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School siting and mode choices for school travel: Rural–urban contrasts in Halifax, Nova Scotia, Canada

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A R T I C L E I N F O

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A B S T R A C T

Mode choices for school travel are important to children's health. School size and siting impose constraints on mode choices, and these factors vary considerably along the rural–urban continuum. Using the Halifax Regional School Board, Nova Scotia, as a case study, this research examines the effects of elementary school size and siting on mode choices and school busing.

Data for 96 elementary schools in the school district are examined for statistical relationships between school and catchment area size, rural–urban location, and reliance on school busing. To estimate potential walkability, a mean Walk Score® was calculated for a 2.4-km pedestrian zone around each school, which represents the school board's courtesy busing threshold. Mode choices from "hands-up" tallies at four schools were employed to calibrate the use of automobile and walking modes.

In inner-city areas, pedestrian zones typically covered almost 90% of the school catchment area, and their walkability was moderately high. However, in suburban, commuter belt, and rural zones, much less area fell within the pedestrian zone, and walkability declined considerably. The proportion of students who walked or cycled for school travel were 40% (inner-city), 37% (suburbs), and only 5% in the commuter belt and rural zones. On the other hand, more than 80% of children who lived in the commuter belt and rural zones rode the bus, compared with 30% in the suburbs and only 6% in the inner-city areas. In both the suburban and inner-city schools, a large proportion of students were chauffeured by car.

Findings suggest that post-1960 school planning for rural areas around Halifax has paid insufficient attention to the potential for children to walk or bike to school. Consequently, school consolidation and busing practices should be reconsidered in light of their negative impacts on the health and well-being of suburban and rural school children.

1. Introduction

Research shows that the journey between home and school is the most common travel activity among Canadian children (Stefan and Hunt, 2006), and is thus the most prevalent opportunity for children to regularly engage in physical activity. Yet, Canadian children walk or bike to and from school much less frequently than twenty years ago (Buliung et al., 2009). Inner-city school consolidation policies, which have become a common solution to declining enrolment for many Canadian and American school boards (City of Hamilton, 2012), may have contributed to the progressive decline of children's active school travel (AST). School consolidation in rural areas, too, which is often affected by the siting of new schools in "central" locations remote from existing communities, also increases reliance on vehicular travel and reduces opportunities for walking and bicycling.

In Nova Scotia, similar to other North American areas where rural school districts still predominate, student population decline, school closures, and school consolidation policies have led to escalation in both the proportion of students bused and bus transportation costs (Bennett and Gillis, 2015). However, there has been little research to date on the combined impacts of these school size and siting policies on school bus reliance and AST mode choices (mainly walking, cycling, and *wheeling*), and, in particular, no peer-reviewed Canadian research comparing urban and rural relationships between size/siting and travel mode choices. By using the Halifax Regional School Board (HRSB) as a case study, this research investigates the effects of elementary school size and siting on school travel mode choice, and emphasises how these relationships vary along the urban–rural continuum. In particular, this

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case study examines the size and configuration of each school catchment area (SCA), the walkability of the neighborhoods immediately surrounding each school, and the extent of reliance on school busing. To validate the analysis, data on revealed preferences for school travel modes at four elementary schools are included in the study.

2. Previous studies

Mode choices for travel to school are important for a variety of reasons, including effects on children's health, environmental effects of vehicular travel, time and financial costs to parents, and costs of busing for school boards. There is a considerable literature on the health benefits of AST, and much complementary research on environmental and other costs related to vehicular school travel. Associated research on mode choices has been well summarized recently by Ermagun and Samimi (2015). A plethora of variables have been considered as influential, and many have been shown to have statistically significant effects. The specific variables may be grouped into several broad classes, which we may term locational, environmental, socio-demographic, and institutional. Locational factors relate to the child's distance from the school, which in turn is related to rural–urban differences in population density, and to school sizes and siting (Ermagun and Samimi, 2017). In addition, municipal transit services are typically unavailable in rural and semi-rural areas (Ermagun and Levinson, 2017). Environmental factors concern both built and natural environments along routes to school, such as the presence/absence of sidewalks, or the perceived crime rates in an area (e.g. Curtis et al., 2015; Yu and Zhu, 2015). Socio-demographic factors include the age and sex of the child, family car ownership, and family time-use constraints (e.g. Oliver et al., 2014). Institutional factors concern policies on school size and siting, catchment area boundaries, and provision of courtesy school busing (Ermagun et al., 2015).

