Playful neighbourhoods for children's wellbeing:
Examining built environment impacts on children's outdoor play during COVID-19

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POLICY BRIEF

Outdoor play is a key factor to children meeting their recommended daily physical activity, which has been diminishing over the past decades. Compounding individual and collective health and wellbeing benefits can be realized by promoting outdoor play for children.

KEY FINDINGS:

- Diverse informal play spaces—such as yards, sidewalks, neighbourhood streets, and parking lots—were found to be the most essential for children's play.
- Walking to public play spaces was only statistically significant for the older age group (12-17 years of age).
- In the younger age group (5-11 years of age), male children are more likely to achieve the recommended physical activity.
- As the pandemic prolonged, less children and youth were likely to meet physical movement guidelines.

The study results provide insights to planners and policymakers on how to design playful and resilient neighbourhoods that can help counteract dismal physical activity levels, accommodate the essential needs of children, and promote individual and collective wellbeing.

POLICY RECOMMENDATIONS:

- The built environment, especially the streetscape, must be retrofitted to safely accommodate children, as they inhabit, play, and learn from a diversity of urban spaces.
- Create diverse urban play spaces that accommodate the vast range of needs and preferences to support the outdoor play of different ages and children that don't identify as male.
- Encourage independent outdoor play for young children with a nuanced and balanced approach that preserves child safety while allowing space for optimal child development.
- Pandemic or crisis health policies that balance health objectives with promoting children's healthy movement.

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1

INTRODUC-TION

In North America, car-centric urban design and policies have heavily domineered our streets and public space. City planners and policymakers continue to grapple with the impacts of the car-centric built environment on our health and wellbeing. The COVID-19 pandemic brought discussions of reimagining public space and streets for better health outcomes to the kitchen table. City inhabitants across the world started asking questions regarding the usage and impacts of the public domain on human health, quality of life, and childhood experience.

The last decade has seen catastrophic declines in children's physical activity. Not only is daily physical activity important in maintaining a healthy lifestyle for children, it is strongly linked to reduced depression and anxiety, higher grade performance, and increased cognitive development (Alvarez-Bueno et al., 2017; Biddle et al., 2019). In 2018, over 60% of Canadian children did not achieve the minimum recommended daily physical activity (ParticipACTION, 2018). This level remained consistent for the following two years (ParticipACTION, 2020). The physical activity numbers become even worse with the pandemic and have not bounced back (ParticipACTION, 2022). Low levels of childhood physical activity can become persistent into late teenage years and adulthood. Ultimately, increasing the prevalence of obesity and chronic diseases in the population. This can place a burden on public health systems, the workforce, and economic growth (Telama et al., 2014; Telama et al., 2005).

Outdoor play is a key factor to children meeting their recommended daily physical activity. The United Nation's Convention on the Rights of the Child (1989) emphasizes children's ability to play as a fundamental right, as play contributes immensely to child's health and wellbeing. Studies show that encouraging outdoor play can meaningfully help counteract the dismally low physical activity levels (Faulkner et al., 2015; Stone & Faulkner, 2014). During the COVID-19 pandemic, health safety measures—such as physical distancing and canceled team sports—restricted indoor and structured play. Hence, outdoor play became even more crucial to healthy movement behaviours in children during the COVID-19 pandemic.

Planners can play an integral role through shaping the built environment. Previous research has shown that the neighbourhood environment influences the type and extent of physi-

cal activity of children (Mitra et al., 2017). Automobile-centric transportation planning and policies of the past decades have pushed children away from the neighbourhood streets and into personal backyards, playgrounds, and recreational facilities (Mitra & Abbasi, 2020). Outdoor play is now corralled within designated and controlled playgrounds, which are less stimulating and imaginative than informal settings (Ball et al., 2019; Herrington & Nicholls, 2007; Visser & Van Aalst, 2022). Children live beyond the arbitrary boundaries of poorly designed 'child-friendly' areas. Children require access to the city that can enable them to play, learn, and grow. As Tim Gill (2021) posits, child-friendly planning and design can save cities. Creating playful neighbourhoods that support and inspire children have compounding social, cognitive, health, and psychological benefits. Building cities for children ensures a more inclusive design for more segments of the population and compounding community benefits (8 80 Cities, 2022).

Planning research related to children's physical activity often focuses on trips to school and independent mobility (Waygood, 2020). There is limited research regarding physical activity in relation to outdoor play locations, especially during the pandemic (Gu et al., 2022). The aim of this paper is to facilitate an understanding of how the built environment influenced outdoor play during COVID-19, when indoor activities were restricted. First, do children that engage in outdoor play reside in distinct neighbourhoods that encourage them to do so? Do these patterns change throughout the pandemic?

To accomplish the research aim, this study applies multilevel statistical modelling to Canadian children's movement behaviour data obtained from the 2020 ParticipACTION survey. The cross-sectional survey was collected for the first-time from households with children within the age of 5 to 17. The survey asked questions related to the child's daily movement behaviours, changes to child's movement behaviours in relation to COVID-19, child's play locations, socio-demographic data, and residential location. This analysis focuses on frequented play locations and movement behaviours to explore Canadian children's relation to their neighbourhood. Various explanatory variables were modelled to understand the likelihood of meeting the minimum recommended physical activity. Ultimately, the intent of this paper

is to better inform how to design playful and resilient neighbourhoods that can help counteract dismal physical activity levels, accommodate the essential needs of children, and promote individual and collective wellbeing.

