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Correlates of Active School Transport Immediately Before and After the Transition from Primary to Secondary School: A Pilot-Study

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Introduction

During the last decade, active school transport (AST) has emerged as an important topic in the fields of public health, urban planning and environmental sciences.[1-3] Despite the numerous benefits of AST, the proportion of children and youth using active modes of transport such as walking and cycling is generally very low and has decreased markedly in the last decades in countries such as Australia,[4] Canada,[5] and the United States.[6] Moreover, according to a recent systematic review, most AST promotion interventions (ie, Safe Routes to School and walking school buses) have led to modest increases in walking and cycling to/from school and the magnitude of the observed changes has been heterogenous.[7]

Current theoretical models assume that parents are the key decision makers with respect to their children's travel mode[8,9]; hence, a large proportion of studies that examined perceived barriers to AST have focused on parents' perceptions. There is consistent evidence showing that the distance between a child's residence and the school that he/she attends (both perceived and objectively measured) is a strong determinant of travel mode choices.[10-12] However, travel decisions can also be influenced by a wide array of factors pertaining to different levels of influence as postulated by social-ecological theory.[9,13] These may include personal characteristics (eg, attitudes toward walking and cycling), the social environment (eg, social support from family and friends), public policies (eg, school policies, municipal bylaws), the built environment (eg, availability of sidewalks and bicycle paths), and the physical environment (eg, topography). These two models[9,13] also posit that the relationship between the correlates of AST and travel patterns is moderated by the age of the child, but longitudinal studies on this topic are scarce.

Although children may have some input into travel mode decisions, few studies have simultaneously assessed child- and parent-perceived barriers to AST.[9] Timperio and colleagues[14,15] examined perceived barriers among children of different age groups and their parents, but they did not report the concordance between these perceptions. More recently, Napier and colleagues[16] reported that children's and parents' perception of five different barriers to AST was similar, except in areas defined as "less walkable" where parents expressed greater concerns. Further research is warranted to determine the extent to which children's and parents' perceptions are concordant across a larger number of barriers pertaining to multiple levels of influence.

Another area that has been under studied is the potential role of parental neighborhood selection in influencing children's travel mode. It has been shown that adults who prefer walking and cycling are more likely

to choose to live in "walkable areas".[17,18] For example, Frank and colleagues[17] assessed the relative influence of neighborhood walkability and self-selection, and they found that both aspects were independently associated with adults' travel modes. To our knowledge, only one study has examined the influence of parental neighborhood selection factors on children's travel patterns, reporting that children were more likely to engage in AST if their parents had chosen to live in their neighborhood so that their children could walk to school.[19] Hence, further research is needed to confirm this association and examine the influence of other parental neighborhood selection factors; for instance parents could choose their neighborhood for its proximity to their workplace or because of monetary constraints.

In addition, there is a growing body of evidence showing that socio-demographic characteristics can influence children's travel mode. Many North American studies have shown that girls[20-22] and children living in high socioeconomic status (SES) families[21,23,24] are less likely to walk or cycle to/from school. Other researchers have reported that car ownership was inversely related to AST.[25] This evidence underscores the need for studies of correlates of AST to consider socio-demographic factors.

Therefore, the present pilot-study had four key objectives: 1) to assess the concordance between child- and parent-perceived barriers to AST; 2) to examine the association between child- and parent-perceived barriers to AST and children's primary mode of transport; 3) to explore the influence of different parental neighborhood selection factors on children's travel mode; and 4) to investigate the association between a series of socio-demographic characteristics of the household and AST. These relationships were assessed at the end of primary school (grade six) and the beginning of secondary school (grade seven) among the same participants. This important transition period is associated with a large decrease in physical activity levels.[26]

Methods

Participants. The principals from four K-6 primary schools agreed to be involved in the Active Transportation Transition Study. Only students in grade six were eligible to participate because the study aimed to assess the influence of the school transition. Consent and assent forms were obtained from 55 grade six students (33.3% response rate) of which 49 returned their study package. Parents were asked to indicate their child's prospective school for grade seven and either their phone number or e-mail address for follow-up purposes. Eleven parents could not be reached for follow-up, either because they did not complete the parent

questionnaire at baseline or because they did not respond to our e-mail reminders. Of the 38 remaining participants, 31 returned their study packages, but two of these contained blank questionnaires; thus data from 29 participants was included in the follow-up analyses. Baseline data were collected in May/June 2012 and the follow-up data in September/October 2012. Primary and secondary schools were respectively given a $100 and $50 honorarium for participation in the study to support physical activity-related initiatives. Ethical approval was obtained from institutional research ethics boards and from the two participating school boards.

