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School travel planning in Canada: Identifying child, family, and school-level characteristics associated with travel mode shift from driving to active school travel

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ABSTRACT

Objective: Active School Travel (AST) can significantly contribute to children's physical activity levels. The primary objective of this study was to evaluate a Canadian School Travel Planning (STP) intervention, by examining child, family, and school-level characteristics that are associated with mode shift from driving to AST one year post-intervention. A secondary objective was to highlight which STP strategies were deemed effective by parents of those children who switched travel modes to AST.
Methods: Schools ($n=103$) across Canada participated between January 2010 and March 2012. STP committees implemented strategies to overcome school-specific AST barriers. Mode shift and child/family demographics were assessed by a retrospective, cross-sectional parental survey ($n=7827$) one year after STP implementation. School level demographics were collected from school administrators. Binomial regression models were applied to examine child, family, and school-level characteristics related to mode shift from driving to AST.
Results: Approximately 17% of the sample reported driving less at one-year follow-up both in the morning and afternoon periods. Among these, the majority switched to AST in the morning ($n=1002$) and afternoon periods ($n=995$). Results from the regression analyses showed that students in higher elementary grades, living less than 3 km from school, attending urban and suburban schools, and attending schools situated in a medium income neighborhood were significantly more likely to change travel mode from driving to AST. Approximately 35% of parents reported that infrastructure improvements and safety education were the most effective STP strategies.
Conclusion: The study findings highlight the potential of the STP process in Canada in promoting mode shift from driving to AST. The findings demonstrate STPs may be more effective in some locations where conditions are conducive to mode change. This should inform the development of STP school-selection criteria that may maximize already limited resources by recruiting schools most responsive to STP.

1. Introduction

Active school travel (AST) can significantly contribute to children's physical activity levels (Faulkner et al., 2009; Larouche et al., 2012). Through non-motorized transport, such as walking and biking to school, AST may also positively enhance children's mental, physical, and psychosocial health (Bowler et al., 2010; Fusco et al., 2012). AST is also an affordable, convenient, and environmentally friendly means of travel. For example, reduced car use may limit greenhouse gas emissions and particulate air pollution around the school setting, which can subsequently decrease the risk of lung-disease (Wilson et al., 2007; Larouche 2012).

Despite these potential health and environmental benefits, there has been a temporal decline in AST internationally (Buliung et al., 2009; McDonald, 2007; Witten et al., 2013). Predominant reasons for this decrease have been highlighted through multilevel, ecological barriers within the AST literature. For example, child and parent attitudes of AST being 'inconvenient' and their lack of motivation for AST have been cited as barriers (Ahlport et al., 2008; Loitz and Spencer-Cavaliere, 2013). The rise of the automobile oriented 'built environment' in many cities in the Global North has favoured funding and resources towards vehicle infrastructure relative to pedestrian infrastructure. This has led

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to greater urban sprawl and distances between the home and school environments, limiting opportunities for AST. The increased distances are also accompanied by heightened parental concerns regarding AST. Specifically, concerns around child abduction, bullying, and pedestrian injury are commonly reported barriers (Carver et al., 2010; Panter et al., 2013). More broadly, policies relating to school siting decisions, school catchment areas, and crossing guards have also been identified as AST barriers (Eyler et al., 2008).

The international AST decline has triggered interventional work to reverse these trends by addressing these many barriers. However, a recent review (Chillon et al., 2011) of AST interventions stressed the lack of interventions in addressing the multitude of factors limiting AST. The sole use of educational or promotional initiatives may only result in short-term changes in AST when employed as a 'one-off' strategy. Hence, the review emphasized the value in engaging multidisciplinary stakeholders to address AST's complex barriers through both non-infrastructure (e.g., education initiatives, safety education, walking school bus) and infrastructure (e.g., sidewalk/bike-rack implementation) strategies. Although acquiring buy-in from schools, parents, and community-level stakeholders can be challenging, Chillon and colleagues note that this may be an essential component in the effectiveness and sustainability of AST interventions. In Canada, a uniquely comprehensive intervention that is gaining attention in addressing the many complex and interrelated barriers to AST via stakeholder collaboration is School Travel Planning (STP).

