhousie University's Research Ethics Board (2020-5351).

During data collection, most schools in Canada were open with altered environments to reduce student movement (e.g., dedicated class bubbles, staggered breaks) with some schools offering virtual learning (Breton et al., 2022). School policies were relatively consistent across Canada at that time.

Measures

Changes in AT and IM

In Survey 1, perceived change in children's AT since the pandemic began was assessed with the question "Compared to before the COVID-19 outbreak and related restrictions, my child walks, bikes or uses other active means of transportation (e.g., scooter, skateboard or rollerblades) to go from place to place" using a 5-point scale ranging from 1 (*a lot less)* to 5 (*a lot more).* Similarly, perceived change in children's IM since the pandemic began was measured with the question, "Compared to before the COVID-19 outbreak and related restrictions, my child's independent mobility (e.g., their amount of freedom to move around in our neighborhood without adult supervision) is" with the same 5-point scale*.* In November 2020, we conducted a separate one-week test-retest reliability assessment with a separate bilingual sample of 53 parents. Kappa coefficients for items on perceived changes in AT and IM were 0.53 and 0.23 respectively, suggesting fair to moderate agreement (Landis & Koch, 1977). At this time, provinces and territories were adopting new restrictions to mitigate the second wave of COVID-19, so reliability statistics may reflect both measurement error and genuine behavior change. Survey 2 included an item on perceived changes in AT to school with the same response options: "Compared to before the COVID-19 outbreak and related restrictions, my child actively transports (i.e., walks, bikes, scoots, etc.) to school." Previous analysis showed the survey had good test-retest reliability (Moore et al., 2020).

COVID-19-Related Questions

Our surveys were designed to assess movement behaviors in the week prior to the survey. In Survey 1, we viewed COVID-19 as a potential confounder; thus, we

asked parents if any household members had been diagnosed with COVID-19 in the previous two weeks and if their household was under isolation/quarantine in the previous week. In Survey 2, parents were screened out if any household members had been diagnosed with COVID-19 in the previous month or if they were currently under isolation/quarantine. In both surveys, we asked parents to report how their child attended school in the last week (*in person*, *online*, *blended*, and *N/A*). The latter category would include homeschooled children and those who did not attend school in the week prior to the survey. In Survey 1, we included additional questions about parental concerns with COVID-19 (*not concerned*, *somewhat concerned*, *very concerned*), and whether school buses were running in the previous week (*yes*, *no*, *N/A*). We included the N/A option because in some cities, there is no school bus service, regardless of pandemic restrictions.

Potential Correlates of Perceived Changes in AT and IM

In both surveys, we collected data on household income and parental employment status using standard questions from the survey vendors. There were six income categories in Survey 1 and ten in Survey 2. Both surveys employed the same items on province/territory of residence, dog ownership, type of home, child and parent age, the number of children and adults in the household, and whether the child had a disability. Survey 1 also collected data on vehicle ownership, time since the child lived in Canada (*2 years or less*, *3-5 years*, *6 years or more*, *born in Canada*), and whether the child suffered from any acute health condition in the previous week (e.g., flu, asthma).

Data Treatment

Because of minimal sample size requirements to carry analyses and in line with previous research on changes in PA associated with COVID-19, we restricted our sample to parents aged 20-65 years and children who identified as either boy or girl (Mitra et al., 2020; Moore et al., 2020). These restrictions led to the removal of 29 parents from Survey 1 and 54 from Survey 2. We recoded response options for items on perceived changes in AT and IM into three categories: *decreased*, *maintained*, and *increased*. Household income was recategorized into three categories in Survey 1 (*CAD$39,999 or less*; *$40,000-99,999*; *$100,000 or more*) and Survey 2 (*CAD$34,999 or less*; *$35,000-99,999*; *$100,000 or more*) to minimize small cell sizes. Using these cut points minimized differences in income categories between the two surveys. Similarly, we recoded response options for parent occupation as *working full-time*, *homemaker*, and *other* for both surveys. We recategorized the participants' type of home as *detached/semi-detached* vs. *others*. Similar to methods used in other publications (e.g., de Lannoy et al., 2020), we also recategorized the participants' province/territory of residence into five geographic regions, namely Pacific (British Columbia and Yukon), Prairies (Alberta, Saskatchewan, Manitoba, and Northwest Territories), Ontario, Quebec, and Atlantic (Newfoundland and Labrador, New Brunswick, Prince Edward Island, and Nova Scotia). For time in Canada, we collapsed the categories *2 years or less* and *3-5 years* because there were few recent immigrants.

Statistical Analyses

We first computed descriptive statistics, including means and standard deviations for continuous variables and frequencies and percentages for categorical variables. We examined differences between boys and girls in perceived changes in AT and IM with chi-squared tests. Because our outcomes were three-level ordered categorical variables, we considered employing ordered logistic regression; however, the assumption of proportional odds was violated for all models at $p \leq 0.001$. Therefore, we examined the correlates of perceived decreases or increases in AT and IM with gender-stratified multinomial logistic regression models. In all models, the group reporting no changes in AT and IM was set as the reference because we were interested in the correlates of perceived changes. For each binary independent variable, multinomial logistic regression models produce two odds ratios: one for decreases in the outcome variable (vs. no changes) and one for increases (vs. no changes); thus, the same exposure can be associated with decreases and increases in AT or IM.