Setting. Previous research has shown that secondary schools generally have larger catchment areas than primary schools.[27] As a result, the average distance between participants' home and the school that they attend should be greater for secondary school students; thereby, the school transition could lead to a decrease in the mode share of AST (eg, the proportion of children engaging in AST). In the subsample of participants (n = 28) that provided baseline and follow-up data, an increase in average distance to school (from 2.61 km to 3.86 km) and a decrease in the mode share of AST (from 57.1% to 46.4%) were observed as reported elsewhere.[28] According to a US study,[10] average distance is generally lower in neighborhoods with greater population density; hence, population density of the primary school census tracts was obtained from the 2006 Canadian census.[29] Participants attending the two primary schools located in higher density census tracts (3531-4100 inhabitants/km^2) all stayed in the same area for secondary school. In contrast, those who attended the two primary schools located in lower density census tracts (988-2159 inhabitants/km^2) went to seven different secondary schools, most of which were located outside of their neighborhood. All schools were located in urban areas within the city of Ottawa (Canada). Assuming that distance is a key determinant of AST, one would assume that the latter participants would be less likely to engage in AST, especially in secondary school. Presumably, the relative influence of barriers to AST will be modified given the change in school location. For example, the distance to school may increase, a different set of safety concerns may present themselves, and travel modes may become more or less convenient or available (eg, school bussing eligibility).

Measures. All assessments described below were done at baseline and follow-up. First, participants were asked to complete a short diary in which they prospectively indicated their mode of transport to and from school for each day during one school week. Second, participants and their parents were asked to complete a 17-item questionnaire on

perceived barriers to AST that has been previously validated among youth and adults.[30] In this questionnaire, individuals were asked to indicate their level of agreement with simple statements on a four-point scale ranging from 1 (strongly disagree) to 4 (strongly agree). While the Forman et al [30] scale has been validated for assessing perceived barriers to active transport for different trip purposes, only the barriers pertaining to the school trip were examined given that the present study focused on AST. Because road safety is an important correlate of AST[9] that is specifically targeted by interventions promoting AST (ie, Safe Routes to School), two items were added to the scale targeting traffic around participants' home and around the school that they attend. These items were added to get additional precision regarding the location of road safety concerns based on previous suggestion that AST research should examine characteristics of the neighborhood, route, and school environments.[31,32] Third, parental neighborhood selection factors were assessed with a seven-item scale adapted from the Neighborhood Selection Questionnaire developed by Frank et al.[17] Parents indicated their level of agreement with these statements on a five-point scale ranging from 1 (strongly agree) to 5 (strongly disagree). Fourth, parents were asked several socio-demographic questions including the number of children and cars in the household, whether their child had access to a bicycle, the type of family (eg, two parents, one parent or other), and the education level and employment status of the mother and father.

Data treatment. Participants were classified as active travelers if they reported using active modes of transport for at least 50% of school trips. Pilot data using the same classification method has shown substantial test-retest reliability over two consecutive weeks of measurements.[28] Given the small sample size, response options for the barrrier statements were dichotomized as "disagree" (strongly disagree or somewhat disagree) and "agree" (strongly agree or somewhat agree). Similarly, response options for the neighborhood selection factors were dichotomized as "disagree" (strongly disagree, somewhat disagree or neither agree nor disagree) and "agree" (strongly agree or somewhat agree). Participants' primary school neighborhood was coded as "higher" vs. "lower" density.

Statistical analyses. First, the concordance between children- and parent-perceived barriers to AST was assessed using Spearman rank-order correlations. Second, Fisher's[33] exact test was used to examine how children- and parent-perceived barriers, parental neighborhood selection factors, and socio-demographic factors relate to children's primary travel mode. This test is suitable for contingency tables when the chi-square test

assumptions are not satisfied. These analyses were performed at baseline and follow-up with IBM SPSS 20 and α was set at .05. Finally, *a posteriori* power calculations were performed with the G*Power 3.1.3 software. Variables that have sufficient statistical power (eg, ≥0.8 according to Cohen[34]) are indicated in the tables.