2.1. Health benefits of active school travel

Active school travel is an important component of youth's physical activity and social contact, as it can conveniently integrate physical activity into children's daily lives (Binns et al., 2009; Davis et al., 2007), and provide opportunities for socialization (Zwerts et al., 2010). Indeed, several health benefits are associated with walking and bicycling for home-school travel (Lubans et al., 2011), including higher levels of physical activity (Cooper et al., 2010; Voss and Sandercock, 2010), more beneficial weight status (Klein-Platat et al., 2005) and better cardio-respiratory fitness (Chillón et al., 2012). Active school travel has also been associated with higher cognitive and academic performance (Martínez-Gómez et al., 2011), and greater independent mobility (Fyhri and Hjorthol, 2009), which can promote several psychological skills (Prezza et al., 2001). Yet, despite many health benefits associated with AST modes, there is evidence in many Western nations that the proportion of school children who use active modes for trips to and from school has been consistently declining in recent decades, including the United States (Ewing and Greene, 2003), United Kingdom (Dollman et al., 2005), and Canada (Buliung et al., 2009).

2.2. Costs of vehicular school travel

Home-school vehicular travel, whether by car or bus, has important environmental impacts, as it accounts for a considerable proportion of all vehicle travel (McDonald et al., 2011). In the United States, 55% of school trips were made by car in 2011, up from 16% in 1969, and this increase has significant implications in terms of traffic congestion around schools, localized air pollution, greenhouse gas emissions, and reduced child safety in walking to and from school (Wilson et al., 2007). There are burdens placed on those parents/guardians who chauffeur their children between home and school, often requiring adjustments to routes and schedules, and imposing a variety of costs (Litman, 2015). In addition, especially in rural areas where large consolidated schools are spaced far apart, school busing has become a major administrative cost. Rural districts spend disproportionately on student transportation services, and rural schools may spend upwards of 6 to 8 percent of their budget on school busing, while non-rural districts spend around four percent (Killeen and Sipple, 2000). Busing also has significant costs to the bused students, who often endure upwards of two hours per day in bus travel, which has physical, social, and emotional implications. For example, bused students report being stressed and tired, getting lower grades, participating in fewer after-school activities, and spending less time with their families (Eyre and Finn, 2002).

2.3. Locational and institutional influences on mode choice

Although environmental and socio-demographic variables are also important determinants of mode choice, in this paper we focus only on locational and institutional factors, with emphasis on rural–urban differences. Distance from home to school is probably the single most important determinant of mode choice for school travel (Duncan et al., 2016; Ermagun and Samimi, 2017; Millward and Spinney, 2011; Spinney and Millward, 2011; Spinney et al., 2018). School siting affects this distance, as does the spatial distribution of the children being served, and these two distributions are of course linked. When determining the location of a new school and its future student population, school boards typically consider a variety of competing requirements, such as demographics, land affordability, access to amenities, attendance boundaries and configuration, stability of student population, travel distance, and the size of the property (Tsai and Miller, 2005). Until the 1950s, small neighborhood schools were the "anchor points" of urban neighborhoods, which provided a wide range of after-school programs, plus social and recreational services (Passmore, 2002). However, in recent decades, school size policies have tended to favour the construction of larger schools, which are perceived to be necessary to accommodate the continued expansion of academic and recreational programs, provide the threshold student numbers to allow provision of specialized infrastructure and student services, serve entire communities, and allow for expansion in the future (McDonald, 2010; Deka and von Hagen, 2015).

In the United States, studies have shown that elementary students in rural areas are likely to experience bus rides that are 30 min or greater than suburban students (Howley et al., 2001). Research has pointed out the possible implications of rural school busing in terms of school achievement, disruption of family life (e.g. reduced time available to children and parents for recreational activities) and community cohesion (Howley and Smith, 2000). Others have argued that long bus rides have economic costs that are not accounted for in school consolidation practices (Witham, 1997). Studies have also shown that parents often mention long bus rides as a reason for opposing school district consolidation plans (Spence, 2000). Yet, the issue of rural school busing has been surprisingly overlooked in the United States (Howley and Smith, 2000). Similarly, in Canada, very little is known about the effects of school consolidation schemes, but data show that annual busing costs have risen at a time of significantly declining student enrolments, while several community groups have started to promote healthy transportation alternatives and advocate for a closer look at the impacts of school consolidation and busing on children's health (Bennett and Gillis, 2015).

In higher-density urban and suburban areas, the catchment areas of newer and larger schools may still be small enough to allow many students to choose AST modes. However, in lower-density rural areas, the shift to larger schools has required consolidation of formerly localized catchment areas into extensive ones that are almost entirely reliant on school busing (Killeen and Sipple, 2000). These consolidated school districts in rural areas are characterized by low student densities spread over large geographic areas, with schools often placed in isolated locations, equally far from several population clusters. In turn, rural school districts are forced to provide additional buses and longer routes to meet the larger demand of students entitled to courtesy busing, as they live farther from the remaining schools (Howley, 1996). In rural areas, therefore, school busing is both a cause and consequence of the greater spacing between schools necessitated by larger school sizes. This disconnect between the school site selection process and land use planning considerations is exemplified by a study conducted in South Carolina, which found that school sites constructed since 1983, often at the edge of communities in rural and undeveloped land, are 41 percent larger than sites built before 1983, and that students were four times more likely to walk to the pre-1983 schools (Kouri, 1999).