First, we ran bivariate multinomial logistic regression models and retained variables associated with the outcome at $p<0.20$ as potential candidates for inclusion in multivariable models. Second, we used a backward selection process to obtain a more parsimonious multivariable model by removing non-significant variables ($p>0.05$). We considered child age as a mandatory variable because it is a consistent correlate of AT and IM (Larouche, 2018; Marzi & Reimers, 2018) and kept it in all models regardless of statistical significance. We conducted all analyses with IBM SPSS version 26 and excluded missing data listwise. We assessed model fit with the deviance statistic (-2 log likelihood) and estimated the proportion of variance explained by the models with Nagelkerke's pseudo-R^2. We found no evidence of multicollinearity in any multivariable model as the highest variance inflation factor value was 1.203.

Results

Descriptive characteristics of Survey 1 and 2 participants are presented in Tables 1 and 2 respectively. In Survey 1, 37.5% of parents reported a decline in their child's AT since COVID-19 was declared a pandemic, 48.5% reported no change, and 14.0% reported an increase. 32.8% of parents reported that their child's IM had decreased, 56.6% reported no changes, and 10.6% reported an increase. Perceived changes in AT and IM were moderately correlated (Spearman's rho = 0.544; $p<0.001$). Parents of boys were more likely to report an increase in IM (11.9% vs. 9.1%; $\chi^2_{[2\ df]}=8.74$; $p=0.013$). In Survey 2, 33.5% of parents reported a decline in AT to school, 49.7% reported no changes, and 16.8% reported an increase. In both surveys, changes in AT did not differ by gender (all $p>0.40$; data not shown).

Table 1. Descriptive characteristics of Survey 1 participants stratified by gender

Variable	Girls (n=1095)		Boys (n=1167)	
	Frequency (%)	Mean (SD)	Frequency (%)	Mean (SD)
Changes in AT				
Decreased	394 (36.0)		451 (38.6)	
No change	546 (49.9)		555 (47.6)	
Increased	155 (14.2)		161 (13.8)	
Changes in IM				
Decreased	341 (31.1)		397 (34.0)	
No change	654 (59.7)		631 (54.1)	
Increased	100 (9.1)		139 (11.9)	
Household income				
$39,999 or less	124 (12.4)		133 (12.6)	
$40,000 to $99,999	487 (48.8)		532 (50.2)	
$100,000 or more	387 (38.8)		394 (37.2)	
Region				
Pacific	123 (11.2)		138 (11.8)	
Prairies	220 (20.1)		217 (18.6)	
Ontario	433 (39.5)		446 (38.2)	
Quebec	249 (22.7)		265 (22.7)	
Atlantic	70 (6.4)		101 (8.7)	
School delivery				
In person	775 (70.8)		855 (73.3)	
Blended	58 (5.3)		62 (5.3)	
Online	198 (18.1)		182 (15.6)	
N/A (e.g., home-schooled)	64 (5.8)		68 (5.8)	
Disability				
No	1000 (91.3)		1012 (86.7)	
Yes	95 (8.7)		155 (13.3)	
Type of home				
Other	271 (24.7)		328 (28.1)	
Detached or semi-detached	824 (75.3)		839 (71.9)	
Dog ownership				
Yes	418 (38.2)		451 (38.6)	
No	677 (61.8)		716 (61.4)	
Employment				
Work full-time	690 (63.4)		741 (63.8)	
Homemaker	128 (11.8)		116 (10.0)	
Other	270 (24.8)		304 (26.2)	
School buses running last week				

Yes	613 (56.0)		695 (59.6)	
No	101 (9.2)		104 (8.9)	
N/A	381 (34.8)		368 (31.5)	
Conditions in the last week				
Yes	113 (10.3)		127 (10.9)	
No	982 (89.7)		1040 (89.1)	
Concerns about COVID-19				
Not concerned	156 (14.2)		156 (13.4)	
Somewhat concerned	594 (54.2)		633 (54.2)	
Very concerned	345 (31.5)		378 (34.2)	
Time since child lived in Canada				
5 years or less	54 (4.9)		53 (4.5)	
6 years or more	145 (13.2)		152 (13.0)	
Born in Canada	896 (81.8)		962 (83.4)	
Vehicle ownership				
No	56 (5.1)		82 (7.0)	
One	408 (37.3)		502 (43.0)	
Two or more	631 (57.6)		583 (50.0)	
Child age		9.9 (1.7)		9.9 (1.7)
Parent age		41.2 (7.3)		41.0 (7.4)
Number of adults in household		2.0 (0.7)		2.0 (0.6)
Number of children in household		2.0 (1.0)		2.0 (1.9)

Table 2. Descriptive characteristics of Survey 2 participants stratified by gender

Variable	Girls (n=767)		Boys (n=801)	
	Frequency (%)	Mean (SD)	Frequency (%)	Mean (SD)
Changes in AT				
Decreased	266 (34.7)		259 (32.3)	
No change	373 (48.6)		407 (50.8)	
Increased	128 (16.7)		135 (16.9)	
Household income				
<$35,000	70 (9.8)		87 (11.6)	
$35,000 to $99,999	364 (50.8)		350 (46.7)	
$100,000 or more	282 (39.4)		312 (41.7)	
Region				
Pacific	81 (10.6)		91 (11.4)	
Prairies	159 (20.7)		142 (17.7)	
Ontario	288 (37.5)		331 (41.3)	
Quebec	136 (17.7)		119 (14.9)	

