

# Is higher school neighbourhood Walk Score associated with greater child pedestrian safety near schools?

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## ABSTRACT

Walk Score is a common index used to estimate how suitable the built environment is for walking. Although Walk Score has been extensively validated as a measure of walkability and walking, there are limited studies examining whether commonly used constructs of walkability are associated with traffic safety in children. This study examined the association between Walk Score and child pedestrian injury controlling for observed walking exposure in school zones in Calgary, Toronto and Montreal, Canada. Results indicate that a higher Walk Score was associated with more child pedestrian injuries in all three cities, even after controlling for walking exposure. School travel planning should consider established individual pedestrian collision risk and individual factors rather than assuming a highly walkable environment is also a safe pedestrian environment.

## INTRODUCTION

Neighbourhood walkability is a measure of how friendly the built environment is for pedestrians. There are many different measures of walkability, with the commercially available Walk Score commonly used in North America for commercial properties, planning, and research.<sup>1</sup> The Walk Score index ranges from zero (“Almost all errands require a car”) to 100 (“Daily errands do not require a car”) and is composed of population density, intersection density, block length and proximity to nine different amenities.<sup>1</sup> In adults, higher Walk Scores have been associated with higher reported walking.<sup>2–4</sup> Weaker associations between Walk Scores and walking in children have been found, including a recent study using observational data around schools.<sup>5 6</sup>

Although Walk Score has been validated as a measure of walkability and walking, limited attention has been paid to its association with road safety. Assumptions likely exist that a walkable environment means a safe environment for walking.<sup>7</sup> Several previous studies have found associations between higher walk scores and more pedestrian collisions.<sup>7–9</sup> Not all studies controlled for pedestrian volume, and none focused on child pedestrians, which is important in that the definition of a walkable and safe environment may be different in children compared with adults.

Data from the multi-city CHild Active-transportation Safety and the Environment (CHASE) study allowed us to examine the relationship between Walk Score and child pedestrian collisions, using observed walking

## WHAT IS ALREADY KNOWN ON THIS SUBJECT

- ⇒ Walk Score is associated with increased walking
- ⇒ There is some evidence that higher walk scores are associated with more pedestrian collisions in adults

## WHAT THIS STUDY ADDS

- ⇒ Walk Score is associated with higher rates of child pedestrian collisions even after adjusting for the percentage of children walking to school.
- ⇒ Walkability indices should more consistently be addressing safety

## HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

- ⇒ It is important that it be recognized by those promoting the use of Walk Scores, that a high score does not imply child pedestrian safety. It is recommended that school travel planning should consider established individual pedestrian collision risk

as an estimate of exposure.<sup>10</sup> Observational counts of children’s travel to school were conducted as part of this larger study in several municipalities across Canada.<sup>10 11</sup>

The objective of this study was therefore, to examine the association between Walk Score and child pedestrian injury around schools after controlling for observed walking in three Canadian cities.

## METHODS

This cross-sectional study was conducted as part of the CHASE study in Calgary, Toronto and Montreal.<sup>5 11</sup>

## Sampling frame

All public elementary schools (students ages 4–11 years) were eligible for inclusion. Middle schools (ages 12–13), high schools (ages 14–17) and specialised schools (eg, arts-based, alternative schools) were excluded, as these schools typically have further travel distances and different travel mode choices due to larger catchment areas. In Toronto and Montreal a stratified random sample of schools was used, based on the school census after-tax low-income cut-off and the Walk Score.<sup>11</sup> In Calgary, all eligible schools were included. Observations were conducted at 125



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**Table 1** Descriptive statistics in school catchment areas in Calgary, Toronto and Montreal, Canada

	Calgary (n=125) Mean (SD)	Toronto (n=76) Mean (SD)	Montreal (n=67) Mean (SD)
Total collisions (n) for Calgary (6 years), Montreal and Toronto (7 years)	214	738	766
Mean pedestrian collisions/school/year	0.27 (0.28)	0.27 (0.24)	0.35 (0.27)
Walk Score (0–100) based on school postal code	48.13 (16.15)	65.33 (19.17)	76.79 (16.35)
Child Population per school catchment area (n)	619.53 (338.86)	1066.27 (606.41)	1607.25 (767.99)
Roadway length per school catchment area (km)	17.38 (4.39)	17.13 (7.65)	23.73 (5.63)
Walking to school (%)	33.9 (11.5)	61.09 (16.85)	63.67 (17.35)

elementary schools in Calgary, 76 in Toronto and 67 in Montreal (see Rothman et al 2021 for further details).<sup>5</sup>

