Motor Vehicle-Pedestrian Collisions and Walking to School: The Role of the Built Environment

WHAT'S KNOWN ON THIS SUBJECT: Many studies have demonstrated that the built environment is related to both collision risk and walking to school. However, little research examines the influence of the built environment on the relationship between walking to school and pedestrian collision risk.

WHAT THIS STUDY ADDS: Increased walking was not associated with increased pedestrian collision once the effects of the built environment and socioeconomic status were modeled. Safety was related primarily to the built environment and specifically features related to road crossing.

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abstract

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OBJECTIVES: Initiatives to increase active school transportation are popular. However, increased walking to school could increase collision risk. The built environment is related to both pedestrian collision risk and walking to school. We examined the influence of the built environment on walking to school and child pedestrian collisions in Toronto, Canada.

METHODS: Police-reported pedestrian collision data from 2002 to 2011 for children ages 4 to 12, proportion of children walking to school, and built environment data were mapped onto school attendance boundaries. Collision rates were calculated by using 2006 census populations and modeled by using negative binomial regression.

RESULTS: There were 481 collisions with a mean collision rate of 7.4/10 000 children per year. The relationship between walking proportion and collision rate was not statistically significant after adjusting for population density and roadway design variables including multifamily dwelling density, traffic light, traffic calming and 1-way street density, school crossing guard presence, and school socioeconomic status.

CONCLUSIONS: Pedestrian collisions are more strongly associated with built environment features than with proportions walking. Road design features were related to higher collision rates and warrant further examination for their safety effects for children. Future policy designed to increase children's active transportation should be developed from evidence that more clearly addresses child pedestrian safety. *Pediatrics* 2014;133:776–784

Road traffic injuries are the leading cause of child death in most developed countries.[1–3] In 2010, 61 children died and over 9000 were injured on Canada's roads.[4] Pedestrian collisions account for ~25% of children's road traffic fatalities.[5] Much of children's exposure to traffic as pedestrians is during school travel.[6–8] Although walking to school rates have declined in Canada, ~50% of Ontario children walk to school.[9–11] In Toronto, Canada, ~50% of child pedestrian collisions occurred during school travel times with more than one-third occurring within 300 m of a school.[12]

Initiatives to increase active school transportation (AST) are popular. In 2005, the US Safe Routes to School (SRTS) program received over $1 billion of federal funding.[13,14] In Canada, SRTS programs have developed at a grassroots level, with limited government funding.[14] Increased walking to school might benefit overall health, but also increase collision risk. A recent Canadian study revealed a possible increase in walking/cycling injuries among youth who regularly walked or cycled longer distances to school (>15 minutes), compared with those who did not walk/cycle to school.[15]

Many conceptual frameworks describing correlates of walking to school focus on the built environment (BE). The BE is defined as "the human-made space in which people live, work, and recreate on a day-to-day basis."[16] No framework considers child pedestrian injury, and there has been little research examining pedestrian collision as an AST outcome. The purpose of this study was to examine the effect of the BE on the relationship between observed walking to school and child pedestrian collisions.

METHODS

Study Design, Setting, and Population

A cross-sectional study examined child pedestrian collisions from 2002 to 2011.

Walking exposure was measured in an observational study in the spring of 2011 in junior kindergarten to grade 6 schools in Toronto. Schools were excluded if they were participating in another active transportation study or had special programs (eg, French immersion), which serve large areas. Further methodological details were reported previously.[17] Ethics approval was obtained from the Toronto District School Board (TDSB) and the Hospital for Sick Children Research Ethics Boards.

Outcome

Collision data were extracted from Toronto Police Service motor vehicle collision reports from 2002 to 2011 for children ages 4 to 12 years. Police-reported collisions include those resulting in no injury, minimal, minor (seen in the emergency department), major (admitted to hospital), and fatal injuries. Collision rates by study school boundary were calculated over a 10-year period and reported as an annualized rate per 10 000 children. Child population numbers were obtained for Dissemination Areas (DAs, 400–700 residents) by using the 2006 Canadian Census. DAs were mapped onto school boundaries, and population estimates were calculated by using area-weighted proportionate estimation.[18,19]

Exposure

Two trained observers measured walking exposure by counting children either arriving to school walking, by car, or other active means (bicycle or scooter) on a single day. Observations were repeated in 22 schools (19%) where at least 1 observer rated <90% confidence in the accuracy of their counts and were repeated 1 week later in another 12 schools (10%) to examine test-retest reliability. Walking proportion was calculated from the

total number observed. The majority of children counted lived within walking distance of the school (ie, ≤1.6 km), as defined by TDSB transportation policy.