This school-specific intervention invites community-wide involvement by collaborating multidisciplinary stakeholders to help assess, document and intervene on AST barriers by means of a 'school travel plan.' Led by a facilitator, these stakeholders comprise a STP committee with representation from various sectors including safety (e.g., police officer), transportation (e.g., traffic engineer), municipal planning (e.g., member of City council) health (e.g., public health nurse) and education (school administration/teachers and parent/student representatives). Based on their expertise, the stakeholders play a contributing role in identifying strategies to alleviate school-specific barriers. For example, students, teachers, parents, and public health officials, could organize educational sessions to promote the awareness and benefits of AST. A traffic engineer may initiate a process to improve pedestrian infrastructure, by implementing sidewalks, crosswalks, and/or traffic signals. A police officer may take the lead in recruiting and providing police or crossing guard services before and after school, helping with traffic calming/speeding concerns. However, although STP interventions appear comprehensive and intuitively appealing, evidence is limited.

STP originated in the United Kingdom (UK), when in 2003 the Department for Transport and the Department for Education and Skills collaboratively launched an initiative to encourage all schools to develop and implement STP (Green Communities Canada, 2007). Rowland et al. (2003) evaluated STP in 21 of these schools using a randomized control trial. Using a parent survey ($n=1386$) to measure children's AST levels (i.e., walk, bike, or public transport) the study found no AST increases following the STP intervention. This is likely due to high baseline AST (70%), and the timing of follow-up data collection, which occurred only two months post-intervention.

Building on the UK initiative, New Zealand's Energy Efficiency and Conservation Authority (EECA) adopted and implemented STP between 2003 and 2006, mostly in Auckland (Green Communities Canada, 2007). Hinckson et al. (2011) measured changes in AST (i.e., walking, biking, walking school bus, and scooter) in approximately 57,000 students from 56 elementary schools in Auckland using a classroom hands-up survey. Teachers tallied the number of students who raised their hands reflecting their school travel mode on a designated day. Travel modes were collected annually over the course of four years. Results revealed that AST rates were similar after two years, with modest increases (3%) surfacing only three years following STP implementation. The findings from Hinckson et al. and Rowland et al. (2003) suggests that longer periods of time may be needed to observe change, with previous research suggesting that school-based interventions may take up to two to three years to see behaviour change (Aarts et al., 1997; Harris et al., 2009; Sallis and Glanz, 2009).

In Canada, STP has been led by Green Communities Canada (GCC), a non-government organization advocating for sustainable transportation. In 2007, GCC reviewed international best STP practices and subsequently developed recommendations for STP pilot testing in Canada (Green Communities Canada, 2007). STP was then pilot tested in 12 schools across four provinces between 2007 and 2009. Buliung et al. (2011) used classroom hands-up surveys and family surveys ($n=1489$) to evaluate the process. One year after STP implementation, the hands-up survey showed a 2% increase in AST (i.e., walking, walking partway, and biking). The parent survey assessed perceptions of the effectiveness of selected STP strategies; parents deemed education strategies (e.g., AST presentation, route identification), special events (e.g., Winter walk day, pedometer challenge), and infrastructure improvements (e.g., cross-walk implementation, sidewalk repair) to be most effective in improving AST. Additionally, 13% of families reported that the STP intervention resulted in 'less driving.'

Building on the pilot STP, GCC received additional funding from the Canadian Partnership Against Cancer and the Public Health Agency of Canada to expand STP to over 100 schools in every province (except Quebec) and territory in Canada from 2010 to 2012. Measured by classroom hands-up surveys, Mammen et al. (2013) found no longitudinal changes in AST (i.e., walking/biking) after one year of implementation in 53 schools. There was some evidence of localized success, with nearly half of the participating schools demonstrating an increase in AST (1–23%). However, the authors note that the national evaluation may be misrepresentative when considering that only 53 of the 106 participating schools had complete baseline and follow-up data that were included in analysis. Thus, examining a complementary data source using the follow-up parent surveys that were collected in all schools may provide a more accurate indication of STP effectiveness on a national scale.

Additionally, all four STP evaluations (Buliung et al., 2011; Hinckson et al., 2011; Mammen et al., 2013; Rowland et al., 2003) had primary objectives in determining longitudinal increases in AST. Although it is apparent that modest increases in AST may occur, the STP evidence provides little indication of which types of children, families, and/or schools would benefit most from STP. More specifically, none of the STP studies explicitly examined a combination of child, family, and school-level characteristics that may indicate greater travel mode change from driving to AST post-intervention.

