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Short Report

Walkable school neighborhoods are not playable neighborhoods

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ABSTRACT

The objectives were to determine whether: (1) playability features differed across walkable and non-walkable school neighborhoods, and (2) physical activity differed in children living in walkable and non-walkable school neighborhoods. A total of 3912 grade 6–8 students from 132 school neighborhoods were studied. There was more developed park space in high walkability neighborhoods than low walkability neighborhoods. Other playability features were more preferable in the low (e.g., undeveloped treed and water areas) and moderate (e.g., physical disorder/esthetics) walkability neighborhoods. Children from low walkability neighborhoods were more likely to engage in free-time physical activity outside of school and to achieve recommended levels of moderate-to-vigorous physical activity than were children from high walkability neighborhoods.

1. Introduction

Physical activity (PA) is an important determinant of health (Tremblay et al., 2011). The physical environment is a potential determinant of PA (Ferreira et al., 2007; Krahnstoever Davison and Lawson, 2006; Owen et al., 2004). Research on the physical environment and PA within adults has focused on "walkability" (Owen et al., 2004). Amongst other factors, the walkability of a neighborhood is a function of how well its streets connect to each other, the density of people and places, the diversity of land use, and the presence of pedestrian infrastructure (Frank et al., 2006). Within adults, walking is the primary source of PA (Tudor-Locke et al., 2010), and the walkability of a neighborhood is positively associated with PA (Owen et al., 2004). Walking accounts for a smaller proportion of total PA within children (Faulkner et al., 2009), and other forms of PA, such as outdoor active free-play, are important to consider (Janssen, 2014a). Thus, for children the "playability" of their neighborhood may be a determinant of their PA. Playability features include the presence of yards, playgrounds, undeveloped green space, cul-de-sacs, and trails (Laxer and Janssen, 2013; Veitch et al., 2006; Veitch et al., 2008). A recent study reported that the PA of 11 to 16-year-olds was positively associated with neighborhood playability features but negatively associated with walkability features (Laxer and Janssen, 2013). This suggests that walkable neighborhoods may not be playable neighborhoods, and that neighborhoods that promote walking within adults may hinder PA within children.

The primary objective of this study was to determine whether playability features differed across walkable and non-walkable school neighborhoods. A secondary objective was to determine whether active travel, free-play, and total PA levels differed in children living in walkable and non-walkable school neighborhoods.

2. Materials and methods

2.1. Data sources and sample

This study was based on the cross-sectional 2009/10 Canadian Health Behaviour in School-Aged Children Survey (HBSC), and has two components: (1) a health survey completed by grades 6–10 children, and (2) geographic information system (GIS) measures of the physical environments in the neighborhoods of the schools the child participants attended. This study includes neighborhood-level analyses that are limited to GIS measures, and multi-level analyses that examined whether GIS measures of neighborhood walkability were associated with students' PA.

The sample was selected using a cluster technique, wherein 26,078 grade 6–10 students (11–15-year-olds) are nested in 436 schools from across Canada. Consent was provided by schools, participants, and their parents/guardians. Ethics approval was obtained from the General Research Ethics Board of Queen's University.

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We used a 1 km radius circular buffer around schools to define neighborhoods for GIS measurement. These measures were used in both the neighborhood-level and multi-level analyses. For the multi-level analyses the neighborhood GIS measures were applied to all students attending a given school. Subsequently, the multi-level analyses were limited to students that lived within the 1 km radius that defined their school neighborhood, as explained elsewhere (Gropp et al., 2012; Laxer and Janssen, 2013).

Since this study focused on playability, a prior decision was made to examine children and not adolescents. Therefore, 11,525 grade 9–10 students from 127 schools were excluded, leaving 14,498 grade 6–8 students from 309 schools. A further 7645 students were excluded because they did not live within 1 km of their school. In addition, 2124 students from 84 schools were excluded due to missing GIS data. Finally, 817 students were excluded because of incomplete questionnaires. This left a final sample of 3912 grade 6–8 students and 163 school neighborhoods. By comparison to the final sample of 3912 students, the 2914 students that were excluded because of missing GIS or questionnaire data were younger (29% vs 36% in grade 6) and more likely to be female (53% vs 48%), White (77% vs 74%), from a single parent household (77% vs 74%), and use active travel to get to school (53% vs 40%).