Critics of school sprawl now contend that large campuses in low-density areas lead to fewer children living within a convenient walking distance to schools. Indeed, research consistently shows that distance to school is the strongest predictor of AST and that children are more likely to walk and bike to school when the immediate areas surrounding schools are densely populated (Spinney and Millward, 2011; Spinney et al., 2018). Evidence also suggests that children living in rural areas are less likely to actively commute to school than those living in urban areas (Davison et al., 2008), because of longer commuting distances, lower residential density, and less infrastructure for safe walking and biking (Dalton et al., 2011).

3. Data and methods

The HRSB was created in 1996 through the amalgamation of three individual boards that operated schools in Halifax and Dartmouth, Halifax County, and Bedford. It serves about 48,000 students in 136 schools, and is the largest school board in Atlantic Canada, with schools located in urban, suburban, and rural areas of the county-sized Halifax Regional Municipality (HRM) (HRSB, 2017). In this study, all HRSB's elementary schools were classified along the rural–urban settlement zones, previously described in the literature, which divided HRM into five geographical zones based on residential density, percent developed area, and commuting linkages to the downtowns of Halifax and Dartmouth (Millward and Spinney, 2011). For simplification purposes, the last two zones were combined into a single category (Rural), which classifies all areas beyond 25 km by road from Halifax or another large town (Table 1).

This study examined 89 elementary schools and seven elementary/junior high schools spread throughout HRSB. Exclusively French-language schools were excluded from the analysis, since they are administered by a separate school board with significantly larger catchment areas. Data on school characteristics, student enrollment, and school busing were retrieved from a recent report published by HRSB (2016), while the geographic boundaries of the SCAs were downloaded from the HRSB website (HRSB, 2017). Children's revealed preferences for mode choice were collected in four inner city and suburban schools, whereby students reported their travel mode to and from school through classroom-based 'hands-up' surveys. These data were collected by the Ecology Action Center, a Nova Scotia-based non-profit organization that works towards the development of sustainable local communities (Barlow, 2012).

To estimate potential walkability, ArcGIS 10.3 Network Analyst was used to develop a 2.4-km (1.5 mile) pedestrian zone (PZ) around each school, representing the walking distance threshold set by HRSB's current transportation policies; courtesy bus services are provided only to elementary students who live 2.4 km or more away from their school (HRSB, 2013). To provide a realistic assessment of walkability, pedestrian zones were based upon existing street and walkway networks, rather than a simple straight-line distance. Pedestrian zones were then "clipped" to reflect the boundaries of the school catchment areas (Fig. 1).

A walkability score was assigned to each pedestrian zone by calculating its mean Walk Score®, which is the only walkability index readily accessible online for all postal codes in Canada (Chiu et al., 2015). The literature shows this index to be a valid measure of neighborhood walkability in numerous geographic locations and at multiple spatial scales (Carr et al., 2010, 2011; Duncan et al., 2011, 2013). The Walk Score® algorithm scores a location based on its proximity to educational, retail, food, recreational, and entertainment facilities, while population density, block length, and intersection density are also included. As shown in Table 2, the final score is on a 0 to 100 scale, divided into five walkability categories, with zero representing the most car-dependent category, and 100 being a "Walker's Paradise" (Walk Score®, 2017).

An average Walk Score® was assigned to pedestrian zones by overlaying a grid of sample points (Fig. 2), and calculating their Walk Scores® through the WalkScoreAPI, an R package that takes a set of geographic coordinates and returns the Walk Score® associated with those locations (Whalen, 2011). Lastly, residential density was estimated by retrieving 2011 census tract data on private dwellings from the CHASS website (Canadian Census Analyzer, 2017). Census tract data were then assigned to the corresponding schools based on their location. IBM's Statistical Package for the Social Sciences (SPSS) was used to generate descriptive statistics and calculate Spearman's rank correlation coefficients to assess the statistical relationships between the variables.

4. Results

The results in Table 3 summarize mean school characteristics for schools in each of the four urban–rural zones. Almost half of the schools are considered suburban, with the rest almost equally split between inner city, inner commuter belt (ICB), and rural areas. Inner city schools are by far the oldest schools in the district. They declined in enrollments for much of the post-1960 period, as did rural schools, while suburban schools experienced burgeoning enrollments. However, since 2006 student enrollment has increased in the inner city and declined in all other settlement zones, especially in the ICB and in rural areas. Reflecting declining student enrollments, schools in rural areas have the highest mean floor area per student, while suburban and ICB schools remain crowded, with less floor area per student. Inner city schools have the largest building footprint, but they are built on smaller properties that are often extensions of neighborhood parks. Schools in other zones tend to be built on larger sites; on average, suburban schools occupy the largest sites.