2

LITERATURE REVIEW

2.1 PHYSICAL ACTIVITY AS OUTDOOR PLAY

The Canadian 24-Hour Movement Guidelines for Children and Youth are the first evidence-based guidelines. They integrate physical activity, sedentary behaviour, and sleep patterns. The movement specific guidelines recommend at least 60 minutes of moderate-to-vigorous physical activity (MVPA) per day and several hours of light physical activity (LPA) per day for children ages 5 to 17. A majority of Canadian children's physical activity is below the required daily levels (Carson et al., 2017; ParticipACTION, 2022; Stone et al., 2012; Stone & Faulkner, 2014).

Children that are active at least once a day are more likely to be generally physically active (Mitra et al., 2017). A Toronto-based study found the duration of outdoor play—regardless of age and gender—is significantly correlated with moderate-to-vigorous physical activity minutes for children (Faulkner et al., 2015). A global systematic review also reported the positive effect of outdoor time on physical activity (Gray et al., 2015). The benefits of outdoor play surpass physical health, the overall well-being—including psychological health, social cohesion and integration, and cognitive development—of a child is linked with outdoor play (Bennet et al., 2012; Cheng & Johnson, 2010; Dale et al., 2021; Faulkner et al., 2015; Gleave & Cole-Hamilton, 2012; Solomon-Moore et al., 2018; Valentine & McKendrick, 1997).

Outdoor play can also contribute positively to child agency and development if it is independent and risky. Unsupervised outdoor play encourages more independence. Without direct attention, children can self-actualize and adults can mingle and build community and social capital (Murray & Devecchi, 2016; Weller & Bruegel, 2009). Risky outdoor play promotes child development, social health and behaviors, and positively channels injuries and aggression (Brussoni et al., 2015). However, parents' perceived safety concerns and risk-aversion have greatly impacted how children play (Giles et al., 2019). Scholars and policy makers are concerned with the decline of Canadian children engaging in independent and risky type of outdoor play (Brussoni et al., 2015; Brussoni et al., 2020; Brussoni et al., 2012; Giles et al., 2019; Pelletier et al., 2021). A leading Canadian research lab, in association with BC Chil-

dren's Hospital, created a website conveying research-backed information for parents to gain confidence and skills to support their children's outdoor and risky play (Brussoni et al., 2023). Outdoor play has synergies with encouraging children's independent mobility and risky play as they encourage similar goals, however, promotion must be nuanced and consider parent's hesitations.

2.2 PLAY DURING THE PANDEMIC

The COVID-19 pandemic related health orders created barriers to children and youth's physical activities. Caldwell et al. (2022) found that areas with higher COVID-19 cases had correspondingly lower physical activity levels in children. Prior to the COVID-19 pandemic, 12.7% of 5-11 year old children and 17.1% of 12-17 year old youth were meeting the minimum recommended physical activity levels in Canada (Carson et al., 2017; Rhodes et al., 2019). Those numbers fell drastically with the start of COVID-19, 4.5% of children and 1.9% youth met the recommended movement guidelines in October 2020 (Moore et al., 2021). A 2021 Canadian study found parents of children aged 5 to 11 noted the decline in physical activity in part due to the dependance on scheduled and structured physical activities (Riazi et al., 2021). Parents also found it challenging to reimagine ways to increase their children's physical activity (Riazi et al., 2021). Given the limitations to indoor play and organized sports, outdoor play and spaces became crucial during the pandemic.

Federal parks were announced closed at the start of the pandemic. The closure of provincial parks varied across provinces and the duration fluctuated with the severity of the wave (de Lannoy et al., 2020). Similarly, at the municipal level, there were major variabilities in the status of playgrounds. Of the 65 Canadian municipalities, 46 closed playgrounds and 27 closed park amenities at the June 2020 mark (Canadian Urban Institute, 2020). During COVID-19, geographical proximity to parks, playgrounds, and school grounds did not ensure access to outdoor public spaces. The accompanying public health communications were also mixed and confusing. For example, British Columbia's Medical Officer of Health encouraged the public to go outside and play during a time when it had the highest COVID-19 cases in

the country (de Lannoy et al., 2020). While other cities were placing curfews during high COVID-19 case numbers. The mixture of physical restrictions and public messaging on outdoor public spaces created complexity in accessing parks. On the flip side, 11 municipalities closed streets to vehicular traffic to encourage physical-distanced pedestrians and cyclist activity (Canadian Urban Institute, 2020). Hence, the COVID-19 pandemic pushed citizens to new behaviour patterns and uses of parks, playgrounds, and other public spaces.

Mitra et al. (2020) found two distinct clusters of children and youth at the beginning of the pandemic: one group with increased levels of activity and the other with decreased activity levels. The former group was characteristic of children living in houses in low dwelling density areas and high dwelling density areas with access to parks (Mitra et al., 2020). Children in higher income households, as well as multi-children households, were more likely to show increased physical activity during the pandemic (Mitra et al., 2020). There have been relatively few other Canadian studies of children and youth's physical activity during COVID-19. All research thus far underscores the necessity for: tailored support for children and youth; more research, especially to understand the longer-term impacts; and the need to balance health objectives with promoting children's healthy movement (Caldwell et al., 2022; de Lannoy et al., 2020; Mitra et al., 2017; Mitra et al., 2020; Moore et al., 2020; Moore et al., 2021).