Atlantic	103 (13.4)		118 (14.7)	
School delivery				
In person	498 (64.9)		522 (65.2)	
Blended	113 (14.7)		132 (16.5)	
Online	137 (17.9)		123 (15.4)	
N/A	19 (2.5)		24 (3.0)	
Disability				
No	695 (90.6)		728 (90.9)	
Yes	72 (9.4)		73 (9.1)	
Type of home				
Other	204 (26.6)		199 (24.8)	
Detached or semi-detached	563 (73.4)		602 (75.2)	
Dog ownership				
Yes	313 (40.8)		319 (39.8)	
No	454 (59.2)		482 (60.2)	
Employment				
Work full-time	513 (66.9)		558 (69.7)	
Homemaker	80 (10.4)		72 (9.0)	
Other	174 (22.7)		171 (21.3)	
Child age		11.6 (3.8)		11.7 (3.7)
Parent age		42.9 (8.5)		42.8 (8.3)
Number of adults in household		2.1 (0.7)		2.1 (0.6)
Number of children in household		1.7 (0.8)		1.7 (0.8)

Correlates of Changes in Active Transportation (Survey 1)

Table 3 provides the results of multivariable models of the correlates of perceived changes in AT reported in Survey 1. In these models, odds ratios (OR) represent the likelihood that parents reported either a decrease or an increase in AT compared to no changes. For example, decreases in AT were much more likely in boys and girls who also presented a decrease in IM (OR and 95% confidence interval = 13.64, 9.72-19.14 and 11.10, 7.76-15.86, respectively). Always in comparison with children presenting no change in AT, we found that an increase in IM was associated with a decline in AT in girls, but not in boys. Attending school online vs. in person was associated with higher odds of a decrease in AT whereas lower parental concerns with COVID-19 were associated with lower odds of a decrease in children's AT. Boys from families who had a COVID-19 diagnosis in the two weeks before the survey, who owned fewer vehicles or lived in areas where school buses are not usually provided had higher odds of a decrease in AT. Girls living in Canada for five years or less were more likely to report a decrease in AT than Canadian-born girls. Conversely, boys and girls who experienced an increase in IM, and girls who had a decrease in IM, were more likely to present an increase in AT. Older children were less likely to present an increase in AT. Girls from families earning between $40,000 and $99,999 (vs. ≥$100,000) or living in areas

where school buses are not usually provided were less likely to report an increase in AT. Boys whose parent respondent was a homemaker (vs. full-time worker) and those living in Quebec (vs. the Atlantic provinces) were more likely to present an increase in AT. Children whose parents were not concerned with COVID-19 were about two times less likely to present an increase in AT, although statistical significance was not met for girls (p=0.050). Gender-stratified multivariable models explained 42.1-48.1% of the variance in changes in AT.

Table 3. Correlates of changes in active transportation in Survey 1 stratified by gender

Variable	Girls (n = 1095)				Boys (n = 1167)			
	Decrease in AT		Increase in AT		Decrease in AT		Increase in AT	
	OR (95% CI)	p	OR (95% CI)	p	OR (95% CI)	p	OR (95% CI)	p
Annual household income (ref = $100,000 or more)								
$39,999 or less	0.90 (0.53-1.56)	0.716	1.00 (0.52-1.91)	0.990				
$40,000 to $99,999	1.05 (0.74-1.49)	0.793	**0.62 (0.39-0.98)**	**0.041**				
Child's age (each additional year)								
	1.02 (0.93-1.13)	0.656	**0.77 (0.68-0.88)**	**<0.001**	0.93 (0.84-1.02)	0.101	**0.87 (0.77-0.99)**	**0.037**
School delivery (ref = in person)								
N/A	1.70 (0.80-3.61)	0.165	1.71 (0.60-4.87)	0.312	1.47 (0.71-3.04)	0.3	0.36 (0.11-1.17)	0.089
Online	**2.06 (1.33-3.20)**	**0.001**	1.78 (0.99-3.20)	0.053	**1.64 (1.03-2.61)**	**0.037**	1.75 (0.93-3.26)	0.081
Blended	1.84 (0.83-4.06)	0.132	2.13 (0.81-5.62)	0.126	0.76 (0.35-1.63)	0.475	1.39 (0.60-3.22)	0.449
Changes in independent mobility (ref = no change)								
Decreased	**11.10 (7.76-15.86)**	**<0.001**	**2.09 (1.19-3.67)**	**0.011**	**13.64 (9.72-19.14)**	**<0.001**	1.22 (0.64-2.31)	0.545
Increased	**2.31 (1.14-4.69)**	**0.020**	**17.84 (9.83-32.37)**	**<0.001**	1.68 (0.91-3.09)	0.099	**17.11 (10.26-28.52)**	**<0.001**
Region (ref = Atlantic)								
Pacific					0.87 (0.42-1.78)	0.700	1.20 (0.42-3.48)	0.733
Prairies					0.98 (0.52-1.87)	0.959	1.06 (0.39-2.90)	0.910
Ontario					1.27 (0.70-2.33)	0.436	2.15 (0.86-5.36)	0.100
Quebec					1.79 (0.96-3.36)	0.067	**2.98 (1.16-7.64)**	**0.023**
School buses running last week (ref = yes)								
No	0.88 (0.46-1.68)	0.691	1.34 (0.61-2.93)	0.472	1.26 (0.68-2.34)	0.458	1.28 (0.53-3.09)	0.581
N/A	0.85 (0.59-1.21)	0.359	**0.51 (0.31-0.83)**	**0.006**	**1.46 (1.02-2.09)**	**0.037**	1.07 (0.67-1.72)	0.784