When considering the configuration of the SCAs, substantial

Table 1
Urban–rural settlement zones.

Settlement zones		Description
Inner City		The older (pre-1960) developed areas of Halifax and Dartmouth, within walking range (c. 5 km) of the downtowns.
Suburbs		Other contiguous built-up areas within the urban service boundary (the area serviced by central water and sewage system).
Inner Commuter Belt (ICB)		All other areas within 25 km road distance of downtown Halifax.
Outer Commuter Belt (OCB)	Combined as Rural	Areas between 25 and 50 km road distance from downtown Halifax or another town (over 10,000 population).
Remote Rural		Areas beyond 50 km by road from Halifax or another large town.

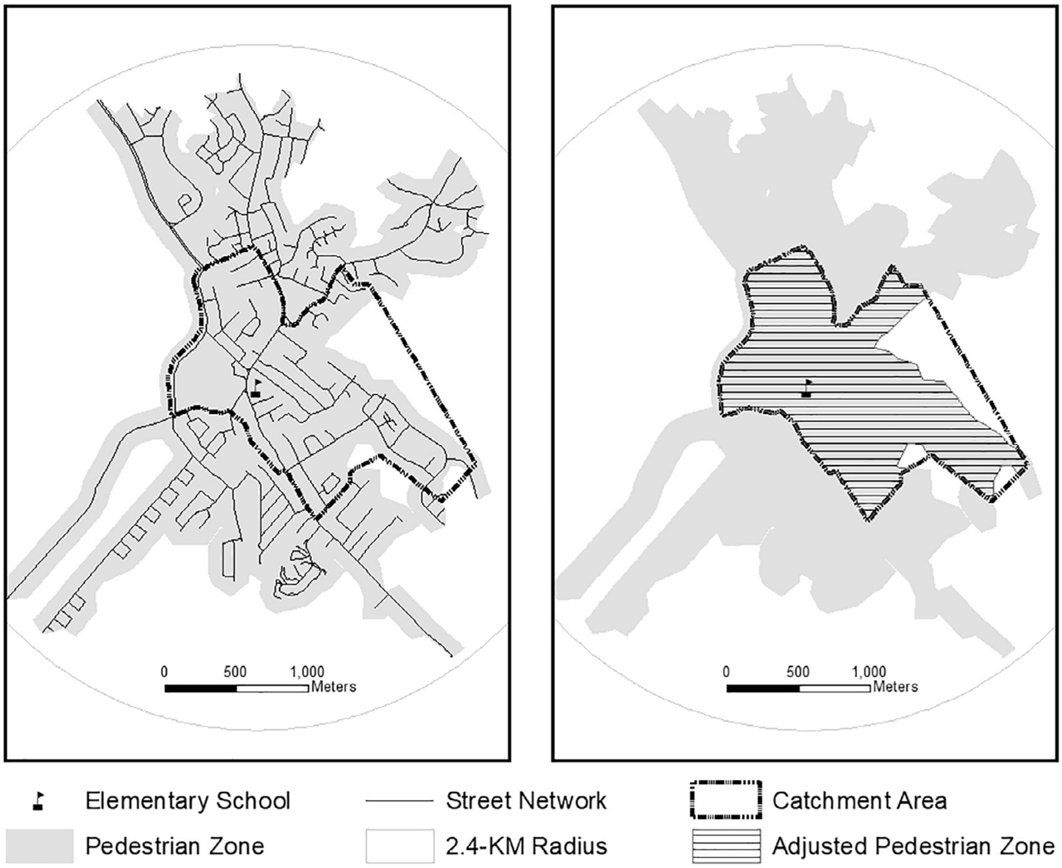

Fig. 1. Pedestrian zones (PZs).

Table 2
Walk Score® categories.

Category	Score	Walk Score® Description
Walker's Paradise	90–100	Daily errands do not require a car
Very Walkable	70–89	Most errands can be accomplished on foot
Somewhat Walkable	50–69	Some errands can be accomplished on foot
Car-Dependent	25–49	Most errands require a car
Car-Dependent	0–24	Almost all errands require a car

Source: www.walkscore.com.

differences across settlement zones exist. The average SCA size for inner city schools is only 2.1 km^2. However, average SCA areas become exponentially larger as one moves outwards, and approach 300 km^2 in the rural areas. Student density presents a reverse pattern, declining from the center until reaching only one student per km^2 in rural areas. The spatial relationships between SCAs and pedestrian zones also vary considerably across the school district. Inner-city areas of Halifax and Dartmouth, on average, have pedestrian zones that cover nearly all the catchment areas' land, and six catchment areas are 100% within HRSB's walking threshold. In the suburbs, the pedestrian zones still cover over half the SCA's, on average, but in the ICB and rural areas only small portions of SCA's are covered by pedestrian zones.