Mode shift from motorized to AST is thus an important outcome measure that can help indicate those students, families, and schools that are more or less likely to respond behaviorally to STP. For instance, identifying the geographical location of schools (e.g., urban/suburban setting), and the 'appropriate' spatial distance between the home and school environment (e.g., <2 km) that are most responsive to mode shift can guide focus for future STP efforts. With a recent Canadian report indicating STP as a relatively cost-effective intervention (Metrolinx, 2014), the knowledge gained could contribute to an important international policy-based research area by helping practitioners and decision-makers maximize the cost-effectiveness of STP intervention by applying it in schools where most appropriate.

By bridging a gap in the literature and building upon the more recent Canadian STP evaluation (Mammen et al., 2013), the study will analyze the parent surveys to: (1) examine the proportion of students who switched from driving to AST after one year of baseline measurement; (2) identify child, family and school-level demographics of this travel mode switch; and (3) highlight which STP strategies were deemed effective by parents of those children who switched travel modes.

2. Methods

2.1. The school travel planning process

The STP intervention was led and implemented by GCC (www.saferoutestoschool.ca). The intervention occurred in 106 elementary schools (Kindergarten to grade 8) across all Canadian provinces (except Quebec) and Territories. As a brief overview, STP consisted of four steps. Led by a STP facilitator, step one involved the recruitment of schools and the formation of STP stakeholder committees at each participating school. Schools were recruited based on prior relationships with municipalities and school boards. Each school received an honorarium of $1000 to be used for AST initiatives. In step two, each STP committee conducted school ‘walkabouts’ to identify factors that may pose barriers for AST. Subsequently, the committees initiated development of a ‘school travel plan’, documenting barriers and plausible solutions (action planning). Step two also consisted of collecting baseline parental data and classroom hands up data from children at participating schools. The information derived from the school walkabouts informed step three (implementation). It is important to note that strategy implementation varied by school since each school possessed unique challenges based on a variety of factors such as geographical location, school size, transportation policies, and socioeconomic status. However, strategies would generally relate to; (a) infrastructure modifications/additions; (b) safety education; (c) special walking events; (d) walking buddies/walking school bus formation; (e) AST newsletter dissemination and (f) identification of best routes to school. In the final step, strategy implementation commenced and follow-up measures were requested to be collected one year after baseline. Further details of the school travel planning process are available elsewhere (Buliung et al., 2011). This paper focuses solely on the follow-up parent survey data. The rationale for examining post-intervention data reflected the inability to compare data sets with baseline measures due to a lack of tracking participants over time (i.e., participant codes were not used). However, the follow-up survey was designed so that retrospective information could still be surveyed to inform outcomes related to STP effectiveness, such as travel mode change and parental perceptions of STP strategy effectiveness. In total, approximately 24,893 families were sent home the questionnaire. A total of 7827 surveys were returned giving a response rate of 31.4%. Ethics from the University of Toronto Ethics Board was granted to conduct secondary data analysis on data collected by Green Communities Canada.

2.2. Measures

2.2.1. Objective one

To address objective one in reporting the proportion of students who changed travel mode, parents responded to an item which stated “In what ways have your family's school travel habits changed for the trip to/from school since the STP project began?” Response items included ‘less driving,’ ‘not changed,’ or ‘more driving.’ Since the outcome of interest in the present study pertained to AST, those who selected ‘less driving’ were targeted to explore the alternative travel modes practiced. This was obtained by asking families: ‘if you are driving less for trips to/from school, what are you/your child doing more of? Response items included ‘walking,’ ‘cycling,’ ‘transit,’ ‘carpooling.’ For all these variables, responses were solicited for both the morning (AM) and afternoon (PM) periods. Examining both time-frames stems from previous research that identified temporal variations in rates of AST between these periods, with higher AST rates typically reported for the trip home from school at the end of the school day (Buliung et al., 2009; Wong et al., 2011).