Results

Descriptive characteristics of the sample are shown in Table 1. Almost all children had access to a bicycle and almost all parents had at least one car. The majority of children lived in two-parent families with highly educated parents and almost all fathers were full-time employed, suggesting that the household SES status may be higher than the average Canadian population.[35] No significant differences in socio-demographic characteristics were found between individuals who participated in the follow-up and those who did not (all $p > 0.232$).

Table 1. Descriptive characteristics of the sample

Characteristic	Categories	Baseline	Follow-up
Child gender	Girls	25 (51.0%)	16 (55.2%)
	Boys	24 (49.0%)	13 (44.8%)
School neighborhood*	Higher density	23 (46.9%)	12 (41.4%)
	Lower density	26 (53.1%)	17 (58.6%)
Travel mode	Active	26 (57.1%)	13 (46.4%)
	Inactive	16 (42.9%)	15 (53.6%)
Number of cars in the household	0	2 (4.7%)	1 (3.6%)
	1	18 (41.9%)	11 (39.3%)
	2	23 (53.5%)	16 (57.1%)
Child has access to a bicycle	Yes	41 (95.3%)	29 (100%)
	No	2 (4.7%)	0
Family type	Two parents	37 (86.0%)	26 (89.7%)
	Single parent	6 (14.0%)	3 (10.3%)
Family size	1 child	6 (14.0%)	4 (13.8%)
	2 children	25 (58.1%)	16 (55.2%)
	3 or more children	12 (27.9%)	9 (31.0%)
Father's education	Less than university	15 (34.9%)	7 (25.0%)
	University	28 (65.1%)	21 (75.0%)
Mother's education	Less than university	10 (23.8%)	2 (7.1%)
	University	32 (76.2%)	26 (92.9%)
Father's employment	Full time	38 (92.7%)	28 (96.6%)
	Other	3 (7.3%)	1 (3.4%)
Mother's employment	Full time	26 (65.0%)	18 (66.7%)
	Other	14 (35.0%)	9 (33.3%)

Data are indicated as the number of participants with the proportion in parentheses.
*School neighborhood refers to the school that participants attended at baseline.

Spearman correlations between child- and parent-perceived barriers to AST at baseline and follow-up are reported in Table 2. At baseline, significant correlations (rho 0.32-0.72) were found for 14 out of 19 questionnaire items. Of particular note, correlations were generally higher for the road safety (eg, traffic, lighting and crossings) and distance components (rho ≥ 0.50). At follow-up, significant correlations between child- and parent-perceived barriers to AST (rho 0.39-0.63) were found for only four items: traffic along the route and around the home, crime-related concerns, and distance between home and school.

Table 2. Spearman correlations between child- and parent-perceived barriers to active transportation at baseline and follow-up

Barriers	Baseline		Follow-up	
	Rho	*p*	rho	*p*
Too many hills along the way	.509*	.001†	.326	.090
No sidewalks or bike lanes	.155	.341	.247	.206
Route is boring	.064	.698	.018	.927
Route does not have good lighting	.525*	.001†	.380	.050
Too much traffic along the route	.721*	<.001†	.391*	.040
Too much traffic around home	.670*	<.001†	.520*	.005†
Too much traffic around the school	.495*	.001†	.247	.214
One or more dangerous crossings	.575*	<.001†	.350	.068
Get too hot and sweaty	.152	.350	.079	.690
No other children walk or bike to school	.078	.638	-.017	.934
Not considered cool to walk or bike	.453*	.003†	-.067	.736
Too much stuff to carry	.684*	<.001†	.182	.353
Easier for parents to drive on the way to something else	.332*	.037	.178	.364
Involves too much planning ahead	.320*	.047	.133	.500
Unsafe because of crime (strangers, gangs, drugs)	.454*	.003†	.425*	.024
Get bullied, teased, harassed	.546*	<.001†	.104	.598
Nowhere to leave a bike safely	.170	.301	-.026	.899
There are stray dogs	.646*	<.001†	-.161	.414
It's too far	.714*	<.001†	.629*	<.001†

* Indicates significant correlations ($p < .05$). † denotes sufficient statistical power (eg, ≥0.8 according to Cohen[34]). The two items that were added to Forman and colleagues' (2008) scale are in italics.