In terms of school siting, especially in suburban and rural areas, schools tend to be located in auto-dependent neighborhoods, where the pedestrian zones surrounding the schools present very low walkability scores. As shown in Fig. 3, while the median Walk Score® was 64.5 for inner city schools, corresponding to a "somewhat walkable" category, all the other schools' walk zones had very low Walk Scores®, delineating areas where a car is required to perform everyday activities, because of

Fig. 2. Assigning a Walkability Score®.

the longer distances to frequently visited amenities.

The population density of areas surrounding schools is pertinent to both school siting and school travel mode choice. In the inner city, elementary schools are in census tracts with an average dwelling density exceeding 2000 private dwellings per km^2. In the suburbs, the number of dwellings per km^2 is only 754, and the density falls off rapidly to very low levels in the ICB and rural areas. Figs. 4 and 5 visually confirm these trends by comparing the street layouts of neighborhoods adjacent to four typical elementary schools. In the inner-city areas, schools are likely to be found near the center of their catchment areas,

Table 3
Urban–rural variations.

	Inner city	Suburbs	ICB	Rural	All schools
General information					
Number of Schools	18	44	17	17	96
Mean School Age (years)	68	47	34	44	47
School characteristics					
Mean Enrollment (2016/17)	278	295	296	170	270
Mean % Capacity Utilization (2016/17)	78	80	83	72	79
Mean % Enrollment Change (2006–2017)	7	−2	−11	−12	−4
Mean Floor Area (m^2)	4243	3622	3580	2725	3572
Mean Floor Area per Student (m^2)	17	14	14	21	16
Mean Parcel Size (ha)	2.67	4.21	3.28	3.40	3.63
School catchment areas (SCAs)					
Mean Area of SCAs (km^2)	2.1	6.9	60.4	290.2	65.7
Mean Student Density per km^2 of SCA	149	98	8	1	74.7
Mean % Area of SCAs Covered by PZs	88.7	60.9	8.2	1.7	46.2
No. of SCAs 100% Covered by PZs	6	5	0	0	11
2.4-km pedestrian zones (PZs)					
Mean Area of PZs (km^2)	1.8	2.0	2.8	2.4	2.2
Median Walk Score® within PZs	64.5	30.0	7.0	6.0	25.5
Census tract data (2011)					
Private Dwelling Density (No. per km^2)	2102	754	33	8	747
School busing					
Median % Students Bused (2015/16)	6.0	30.5	81.0	82.0	36.5

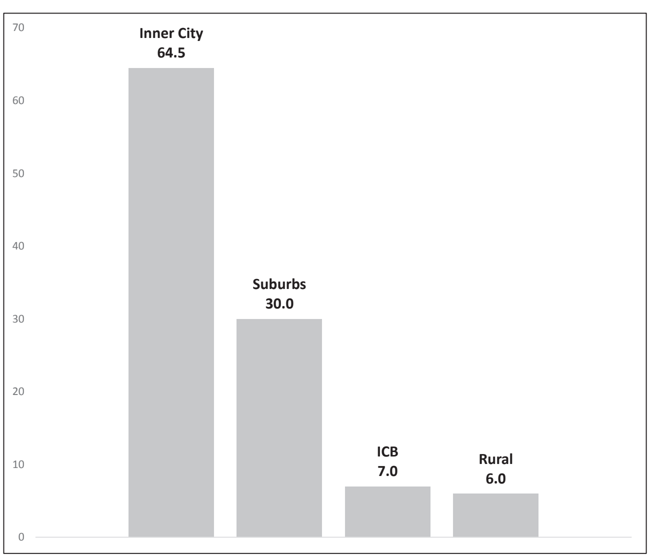

Fig. 3. Median Walk Score® of pedestrian zones (PZs).