2.3 SOCIO-ECOLOGICAL MODEL

Supporting children to play outdoors more requires a deep understanding of the factors that influence children's movement. Children's mobility research often invokes socio-ecological models (SEM) of health behaviour; this approach emphasizes the equal footing of the various contexts that shape health behaviours (Mitra et al., 2017; Mitra & Manaugh, 2020; Sallis et al., 2008). The conceptual framework can be used to explore the complex interplay of determinants—such as, political, cultural, social, and environmental—influencing children's mobility and physical activity. Through a SEM lens, Lee et al. (2021) conducted a systematic literature review of outdoor play and time. The review found social and built environment

factors to be the most critical elements for outdoor play.

2.3.1 Social factors

Studies have found the built environment alone to be insufficient in explaining children's outdoor play (Carson et al., 2014; Cleland et al., 2010). Undoubtedly, socio-demographic, household, and individual characteristics influence the amount of time spent in outdoor play (Faulkner et al., 2015). For example, parental safety perceptions and concerns have a significant inverse relationship to outdoor play time (Faulkner et al., 2015). Factors that have a positive relationship with outdoor play are parent encouragement, dog ownership, social opportunities, and having younger siblings (Bringolf-Isler et al., 2010; Christian et al., 2014; Cleland et al., 2010). Some studies have found differences by gender, for example, males are generally more active than females (Gemmell et al., 2023; Gorely et al., 2007; Lee et al., 2021). However, some reviews have not found consistent results in relation to gender (Gemmell et al., 2023). Research of socio-demographic correlates of children's movement behaviour remains limited and the results are mixed (Mitra et al., 2020). Planners need a more nuanced understanding of the complex social determinants to design holistic planning policies and programs.

2.3.2 Built environment factors

Children's places of play exist beyond prefabricated slides and swing-sets. A growing body of literature has found informal spaces to be impactful in outdoor play outcomes. A study of 33 Dutch neighbourhoods found that the presence or the overall quality of play facilities were not positively related to children's outdoor play (Aarts et al., 2012). Rather the informal play areas, like sidewalks, were positively related to more outdoor play (Aarts et al., 2012). A literature reviewing 25 quantitative and qualitative studies, concluded similar findings: informal opportunities for play were more stimulating than designated playgrounds (Visser & Van Aalst, 2022). Not only are a variety of play environments good for development, they also robustly support mental health. A study with over 150,000 children found the proximity to outdoor play spaces, green spaces, and diversity of outdoor play spaces are all positive-

ly associated with behavioural health and lower prevalence of psychological development disorders (Perez-Del-Pulgar et al., 2021). Given the importance of informal play spaces, it is imperative to explore the built environment—outside children's designated playgrounds—in relation to children's play outcomes.

There have been three recent systematic literature reviews (Gemmell et al., 2023; Lambert et al., 2019; Visser & Van Aalst, 2022) regarding the influence of the built environment features on outdoor play. The main types of environment features reported encompass the streetscape and traffic features, residential density, yard access, and greenery. Calm traffic areas—created from features like fewer intersections, low traffic volume, low vehicle speeds, and low residential density—have some positive association to children using outdoor play spaces (Lambert et al., 2019). Similarly, Gemmell et al. (2023) found traffic protected routes were important in children using outdoor play spaces. The Lambert et al. (2019) review found yard access and neighbourhood greenness to have moderate positive associations with children using outdoor play spaces. Neighbourhoods that have nearby outdoor play spaces and areas that facilitate interactions between people, nature, and structures are more likely to encourage outdoor play (Gemmell et al., 2023). Given this is a relatively emerging topic of research and the size, location, and methodology of the studies range greatly, there is contention and variability between studies. For example, Visser and Van Aalst (2022) reviewed two studies that found positive impacts of green space availability (Bringolf-Isler et al., 2010; Handy et al., 2008), whereas, another two studies found no effect of access to green spaces on outdoor play (Aarts et al., 2010; Aarts et al., 2012).

There is ample evidence that the built environment has an influence on outdoor play, however, many knowledge gaps remain. Lambert et al. (2019) noted their systematic review was the first on the topic and stressed the need for more research. Since 2019, there have been two systematic literature reviews. Despite the growing body of literature, the studies still differ in results regarding the relative importance of the various physical factors (Gemmell et al., 2023; Lambert et al., 2019; Visser & Van Aalst, 2022). Furthermore, there remains a vacuum within the Canadian space. From all three reviews, only seven studies were located

within Canada. Six of these seven studies were regarding perspectives and perceptions of the built environment. There was one Canadian study within all the comprehensive reviews examining the effects of neighbourhood characteristics on physical activity. Moreover, children's locations of play remains an understudied topic in Canada. Given the differing results within the existing literature, it is even more imperative to substantiate the play-space relationship within the Canadian environment for plans and policies to be effective in our unique combination of built environment, geographical landscape, and climate.

3

METHODOL-OGY

3.1 DATA

This study relies on data obtained from a survey created by ParticipACTION, a non-profit organization that promotes healthy living and fitness in Canada. The overall aim of the survey was to assess the impact of COVID-19 on Canadian children's physical activity, play, sedentary behaviours, and sleep quality. The cross-sectional survey collected baseline responses in mid- to late-April 2020 (Wave 1) and a follow up in mid- to late-October 2020 (Wave 2). The survey was distributed nationally by Maru/Matchbox, a third-party market research company, which recruited 1500 families—representing the diverse population of Canada, in terms of age, gender, ethnicity, geography, and socioeconomic status—for Wave 1 and Wave 2. Individuals were not eligible if anyone in the family had covid or was in isolation.