Concern about COVID-19 (ref = very concerned)								
Not concerned	**0.53 (0.31-0.89)**	**0.016**	0.49 (0.24-1.00)	0.050	**0.43 (0.26-0.71)**	**0.001**	**0.46 (0.22-1.00)**	**0.049**
Somewhat concerned	**0.65 (0.45-0.94)**	**0.022**	0.77 (0.48-1.25)	0.295	**0.52 (0.37-0.73)**	**<0.001**	0.94 (0.58-1.51)	0.793
Time since child lived in Canada (ref = born in Canada)								
5 years or less	**2.27 (1.01-5.11)**	**0.048**	1.36 (0.46-4.04)	0.579				
6 years or more	1.14 (0.72-1.82)	0.580	1.03 (0.55-1.91)	0.934				
Dog ownership (ref = no)								
	0.92 (0.66-1.29)	0.641	0.64 (0.41-1.00)	0.050				
Occupation (ref = work full-time)								
Homemaker					1.00 (0.58-1.73)	0.995	**2.00 (1.04-3.83)**	**0.037**
Other					0.74 (0.52-1.07)	0.107	1.01 (0.61-1.67)	0.965
Vehicle ownership (ref = 2 or more)								
No					**2.24 (1.20-4.16)**	**0.011**	0.79 (0.33-1.88)	0.597
One					**1.46 (1.05-2.04)**	**0.023**	0.99 (0.63-1.54)	0.949

Note. Model fit information for girls: deviance (empty model) = 1,715.094; deviance (final model) = 1,2644.966; Nagelkerke pseudo R^2 = 0.421. Model fit information for boys: deviance (intercept only model) = 2,146.078; deviance (final model) = 1,523.753; Nagelkerke pseudo R^2 = 0.481.

Correlates of Changes in Active Transportation to School (Survey 2)

Table 4 presents multivariable models of the factors associated with changes specifically in AT to school in Survey 2, which did not include a measure of IM. Consistent with Survey 1, we observed that attending school online vs. in person was associated with greater odds of a decline in AT to school for both genders. Attending school in a blended format was also associated with a decline in AT. Interestingly, online school was also associated with higher odds of an increase in AT for girls. It is worth noting that the question about school attendance was specific to the previous week, whereas the question about perceived changes in AT was "compared to before the COVID-19 outbreak." Children from Ontario and boys from Quebec had higher odds of a decline in AT to school than their counterparts from the Atlantic provinces. Children who had more siblings and boys from dog-owning families were less likely to report a decline in AT to school. Girls living in condos, apartments or townhouses (vs. detached/semi-detached houses) were more likely to report a decline in AT. If the respondent's occupation was classified as "other" vs. full-time worker, boys were more likely to experience a decline in AT. Boys from lower-income households were less likely to report an increase in AT, whereas boys living in the Prairies or Quebec (vs. the Atlantic provinces) were more likely to report an increase. Gender-stratified multivariable models explained 13.5-13.7% of the variance in changes in AT to school.

Table 4. Correlates of changes in active transportation in Survey 2 stratified by gender

Variable	Girls (n = 767)				Boys (n = 801)			
	Decrease in AT		Increase in AT		Decrease in AT		Increase in AT	
	OR (95% CI)	p	OR (95% CI)	p	OR (95% CI)	p	OR (95% CI)	p
Annual household income (ref = $100,000 or more)								
<$35,000					1.22 (0.68-2.19)	0.497	**0.17 (0.05-0.51)**	**0.002**
$35,000 -$99,999					0.75 (0.51-1.10)	0.138	**0.63 (0.41-0.99)**	**0.043**
Child's age (each additional year)								
	1.01 (0.96-1.06)	0.642	0.95 (0.90-1.01)	0.097	0.99 (0.94-1.04)	0.649	0.99 (0.93-1.05)	0.711
School delivery (ref = in person)								
N/A	1.79 (0.64-5.04)	0.267	1.06 (0.22-5.22)	0.944	1.85 (0.69-4.97)	0.224	2.85 (0.95-8.52)	0.061
Online	**2.93 (1.84-4.68)**	**<0.001**	**2.33 (1.32-4.13)**	**0.004**	**2.78 (1.70-4.52)**	**<0.001**	1.65 (0.87-3.12)	0.124
Blended	**2.11 (1.28-3.47)**	**0.003**	1.68 (0.88-3.21)	0.115	**2.12 (1.31-3.45)**	**0.002**	1.41 (0.76-2.59)	0.275
Region (ref = Atlantic)								
Pacific	1.56 (0.85-2.84)	0.152	0.71 (0.33-1.49)	0.360	1.49 (0.79-2.79)	0.211	1.45 (0.62-3.37)	0.388
Prairies	0.99 (0.48-2.03)	0.970	0.66 (0.27-1.58)	0.345	1.84 (0.90-3.76)	0.092	**3.32 (1.42-7.76)**	**0.006**
Ontario	**2.00 (1.14-3.53)**	**0.016**	1.59 (0.83-3.02)	0.160	**1.87 (1.08-3.24)**	**0.024**	2.07 (0.99-4.23)	0.052
Quebec	1.23 (0.65-2.31)	0.525	1.19 (0.58-2.44)	0.637	**2.72 (1.43-5.18)**	**0.002**	**3.80 (1.69-8.57)**	**0.001**
Disability/chronic condition (ref=no)								
Type of home: apartment, condo, townhouse, other (ref = detached or semi-detached)								
	2.04 (1.41-2.97)	**<0.001**	0.83 (0.49-1.39)	0.477				
Dog ownership (ref = no)								
					0.69 (0.48-0.98)	**0.039**	0.72 (0.47-1.11)	0.135
Occupation (ref = work full-time)								
Homemaker					1.20 (0.62-2.31)	0.590	1.60 (0.73-3.52)	0.245
Other					**1.85 (1.17-2.92)**	**0.009**	1.71 (0.97-3.01)	0.066
Number of adults in household (each additional adult)								
Number of children in household (each additional child)								
	0.77 (0.62-0.96)	**0.018**	0.84 (0.65-1.09)	0.198	**0.74 (0.58-0.93)**	**0.011**	1.01 (0.77-1.33)	0.932