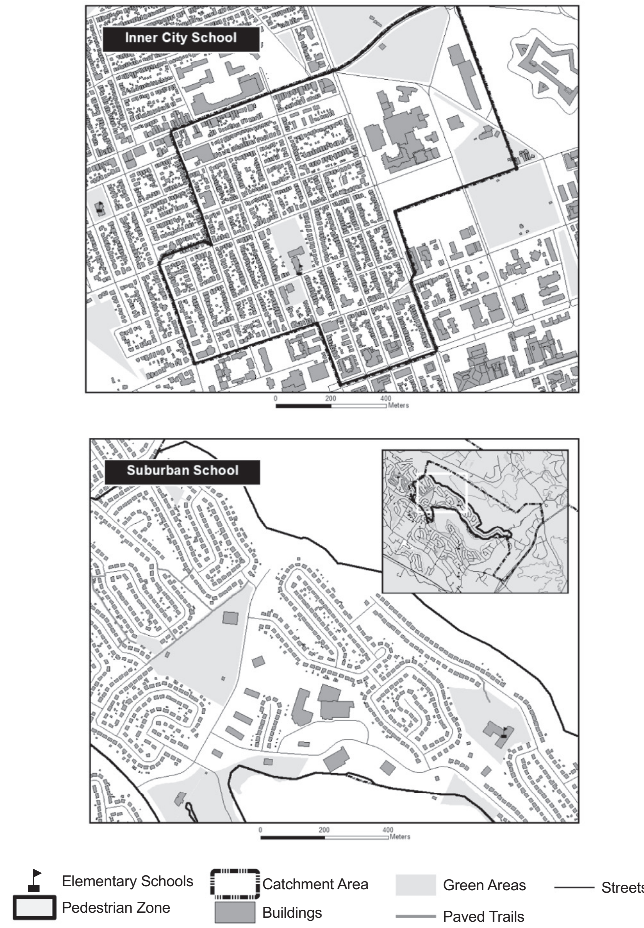

Fig. 4. Typical pedestrian zones' street layouts: Inner City and Suburban areas.

and in close proximity to residential dwellings. In the other settlement zones, elementary schools are much more likely to be situated on the outskirts of communities, and typically more distant from residential properties, which results in fewer children living within a convenient walking distance.

With more children living farther from their school, it is not surprising that a large proportion of elementary students need to be bused. During the 2015/16 school year, more than 80% of children living in the inner commuter belt and rural areas had to be bused between home and school. In the suburbs, about 30% of students needed bus services, while only 6% of children in the inner-city areas rode the school bus (Fig. 6). Spearman's rank-correlations are presented in Table 4. Area of the school's SCA has the strongest correlation with busing, and other variables associated with it (student density and PZ as percent of SCA area) also show similarly large and significant correlations. Interestingly, school busing was negatively correlated with the Walk Score® of the pedestrian zone ($\rho = -0.69$; $p < 0.01$). Since students living in the pedestrian zone are not entitled to busing, one might expect no effect. However, the two variables are linked symptoms of low residential density in rural areas. Only a small proportion of ICB and rural students reside within pedestrian zones, and as Fig. 5 suggests, even the pedestrian zones display low connectivity, and low land-use mix.

School age is negatively and significantly correlated with school busing, indicating that more recent schools tend to be built farther away from densely populated areas. The relationship, however, is not very strong. As to school size, it is noteworthy that this variable, measured by enrollment, lacks a significant correlation with percent of students bussed. This is understandable when we note that ICB schools have large enrollments, while rural schools have low enrollments, but both are heavily reliant on busing.

The "hands-up" tally data confirmed that students in suburban schools are less likely to walk or bike to school, and more likely to ride the school bus. As shown in Table 5, on average, 38% of school children walked to suburban schools and 20% rode the school bus, compared to 49% of inner-city school children and 1% rode the school bus. For example, the suburban Colby Village school shows a high proportion of walking, and also has key characteristics of an inner-city school, notably a small SCA area and high proportion of SCA in the PZ. In contrast, Cavalier Drive is perhaps more typically suburban, with less

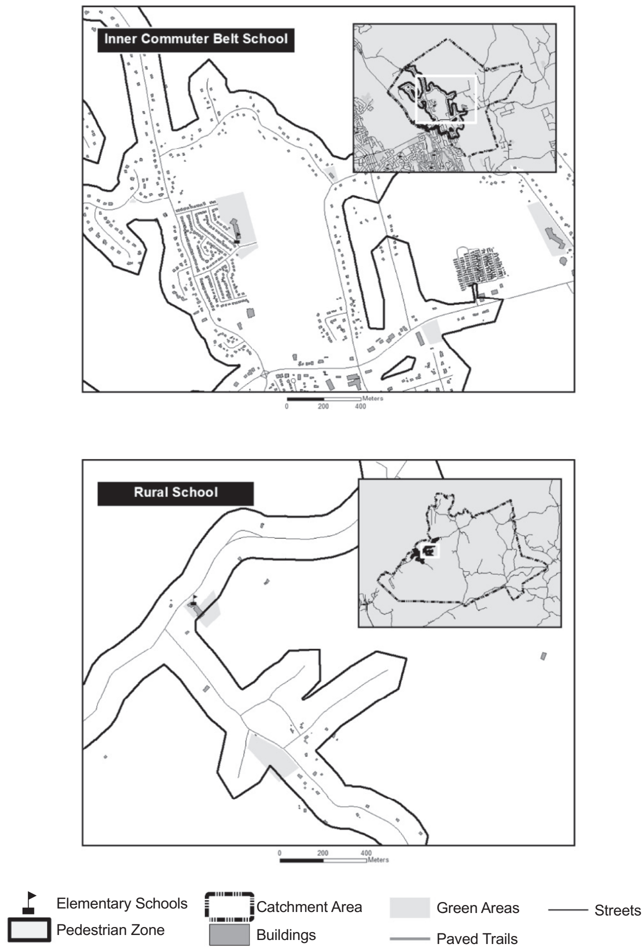

Fig. 5. Typical pedestrian zones' street layouts: Inner Commuter Belt and Rural areas.