Associations of children's primary travel mode with child- and parent-perceived barriers to AST at baseline and follow-up are reported in Table 3. At baseline, 26 participants were classified as active travelers, 19 as inactive travelers and four did not complete the log sheet or provided

insufficient information for the determination of their primary travel mode. Children who perceived that the school is too far ($p < .001$), that there is too much traffic around the school ($p = .014$), that the route does not have good lighting ($p = .019$), and that they have too much stuff to carry ($p = .038$) were less likely to engage in AST. Similarly, children were less likely to engage in AST if their parents perceived that the school is too far ($p < .001$), that their child has too much stuff to carry ($p = .005$) or gets too hot and sweaty ($p = .015$), that it is unsafe because of crime ($p = .015$), that there is too much traffic along the route ($p = .018$) or the home ($p = .035$), that the route does not have good lighting ($p = .046$), and that no other children walk or bike to/from school ($p = .046$). Participants who somewhat or strongly agreed that the school is too far were all inactive travelers.

Table 3. Associations between child-perceived barriers and active school transport at baseline and follow-up

Barriers	Study period	Respondent	AT (%)	IT (%)	*p*
Too many hills along the way	Baseline	Child	13.0	17.6	.666
	Baseline	Parent	4.0	7.1	1.000
	Follow-up	Child	7.7	33.3	.173
	Follow-up	Parent	0.0	26.7	.106
No sidewalks or bike lanes	Baseline	Child	19.2	41.2	.168
	Baseline	Parent	16.0	40.0	.135
	Follow-up	Child	7.7	40.0	.084
	Follow-up	Parent†	0.0	46.7	.008*
Route is boring	Baseline	Child	7.7	17.6	.369
	Baseline	Parent	0.0	7.1	.359
	Follow-up	Child	0.0	13.3	.484
	Follow-up	Parent	0.0	0.0	N/A
Route doesn't have good lighting	Baseline	Child	0.0	23.5	.019*
	Baseline	Parent	0.0	20.0	.046*
	Follow-up	Child	7.7	14.3	1.000
	Follow-up	Parent	8.3	20.0	.605
Too much traffic along the route	Baseline	Child	30.8	47.1	.343
	Baseline	Parent	24.0	66.7	.018*
	Follow-up	Child	23.1	60.0	.067
	Follow-up	Parent	41.7	60.0	.449
Too much traffic around home	Baseline	Child	15.4	41.1	.080
	Baseline	Parent	16.0	46.7	.035*
	Follow-up	Child	15.4	20.0	1.000
	Follow-up	Parent	41.7	20.0	.398
Too much traffic around the school	Baseline	Child	11.5	47.1	.014*
	Baseline	Parent	28.0	53.3	.177
	Follow-up	Child†	0.0	33.3	.044*
	Follow-up	Parent	54.5	46.7	1.000
Dangerous crossings	Baseline	Child	19.2	37.5	.281
	Baseline	Parent	36.0	66.7	.102
	Follow-up	Child	7.7	60.0	.006*
	Follow-up	Parent	33.3	46.7	.484
Get too hot and sweaty	Baseline	Child	11.5	23.5	.407
	Baseline	Parent†	0.0	26.7	.015*
	Follow-up	Child	7.7	13.3	1.000
	Follow-up	Parent	0.0	13.3	.487

Note: The percentage of individuals who strongly or somewhat agreed with the items in the 1st column was compared between active travelers (AT) and inactive travelers (IT) with Fisher's exact test. * Indicates $p < .05$. † denotes sufficient statistical power[34].