The responses were reported by an adult or guardian within the household. Parent-reports are a common method to obtain children's movement patterns and have been found to be reliable: Burdette et al. (2004) found significant correlation when comparing measured physical activity in preschoolers to parent's reports of the child's outdoor play time. Adults with more than one child in the household were asked to answer the survey questions for the child that is alphabetically first. Participants received a small cash incentive (CDN $0.50-$3.00) and prize opportunities for completing the survey. Moore et al. (2020) provides the full recruitment details and survey protocol.

The residential postal codes were not provided with the survey data for privacy protection. Hence, a two-step process was employed to join built environment measures of the home location to the survey data. First, the survey data owners sent a list of the residential postal codes with a unique identifying number and no survey data. We joined built environment measures to the residential postal codes and sent it back to the survey owners. Second, the survey owners were able to attach the survey data to the built environment measures with the unique identifying numbers. The survey owners deleted the columns with the residential postal codes and unique identifying numbers before sending the combined data to us for analysis. Through this two-step process, we were able to have built environment measures

for each survey point without infringing on the privacy of the respondents.

Figure 1 shows the distribution of the responses from both survey waves across Canada. Our analysis focused on a subset of the data, only respondents living within Census Metropolitan Areas (CMA) were included (N=2,715). The relatively few respondents living outside a CMA were excluded (N=342) from the analysis.