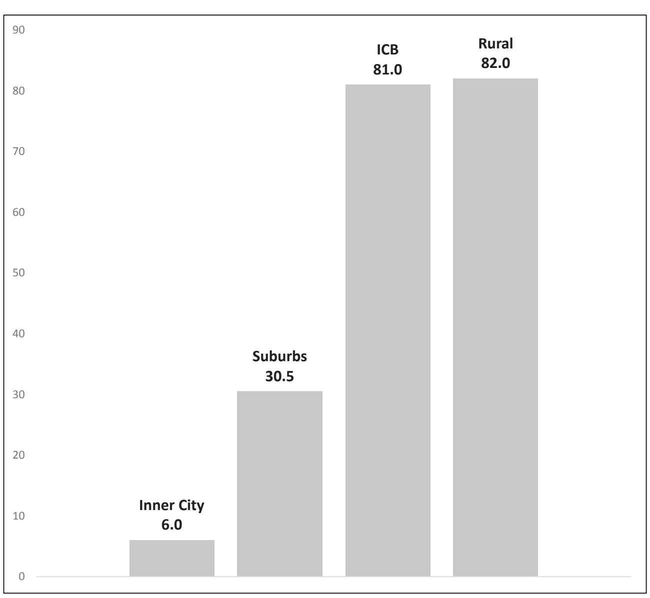

Fig. 6. Median % students bused (2015/16).

walking owing to a larger SCA and smaller proportion of SCA in the PZ. In both the suburban and inner-city schools, a significant proportion of parents (37% and 40%, respectively) chose to drive their children to school, even in the cases where over 75% of the SCA (and presumably of the students) lies within the pedestrian zone.

Table 4
Statistical correlations with percent students bused (for 96 schools).

		2015/16% students bused
School age	Spearman's rho	−0.313**
	Sig. (2-tailed)	0.002
Area of SCA (km^2)	Spearman's rho	0.757**
	Sig. (2-tailed)	0.000
Enrollment (2016/17)	Spearman's rho	0.069
	Sig. (2-tailed)	0.507
SCA student density	Spearman's rho	−0.680**
	Sig. (2-tailed)	0.000
% Area of SCA covered by PZ (n = 95)	Spearman's rho	−0.749**
	Sig. (2-tailed)	0.000
Median Walk Score® of PZ	Spearman's rho	−0.698**
	Sig. (2-tailed)	0.000

** Correlation is significant at the 0.01 level (2-tailed).

5. Discussion

This study shows that larger catchment areas greatly constrain the possibility for elementary school children in the Halifax region to be physically active for their journey to and from school. Rural-urban contrasts in walkability are very strong: for inner-city schools, on average, 90% of their catchment area (and presumably of their students) lies within walking range (2.4 km), and this proportion remains over 60% in the suburbs. Beyond the continuously-developed suburbs, however, in the exurban inner commuter belt (ICB), there is a marked decline to only 8%, and the proportion is a woeful 2% in rural areas. Parents in the commuter belt and rural zones mostly, therefore, rely on school bus services, and over 80% of students in both zones are bused. By extension, results suggest that approximately 5% of students in both ICB and rural zones employ AST modes, and 15% are chauffeured by their parents.

These results show how post-1960 school planning for rural areas of the HRSB has paid insufficient attention to the potential for children to walk or bike to school and to the imposition of unnecessarily long bus commutes. To some extent, reliance on busing in the countryside is unavoidable, but it was not always so. In the days of the one-room schoolhouse, common into the 1960s, schools were present in most rural communities, and the majority of rural students walked to school. The adoption of policies favoring large consolidated schools, while made for sound administrative and pedagogic reasons, required schools sited far apart, and had seemingly incidental, but seriously negative, effects on student welfare. Walking to and from school is no longer an option for most Nova Scotian students, and many now spend long hours on the bus. An issue that warrants increased attention from academics, school planners, and public health practitioners alike.

This case study used HRSB busing data for all elementary schools throughout the entire study area, but only had access to data on walking and parental chauffeuring for a limited number of schools in the inner-city and suburbs. "Hands-up" tallies for these schools, however, clearly indicate that many parents who live within the 2.4 km pedestrian zone still choose to drive their children to school, supporting those studies that have found that many parents drive their children regardless of distance (He and Giuliano, 2017; Lee et al., 2013) or the walkability of the environment (Mah et al., 2017). This is perhaps more understandable in the auto-oriented suburbs, either because the parents themselves commute by automobile and can conveniently combine the trips, while spending time with their children (Westman et al., 2017), or because suburban households are more likely to have two vehicles, thus

Table 5
Selected elementary schools.