Note. Model fit information for girls: deviance (empty model) = 1,173.596; deviance (final model) = 1,077,475; Nagelkerke pseudo R^2 = 0.137. Model fit information for boys: deviance (intercept only model) = 1,393,691; deviance (final model) = 1,301.098; Nagelkerke pseudo R^2 = 0.135.

Correlates of Changes in Independent Mobility

Table 5 presents the correlates of changes in IM in Survey 1. Children living in households who received a COVID-19 diagnosis in the two weeks prior to the survey had higher odds of reporting a decline in IM. Yet, boys living in such households also had higher odds of reporting an increase in IM. Lower parental concerns with COVID-19 were associated with lower odds of a decrease in IM whereas living in apartments, condos or townhouses (vs. detached/semi-detached houses) was associated with higher odds. Girls living in Canada for five years or less (vs. Canadian-born girls) and those living in areas where school buses were not running in the week before the survey were more likely to report a decrease in IM. Boys attending school online vs. in person were more likely to experience a decline in IM whereas boys living in areas where school buses are not usually provided were less likely to report a decline. Girls with older parents or living in lower-income households were less likely to report an increase in IM, while girls attending school in a blended format vs. in person were more likely to report an increase. Boys who did not attend school in the week prior to the survey (or were homeschooled) and those living in the Pacific region were more likely to report an increase in IM. Conversely, boys living in areas where school buses were not running in the week prior to the survey or with parents who were not concerned about COVID-19 were less likely to experience an increase in IM. Gender-stratified multivariable models explained 10.9-13.9% of the variance in changes in IM. Table 6 provides a summary of the statistically significant correlates of changes in AT and IM in the surveys.

Table 5. Correlates of changes in independent mobility in Survey 1 stratified by gender

Variable	Girls (n = 1095)				Boys (n = 1167)			
	Decrease in IM		Increase in IM		Decrease in IM		Increase in IM	
	OR (95% CI)	p	OR (95% CI)	p	OR (95% CI)	p	OR (95% CI)	p
Annual household income (ref = $100,000 or more)								
$39,999 or less	0.94 (0.57-1.53)	0.788	**0.41 (0.18-0.94)**	**0.035**				
$40,000 to $99,999	0.94 (0.68-1.30)	0.721	**0.52 (0.32-0.85)**	**0.009**				
Child's age (each additional year)								
	1.06 (0.97-1.16)	0.231	1.00 (0.87-1.15)	0.961	1.08 (1.00-1.17)	0.061	1.12 (1.00-1.26)	0.053
Parent's age (each additional year)								
	1.00 (0.98-1.02)	0.782	**0.95 (0.92-0.99)**	**0.005**				
School delivery (ref = in person)								
N/A	1.40 (0.73-2.67)	0.308	0.62 (0.16-2.34)	0.477	1.24 (0.64-2.39)	0.521	**2.88 (1.23-6.75)**	**0.015**
Online	1.38 (0.95-2.02)	0.095	0.88 (0.44-1.74)	0.712	**2.05 (1.41-2.97)**	**<0.001**	1.25 (0.70-2.24)	0.450
Blended	2.01 (0.99-4.08)	0.055	**5.68 (2.55-12.63)**	**<0.001**	1.06 (0.58-1.93)	0.853	1.33 (0.61-2.91)	0.469

Region (ref = Atlantic)								
Pacific					1.01 (0.55-1.88)	0.967	**3.25 (1.24-8.49)**	**0.016**
Prairies					1.31 (0.77-2.24)	0.315	1.37 (0.53-3.52)	0.516
Ontario					0.96 (0.58-1.58)	0.861	1.99 (0.84-4.71)	0.116
Quebec					0.91 (0.54-1.53)	0.719	1.53 (0.62-3.75)	0.353
School buses running last week (ref = yes)								
No	**1.83 (1.06-3.16)**	**0.030**	1.23 (0.52-2.94)	0.635	0.66 (0.39-1.12)	0.119	**0.38 (0.17-0.89)**	**0.025**
N/A	0.94 (0.68-1.30)	0.720	0.68 (0.40-1.15)	0.148	**0.65 (0.48-0.89)**	**0.007**	0.74 (0.47-1.15)	0.175
Concern about COVID-19 (ref = very concerned)								
Not concerned	**0.39 (0.24-0.64)**	**<0.001**	0.60 (0.29-1.23)	0.164	**0.47 (0.30-0.73)**	**0.001**	**0.49 (0.25-0.98)**	**0.042**
Somewhat concerned	**0.48 (0.35-0.66)**	**<0.001**	0.68 (0.41-1.15)	0.150	**0.65 (0.49-0.87)**	**0.004**	0.86 (0.57-1.32)	0.497
Time since child lived in Canada (ref = born in Canada)								
5 years or less	**2.19 (1.12-4.30)**	**0.023**	1.56 (0.52-4.72)	0.428				
6 years or more	1.37 (0.90-2.06)	0.135	0.90 (0.43-1.85)	0.765				
Type of home (ref = detached or semi-detached)								
Other	**1.51 (1.08-2.12)**	**0.016**	1.20 (0.69-2.06)	0.515	**1.71 (1.27-2.31)**	**<0.001**	1.01 (0.65-1.58)	0.968