2.2. Walkability of neighborhoods

Based on previous research (Dill, 2004; Frank et al., 2010; Laxer and Janssen, 2013), 8 walkability items were considered: intersection density (total number of real nodes/land area), average block length (distance of all roads/number of blocks), connected node ratio (true street intersections/total number of intersections including cul-de-sacs and dead ends), low road speeds (distance of roads with speed limits of ≤ 50 km/h), sidewalk coverage (% of total road distance with sidewalks), mixed land use (% land area comprised of residential area), population density (number of people/land area), and retail area ratio (retail building floor area footprint/retail land area). These items were measured using ArcGIS version 10 (Esri, Redlands, CA) with CanMap Streetfiles, CanMap Route Logistics, and Google Earth Streetview data sources.

We created a summary walkability score based upon the 8 walkability items using principal component analysis. One factor emerged and it included four items. These items and their factor loadings were: population density (0.83), mixed land use (0.83), intersection density (0.82), and sidewalk coverage (0.80). The standardized coefficients from the principal components analysis were used to calculate a summary walkability z-score, which was divided into tertiles to define low, moderate, and high walkability neighborhoods.

2.3. Playability of neighborhoods

Eight playability items were examined: developed parks and playgrounds including sports fields (% of land area) (Laxer and Janssen, 2013), undeveloped wooded areas (% of land area) (Janssen and Rosu, 2015), undeveloped fields and meadows (% of land area) (Janssen and Rosu, 2015), presence of yards at homes (summary score of 0–60) (Laxer and Janssen, 2013), water bodies (% buffer area), density of cul-de-sacs (number of cul-de-sacs/land area) (Laxer and Janssen, 2013), developed trails and paths (distance in km), and physical disorder/esthetics (summary z-score that reflects litter, graffiti tags, and condition of buildings and grounds) (Carson and Janssen, 2012). These items were selected based on evidence from etiological studies reporting that they are associated with physical activity in children, and descriptive studies reporting that they are common play areas (Boone-Heinonen et al., 2010a; Boone-Heinonen et al., 2010b; Carson and Janssen, 2012; Carver et al., 2008; Laxer and Janssen, 2013; Liu et al., 2007; Mecredy et al., 2011; Roemmich et al., 2006; Veitch et al., 2006; Veitch et al., 2008). These items were measured in ArcGIS and relied upon CanMap Streetfiles, CanMap Route Logistics, CanMap Parks and Recreation, and Google Earth Streetview data sources.

2.4. PA of students

Active transportation to school. Students were asked: "*On a typical day, the MAIN part of your journey TO school is made by...*". Responses were grouped as yes (walking or bicycle) or no (all motorized forms of transportation). There is excellent agreement (Cronbach's alpha ≥ 0.80) between repeated responses to this question (Roberts et al., 2006).

PA in free-time outside of school. Students were asked "*Outside school hours: how many hours do you usually exercise in your free time so much that you get out of breath or sweat?*" Based upon previous HBSC studies of the environment and PA, responses were categorized to create a dichotomous outcome of ≥ 4 or < 4 h/week (Janssen, 2014b; Mecredy et al., 2011).

Total moderate-to-vigorous PA. Students were asked: "*Over a typical or usual week, on how many days are you physically active for a total of at least 60 minutes per day?*". They were placed into physically inactive (≤ 6 days/week) or active (7 days/week) groups based on recommendations that children accumulate ≥ 60 min of moderate-to-vigorous PA daily (Tremblay et al., 2011). There is a good test–retest reliability of this question (intra-class correlation = 0.71) and responses are correlated with objective PA measures (Booth et al., 2001).