Barriers	Study period	Respondent	AT (%)	IT (%)	*p*
No other children walk or bike to school	Baseline	Child	3.8	6.3	1.000
	Baseline	Parent	0.0	20.0	.046*
	Follow-up	Child	0.0	13.3	.484
	Follow-up	Parent	0.0	13.3	.492
Not considered cool to walk or bike	Baseline	Child	0.0	0.0	N/A
	Baseline	Parent	0.0	13.3	.135
	Follow-up	Child	0.0	0.0	N/A
	Follow-up	Parent	0.0	6.7	1.000
Too much stuff to carry	Baseline	Child	7.7	37.5	.038*
	Baseline	Parent†	4.0	42.9	.005*
	Follow-up	Child	0.0	40.0	.018*
	Follow-up	Parent	8.3	33.3	.182
Easier to drive	Baseline	Child	19.2	44.4	.098
	Baseline	Parent	16.0	42.9	.124
	Follow-up	Child	7.7	46.7	.038*
	Follow-up	Parent	0.0	26.7	.106
Involves too much planning ahead	Baseline	Child	3.8	11.8	.552
	Baseline	Parent	8.3	20.0	.354
	Follow-up	Child	7.7	26.7	.333
	Follow-up	Parent	0.0	20.0	.231
Unsafe because of crime	Baseline	Child	7.7	29.4	.093
	Baseline	Parent	0.0	26.7	.015*
	Follow-up	Child	15.4	13.3	1.000
	Follow-up	Parent†	0.0	26.7	.106
Get bullied	Baseline	Child	3.8	5.9	1.000
	Baseline	Parent	0.0	6.7	.375
	Follow-up	Child	7.7	6.7	1.000
	Follow-up	Parent	0.0	6.7	1.000
Nowhere to leave a bike safely	Baseline	Child	3.8	17.6	.284
	Baseline	Parent	0.0	0.0	N/A
	Follow-up	Child	7.7	33.3	.173
	Follow-up	Parent	0.0	7.1	1.000
There are stray dogs	Baseline	Child	4.0	5.9	1.000
	Baseline	Parent	0.0	0.0	N/A
	Follow-up	Child	7.7	6.7	1.000
	Follow-up	Parent	0.0	6.7	1.000
It's too far	Baseline	Child†	0.0	76.5	<.001*
	Baseline	Parent†	0.0	66.7	<.001*
	Follow-up	Child†	7.7	66.7	<.001*
	Follow-up	Parent†	0.0	53.3	.003*

At follow-up, 13 participants were classified as active travelers, 15 as inactive travelers, and one provided insufficient information to allow for the determination of travel mode. Children were less likely to engage in

AST if they perceived that the school is too far (p = .002), that there are dangerous crossings along the route (p = .006), that they have too much stuff to carry (p = .018), that it is easier for their parents to drive them (p = .038), and that there is too much traffic around the school (p = .044). Children were also less likely to engage in AST if their parent perceived that the school is too far (p = .003) and that there are no sidewalks or bike lanes along the route (p = .008). Only one child who perceived that the school is too far engaged in AST.

Table 4 shows the association between parental neighborhood selection factors and children's travel mode at baseline and follow-up. At both time points, children were more likely to engage in AST if their parents indicated that they have chosen to live in their neighborhood because "it is easy for our children to walk or cycle to school" (p = .001 and .047 respectively). At follow-up, children were also more likely to engage in AST if their parents indicated that they have chosen to live in their neighborhood because "there are shops and restaurants you can walk or cycle to" (p = .036).

Table 4. Associations between parental neighborhood selection factors and child's travel mode at baseline and follow-up

Neighborhood selection factors	Study period	AT (%)	IT (%)	*p*
We liked some aspects of its built environment (street layout, the organization of buildings along the streets, the green spaces & parks, etc.)	Baseline	92.0	81.3	.362
	Follow-up	91.7	92.9	1.000
We like some aspects of its social environment, such as proximity to friends and family	Baseline	52.0	68.8	.344
	Follow-up	66.7	71.4	1.000
It was one of the few neighborhoods we could afford to live in	Baseline	26.1	18.8	.711
	Follow-up	16.7	28.6	.652
It is easy for our child(ren) to walk or cycle to school	Baseline†	64.0	12.5	.001*
	Follow-up	75.0	28.6	.047*
It is a convenient location with respect to work	Baseline	66.7	75.0	.729
	Follow-up	83.3	64.3	.391
It is a convenient location with respect to our household's non-work activities, such as shopping, exercise, parks, etc.	Baseline	84.0	68.8	.276
	Follow-up	91.7	64.3	.170
There are shops and restaurants you can walk or cycle to	Baseline	64.0	43.8	.334
	Follow-up	91.7	50.0	.036*

Note: all statements began with "*We have chosen to live in this neighborhood because*". The percentage of individuals who strongly or somewhat agreed with the statements in the 1st column was compared between active travelers (AT) and inactive travelers (IT) with Fisher's exact test. * Indicates significant differences (p < .05). † denotes sufficient statistical power[34].