Note. Model fit information for girls: deviance (empty model) = 1,718,797; deviance (final model) = 1,595,683; Nagelkerke pseudo R^2 = 0.139. Model fit information for boys: deviance (intercept only model) = 1,480.633; deviance (final model) = 1,366.758; Nagelkerke pseudo R^2 = 0.109.

Table 6. Summary of the correlates of changes in active transportation and independent mobility in the two surveys

Survey	Indicator	Gender	Direction of change	Variables
1	AT	Girls	Decrease	Attending school online in the previous week, increases or decreases in IM, and living in Canada since ≤5 years associated with higher odds; parent not/ somewhat concerned with COVID-19 associated with lower odds
1	AT	Boys	Decrease	Attending school online in the previous week, decreases in IM, household COVID-19 diagnosis in previous 2 weeks, living in a household owning <2 vehicles, living in an area where school buses not normally provided associated with higher odds; parent not/ somewhat concerned with COVID-19 associated with lower odds
1	AT	Girls	Increase	Increases or decreases in IM associated with lower odds; household income between $40,000-99,999 (vs. $100,000+, higher child age, and living in an area where school buses are not normally provided associated with lower odds
1	AT	Boys	Increase	Increases in IM, living in Quebec (vs. Atlantic provinces), and homemaker parent (vs. full-time worker) associated with higher odds; higher child age and parent not concerned about COVID-19 associated with lower odds
1	IM	Girls	Decrease	COVID-19 diagnosis in previous two weeks, living in an area where school buses were cancelled in the previous week, living in Canada since ≤5 years, and living in an apartment, condo, or townhouse (vs. detached/semi-detached house) associated with higher odds; parent not/ somewhat concerned with COVID-19 associated with lower odds
1	IM	Boys	Decrease	Attending school online in the previous week, COVID-19 diagnosis in previous two weeks, living in an apartment, condo, or townhouse (vs. detached/semi-detached house) associated with higher odds; living in an area where school buses are not normally provided, and parent not/ somewhat concerned with COVID-19 associated with lower odds
1	IM	Girls	Increase	Attending school in a blended format in the previous week associated with higher odds; lower household income and higher parent age associated with lower odds
1	IM	Boys	Increase	Not attending school in the previous week, COVID-19 diagnosis in previous two weeks, and living in the Pacific (vs. Atlantic region) associated with higher odds; living in an area where school buses were cancelled in the previous week, and parent not concerned with COVID-19 associated with lower odds
2	AT to school	Girls	Decrease	Attending school in an online or blended format in the previous week, living in Ontario (vs. Atlantic provinces), and living in an apartment, condo, or townhouse (vs. detached/semi-detached house) associated with higher odds; living in a household with more children associated with lower odds
2	AT to school	Boys	Decrease	Attending school in an online or blended format in the previous week, living in Ontario or Quebec (vs. Atlantic provinces), and having a parent who does not work full-time associated with higher odds; dog ownership and living in a household with more children associated with lower odds
2	AT to school	Girls	Increase	Attending school online associated with higher odds
2	AT to school	Boys	Increase	Living in the Prairies or Quebec (vs. Atlantic provinces) associated with higher odds; lower household income associated with lower odds

Note. Only statistically significant (p<0.05) correlates of changes in active transportation and independent mobility are included in this summary table. Effect sizes (odds ratios) for all variables included in this table are provided in Tables 3 to 5. AT: active transportation; IM: independent mobility

Discussion

Using data from two comparable national surveys, we aimed to describe parent-reported changes in children's AT and IM from the beginning of the COVID-19 pandemic in Canada and explore correlates of behavior change. Even though the cross-sectional surveys were conducted by separate firms and at different times (October and December 2020), perceived changes in AT were remarkably similar with two to three times more children experiencing a decrease than an increase in AT, although about half of parents reported no changes in AT and IM as a result of COVID-19. In Survey 1, declines in AT and IM were moderately correlated and changes in IM were the strongest correlate of changes in boys' and girls' AT. Collectively, our findings suggest that COVID-19 was associated with a perceived decline in children's mobility (in the broader sense that also includes travel behaviors) and is likely one important reason for reported declines in PA (Paterson et al., 2021).