Potential Covariates

BE variables were identified from a literature review and conceptually organized by using Cervero and Kockelman's 3Ds: density of population, diversity of land use, and design of the roadway environment.[20] Socioeconomic status (SES) variables were included because of previously reported correlations with child pedestrian injury.[21,22] Table 1 presents each variable according to its conceptual category, level of measurement, and data source. Variables were measured at the school and school attendance boundary level.

Data Sources

Canadian Census

DA data were obtained from the 2006 Canadian census. Social environment variables included the proportion of households falling below the after-tax, low income cut-offs in each school's DA, as a proxy measure for the school neighborhood SES.

Municipal Property Assessment Corporation

Land use diversity variables were derived by using 2011 parcel level data from the Municipal Property Assessment Corporation (MPAC), which classifies and assesses properties in Ontario. Mixed land use was calculated by using an entropy index, which ranges from 0 (single land use) to 1 (equal distribution of residential, commercial, industrial, institutional, and vacant land classifications).[23,24]

Site Audits

School level design variables were obtained from site audits conducted by the observers during school drop-off

TABLE 1 Variables According to Conceptual Domain, Level of Measurement, and Data Source

Domain	Level	Data Source	Variables
Outcome	School boundary level	Toronto Police Services	Collision rate/10 000/year
Exposure	School level	Site Survey	Proportion walking to school
Built environment			
Density	School boundary level	Canadian Census	Multidwelling (apartments, duplexes) density (no.)/1000 m^2
Diversity	School boundary level	MPAC	Commercial land use area/boundary
		Derived	Entropy Index
		MPAC	Industrial land use area/boundary
		MPAC	Institutional land use area/boundary
		MPAC	Park land area/boundary
		City of Toronto	Recreational facilities (no.)/km^2
		MPAC	Vacant land area/boundary
Design	School level	Site Survey	Cars appear to be driving fast near school
		Site Survey	Cars blocking view
		Site Survey	Dangerous intersection near school
		Site Survey	Dangerous midblock crossing near school
		Site Survey	Double parking
		Site Survey	Drop offs opposite side of road
		Site Survey	Mean speed > 5 km over speed limit
		Site Survey	School major roadway traffic volume (number of cars/minute)
		Site Survey	School crossing guard observed
		Site Survey	School traffic/minute
		Site Survey	Traffic congestion seen around school during drop off
	School boundary level	City of Toronto	Collector roads km/km road
		City of Toronto	Crossing guard (no.)/10-km road
		City of Toronto	Dead end (no.)/km road
		City of Toronto	Flashing lights density (no.)10/km road
		City of Toronto	Intersection (no.)/km road
		City of Toronto	Major roads km/km road
		City of Toronto	Minor roads km/10-km road
		City of Toronto	One way streets km/10-km road
		TDSB, TCDSB	Other schools within school boundary (no.)
		City of Toronto	Pedestrian crossover (no.)/km road
		City of Toronto	Sidewalks (both) missing km/km road
		City of Toronto	Sidewalks (one) missing km/km road
		City of Toronto	Traffic calming segment km/10-km road (eg, speed bumps)
		City of Toronto	Traffic light no./km road
		City of Toronto	Trails density km/km road (km)
		Canadian Census	Central city
Social environment			
	School level	TDSB	Children grades 4 to 6
		TDSB	English not primary language
		TDSB	Boys at school
		TDSB	New immigrants (≤ 5 y)
		TDSB	Total school population
		TDSB	School LOI
	DA level	Canadian Census	AT below LICO cut off (school DA)

AT, after tax; LICO, low income cutoff.

time. Only adults employed by Toronto Police Services surrounding the school were identified as school crossing guards. Vehicle speed and volume were measured along a road within 150 m of the school by using manual short-based methods.[25,26]

City of Toronto

Collision outcome data, school boundary level design variables, and recreational facility land use were obtained from The City of Toronto (Transportation Services and the Open Data Web site).[27] Densities were calculated either per school boundary area or per kilometer of roadway. Toronto consists of an older central city with many pre–World War II traditional neighborhoods and an inner ring representing newer, car-oriented post–World War II neighborhoods.[28] Central city status was assigned if >50% of the school boundary overlapped with the central city area.