2.2.2. Objective two

To address objective two in examining predictors of those who switched from driving to AST (i.e., walking and biking), a range of child, family and school-level demographics were collected. Child and family demographics were obtained through the parent survey which included child gender and age, and living distance from school (<500 m, .5–1.5 km, 1.5–3 km, >3 km). School-level demographics were collected via a school administrator including student enrollment (<264 students, 265–367, 368–475, 476+) and geographical location (urban, suburban, rural). Further school-level demographics were obtained using Geographical Information System (GIS) software, including school's host neighborhood socioeconomic status. Using 2006 Census of Canada data, the median household income of all dissemination areas (DA) within 1.6 km from each of the sampled schools was averaged to characterize neighborhood level income (i.e., SES). Determined by tertile distributions, SES was categorized as low, medium and high.

2.2.3. Objective three

To address objective three in highlighting which STP strategies were deemed effective among those who changed travel mode (i.e., driving to AST), parents were asked ‘Which STP activity do you feel has been most effective for your family?’ Selection items included ‘infrastructure improvements,’ ‘safety education,’ ‘special events,’ ‘special activities,’ ‘special weekly or monthly Walking Wednesdays,’ ‘Walking buddies,’ ‘Newsletter,’ ‘Identification of best routes to school.’

2.2.4. Statistical analysis

To address objective one, a descriptive statistical analysis was conducted to examine student travel mode change post-intervention. Possible survey responses included: ‘less driving,’ ‘no change’, and ‘more driving’ at one year of follow-up. Those reporting ‘less driving’ were further analyzed to examine the alternative travel mode chosen, including AST or public transit. To address objective two, binomial regression models were specified and estimated with a view to identify correlates of travel mode change from driving to AST relative to those reporting ‘no change’ and ‘more driving.’ Objective three was addressed by filtering the data to include only those families who changed travel mode from driving to AST and then providing frequencies of the STP strategies deemed most effective by parents. All statistical analyses were conducted using IBM SPSS statistics 19 (IBM, PASW Statistic). An alpha level of.05 was used for all statistical tests.

3. Results

3.1. Objective 1 – how many students changed travel habits after one year?

Table 1 outlines the proportion of families and students who changed travel habits and modes at one year follow-up. Approximately 17% of the sample (AM: $n=1188$; PM: $n=1211$) reported driving less at one year follow-up both in the morning and afternoon periods; around 80% of the sample reported 'no change' in their travel habits and 3% reported driving more at one year of follow-up. Among the sample that reported 'no change,' approximately 27% were already engaging in AST, and 42% sustained their driving habits.

Of the 17% that reported driving less, a large majority (i.e., ~83%) switched to AST in the morning ($n=1002$) and afternoon periods ($n=995$). The second objective helps to elucidate what predictors were indicative of this behavior change from driving to AST.

3.2. Objective 2 – what predictors indicated mode shift to AST?

Table 2 highlights child, family and school-level demographics that predict mode change from driving to AST in both the AM and PM periods. Results from the binomial regression analyses showed that the child's age was a significant predictor in the regression model; for every one year of age (AM: $OR=1.08$, $p<.001$; PM: $OR=1.08$, $p<.001$), children were more likely to change from being driven to AST in the AM and PM periods. Households less than 500 m (AM: $OR=4.63$, $p<.001$; PM: $OR=5.63$, $p<.001$), between .5–1.5 km (AM: $OR=4.70$, $p<.001$; PM: $OR=5.85$, $p<.001$), and between 1.5–3 km (AM: $OR=2.14$, $p<.001$; PM: $OR=2.74$, $p<.001$) were significantly more likely to change from driving to AST in both the morning and afternoon periods. Students in urban (AM: $OR=1.78$, $p<.001$; PM: $OR=1.85$, $p<.001$) and suburban (AM: $OR=2.54$, $p<.001$; PM: $OR=2.23$, $p<.001$) schools were significantly more likely to change from driving to AST relative to those who go to schools in rural areas in both the morning and afternoon periods. Students attending schools situated in a middle class neighborhood (i.e, 'medium' SES; $51,021–$68,518) were significantly more likely to change from driving to AST relative to those attending low SES schools, in the AM period only ($OR=1.32$, $p<.005$). Significant or not, the parameter estimates for all variables in the PM period were generally higher, reflecting the greater proportion of children engaging in AST in the afternoon period. The number of family vehicles owned, student enrollment, and gender revealed null effects.

3.3. Objective 3 – what were perceived as the most effective STP strategies by parents?

Fig. 1 displays the most effective STP strategies reported by families who changed to AST. Approximately 35% of these families reported that infrastructure improvements (e.g., bicycle rack) and safety education (e.g., information session/workshop) were the most effective STP

Table 1
Proportion of families who changed travel mode to AST at one-year follow-up.