We explored associations between COVID-19 infections, parental concerns about the disease, and changes in AT and IM in Survey 1. Our multivariable models showed that boys from households who had a COVID-19 diagnosis in the two weeks prior to the study were more likely to present declines in AT and IM compared to boys from households who did not experience such diagnoses. We observed similar results for girls' IM. Unexpectedly, boys from families with recent infections were also more likely to present increases in IM than those from families without infections. It is worth noting that there was a time mismatch between the questions on COVID-19 diagnoses (in the last two weeks) and those on changes in AT and IM (since the beginning of the pandemic), so these findings should be interpreted cautiously. Children whose parents were not concerned or somewhat concerned with COVID-19 (vs. very concerned) were less likely to present changes in AT and IM, although results were not statistically significant for increases in AT and IM among girls. Based on the health belief model (Rosenstock et al., 1988), individuals who are less concerned with the severity of a disease or their susceptibility to it are less likely to respond by changing their behavior. Conversely, parents who were more concerned with COVID-19 may have responded to physical distancing orders by restricting their child's AT and IM (as well as school bus use). From a public health perspective, this suggests that presentation of measures to minimize risk of infections should be accompanied by messaging on strategies to safely maintain or increase AT and PA levels. As public health measures are reduced, former school bus/transit users may still hesitate to return to their previous commuting methods, and AT could alleviate concerns associated with a lack of physical distance.

As part of measures to prevent COVID-19, many provinces required that students attend school in online or blended formats. Online school attendance was consistently associated with greater odds of declines in AT and IM. The blended format was also associated with greater odds of declines in AT to school in Survey 2. Unexpectedly, the blended format was associated with higher odds of increases in girls' IM (Survey 1) and online attendance was associated with higher odds of AT to school in Survey 2. This finding must be interpreted with caution given that questions about schooling asked parents to consider the past week while questions about mobility were "compared to before the COVID-19 outbreak." Therefore, it is

possible that some children experienced an increase in AT or IM before schools shifted from in person to blended or online delivery due to public health restrictions. Alternatively, we cannot exclude the possibility that this finding is a type I error.

The pandemic may also have limited travel mode choice due to the suspension of school buses in some regions for those that were attending school in person or in blended learning situations. To this end, we asked Survey 1 participants if school buses were running in the week prior to the survey. If buses were not running, girls were significantly more likely to report a decrease in IM and boys were less likely to report an increase in IM. Although using school buses is not considered as a form of IM (e.g., see Hillman et al., 1990), it does provide less parental supervision than car travel. In areas where school buses were not normally provided, which would primarily correspond to larger cities, girls had lower odds of an increase in AT and boys had higher odds of a decrease in AT and IM. Further, boys from families owning fewer vehicles were more likely to present a decrease in AT in Survey 1. These findings could be attributable to a ceiling effect where people with initially higher AT levels naturally had greater odds of reducing AT. Previous studies documented that children living in larger cities and in households with fewer cars have higher odds of engaging in AT (Gray et al., 2014; Grize et al., 2010; Larouche, 2018; Rothman et al., 2021). Future infection control interventions should be accompanied by messages that promote other types of PA that can comply with physical distancing guidelines.

We found some evidence that changes in AT and IM differed by regions and immigration status. We treated the Atlantic provinces as the reference group given that they had the lowest rates of COVID-19 infections (Statistics Canada, 2022). The surveys were completed by parents in October or December 2020, and they were asked to compare AT/IM at that time to pre-pandemic. School policies were relatively consistent across Canada at that time (Breton et al., 2022), suggesting that other unmeasured factors may have contributed to regional differences. In Survey 1, boys from Quebec were more likely to present an increase in AT and boys from the Pacific region were more likely to present an increase in IM. In Survey 2, boys and girls from Ontario and boys from Quebec were more likely to report a decline in AT to school whereas boys from Quebec and the Prairies were more likely to report an increase. Disparities between provinces were expected given that policies related to outdoor play (inclusive of activities such as walking and cycling) and school closures during COVID-19 differed substantially between provinces (de Lannoy et al., 2020). In addition, we found that girls living in Canada for five years or less were more likely to report decreases in AT and IM. Previous studies have reported that immigrant children were less likely to engage in AT (Pabayo & Gauvin, 2008) and that children speaking a minority language at home had less IM (Riazi et al., 2019), underscoring a need for future research with minority groups.

We also observed disparities in changes in AT and IM by household income. In Survey 1, girls from low- and middle-income households had lower odds of increases in IM and girls from middle-income households had lower odds of increases in AT. In Survey 2, boys from low-income families were about six times less likely to present an increase in AT to school. Previous North American studies

have found higher rates of AT to school among children from low-income households (Chaufan et al., 2015; Gray et al., 2014; Pabayo et al., 2011), suggesting that they had a higher "baseline" (or pre-pandemic) AT level. Low-income populations have faced a higher incidence of COVID-19 (Whittle & Diaz-Artiles, 2020) and lower household income may be associated with living in apartment buildings. We found that living in apartments, condos or townhouses (vs. detached/semi-detached houses) was associated with greater odds of declines in IM (Survey 1) and AT (Survey 2 for girls). We also noted a positive correlation between income and living in detached/semi-detached houses ($r=0.310$; $p<0.001$). These observations suggest that, collectively, public health measures implemented to prevent COVID-19 transmission may have made it harder for children from low- and middle-income households to reap the benefits of AT and IM.

Other household characteristics facilitated or deterred AT and IM in the COVID-19 context. In Survey 2, boys and girls who had more siblings and boys from dog-owning households had reduced odds of a decline in AT. Both of these variables could facilitate AT by increasing parents' confidence in their child's safety. In contrast, older parents were less likely to report that their daughters had an increase in IM, suggesting that they may have been more protective since the beginning of the pandemic. Older children were also less likely to experience an increase in AT in Survey 1. In a post-hoc analysis, we found that the proportion of children who attended school in person at the time of the survey was lower for older children ($\chi^2_{[5df]}=31.73$; $p<0.001$), suggesting that they had less opportunities to engage in AT.