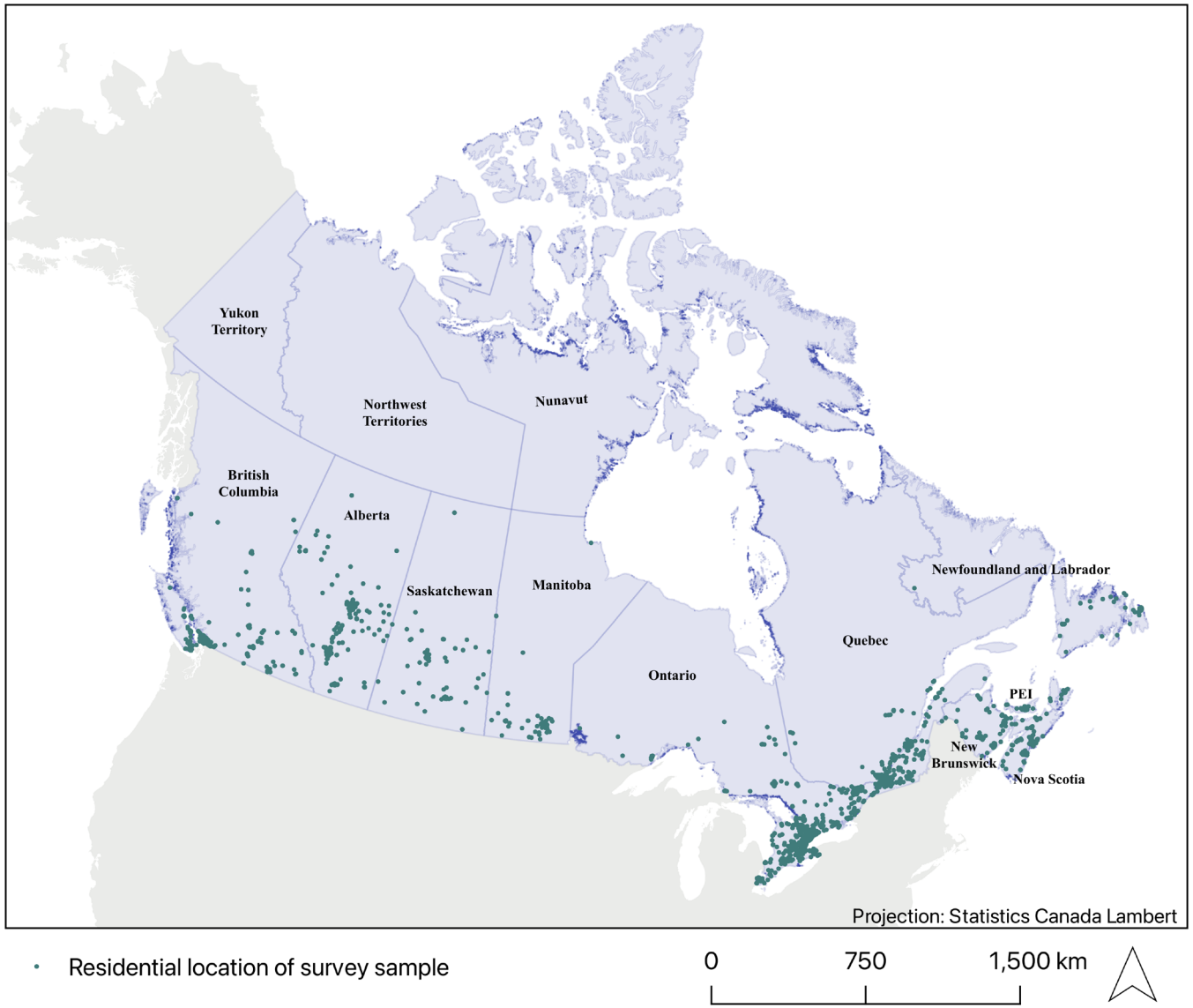

Figure 1. Distribution of survey responses

3.2 ANALYSIS

3.2.1 Developing the model

The primary aim of this research is to determine which built environment features contributed to Canadian children and youth achieving movement guidelines during the pandemic. The secondary goal is to monitor any development of physical activity levels over the pandemic time. A multi-level logistic regression model with a dichotomous outcome variable of meeting moderate-to-vigorous physical activity (MVPA) guidelines was constructed using the lme4 package in R statistical programming language (Bates et al., 2015). Census tracts were the higher level of analysis, this approach addresses any shared characteristics within the neighbourhood level that could not otherwise be accounted for within the model.

The dependent variable, meeting MVPA, was determined based on the answer to the following question: “In the last week, on how many days did your child engage in moderate-to-vigorous physical active for a total of at least 60 minutes per day?” As per Canadian movement guidelines, respondents that indicated six or seven days were coded as 1, all other respondents were coded as 0. In order to develop a linear regression model to explore what factors influence meeting MVPA, variables related to built environment characteristics, play behaviours, locations of play, and individual characteristics were assembled. Many combinations of the various variables were run and the results were analyzed to iterate the model for stability and accuracy.

Despite 5-17 year old children having the same recommended MVPA guidelines, the statistical analysis was run as two separate age groups, 5-11 and 12-17 years of age. Studies have found physical activity outcomes can vary with age. For example, one Canadian study of youth’s relationship of physical inactivity and built environment found—the opposite of expectations and children’s studies—walkability, cul-de-sac density, and park space are negatively associated with physical activity (Laxer et al., 2013). For this paper, the term ‘child’ is used as a catch all for a large age range. However, for the purposes of the analysis, the 5-11 year old group is referred to as ‘children’ and 12-17 year old as ‘youth.’

3.2.2 Explanatory variables

To explore the first question, the model included three types of explanatory variables: built environment characteristics; play behaviours and locations; and individual characteristics. For the second question, a dummy variable was created to indicate if the survey point was collected in Wave 2. Some of the variables were transformed into categories, binary values, or dummy factors. Variables that were not statistically significant or too closely correlated with other variables were removed to avoid multi-collinearity.

Three built environment measures were Walkscore and Bikescore, dwelling density, and intersection density. Walkscore and Bikescore are a common measure of neighbourhood walkability and bikability; they are gravity-based assessments of reaching amenities by active transport within one mile of locations. Postal code-level Walkscores and Bikescores were obtained from Walkscore.com using an online application programming interface (API) and spatially joined to home postal code locations. Similarly, home postal code locations were spatially joined to Canadian Active Living Environment Database's dwelling density and intersection density z-score, which are available at the dissemination area (DA) level. The dwelling density measure was calculated by adding the number of dwellings per square kilometre from Statistics Canada Census data (Ross et al., 2018). Intersection density measure was calculated by the number of three-way or more intersections per square kilometre using OpenStreetMap (Ross et al., 2018).

The play behaviours, locations of play, and individual characteristics were retained from the survey data. The change in movement behaviour questions were posed as incomplete sentences: "compared to before the COVID-19 outbreak and related restrictions, my child plays inside" and "compared to before the COVID-19 outbreak and related restrictions, my child plays outside." A Likert-type scale was provided to complete the statements posed and the responses were converted into a binary variable. Respondents that indicated "a little more" or "a lot more" were coded as 1, otherwise, they were coded as 0 for answering "a lot less," "a little less," or "about the same." The question related to play locations was posed as the following: "if your child is spending any time outside during the COVID-19 outbreak, where

are the common places this outside time is being spent?" Numerous options were provided and the survey respondents were able to check all the options that applied to their child. Finally, identifying as 'male' were coded as 1 and children identifying as 'female' or 'other' were coded as 0.

To fulfill the aim of the second research question, a dummy variable was created to specify if the survey was completed during Wave 1 or Wave 2. Respondents from Wave 1 were coded as 0 and Wave 2 as 1. Interactions with the Wave 2 groups were explored to understand if any of the explanatory variables had more influence as the pandemic persisted.

4

RESULTS & DISCUSSION

4.1 DESCRIPTIVE STATISTICS

There was a total of 1,271 children and 1,444 youth within the CMA. Only 18.6% of children completed at least one hour of moderately-to-vigorously active for six days a week. Even less youth (12%) met the minimum recommended MVPA levels. Table 1 includes the summary statistics of the final model variables.