Toronto District School Board

The TDSB provided social environment variables and school attendance boundary data. The 2011 Learning Opportunities Index (LOI) is a composite measure of children's SES attending a school reflecting parental education,

income, housing and immigration, and ranges from 0 (high) to 1 (low SES).

Statistical Analysis

School attendance boundaries were the unit of analysis. All features were mapped onto boundaries by using ArcMap version 10.[29] Statistical analysis was conducted by using SAS, version 9.3.[30] Mutlicollinearity was assessed by using variance inflation factors. If 2 correlated variables had variance inflation factors >10, the variable with the higher standardized unadjusted β was retained.[31]

Child pedestrian collision rates were modeled by using negative binomial regression. Variables with $P \leq .2$ in the unadjusted analysis were entered by using forward manual stepwise regression, according to the magnitude of standardized βs.[32] Variables were retained if significantly associated with the outcome at $P \leq .05$, with confounding identified if the variable also changed walking estimates by $\geq 10\%$.[32,33] Stratified analyses were conducted by tertiles for design features to assess for differential impact on outcome.

Model fit was assessed by using the Akaike Information Criteria.[34,35] Incident rate ratios (IRRs) were calculated through exponentiation of βs from the regression models and presented with 95% confidence intervals (CIs). Sensitivity analysis was conducted by using 10, 7, and 5 years of collision data. A subanalysis was done of collisions occurring only during school travel times (7:30–9:00 AM, 11:30 AM–1:00 PM, 3:00–5:00 PM, weekdays, September through June). Both before and after school collisions were included, as numbers of elementary school children walking to and from school are comparable.[36,37]

RESULTS

Among 245 junior kindergarten to grade 6 schools, 126 met inclusion criteria, 8 refused, and 118 schools participated in the study. A total of 481 collisions occurred within 105 school boundaries. There were 24 collisions resulting in no injury, 191 minimal, 236 minor, 30 major injuries, and 1 fatality. The average collision rate was 7.4/10 000 per year (range, 0–27/10 000, SD = 6.7). Two outlier schools with extreme collision rates (>3 interquartile ranges above the 75th percentile) were excluded. These were inner city schools with very small attendance boundaries and few resident children contributing to low rate denominators. The mean proportion of children walking to school was 67.0% (range, 27.9%–98.2%, SD = 14.4%) with high test-retest reliability of walking counts (Pearson's $r = 0.96$).

In the unadjusted analysis, increased walking proportions were associated with higher pedestrian collision rates (IRR = 3.47; 95% CI = 1.15–10.47; Table 2). This was equivalent to a 13% increase in collision rate with every 10% increase in walking.

Older housing, residential, road, and local road density were dropped from further analyses due to multicollinearity.

In the adjusted collision model, walking proportions were no longer associated

TABLE 2 Descriptive Statistics and Significant Unadjusted Incident Rate Ratios

Variable	Mean (SD)	Unadjusted IRRs (95% CI)
Outcome		
Collision rate/10 000/year[a,1]	7.41 (6.73)	NA
Exposure	67.0% (14.5)	3.47 (1.15–10.47)
Proportion walking to school[b,2]		
BE		
Density		
Multifamily dwelling (apartments, duplexes) (no.)m/1000 m[2a]	1.41 (1.29)	1.12 (1.00–1.26)
Diversity		
Commercial land use area/boundary[b]	6.35 (7.20)	30.04 (4.72–191.04)
Entropy index[a]	0.61 (0.13)	3.67 (1.11–12.14)
Recreational facilities (no.)/km[2a]	1.70 (1.46)	1.12 (1.01–1.24)
Park land area/boundary[b]	7.56 (6.80)	0.14 (0.02–1.35)
Design, N (%)		
School crossing guard observed[c]	45 (38.79)	1.51 (1.12–2.02)
Dangerous intersection near school[c]	39 (33.62)	1.22 (0.90–1.67)
Double parking[c]	54 (46.55)	0.82 (0.60–1.10)
Traffic congestion seen around school	76 (65.52)	0.81 (0.60–1.11)
Design		
Traffic light no./km road[a]	0.53 (0.29)	2.61 (1.60–4.24)
Pedestrian crossover (no.)/km road[a]	0.10 (0.12)	2.41 (0.65–8.94)
Central city N (%)[c]	37 (31.90)	1.70 (1.26–2.28)
Other schools within school boundary (no.)[c]	38 (32.8)	1.52 (1.13–2.05)
Minor roads density km/10-km road[a]	0.77 (0.72)	1.43 (1.16–1.76)
Traffic calming segment km/10-km road (eg, speed bumps)[a]	0.44 (0.70)	1.31 (1.06–1.61)
One way streets km/10-km road[a]	0.70 (1.16)	1.29 (1.15–1.46)
Flashing lights (no.)/10/km road[a]	0.68 (0.92)	1.25 (1.08–1.46)
Intersection (no.)/km road[a]	5.56 (1.70)	1.19 (1.09–1.29)
Crossing guard density (no.)/10 km road[a]	1.15 (0.98)	1.15 (0.98–1.34)
Collector roads km/km road[a]	0.15 (0.09)	0.26 (0.04–1.47)
Sidewalks (both) missing km/km road[a]	0.05 (0.09)	0.08 (0.01–0.59)
Trails km/km roads[a]	0.50 (0.74)	0.80 (0.64–0.99)
Sidewalks (one) missing km/km road[a]	0.08 (0.09)	NS
Social environment		
School LOI[a]	0.50 (0.28)	1.75 (1.00–3.05)
Total school population[a]	311.08 (144.01)	0.93 (0.85–1.02)
Children grades 4 to 6[b]	32.70 (45.63)	0.06 (0.00–1.62)