	AM	PM
Δ Travel habit	$n=7107$	$n=7077$
Less driving	16.7% ($n=1188$)	17.1% ($n=1211$)
No change	80.3% ($n=5707$)	80.2% ($n=5676$)
More driving	3.0% ($n=212$)	2.7% ($n=190$)
Δ Travel mode	$n=1188$	$n=1211$
AST	84.3% ($n=1002$)	82.2% ($n=995$)
Public transit	9.1% ($n=108$)	9.5% ($n=115$)
Other (e.g., carpooling)	6.6% ($n=78$)	8.3% ($n=101$)

Table 2
Correlates of travel mode change from driving to AST one year following STP implementation.[a]

		AM PERIOD: B(SE), OR (95% CI interval)	**PM PERIOD**: B(SE), OR (95% CI interval)
Child age		.07(.02), 1.08 (1.04–1.11)***	.07(.02), 1.08 (1.04–1.12)***
Gender (female)		.11(.08), 1.12 (.95–1.32)	-.03(.08),.98 (.83–1.15)
Distance	(> 3 km)	Reference category	Reference category
	< 500 m	1.53 (.19), 4.63 (3.20–6.66)***	1.73 (.21), 5.63 (3.76–8.43)***
	.5–1.5 km	1.54 (.18), 4.70 (3.32–6.66)***	1.77 (.20), 5.85 (3.99–8.56)***
	1.5–3 km	.76 (.20), 2.14 (1.45–3.13)***	1.01 (.21), 2.74 (1.81–4.14)***
Vehicles owned		.04(.05), 1.00 (.91–1.11)	.02(.05), 1.02(.92–1.12)
Number of students		.00(.00), 1.00 (1.00–1.01)	.000(.00), 1.00 (1.00–1.01)
Location	Rural	Reference category	Reference category
	Urban	.58 (.23), 1.78 (1.13–2.81)**	.62 (.24), 1.85 (1.16–2.95)**
	Suburban	.80 (.23), 2.54 (1.41–3.53)***	.80 (.24), 2.23 (1.39–3.56)***
School SES	low	Reference category	Reference category
	Medium	.27 (.11), 1.32 (1.05–1.64)[a]	.18(.11), 1.19(.95–1.50)
	High	.11(.14), 1.12 (.85–1.47)	.11(.14), 1.12(.85–1.48)

AM period: $R^2=.112$ (Cox and Snell),. 173 (Nagelkerke). Model $x^2(1)=103.73$, $p=.000$; PM period: $R^2=.078$ (Cox and Snell),. 106 (Nagelkerke). Model $x^2(1)=70.850$, $p=.000$

[a] Binomial regression analysis employed.

*** denoted $p<.001$.

** denoted $p<.05$.

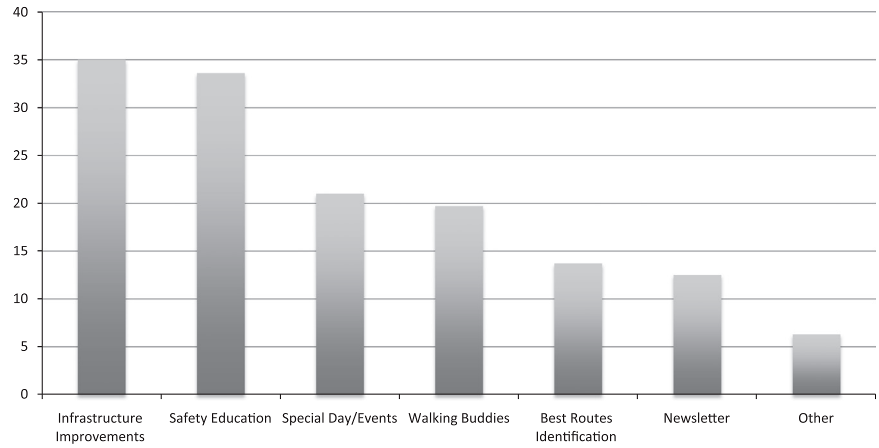

Fig. 1. Most effective STP strategies deemed by families who changed to active modes of travel.

strategies implemented. Approximately 20% of these families also reported that special days/events (e.g., walking Wednesday) and walking buddies were effective strategies that may have facilitated more walking.