	Inner city schools			Suburban schools		
	Le Marchant-Saint Thomas	Saint Stephen's	Mean	Cavalier Drive	Colby Village	Mean
School characteristics						
School Age (years)	94	69	81.5	32	42	37
Enrollment (2016/17)	429	217	323	325	154	239.5
% Capacity Utilization (2016/17)	138	65	101.5	61	53	57
% Enrollment Change (2006–17)	43	0	21.5	−29	−39	−34
Floor Area (m^2)	3467	4336	3901	4784	2548	3666
Floor Area per Student (m^2)	8	20	14	15	17	16
Parcel Size (ha)	1.93	2.20	2.06	3.36	4.29	3.82
Catchment areas (SCAs)						
Area of SCA (km^2)	1.0	3.1	2.0	5.5	1.4	3.4
% Area of SCA Covered by PZ	100	78.7	89.3	32.5	92.1	62.3
Student Density per km^2	429	70	249.5	59.1	110	84.5
2.4-km pedestrian zones (PZs)						
Area of PZ (km^2)	1.0	2.4	1.7	1.7	1.2	1.4
Median Walk Score®	87	51	69	27	43	35
Walk Score® Category	Very Walkable	Somewhat Walkable		Car Dependent	Car Dependent	
School busing (2015/16)						
Median % Students Bused	9	3	6	52	5	28.5
Hands-up surveys (2010)						
	Inner city schools			Suburban schools		
	Le Marchant-Saint Thomas	Saint Stephen's	Mean	Cavalier Drive	Colby Village	Mean
Modes of travel to school (%)						
Walked	52	46	49	27	49	38
Bicycle	3	3	3	0	2	1
School Bus	2	0	1	39	1	20
Public Transit	1	1	1	0	1	0.5
Car	39	41	40	33	42	37.5

facilitating the chauffeuring option. In the inner-city, similar reasons may often apply, and there may also be greater concerns about pedestrian safety, which tend to discourage walking and encourage parental chauffeuring (Mehdizadeh et al., 2016).

The policy implication is that to increase AST, in addition to improving the infrastructure for walking and cycling, policy makers should also address parental time constraints and parents' perceptions on safety issues. In Canada, multi-sectorial, school-specific School Travel Planning (STP) strategies have been implemented to promote AST (Mammen et al., 2014). Although their effectiveness is inconclusive, research suggests that these interventions are more effective when they focus on parents' perceived safety (Buliung et al., 2011). Other studies have shown that children are more likely to engage in AST in schools that employ crossing guards, identify safe routes to school, and observe traffic calming measures (Larouche et al., 2014), and that children consider traffic-related barriers as very risky factors (Fusco et al., 2012). Although it may be difficult to recruit sufficient volunteer support (Buliung et al., 2011), one promising way to potentially reduce car travel is the use of Walking School Buses programs, as parents share chaperoning responsibilities by taking turn in walking groups of children to school (McDonald, 2008).

6. Strengths and limitations

This case study has two major strengths: 1) it is the first attempt to investigate in Canada the effects of school consolidation policies on school bus reliance and the propensity of elementary students to walk or bike to and from school; and, 2) it reveals that the decisions made about the size and locations of schools in rural areas seriously limit elementary school children's AST and exacerbate reliance on busing. Yet, this study is not without limitations. As previously noted, "Hands up" tallies were available only for four schools, which limited the ability to compare revealed mode choices preferences with the size and configuration of the SCAs for the whole study area. In addition, although useful as a general indicator of walkability, the Walk Score® index has limitations when applied to the journey to school, since the primary destination of interest to students and their parents is the school itself. To strengthen the analysis, a school-specific walkability index should be developed.

7. Conclusions

This research investigated the effects of elementary school size and siting on school travel mode choice, with emphasis on how these relationships vary along the urban–rural continuum. Study results contribute to the North American policy debate on whether schools should be sited and sized to encourage active transportation, and on where such a policy goal is feasible. They provide evidence that rural and outer suburban areas face particular challenges and require more effective strategies to promote walking and cycling to and from school. We concur with those authors who have highlighted the need to reconsider school consolidation practices in light of transportation inefficiencies and their disproportionate impacts on the health and well-being of rural and suburban school children (Howley, 2001; Killeen and Sipple, 2000; Steiner et al., 2008).

We acknowledge that school buses are often the only way for many students to get to school on time every day, especially for those students with disabilities, special needs, and families with lower incomes who may not own a car. Yet, this is only part of the issue, and local planners and policy-makers should also consider children's health, students' engagement and academic achievement, community well-being, and environmental sustainability, when making decisions on school siting and transportation policies.

Declaration of interest

None.

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