The association between socio-demographic charecteristics of the household and children's travel mode at baseline and follow-up is shown in Table 5. At baseline and follow-up, children attending school in denser areas were significantly more likely to engage in AST (p = .003 and p < .001 respectively). At follow-up only, children whose parents owned at least two cars were less likely to engage in AST (p = .006). Other socio-demographic characteristics were not associated with children's travel mode at any time point. Because more than 95% of participants had access to a bicycle, this variable was omitted from the analyses.

Table 5. Associations between socio-demographic characteristics of the household and children's travel mode at baseline and follow-up

Characteristic	Categories	Study Period	AT (%)	IT (%)	*P*
Child gender	Girls vs. boys	Baseline	51.9	47.4	1.000
		Follow-up	61.5	46.7	.476
School neighborhood	Higher vs. lower density	Baseline†	66.6	21.1	.003*
		Follow-up†	84.6	6.7	<0.001*
Number of cars in the household	≤ 1 vs ≥ 2	Baseline	46.1	43.8	1.000
		Follow-up†	69.2	14.3	0.006*
Family type	2 parents vs. others	Baseline	88.5	81.3	.658
		Follow-up	92.3	93.3	1.000
Family size	1 children vs. others	Baseline	11.5	18.8	.658
		Follow-up	15.4	13.3	1.000
Father's education	University vs. others	Baseline	73.1	56.3	.322
		Follow-up	91.7	66.7	.182
Mother's education	University vs. others	Baseline	84.0	68.8	.276
		Follow-up	100.0	86.7	.484
Father's employment	Full time vs. others	Baseline	96.2	86.7	.543
		Follow-up	100.0	93.3	1.000
Mother's employment	Full time vs. others	Baseline	69.6	56.3	.503
		Follow-up	61.5	71.4	.695

The percentage of individuals with the referent categories mentioned in the 2nd column was compared between active travelers (AT) and inactive travelers (IT) with Fisher's exact test (eg, at baseline, 51.9% of active travelers were girls; implying that the remaining 48.1% were boys). * Indicates significant differences (p < .05). † denotes sufficient statistical power[34].

Discussion

The present study aimed to compare child- and parent-perceived barriers to AST and to identify how perceived barriers to AST, parental neighborhood selection factors and socio-demographic characteristics of the households relate to children's primary travel mode for the trip to/from school.

Concordance of child- and parent-perceived barriers to AST. In general, children's and parents' perceptions of barriers to AST were significantly correlated at baseline. Using the same instrument, Forman et al[30] reported high intraclass correlation coefficients between adolescent and parent reports, but they combined survey items in three subscales instead of examining agreement for each barrier separately. Another study in the US found good agreement between children and parent reports, except within less walkable neighborhoods where parents expressed greater concerns.[16]

However, at follow-up significant correlations were found for only four of 19 questionnaire items. Because follow-up data collection occured only a few weeks after participants started secondary school, it is possible that children and/or their parents were less familiar with the route to/from school and the school surroundings. This novelty aspect may have biased the comparisons toward the null hypothesis. It is also worth emphasizing that there was sufficient power for 12 items at baseline, but only two at follow-up. Nevertheless, at both time points, the concordance was generally higher for the distance and road safety components and most of these components were associated with children's travel mode. To our knowledge, no other study has assessed how the concordance between child- and parent-perceived barriers changes from primary to secondary school, underscoring a need for future research on this topic.