4. Discussion

The purpose of this study was to evaluate a national STP intervention by examining predictors of mode shift from driving to AST one-year post intervention. The first objective examined the proportion of families that switched mode shift from driving to AST. Results revealed that 17% of the sample reported less driving. Furthermore, out of the approximate 1200 students that changed travel modes, the majority (~82%) changed to active modes such as walking and biking. Overall, 14% of the sample surveyed, and 4% of the total amount of students enrolled at all schools (i.e., 24,893) changed to AST at follow-up. These results are promising given the short time-frame and are in line with findings from New Zealand (3% increase in AST; Hinckson et al., 2011). A novel objective of this study was to identify those students, families, and schools that are more or less likely to respond behaviorally to STP.

Results revealed that child age, home distance from school, and school location significantly predicted mode shift from driving to AST. The Canadian STP intervention focused on children ranging from Kindergarten (i.e., age 6) to grade 8 (i.e., age 14) but households with older children were more likely to switch to AST. This finding implies that parents may be more willing to allow their child to engage in AST when they are 'older' and when they have or are perceived to possess the cognitive maturity and capacity to navigate their way to school. Previous literature has supported this claim, suggesting that younger children are at greater risk of injury when exposed to higher traffic volumes (Macpherson et al., 1998). This may be due to their attentional skills and their age-moderated appetite for risk taking (Connelly et al., 1998; Pitcairn and Edlmann, 2000). Collectively, the age-related findings may imply that older elementary students and their parents may be more responsive to STP interventions. From a STP practitioner perspective, additional focus could be placed on solutions to increase AST among 'younger' elementary students via adult, peer, or sibling accompaniment.

Distance has consistently been identified as a significant barrier to AST (Su et al., 2013; Wong et al., 2011). In the current study, those who lived less than 1.5 km from school were much more likely to change from driving to AST relative to those who lived greater than 1.5 km from school. AST work has traditionally targeted the immediate school environment (Mitra et al., 2010). Accordingly, any impact of STP strategy implementation is likely to favor those living closer to school. In general, STP interventions may provide enough of a 'nudge' for households to reconsider their school transport options when located within a walkable distance from school. Targeting driving families living within reasonable walking distance, generally established to be within two kilometers from school (Nelson et al., 2008), appears a sensible focus for STP efforts. Schools where driving is not common among households within close proximity may not respond to STP interventions. As school distance from home continues to be a major predictor of AST, school boards must be cognizant of how siting decisions will impact travel modes habits and consequently the health of children.

School location also predicted change in travel mode from driving to AST. Students enrolled in schools located in urban and suburban areas were more likely to change to AST compared to those enrolled in rural-based locations. This parallels findings from the child hands-up data (Mammen et al., 2013), which showed greater AST trends in urban locations only. Together, these results may imply that comprehensive interventions such as STP may be more suitable for urban/suburban communities that have increased density, mixed land use, street connectivity, and esthetic qualities that are typically associated with urban regions and higher AST (Handy et al., 2002; Kemperman and Timmermans, 2012; Van Kann et al., 2014).

Obviously in the rural case school travel distances are typically much longer, working against the uptake of active modes. Moreover, rural travel routes may often include road facilities without sidewalks, unpaved shoulders, and relatively high speed limits. Schools located in rural areas, however, could consider strategies to encourage some AST in the context of busing. School bus drop-off/pick-up zones could be established further from the school site, however, traffic safety considerations and the availability of pedestrian supportive road infrastructure between a more distance drop-off and the school site would need to be considered.

School-level SES, another predictor of AST change, showed that those students enrolling at a school (i.e., medium SES) located in a middle class neighborhood (i.e., $51,021–$68,518) were more likely to change to AST relative to those enrolling at a 'low' or 'high' SES-based school. This may reflect differences in resources. The AST literature has shown that car ownership is often a proxy measure for family SES status. Those owning more cars are more likely to be driven to school relative to those owning fewer cars (Mammen et al., 2012; Park et al., 2013). Conversely, lower SES children may have limited choice in their travel mode to school, and walk by necessity. As with other differences, these findings help demonstrate that STP is unlikely to be equally effective at all schools. The STP process needs to be tailored accordingly to address the different challenges faced by schools in different socioeconomic and built environments. In low SES schools, STP interventions may focus more on ensuring safety among those already actively traveling to school by improving the quality of AST routes.