2.5. Confounding variables

Potential confounders for the multi-level analyses were gender, grade, race (White or other), number of parents in household (single or dual), and perceived family wealth (assessed with question: "*How well off do you think your family is?*").

2.6. Statistical analysis

Analyses were performed in SAS 9.4 (SAS Inc., Cary, NC) and, when appropriate, accounted for clustering and sample weights. First, we described neighborhood playability features using medians and interquartile ranges because of non-normal distributions. Kruskal–Wallis pairwise comparisons were used to determine if there were differences in median values across walkability groups. Because there were three pairwise comparisons, $p < .0167$ was considered significant. Next, we used conventional descriptive statistics to describe student participants. We then examined the associations between neighborhood walkability and PA using log-binomial regression. Multivariate regression models adjusted for confounders; these were selected using backwards elimination ($p > .15$).

3. Results

As seen in Table 1, developed park and playground space was greater in high walkability neighborhoods than low walkability neighborhoods. Conversely, undeveloped wooded areas and water body space was lower in high walkability neighborhoods than in low walkability neighborhoods. High walkability neighborhoods had greater a physical disorder score (i.e., poorer esthetics) than moderate walkability neighborhoods. The remaining playability features did not differ across low, moderate, and high walkability neighborhoods

Characteristics of student participants are in Table 2. There were comparable numbers of boys and girls and grade 6, 7, and

Table 1
Playability features of the school neighborhoods according to their walkability ($n = 163$).

Neighborhood playability feature	All school neighborhoods	Neighborhood walkability tertile[*]		
		Tertile 1 (low walkability)	Tertile 2 (moderate walkability)	Tertile 3 (high walkability)
Park and playground area (% land area)	2.9 (0.1–6.1)	0.6 (0.0–2.9)	4.3 (1.5–13.6)[*]	3.8 (1.6–9.0)[*]
Treed area (% land area)	3.5 (0.1–14.2)	16.4 (4.2–36.8)	1.1 (0.0–7.6)[*]	0.7 (0.0–4.1)[*]
Meadow area (% land area)	2.9 (1.4–6.0)	2.9 (1.9–7.1)	3.5 (1.5–6.4)	2.4 (1.0–4.7)
Yards at home score (range 0–60)	56.0 (53.0–59.0)	55.0 (49.0–59.0)	57.5 (54.0–59.0)	57.0 (52.0–59.0)
Water area (% buffer area)	0.1 (0.0–2.6)	0.7 (0.0–7.8)	0.0 (0.1–1.0)	0.0 (0.0–0.5)[*]
Trails and paths (length in km)	0.3 (0.0–1.3)	0.0 (0.0–0.9)	0.3 (0.0–1.5)	0.5 (0.0–1.9)
Cul-de-sac density (number per km^2)	6.4 (4.1–11.1)	5.1 (3.8–8.3)	7.6 (4.8–12.3)	6.7 (4.1–12.1)
Physical disorder score (z-score)	−0.1 (−0.4–0.3)	0.0 (−0.4–0.2)	−0.3 (−0.6–0.1)	0.1 (−0.4–0.5)[†]

Data presented as median (25th percentile–75th percentile).

[*] Significantly different from low walkability tertile ($p < 0.0167$).
[†] Significantly different from moderate walkability tertile ($p < 0.0167$).

Table 2
Descriptive characteristics of student participants ($n = 3912$).

Variable	N	% of total[a]
Gender		
Boys	1860	46.7
Girls	2052	53.3
Grade		
6	1142	29.2
7	1160	28.0
8	1610	42.8
Race		
White	2393	59.3
Other	1519	40.7
Perceived family wealth		
Not at all well off	137	3.2
Not very well off	246	6.1
Average	1402	34.5
Quite well off	1160	30.3
Very well off	967	25.9
Parents in household		
Single parent	903	23.1
Dual parent	3009	76.9
Physical activity		
Use active travel to get to school	1709	53.0
≥ 4 h/wk of physical activity in free-time outside of school	1274	31.9
≥ 60 min/d of daily moderate-to-vigorous physical activity	726	18.6

[a] Based on weighted *N*.