Associations between perceived barriers and AST. In the present study, the strongest perceived barrier to AST was the distance between home and school as perceived by both children and parents. Moreover, in the sub-sample of participants who provided travel mode data at both time points, the average distance increased upon the transition from primary to secondary school while the mode share of AST decreased significantly.[28] These longitudinal findings are consistent with cross-sectional studies comparing the mode share of AST between primary, middle school, and high school students in Canada[24,36] and the United States.[20,23] In addition, data from the US National Household Travel Survey suggest that a 10% increase in distance is associated with a 7.5% decrease in the mode share of walking.[10] Finally, a systematic review of the relationship between objectively-measured environmental factors and AST found that distance was the only consistent correlate.[12]

Road safety concerns related to heavy traffic were important correlates of travel mode, especially at baseline. However, their influence was not as strong as that of distance, likely because some participants were engaging in AST in spite of their parents' and their own safety concerns. Interestingly, the proportion of children and parents who

perceived the absence of sidewalks and cycle paths as a barrier was consistently greater among the inactive travelers, but this relationship was only significant at follow-up among parents. This might be an artifact of the small sample size and low statistical power. In the published literature, several studies have found that perceived road safety was an important barrier to AST.[37-40] In addition, an Australian study that examined the predictors of increasing AST found that when parents perceived that there were not enough traffic lights and pedestrian crossings in their neighborhood, children were half as likely to begin walking or cycling to school.[41] Nevertheless, conflicting findings have also been reported with respect to the association between road safety elements and AST.[14,42]

The perception of having too much stuff to carry was associated with inactive travel at baseline and follow-up. This element was mentioned as an important barrier in a qualitative study,[43] although it has not been assessed often in quantitative studies. Technology could help to reduce backpack loads (ie, using USB sticks and tablets instead of heavy textbooks). Another possibility would be to equip bikes with racks and panniers to avoid the need for carrying heavy loads on one's back.[44]

At baseline only, parents' crime-related concerns were associated with motorized travel; however, there were no associations between children's personal safety concerns and travel mode at any time point. The lack of concordance in this regard warrants future investigation. Nevertheless, it is noteworthy that a literature review has reported inconsistent evidence regarding the relationship between personal safety aspects (eg, "stranger danger," crime, bullying) and AST among both children and parents.[9] Given the higher rates of AST among children living in low SES neighborhoods (which also tend to have higher crime rates), SES might be an important confounding variable.[45,46]

In the present study, a greater proportion of inactive travelers and their parents reported that "it is easier to drive" and that walking or biking to school "involves too much planning ahead" at both time points. However, the associations were not significant except among children at follow-up. This may reflect the increased distance (and associated time cost) between home and school. Previous research has shown that perceived convenience of driving and time constraints were key reasons underlying parents' decision to drive their children to/from school.[47,48] Based on semi-structured interviews, Faulkner and colleagues[47] concluded that parental travel mode decisions are based on two key questions: 1) does the child need to be escorted to/from school?; and 2) what is the easiest and most convenient way to travel? Again, the small

sample size may explain why such associations were not found in the present study.

In her theoretical framework, McMillan[8] assumed that parents are the key decision-makers regarding their children's mode of transport. However, more recent frameworks posit that as children become older, they likely have a greater input into this decision.[9,13] This assumption is consistent with the observation that independent mobility (eg, the degree of freedom of children and youth to move around in public spaces without adult supervision) increases with age.[49] In turn, independent mobility is associated with greater AST and PA levels.[50,51] Another study has shown that Canadian adolescents who have some input in the decision making process are more likely to engage in AST,[52] and an American study indicated that although children- and parent-perceived barriers were correlated, they were still independently associated with the frequency of walking trips.[16] Together, this body of evidence emphasizes the need to consider both child- and parent-perceived barriers to AST. Similarly, future research should examine how these perceived barriers change over time among both parents and children to inform the development of more effective AST interventions.

Parental neighborhood selection factors. At both time points, children were significantly more likely to engage in AST when their parent reported that they chose to live in their neighborhood so that their children could easily walk or cycle to school. Another study in the Greater Toronto Area found that children were less likely to be driven to school if their parents reported that they had chosen to live in their neighborhood so that their children can walk to school.[19] In addition, children were more likely to engage in AST at follow-up if their parents chose their neighborhood for the proximity of parks and restaurants. Perceived proximity to such destinations has been shown to be associated with higher physical activity levels in children and youth.[53] Our findings provide preliminary evidence suggesting that parental neighborhood selection factors can influence their child's travel modes. Future studies could use a design similar to Frank et al[17] to attempt to disentangle the relative influence of self-selection and built environment characteristics.