### Variables

The child pedestrian collision outcome was derived from police collision reports (ages 1–12) obtained from 2012 to 2018 in Toronto and Montreal (7 years), and 2012–2017 in Calgary (6 years), based on availability. Collisions were mapped onto 1000-metre network-based buffers around schools using ArcMap V.10.7, representing “proximity” buffers. This distance was chosen as it approximates walking distance used for elementary school students.<sup>11</sup> Two-step floating catchment area (2SFCA) methods were used to assign collisions to schools, proportionally based on the distance to schools where two school areas overlapped.<sup>11</sup> These methods have been used previously related to road traffic collisions and is used to create a ‘school burden’ of collisions with the recognition that a collision more proximate to school is more directly related to that school’s burden of injury. Proportional weighting was assigned based on the inverse distance along the road network, and weights were indexed to one to prevent population inflation where areas overlapped. Please see Rothman et al (2022),<sup>11</sup> for more information.

The percentage of children observed arriving to school by different modes of transportation was captured in the spring of 2017 and 2018 using a reliable methodology.<sup>5 12</sup> Two trained observers (three at schools > 700 students) conducted observations using a standardised protocol. Children were counted arriving to school by car, walking or cycling, at the busiest arrival locations, from 20 min before until 5 min after the morning school bell. The percentage of children observed walking was used as an estimate for exposure to road traffic within the proximity areas. Walk Scores, which are calculated on a scale of 0–100, were obtained for the school postal codes from the Walk Score website.<sup>1</sup> Length of roadway in the catchment area (excluding highways) and child population (ages 1–12, from the 2016 census) were controlled for, as areas with more dense road networks and with more child residents, have higher collision rates.<sup>13</sup>

### Statistical analysis

Descriptive statistics were calculated for the proximity areas. Multivariable negative binomial regression models (due to data overdispersion) first estimated the relationship between Walk Score and child pedestrian collisions, controlling for length of roadway and child population within the proximity areas (Model A) and then adding percentage of children walking to school (Model B). SAS software 9.4 was used for the analysis.

### RESULTS

Mean collision rates/school/year were highest for Montreal, followed by Calgary and Toronto (table 1). Montreal also had the highest Walk Scores, child population, roadway length and percentage of active school transportation, followed by Toronto

for all variables (with the exception of roadway length). Calgary had the lowest percentages of children walking to school.

In the multivariable analysis (Model A, table 2), Walk Score was significantly associated with more pedestrian collisions in Calgary and Montreal while adjusting for road length and child population and remained significantly associated specifically in Montreal and in all cities overall after adjusting for walking exposure (Model B). Insignificant associations between higher Walk Score and more pedestrian collisions were found in Toronto and Calgary after adjusting for exposure. Higher child population was significantly associated with more child pedestrian collisions in all cities and higher percentage walking to school was associated with more collisions in Montreal and in all cities overall. Higher Walk Score was also associated with more walking to school (OR 1.13, 95% CI: 1.04, 1.23) in univariate analysis in all cities overall.

### DISCUSSION

Our findings show that more walkable environments, as defined by the Walk Score, may be associated with more child pedestrian

**Table 2** Negative binomial regression analysis of the association between Walk Score and child pedestrian collision

	Model A Adjusted OR (95% CI), Collisions- adjusted for road coverage and child population	Model B Adjusted OR (95% CI) Collisions- Adjusted for road coverage, child population and walking to school
Calgary (n=125)		
Walk Score (0–100)	1.15 (1.03, 1.29)	1.10 (0.97, 1.24)
Road Coverage (10 m)	0.90 (0.58, 1.42)	0.93 (0.59, 1.46)
Child Population (per 1000)	4.29 (2.73, 6.71)	3.37 (2.02, 5.62)
Walking to school (%)	–	1.17 (0.99, 1.37)
Montreal (n=67)		
Walk Score (0–100)	1.26 (1.04, 1.51)	1.20 (1.00, 1.45)
Road Coverage (10 m)	0.69 (0.44, 1.09)	0.73 (0.47, 1.12)
Child Population (per 1000)	1.54 (1.15, 2.06)	1.46 (1.11, 1.93)
Walking to school (%)	–	1.12 (1.01, 1.25)
Toronto (n=76)		
Walk Score (0–100)	1.15 (0.97, 1.36)	1.14 (0.97, 1.36)
Road Coverage (10 m)	1.02 (0.74, 1.40)	1.02 (0.74, 1.40)
Child Population (per 1000)	1.70 (1.19, 2.44)	1.66 (1.07, 2.60)
Walking to school (%)	–	1.01 (0.86, 1.19)
All Cities (n=268)		
Walk Score (0–100)	1.15 (1.07, 1.24)	1.09 (1.01, 1.19)
Road Coverage (10 m)	0.96 (0.79, 1.18)	1.03 (0.84, 1.25)
Child Population (per 1000)	1.95 (1.62, 2.36)	1.67 (1.37, 2.03)
Walking to school (%)	–	1.13 (1.05, 1.21)