Table 1. Summary statistics

Variables	Children (5-11 yo) (n=1271)		Youth (12-17 yo) (n=1444)	
	Frequency	%	Frequency	%
Meet MVPA	237	18.6	172	11.9
Timeline				
Wave 1	616	48.5	693	48.0
Wave 2	655	51.5	751	52.0
Gender				
Male	659	51.8	756	52.4
Female or other	612	48.2	688	47.6
Playing inside				
Decrease	125	9.8	153	10.6
Same	520	40.9	720	49.9
Increase	626	49.3	571	39.5
Playing outside				
Decrease	515	40.5	686	47.5
Same	462	36.4	597	41.3
Increase	294	23.1	161	11.2
Outdoor play locations				
Yard/driveway	939	73.9	752	52.1
Sidewalks, parking lots, or neighbourhood streets	515	40.5	557	38.6
Parks/trails/outdoor spaces in walkable distance	639	50.3	699	48.4
Parks/trails/outdoor spaces in drivable distance	326	25.6	281	19.5
Built environment measures				
Average intersection density (z-score)	0.24	NA	0.28	NA
Average dwelling density (z-score)	0.15	NA	0.18	NA
Average WalkScore	33	NA	33	NA

There is almost an even split between the number of respondents from Wave 1 and 2. Gender also was closely split, 48.2% children and 47.6% youth identified as female or other. Around 10% of both children and youth decreased their indoor play time. The change in outdoor play time is more dramatic, 40.5% children and 47.5% youth decreased playing outside. More children (23.1%) than youth (11.2%) increased their outdoor playing. The most to least popular of play locations is consistent for both children and youth: yard/driveway; parks/trails/outdoor spaces in walkable distance; sidewalks, parking lots, or neighbourhood streets; and parks/trails/outdoor spaces in drivable distance. The average Walkscore was 33 for both age groups, this score falls within the lowest Walkscore category which is labelled as "car-dependent."

4.2 STATISTICAL ANALYSIS

4.2.1 Child model

Table 2 displays the results and the random effects of the linear regression model developed to study the relationship between the neighbourhood and children meeting MVPA, while controlling for some individual characteristics.

Table 2. Model results for 5-11 year old children

Predictors	*Odds Ratio*	*CI*	*p*
Intercept	0.19 ***	0.09 – 0.44	**<0.001**
Various characteristics			
Child's age	0.94	0.87 – 1.01	0.078
Gender (male)	1.52 **	1.12 – 2.05	**0.007**
Wave 2 (October 2020)	0.66 *	0.47 – 0.93	**0.018**
Change in play patterns			
Play more outside covid started	1.27	0.90 – 1.78	0.174
Play more inside since covid started	0.54 ***	0.39 – 0.73	**<0.001**
Outdoor play locations			
Yard/driveway	2.20 ***	1.46 – 3.32	**<0.001**
Sidewalks, parking lots, or neighbourhood streets	1.57 **	1.16 – 2.13	**0.004**
Parks/trails/outdoor spaces in walkable distance	1.30	0.92 – 1.82	0.132
Parks/trails/outdoor spaces in drivable distance	0.70	0.48 – 1.03	0.074
Built environment			
Intersection density (z-score)	1.14	0.96 – 1.34	0.136
Dwelling density (z-score)	0.72 *	0.53 – 0.99	**0.041**
WalkScore	1.00	0.99 – 1.01	0.959
Random effects			
σ^2	3.29		
τ_{00}	0.18		
ICC	0.05		
N	995		
Observations	1271		
Marginal R^2 / Conditional R^2	0.129 / 0.174		

** p<0.05 ** p<0.01 *** p<0.001*

Bold p-values denotes statistically significant at 95% confidence level.

Built environment variables that were statistically significant for children meeting the minimum recommended MVPA levels were playing in a yard or driveway, utilizing the in-between space, and dwelling density. Other explanatory variables that were significant in meeting movement guidelines are gender, duration of pandemic, and playing more inside since the pandemic started.

4.2.2 Youth model

Table 3 presents the results and the random effects of the linear regression model developed to study the relationship between the neighbourhood and youth meeting MVPA, while controlling for some individual characteristics. The youth model has a higher between-level variance than the child model, hence, the common characteristics shared in a neighbourhood are more impactful for the older age group.

Table 3. Model results for 12-17 year old youth

Predictors	*Odds Ratio*	*CI*	*p*
Intercept	0.16*	0.03 – 0.79	**0.024**
Various characteristics			
Child's age	0.93	0.84 – 1.02	0.133
Gender (male)	1.13	0.80 – 1.59	0.490
Wave 2 (October 2020)	0.88	0.55 – 1.40	0.584
Play more inside x wave 2	0.41 *	0.19 – 0.85	**0.017**
Change in play patterns			
Play more outside covid started	2.48 ***	1.60 – 3.85	**<0.001**
Play more inside since covid started	1.26	0.78 – 2.02	0.340
Outdoor play locations			
Yard/driveway	1.80 **	1.25 – 2.59	**0.001**
Sidewalks, parking lots, or neighbourhood streets	1.42 *	1.00 – 2.00	**0.049**
Parks/trails/outdoor spaces in walkable distance	1.72 **	1.18 – 2.50	**0.005**
Parks/trails/outdoor spaces in drivable distance	1.14	0.74 – 1.77	0.549
Built environment			
Intersection density	0.92	0.71 – 1.19	0.503
Dwelling density	0.96	0.70 – 1.33	0.824
WalkScore	1.00	0.99 – 1.01	0.565
Random effects			
σ^2	3.29		
τ_{00}	0.53		
ICC	0.14		
N	1134		
Observations	1444		
Marginal R^2 / Conditional R^2	0.103 / 0.228		

** p<0.05 ** p<0.01 *** p<0.001*

Bold p-values denotes statistically significant at 95% confidence level.

Built environment variables that were statistically significant for youth meeting the minimum recommended MVPA levels are playing in a yard or driveway, utilizing the in-between space, and walking to public play spaces. Other explanatory variables that were significant in meeting movement guidelines are playing more outside since covid started and playing more inside as the pandemic prolongs.