$P \leq .20$. NA, not applicable; NS, not significant.
[a] Continuous data type.
[b] Proportion data type.
[c] Dichotomous data type.

TABLE 3 Correlates of Child Pedestrian Collisions in Adjusted Analyses

Component	Variable	IRR (95% CI)	P
Outcome	Child pedestrian collisions		
Exposure	Proportion walking to school	0.84 (0.29–2.46)	.747
Density	Multifamily dwelling (no.)/1000 m^2	0.84 (0.73–0.96)	.009
Design	Traffic light no./km roads	3.20 (1.89–5.41)	<.0001
Design	School crossing guard	1.45 (1.09–1.91)	.010
Design	Traffic calming km/10 km road	1.31 (1.06–1.63)	.014
Design	One way streets km/10 km road	1.19 (1.03–1.36)	.015
Social environment	School LOI	2.36 (1.39–3.99)	.001

with collision rates (Table 3). Collisions were less frequent in areas with higher multifamily dwelling density (IRR = 0.84; 95% CI = 0.73–0.96). Design variables, including higher densities of traffic lights (IRR = 3.20; 95% CI = 1.89–5.41), traffic calming (IRR = 1.31; 95% CI = 1.06–1.63), 1-way streets (IRR = 1.19; 95% CI = 1.03–1.36), school crossing guards (IRR = 1.45; 95% CI = 1.09–1.91), and low school SES (IRR = 2.36; 95% CI = 1.39–3.99) were positively associated with collisions and changed the walking exposure by ≥10%. Significant design variables were generally related to road crossing. Traffic light density and SES exhibited the strongest associations.

The association between walking and collisions differed by levels of traffic light density; walking was positively associated with collisions in low traffic light density areas, with no association in medium/high density areas (Table 4). Tertiles were dichotomized into low density and medium/high density areas for ease of interpretation.

Analysis using 5- and 7-year collision data revealed very similar models. School travel time collisions represented 44% (n = 214) of total collisions within 83 school boundary areas. Although there were reductions in the magnitude of effects, effect direction was similar to the full model with less precise estimates because of the smaller sample size.

DISCUSSION

A significant positive univariate association between walking and pedestrian collisions was no longer observed in adjusted models that controlled for population density, design features (primarily related to road crossings), and SES. Land use diversity was unrelated to collisions. These findings are encouraging in that it suggests that modification of the BE may both promote walking and make it safer. Although causality could not be definitively determined because of the cross-sectional and ecological study design, the results suggest a potentially important influence of the BE on walking and collisions.

Comparisons of Findings to Previous Studies

Previous studies of the association between pedestrian collisions and walking have revealed inconsistent results. In population studies, increased pedestrian volume was associated with decrea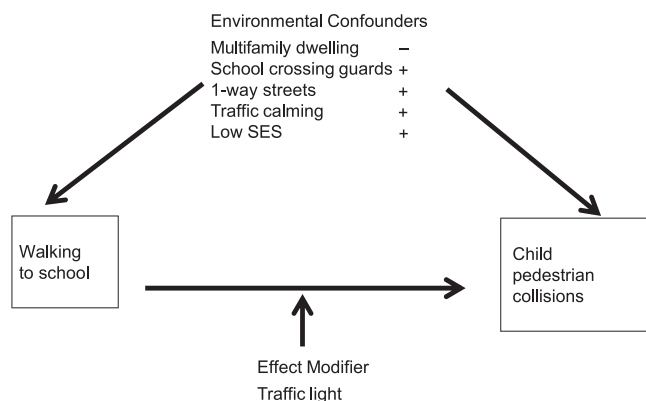sed collisions leading to a "safety in numbers" effect.[38,39] Other studies revealed positive relationships between walking exposure and child pedestrian collisions.[15,40,41] Different environmental conditions and a lack of adequate control for confounders may contribute to these contradictory findings.