collisions in some cities even after controlling for the percentage of children walking to school. For example, Montreal, which had the highest average number of pedestrian collisions, Walk Scores, child population, roadway length and percentage of children walking, had the strongest positive association between Walk Scores and collisions, even after controlling for walking. These results suggest that this common measure of walkability may be related to less safe environments, and the higher numbers of collisions may be a result of more child pedestrians in unsafe environments in some cities. This may indicate that infrastructure related to road safety may be lacking in more walkable school environments.

The composite Walk Score index includes metrics such as more intersections and shorter block lengths and proximity to services—all of which individually have been associated with higher child pedestrian collisions in previous work.<sup>13</sup> It does not include features of the built environment that contribute to safe walking in children, such as traffic calming and greater residential land use.<sup>11 13</sup>

Our findings reflect other studies relating Walk Score to higher pedestrian injuries. Chong *et al* reported that higher Walk Scores were associated with increased rates of pedestrian-related hospitalisation among those 65+ years, and in most disadvantaged areas in Sydney, Australia controlling for traffic volumes.<sup>8</sup> Although there was no significant association between Walk Score and collisions in children 0–18 years of age, the relative risks were above 1. Yin and Zhang reported that higher Walk Score was also associated with more pedestrian collisions in Buffalo, NY with no control for exposure.<sup>9</sup> Osama *et al* reported an association between higher Walk Scores and more pedestrian injuries in Vancouver, Canada using self-reported travel behaviour to attempt to control for pedestrian volumes.<sup>7</sup>

The associations of higher child populations with more pedestrian collisions and more walking to school and collisions have been reported previously.<sup>11 13</sup> The literature related to adult populations reports a ‘safety in numbers’ effect that doesn’t seem to be consistently present for children.<sup>14 15</sup> Previous research in Toronto found that walking to school and child pedestrian collision rates were no longer associated after controlling for built environment features such as traffic calming.<sup>16</sup> Therefore, the safety in numbers effect may not apply unless the roadway environment is built to be safe. Therefore, the ideal solution is not to suggest less walking, with all its health benefits, but to design safe walking environments for children, particularly around schools.

This study is the first to examine the association between Walk Score and child pedestrian collisions adjusting for directly observed child walking exposure. Limitations included using the percentage of children based on count data arriving to school by walking, which is only an estimate of exposure. It is possible that children were missed in the counts, however, the intention was not to count every child, but to capture a representative sample of the travel modes. Therefore, the two busiest arrival points were used for the observations. High test–retest reliability of these methods was found in a sample of schools in some of our previous work (Pearson’s  $r=0.96$ ).<sup>12</sup> It is not possible to directly link the collisions to a school nor confirm they occurred during school travel with the data available (eg, the child victim could attend another school outside of the catchment area).<sup>11</sup> Walk Scores were also assumed to remain unchanged over the 6–7 year collision data period. There may be other, unmeasured variables associated both with Walk Scores and child pedestrian collisions (eg, speed limits in the school catchment area) that were not considered here.

This study suggests that increased Walk Score may not confer child pedestrian safety and points to the question of whether the Walk Score should be addressing safety. There is no common consensus regarding the conceptual definition of walkability,<sup>7 17</sup> and all too frequently, objectively defined safety is not considered within many walkability scales.<sup>18–20</sup> Some of the factors included in the scales have well established correlations with pedestrian collisions (eg, intersection density).<sup>13</sup> It is important that it be recognised and communicated by those promoting the use of Walk Scores, that a high score does not confer anything about child pedestrian safety. It is also recommended that school travel planning should consider established individual pedestrian collision risk and individual factors rather than assuming a highly walkable environment is also a safe pedestrian environment.

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