4.3 (IN)FORMAL PLACES OF PLAY

Yards, driveways, and the in-between spaces are the foundation for outdoor play. Our regression results for both age groups suggest informal locations of play are key to meeting physical activity levels. Children that played in a yard or driveway were 2.20 times more likely to achieve MVPA. Young children that played in the in-between places—like sidewalks, parking lots, or neighbourhood streets—were 1.57 times more likely to meet recommended physical activity. Similarly, youth that played in yards or driveways and the in-between places were 80% and 42%, respectively, more likely to be physically active. Driving to parks, trails, and other outdoor spaces was not significant in meeting the physical activity requirements for either age group. Despite the ingrained North American car culture, driving children to play spaces is not a dependable routine for children of all ages to meet their physical activity levels every day. Rather it is the yards and in-between spaces, like sidewalks and neighbourhood streets, that are crucial to children meeting physical movement goals.

The one notable difference of play locations between children and youth is the relevance of walking to parks, trails, and outdoor spaces (such as green spaces, playgrounds, or schoolgrounds). Walking to these public play spaces was not significant for the younger children meeting their physical activity levels. Even though more children selected public play spaces as a location of play rather than selecting in-between places which was statistically significant. Similar to driving to public play spaces, walking to play spaces cannot be relied upon for meeting daily physical activity as it may require adult supervision for younger children. Policymakers and scholars have noted a steep decline in children's independent mobility (Waygood & Manaugh, 2020). Encouraging independent mobility at younger age could pro-

vide the associated benefits (Murray & Devecchi, 2016; Weller & Bruegel, 2009), as well as consistent access to play locations that could further support daily physical activity. However, policies and programs that encourage independent outdoor play for young children must require a nuanced and balanced approach that preserves child safety while allowing space for optimal child development.

For youth, playing in public play spaces that can be reached by walking was statistically significant (72% more likely), even more than playing in the in-between spaces (42% more likely). Unlike younger children, youth may not need to rely on the availability of adults to walk to the nearby park. Older children, aged 12-17, are likely to have more independent mobility. Therefore, walking to public play spaces can be a consistent way to achieve physical activity.

The model findings regarding play location resonate with international studies (Aarts et al., 2012; Marino et al., 2012; Visser & Van Aalst, 2022). Children inhabit, play, and learn from a diversity of urban spaces outside of the monotonous and fixed play structures. Our cities, especially residential areas, need to be designed to accommodate children. Advocating built environment changes for children can be a politically sensitive way to broach the topic and have the potential to garner large-scale public support. Furthermore, urban play spaces can be an important source of joy and beauty within a city (Lefebvre et al., 2014). Thoughtfully built child-friendly urban play spaces can be a respite from the concrete jungles—not only for children—and contribute positively to overall wellbeing.

4.4 BUILT FORM

WalkScores represent the accessibility to points of interest via active modes of transport and have been proven to be dependable in Canadian transport research. Contradictory to expectation, WalkScore showed no significance for both age groups. Especially for the younger children, the WalkScore odds ratio was 1.00 and far from significant with a 0.959 p-value. The WalkScore database may not be a reliable measure for kids as children's destinations—especially leisure and play locations—differ from adults' points of interest.

Dwelling density and intersection density are two features which contribute to shaping the built form. Both variables had no statistical significance for youth. The intersection density also did not have an impact on children, whereas, dwelling density was statistically significant and a deterrent to children's physical activity. The model suggests living in less dense neighbourhoods can support younger children's physical activity outcomes. Living in denser urban neighbourhoods has been associated with increased parental safety concerns, perhaps impacting the child playing outside. While parents in less-dense, suburban type neighbourhoods may feel more comfortable allowing their younger children to play outside.

Canada is a suburban nation with a plethora of low-density single dwelling homes. Homes in low density areas tend to be surrounded by quieter, residential streets. The literature suggests lower traffic volume and vehicle speeds are contributors in encouraging children's outdoor play (Lambert et al., 2019). Living in less dense areas is commonly synonymous with having calmer streets, hence, could support children's physical activity. Designing residential streets for children's safety has a tremendous impact on children's mobility and it inadvertently creates a safe environment for other vulnerable road users, like seniors and individuals using mobility aids.

Planners and policymakers have long supported denser communities because they are more environmentally sustainable, livable, and economically sustainable than suburban typologies. Some high-density cities, like New York City, were severely hit by COVID-19 waves. Hence, high-density buildings underwent temporary scrutiny from a public health perspective. However, cities even denser than New York City, like Tokyo, were able to withstand severe COVID-19 waves with governmental support and policies. In the current environment, younger children's physical activity goals are deterred by denser living. Similar to the high-density cities that combatted harsh COVID-19 waves, we need targeted planning, policies, and programs that can appropriately promote children's play and ensure they flourish in livable, and dense neighbourhoods.

4.5 EQUITY CONCERNS: GENDER AND AGE

For the younger age group, male children were 52% more likely to meet the minimum MVPA levels compared to female or other children. There are a myriad of factors that influence female or other children to use outdoor play spaces differently than their male peers. The physical quality of a playground can impact use; girls are less likely to play in bad conditions or with minimal play objects (Karsten, 2003). Ferré et al. (2006) noted activity type as a factor that deviates girls and boys use of public space. For example, girls will roller skate, whereas boys might prefer to play soccer. Another factor is social safety concern, Horton and Kraftl (2017) study found girls were often more constrained by parents than boys. The various studies stress the need to create urban play spaces that accommodate the vast range of needs and preferences to support the outdoor play of children that don't identify as male.