Notwithstanding the above correlates, we observed that changes in IM were by far the strongest predictor of changes in AT. For instance, children whose IM increased were over 10 times more likely to present an increase in AT and vice-versa. These effect sizes were not attenuated when controlling for other variables. In girls only, increases in IM were also associated with decreases in AT and decreases in IM were associated with increases in AT, but effect sizes were much weaker. The latter findings suggest that some children may have engaged in more AT, but with their parents rather than in the absence of adult supervision. The majority of previous studies found that children who are granted more IM are more likely to engage in AT to/from school, but the use of cross-sectional designs precluded investigation of relationships between changes in IM and AT (Marzi & Reimers, 2018). Given our retrospective design, we cannot confirm that changes in IM caused changes in AT, emphasizing a need for prospective longitudinal studies. Nevertheless, our results are in agreement with a qualitative study with parents in Toronto and Vancouver suggesting that, with the closures of parks, playgrounds, and other outdoor facilities, children had access to fewer destinations (Riazi et al., 2021).

Another qualitative study with families in Prince George, BC suggested that the pandemic was associated with a shift from organized activities to unstructured outdoor activities, including cycling (Pelletier et al., 2021). Yet, as the authors pointed out, their findings may not represent the experience of Canadian families in general. The decrease in IM that we observed concurs more with the stories told by parents in Toronto and Vancouver (Riazi et al., 2021), and may primarily reflect the

experience of children living in larger cities and areas with more severe COVID-19 restrictions. de Lannoy et al. (2020) also reported substantial regional disparities in access to outdoor play opportunities during the pandemic. Furthermore, Mitra et al. (2021) found that children who had greater access to places for play and exercise during the pandemic were less likely to have low subjective wellbeing. Collectively, this body of evidence suggests that, in preparation for future pandemics, efforts to preserve access to outdoor activities and minimize socio-economic disparities are warranted to support children's AT, IM, and PA. Such efforts can help children cope with stress (Kemple et al., 2016; Mitra et al., 2021), and are crucial to respect children's rights to play and to grow up in a safe and healthy environment, which are recognized in the Convention on the Rights of the Child (United Nations, 1989).

Limitations and Strengths

The main limitation of our study is the reliance on retrospective parental reports of changes in AT and IM, which are vulnerable to recall and social desirability biases. In Survey 1, the test-retest reliability of our questions was modest, though these estimates should be interpreted with caution given that the test-retest assessment was conducted during the second wave of COVID-19. Thus, differences in parents' responses in the test-retest reliability study may reflect both measurement error and true behavior change. The fact that Survey 2 only inquired about changes in AT to school may have yielded discrepancies between surveys in the correlates of changes in AT. In Survey 1, there was a mismatch between the time period addressed by the questions on changes in AT and IM and the question about COVID-19 diagnoses and school attendance, so associations between these variables should be interpreted with caution. Our measures of environmental variables were crude, and our survey did not include questions about community size and distance between home and school, which can influence the likelihood of engaging in AT. Further, as the analysis of correlates of changes in AT and IM was exploratory and many potential correlates were tested, there is a considerable risk of type I errors, so future studies would be needed to confirm our findings. However, the use of two relatively large national surveys upholds the external validity of our findings (within the Canadian context). The fact that surveys conducted by separate firms provided similar results regarding changes in AT is remarkable and reassuring. Finally, it is a strength that we investigated multiple potential correlates based on factors previously identified as potential determinants of AT and IM in the literature.

Conclusion

Using data from two national surveys, we found that about half of Canadian parents reported no changes in their child's AT and IM since the beginning of the COVID-19 pandemic. However, two to three times more parents reported decreases vs. increases in AT and IM. Changes in IM were the strongest predictor of changes in AT. Furthermore, our results suggest that there is a complex web of factors at the individual, household, built environment (e.g., type of home), and policy levels (e.g., pandemic restrictions and changes in school delivery mode) that are related to changes in AT and IM during the pandemic. Our findings extend previous research showing that COVID-19 has been associated with significant decreases in children's PA (Paterson et al., 2021). These observations underscore a need for

developing public health strategies designed to minimize the unintended negative impacts of policies adopted to prevent the spread of infectious diseases. This is particularly important given the potential of global trends such as deforestation, climate change, and globalization to increase the frequency of pandemic outbreaks (Myers & Frumkin, 2020; Patz et al., 2014).

Acknowledgments

We acknowledge the contribution of Ms. Victoria Hecker in reviewing the questionnaire for Survey 1 and Ms. Madeline Kleinfeld for assisting with manuscript formatting and identifying previous studies on the effects of the COVID-19 pandemic. Richard Larouche holds a Board of Governors Research Chair from the University of Lethbridge and receives book royalties from Elsevier. Mariana Brussoni is supported by a salary award from the British Columbia Children's Hospital Research Institute. The other authors have no conflicts of interest to declare. Survey 1 was sponsored by a grant-in-aid from the Heart & Stroke Foundation of Canada. Survey 2 was partly funded by Dalhousie University, the Province of Nova Scotia's Department of Communities, Culture and Heritage, and ParticipACTION.

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