The current study also examined differences in the AM and PM periods with the aforementioned predictor variables. Only one variable showed variation between the morning and afternoon periods. Students enrolling at a 'medium' SES located in a middle class neighborhood were more likely to switch from driving to walking at one year follow-up in the AM, but not during the PM period. The morning period may appear to be a target time period to intervene and help change travel habits from driving to AST. The before-school period may be more amenable to change since parent and child day-schedules get underway at approximately the same time. Furthermore, recent research reports higher rates of AST in the PM period (Buliung et al., 2009; Larsen et al., 2012; Mitra et al., 2010; Wong et al., 2011). These higher rates of AST, combined with the lower flexibility of parents/guardians to alter their after-school travel habits, may partially explain why there is less change in travel habits in the afternoon. More research is therefore needed in exploring strategies to facilitate behaviour change in the AM period. STP interventions may strategically emphasize the morning as an opportunistic period to intervene and help increase AST levels.

The study's last objective was to highlight the most effective STP strategies by families who changed to active modes of travel at one year of follow-up. Approximately 35% of these families reported that infrastructure improvements and safety education were the top STP strategies. Similar parental perceptions were found in the STP evaluation conducted by Buliung et al. (2011). The most effective infrastructure strategies reported by parents were school-related signage and bicycle rack implementation. Importantly, such infrastructure changes may have a lasting impact that continues to facilitate AST in the future. Parent/child safety education and workshops, as well as best routes to school mapping, were viewed as the top safety education strategies. Future STP implementation practices can use this information to prioritize strategies, time, and resources into AST awareness and infrastructure improvements.

4.1. Limitations and future research

This is the first STP study to examine how child, family, and school-level characteristics associate with mode shift from driving to AST following a STP implementation. Other strengths include its national scope, large sample size, and interventional nature. However, since STP is largely a grassroots initiative in Canada (Mammen et al., 2013), there were limited resources to support STP implementation and evaluation and thus the results should be interpreted with caution. First, the cross-sectional study design limits the ability to make causal inferences related to the STP intervention. Second, subjective surveys like the parent survey in the current study typically contain social desirability bias, i.e., parents may have felt inclined to report a change in travel mode. Third, there was no student and household tracking, or control schools, to allow for comparability. As Chillon et al. (2011) highlighted in their review of AST interventions, stronger methodologies, using control schools especially, will enable stronger evaluations.

Fourth, the dates and completion dates of specific interventions (e.g, infrastructure) were not consistently captured by the facilitators. For instance, in some cases, follow-up measures may have been collected prior to any infrastructure changes. Infrastructure changes in particular, such as sidewalk construction, may take several months or years to be implemented. Only one STP evaluation (Hinckson et al., 2011) collected AST data for more than one year; STP evaluation could benefit from longer-term surveillance and monitoring of outcomes.

4.2. Conclusion

Of the 103 Canadian schools exposed to a STP intervention and 7827 of parents who responded to our parental survey, approximately 17% reported driving less after one year of implementation. These results demonstrate the potential of the STP process in Canada in promoting a switch from driving to AST. By exploring and revealing factors that facilitate greater mode shift following a school's implementation of STP, this study contributed to a key gap in the literature. Given that STP is still in its infancy and testing in Canada, our findings can inform the development of STP school-selection criteria that may maximize already limited resources by recruiting schools most responsive to STP. There is spatiotemporal complexity in school travel mode share (Mitra et al., 2010) across Canada and likely most developed countries. The STP process remains best suited to addressing this complexity. However, at the same study our findings demonstrate that perhaps it is not suited for every school. The study emphasizes STP's suitability for children in higher grades and for suburban and urban-based schools. Although these findings are aligned with the broader predictors of AST, our study confirms the issue of age, location and distance within the context of STP. Additionally, the evidence indicates STP may be more effective for medium SES-schools and schools where a high proportion of households are within 'walkable' distance but children are driven. The study also examined parental perceptions of specific STP strategies that were perceived as most effective (i.e., changes in infrastructure). Overall, the findings from this study should inform future STP interventions by providing a clearer basis for appropriate school recruitment.

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