A gendered dynamic is not statistically significant for youth, however, there are concerns of most youth facing barriers when accessing the city and public spaces. Youth meeting the prescribed MVPA levels (11.9%) was even lower than the dismal rates for children (18.6%). There is an urgent need to carve out space for youth and their specific needs within public spaces. Moreover, encouraging outdoor play is important because it can be an antidote or escape during stressful times (Yogman et al., 2018). Creating an environment that brings adolescents outside can increase outdoor participation, physical activity, and be a vital piece of youth's mental health.

4.6 PLAY AND THE PANDEMIC

The pandemic was an instant disrupter that caused many households to adjust and change everyday preferences and patterns. At the start of the pandemic, playing more inside compared to pre-pandemic was statistically significant, children were 46% less likely to meet minimum MVPA levels. An early pandemic study found that many parents were struggling to replace cancelled sports and structured physical activities (Riazi et al., 2021). Parents could benefit from weekly physical activity e-newsletters that provide ideas for outdoor play. Some repositories and programming currently exist online through NGOs, like ParticipACTION. In

a similar vein, youth playing more outside since covid started was statistically significant, they were 148% more likely meet minimum MVPA levels. A COVID-19 study found that youth which participated in outdoor play and nature-based activities had smaller declines in subjective well-being (Jackson et al., 2021). Youth could benefit from policies and programs that are tailored to specifically bolster teenagers to spend more time outdoors.

As the pandemic continued, families grew warier and it took a permeant toll on many households that experienced severe changes to their lives. As anticipated, children were 34% less likely to meet their MVPA levels as the pandemic continued. There was no one specific variable that solely interacted significantly with Wave 2. Youth meeting MVPA levels also decreased as the pandemic persisted. This was primarily attributed to the youth that were playing more indoors than pre-pandemic, they were 59% less likely to meet the recommended MVPA levels.

The COVID-19 pandemic related health orders and restrictions created new barriers to the public domain. It should be used as an opportunity to reflect and adapt for the future of public health resiliency planning. Even studies in early pandemic times showed restrictions to outdoor public space use had minimal positive impact in reducing COVID-19 transmission (Qian et al., 2020). However, these ineffectual restrictions had a damaging impact to children and youth's outdoor play. Not only did the restrictions have negative consequences to kid's physical health, but they also severely impacted children's mental, developmental, cognitive, and social health. Children and youth's dismal health movement behaviours and accompanying consequences during the COVID-19 pandemic highlighted the necessity for future health policies to balance health objectives with promoting children's healthy movement. This urgency is further underscored as children's physical activity levels did not bounce back after the pandemic. Post-covid recovery and policies must diligently work to counteract the worsening crisis of children's physical health by encouraging outdoor play.

5

CONCLUSION

5.1 TAKEAWAYS

This study offers insights into children and youth's play locations, movement behaviours, and changes through the COVID-19 pandemic. The findings highlight the importance of the neighbourhood environment in supporting children to meet the recommended minimum physical activity levels. Based on the survey data which polled a large sample of households across Canada, the regression results indicated a diversity of informal play spaces are necessary for children's play. The results show the patterns continued as the pandemic prolonged. The dampened physical activity levels of the pandemic sustained and have not bounced back to the pre-covid physical activity levels, which were already low.

The results add evidence to the growing body of literature regarding children's play to better inform urban planning. Given the cascade of individual and collective benefits to promoting outdoor play, it is the responsibility of planners to work on the built environment to positively impact health and wellbeing outcomes for children. The study findings can be useful for policymakers and planners to build-in children and youth's essential needs within the built environment for the post-covid era and potential future pandemics. Diverse, sensitive, and context-specific play spaces are required to suit children of different age groups and genders (Visser & Van Aalst, 2022). Creating a built environment that children are safe to play in, ensures our neighbourhoods are friendly for seniors and more of the population. Planners alone won't fix this crisis, however, we can play an integral role in shaping the environment that has a measurable impact on our children and youth.

5.2 LIMITATIONS AND FUTURE SCOPE OF RESEARCH

There are some limitations of the study that could not be accounted for. Even though the age range was split in two groups, the range still remains large and findings may not apply for the youngest of the group. Answers to questions with the Likert scale are subjective, the survey data has not been triangulated with other methods or measures. The geographical scale of Canada and the legislative powers endowed at the provincial level create unique realities in each province. The everyday pandemic realities were even different from city to

city within a province. This was due to the cocktail of factors that influenced living during the pandemic, including but not limited to, the severity of the COVID waves, school closures, stay at home orders, public space closures, and public health messaging.

Despite these limitations, this study offers unique insights as it is one of the first to explore Canadian children's play locations and pattern changes throughout the COVID-19 pandemic. Hence, there is much room for further research within this realm. This study does not dive into parental encouragement or account for children with different mobilities and abilities. Moreover, this study pertains to urban Canada, it would be interesting to compare results with children in rural areas. Children's mobility research from an Indigenous lens is lacking. Interesting comparisons could be drawn from understanding children in the United States, as they have similar built environments but vastly different COVID-19 responses and health measures.

6

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