8 students. The majority were White. Fifty three percent walked or bicycled to school on most days, 32% accumulated ≥ 4 h/week of PA in their free-time outside of school, and 19% accumulated 60 min/day of moderate-to-vigorous PA.

Neighborhood walkability was not associated with active transportation to school. There were significant associations for the other two PA outcomes (Table 3). By comparison to students living in high walkability neighborhoods, students living in low walkability neighborhoods were 44% more likely to accumulate ≥ 4 h/week of PA in their free-time outside of school and 42% more likely to accumulate 60 min of daily moderate-to-vigorous PA (Table 3).

4. Discussion

More space was devoted to developed parks and playgrounds in high walkability neighborhoods than low walkability neighborhoods. However, some of the other playability features were more preferable in the low (e.g., undeveloped treed and water areas) and moderate (e.g., physical disorder/esthetics) walkability neighborhoods than the high walkability neighborhoods. Grade 6–8 students from low walkability neighborhoods were more likely to engage in free-time PA outside of school and to achieve recommended levels of moderate-to-vigorous PA than were students from high walkability neighborhoods.

The positive association between walkability and active transportation observed consistently within adults (Frank et al., 2010; Owen et al., 2004) did not hold true within the children studied here. Furthermore, we found that walkable neighborhoods negatively impacted childrens' free-play and total PA. In fact, some of the features that make neighborhoods highly walkable, such as limited or no undeveloped space for children to use (e.g., wooded areas), a high population density, and mixing residential and commercial areas, may present barriers for outdoor free-play. Perceptions of stranger danger may be particularly high in walkable neighborhoods since there are more adults outside walking. Such perceptions, even if baseless, negatively influence childrens' outdoor free-play (Timperio et al., 2005). Physical disorder is another feature of the environment that may alter perceptions of safety. In our study physical disorder was a greater issue in high walkability neighborhoods than moderate walkability neighborhoods.

Strengths of this study include that it was national in scope and considered several GIS measures of walkability and playability. Key limitations include the cross-sectional design and use of self-reported measures for the multi-level analysis. This study was also limited to school neighborhoods and grade 6–8 children residing within 1 km of their school. Finally, the exclusion of a large number of participants with missing data may have biased the results.

5. Conclusion

Public health efforts to develop more highly walkable neighborhoods, with the goal of increasing active transportation among adults, could potentially have a negative impact on PA among children. Future research needs to identify neighborhood designs that are conducive to PA in all age groups.

Table 3
Association between school neighborhood walkability and student physical activity.

Physical activity variable	Neighborhood walkability tertile			P trend
	Tertile 1 (low walkability)	Tertile 2 (moderate walkability)	Tertile 3 (high walkability)	
Use active travel to get to school				
% yes	36.0	46.0	48.0	
Bivariate prevalence ratio	0.89 (0.70–1.13)	0.95 (0.76–1.18)	1.00 (referent)	.35
Multivariate prevalence ratio	0.93 (0.73–1.19)	0.96 (0.77–1.19)	1.00 (referent)	.56
≥4 h/wk of physical activity in free-time outside of school				
% yes	33.5	35.2	29.9	
Bivariate prevalence ratio	1.59 (1.26–2.00)	1.56 (1.21–2.01)	1.00 (referent)	<.001
Multivariate prevalence ratio	1.44 (1.12–1.84)	1.37 (1.08–1.74)	1.00 (referent)	.002
≥60 min of daily moderate-to-vigorous physical activity				
% yes	20.5	18.3	17.2	
Bivariate prevalence ratio	1.57 (1.24–1.98)	1.21 (0.91–1.60)	1.00 (referent)	<.001
Multivariate prevalence ratio	1.42 (1.17–1.73)	1.06 (0.81–1.39)	1.00 (referent)	<.001

All prevalence ratios accounted for clustering by school and sampling weights. Multivariate prevalence ratios were adjusted for grade, gender, race, perceived family wealth, and number of parents in the household.

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