BE features have been previously correlated with both walking to school and pedestrian collisions.[42–47] Major roads, urban location, street/intersection density, sidewalks, school crossing guards, population density, distance, and traffic controls have been associated with walking to school.[45,47] A reduction in pedestrian injures has been associated with BE road design interventions by 50% to 75% in specific locations.[43] Traffic calming has been associated with a 37% reduction in fatal pedestrian outcomes[48] and a 53% reduction in child pedestrian collision risk.[49] The BE influences both the walking exposure and risk, so it must be considered as a confounder in child pedestrian safety studies.

Multifamily dwelling density, SES, 1-way streets, traffic calming, and school crossing guards were confounders of the relationship between walking to school and child pedestrian collisions as they changed the walking exposure estimates by ≥10%. Higher multifamily dwelling density was associated with lower collision rates, which may indicate a safer walking environment and supports the safety in numbers concept (Fig 1). Multifamily dwelling has been associated with higher pedestrian collision risk at the individual level, unadjusted for walking exposure.[50,51] At the population level, higher population density may reflect shorter distances to school with fewer road crossings, resulting in less traffic exposure and fewer collisions. Lower SES has been consistently associated with higher child pedestrian collisions,[52,53] with higher rates attributed to lack of safe play areas and higher walking

TABLE 4 IRRs of Collisions Stratified by Traffic Light Density

Component	Variable	Low Density (n = 38)	Medium/High (n = 78)
		IRR (95% CI)	IRR (95% CI)
Exposure	Proportion walking to school	23.33 (1.21–415.10)	0.78 (0.24–2.60)
Density	Multifamily dwelling (no.)/1000 m^2	0.54 (0.28–1.03)	0.90 (0.79–1.02)
Design	School crossing guard	0.94 (0.48–1.86)	1.56 (1.11–2.19)
Design	Traffic calming km/10-km road	1.89 (1.11–3.10)	1.05 (0.82–1.34)
Design	One-way streets km/10-km road	1.29 (0.98–1.70)	1.25 1.07–1.46)
Social environment	School LOI	2.62 (0.82–8.40)	2.08 (1.14–3.80)

Environmental Confounders
Multifamily dwelling   –
School crossing guards   +
1-way streets   +
Traffic calming   +
Low SES   +

Walking to school

Child pedestrian collisions

Effect Modifier
Traffic light

FIGURE 1
Multivariate relationship between walking to school, child pedestrian injury, and the environment.

exposures because of lower car ownership.[41,54–57] More collisions on 1-way streets have also been found in Hamilton Ontario, with a 2.5 times higher injury rate on 1-way compared with 2-way streets.[58] Traffic calming devices were positively associated with collisions, whereas other studies revealed a negative association; however, no adjustment was made previously for traffic exposure.[49,59,60] Finally, the presence of school crossing guards was positively associated with collisions, which has similarly been found in Montreal, Quebec.[61]

Features considered to be confounders in this analysis may fall on the casual pathway (particularly school crossing guards) between walking to school and pedestrian collisions. However, the relationships are complicated in that they may be bidirectional with the possibility of reverse causality. The cross-sectional nature of the data restricted the ability to determine temporality and directionality of the relationships. Casual pathways need to be established to determine if any of these features act as mediators between walking to school and child pedestrian collisions.

Overall, traffic light density was positively related to both walking and collisions. Stratified analysis revealed that traffic light density was an effect modifier, as walking was only positively associated

with collision rates where traffic light densities were low. Traffic light density has been previously associated with less pedestrian collisions.[62,63]

There were several unexpected results of these analyses. Traffic speed and volume were not associated with collision rates, which have been previously identified as important confounders for pedestrian-related collisions.[64] These null findings are likely a result of poor sensitivity of the measurements taken only on 1 busy roadway near the schools. Accurate traffic data were not available close to schools from other sources. Volume and speed were, however, likely measured by proxy through other variables, such as traffic calming and road type.

The positive associations between collision rates and both school crossing guards and traffic calming were unexpected, as these features are intended to be protective. These features may be indicators for more hazardous locations with the feature's safety effect insufficient to reduce injury risk.[50,61] These features could also potentially create hazardous traffic situations for children. Although evidence exists of reduced effectiveness of specific road design features for older adults, this has not been well studied in children.[65] More rigorous study of these features with further spatial analysis is required to better ascertain the safety effects for children.

The ecological nature of the data may also have contributed to these unexpected findings. Collisions occurred at a specific location, whereas the built and social environment data were measured area-wide and may not represent the environment at the collision location. Area-level data would also not identify if a BE feature either displaced collisions or was a marker for a more dangerous traffic environment elsewhere within the school boundary. Ecological analysis was, however, felt to be most appropriate, as an understanding of both the physical and social environment measured on a geographic level is essential when examining pedestrian injury.

The possibility of reverse causality existed, with collisions occurring before the installation of these features, because of the cross-sectional design of the study. Several assumptions were made regarding the data. Walking exposure measured in 2011 was assumed to be representative of exposure throughout the 10-year collision data period (2002–2011). This was reasonable because there was evidence of stabilization of active school travel prevalence from 2001 onwards, after an earlier period of sharp decline.[10,66,67] The BE was also assumed to remain unchanged over the collision data period. Substantial changes would not be expected in the BE generally because the study neighborhoods were well-established. However, this may not have been the case for features more easily implemented, such as the installation of traffic calming or school crossing guards.

Results may also have been affected by the walking exposure, which was measured only en route to school and did not include nonschool travel time collisions. The study's intention was to examine factors related to all child pedestrian collisions in Toronto. Because school is children's most common walking

destination, walking to school is considered the best proxy for their general walking activity.[6–8] Consistent evidence also exists that children who actively commute to school walk more in general.[68] The inclusion of nonschool travel time collisions when school crossing guards were off-duty could potentially have produced an artificial positive association between guards and collisions. However, when restricting the data to school times, the directions of effects were maintained. The use of walking to school as a proxy for children's general walking is currently the most feasible measurement of children's walking exposure. Walking exposure has been poorly dealt with in the past, and creative methods of measurement are needed to most accurately evaluate pedestrian risk.

Study strengths included that it was large and population-based and directly measured walking to school as a proxy for general walking exposure. The only previous study that used direct observation of walking to school to investigate associations with BE was limited by a small sample and little geographic diversity.[36] Multivariable modeling was used to test the association between walking and pedestrian collisions while controlling for the BE. The model identified BE features acting as confounders and effect modifiers of the relationship between walking exposure and collision outcome. One other recent study that modeled walking school trips and active

transportation injuries examined limited numbers of potential BE confounders.[15] However, none of the roadway design features significant in our study were included.

Conclusions

The study findings are relevant for parents and pediatricians and on the policy and public health levels. Walking to school over a short distance was found to be relatively safe in Toronto. Pediatricians can counsel parents to encourage children to walk to school as a healthy lifestyle choice. Parents can be informed that the number and type of road crossings are the major determinant of injury risk. Parents, pediatricians, and school principals can advocate for walkable environments, by approaching school boards, the police, and city officials to ensure the safety of children walking to school.

Active school travel policy is currently undergoing changes in Canada and the United States. In Ontario, Canada, the provincial government recently initiated the "Stepping It Up" school travel planning program under its regional transportation plan, intending to spend $200 million on active transportation infrastructure and research to improve safety and achieve AST >60% for all schools.[9,69] In the United States, recent changes to the federal transportation bill have eliminated SRTS as a separate funding program. Alternative funding through the federal Highway

Safety and Infrastructure Program now requires SRTS projects to show both evidence of increasing active transportation and a reduction in collisions.[70] These changes provide an opportunity to incorporate safety evaluation into new policies.

Several important conclusions and implications have emerged from the study. Firstly, the positive relationship between walking and collision rates was no longer significant after controlling for the BE. These results are encouraging for walking promotion programs, suggesting that safety issues are concerned primarily with the BE and not the numbers walking. Secondly, design features related to road crossing exhibited the most influential effects. To increase walking safety in children, focus should be on minimizing or mitigating road crossings, as opposed to changing other factors such as land use, which may be more applicable to adults. Finally, the mechanisms of how to mitigate road crossings for children are not well understand, and well-controlled research designs must be integrated into SRTS program evaluation. Future policy designed to increase children's active transportation should be developed from strong evidence that addresses child pedestrian safety.

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