Socio-demographic characteristics. At both time points, children who attended primary schools located in denser census tracts were more likely to engage in AST. These schools were located significantly closer to participants' homes, presumably facilitating AST. Similarly, McDonald[8] reported that in denser areas, it is more likely that a greater proportion of children live within a walkable distance, suggesting that the effect of density on travel mode may be partially mediated by distance.

Nevertheless, there is conflicting evidence with respect to the association between density and AST in the literature.[12] This may be due to inconsistencies in methodology[12], to the indirect effect of density (eg, mediated by distance[8]), to a ceiling effect (eg, beyond a certain level, increasing density may have no effect on AST), or because denser areas may be associated with greater traffic exposure and safety concerns.[54] Density may be less salient when a large proportion of children do not attend a school within their neighborhood as seems to be the case for the participants who attended primary schools in lower density areas. Moreover, differences in AST between school neighborhoods could also be due to other characteristics of the built environment and to school policies that may favor AST to a greater extent in these schools.

Parents' car ownership was the only other socio-demographic variable that was associated with children's travel mode, but this association was found only at follow-up. Specifically, children were almost five times less likely to engage in AST when their parents owned at least two cars. However, only two families did not own a car so they were combined with those that owned one car in analyses. Moreover, children who traveled by car and bus were combined in the analyses; this has likely biased the results toward the null hypothesis. This could explain why our findings differ from those of DiGuiseppi et al,[25] who reported that British children were much more likely to be driven to school by their parents if they owned at least one car, and the odds were even greater when parents owned two cars. Presumably, higher car ownership makes the option of driving children to/from school more feasible.

The lack of association for the other socio-demographic variables might be due to the small sample size and to the limited variability of these characteristics in the sample (eg, the majority of parents had university education and almost all fathers worked full time). Therefore, these findings should be interpreted cautiously. North American studies have generally found higher rates of AST in children living in low SES households,[21,23,24,45] in single-parent families,[24] and in boys.[20-22]

Policy implications. When combined with the broader literature, the present findings have some implications for policies related to AST. In the US, the school siting guidelines recommend that schools be built on large lots; for example one acre of land for every 100 students plus an additional 10 acres for elementary schools, 20 acres for middle schools and 30 acres for high schools.[55] Application of these guidelines has led to the construction of large schools in the outskirts of cities; thereby leading to large distances between home and school, especially for high school students.[27] In the present study, the transition to secondary school was

associated with a significant increase in distance and a marked decrease in the mode share of AST. Based on data from the National Household Travel Survey, McDonald[8] estimated that only 20% of US students lived within 1.6 km (1 mile) from their school and argued that this situation greatly reduces the potential effectiveness of Safe Routes to School interventions. To address this issue, a recent policy statement from the American Academy of Pediatrics[56] recommended that consideration be given to children's ability to engage in AST in the process of determining the location of new schools.

Policies can also be implemented to address some of the road safety barriers identified in the present study and in other investigations. For example, walking school buses can reduce parental safety concerns and foster AST and physical activity.[57,58] US schools located in states where crossing guards are required and in school districts with strong Safe Routes to School policies were more likely to implement walking school buses.[59]

In another US study, investigators asked the principals of over 600 schools to estimate the proportion of students who engaged in AST and collected information on state transportation laws.[60] They found that more children engaged in AST in states that required the presence of crossing guards and lower speed limits around schools. In London (UK), the implementation of 32 km/h (20 mph) speed limits has led to a 49% decrease in road casualties among children.[61] In addition, an evaluation of the California Safe Routes to School legislation has shown that urban form changes such as adding or improving sidewalks, traffic lights, pedestrian crossings, and bike paths can lead to an increase in AST.[62] In New York City, a 44% decrease in pedestrian injuries among school-aged children was observed in census tracts where Safe Routes to School interventions had been implemented while no changes were observed in control census tracts.[63]

Limitations and strengths. The small sample size should be considered when interpreting the present findings for the following reasons. First, statistical power was small (especially at follow-up), potentially reducing the likelihood of observing significant associations; thus caution is needed in making a distinction between a lack of evidence of effect and evidence of no effect.[64] *A posteriori* sample size calculations were performed to help the reader interpret the findings and to inform sample size calculations for future studies. Statistical power ranged from 0 to 1 with values consistently greater than 0.9 for distance-related perceptions. Second, it was unfeasible to take advantage of the longitudinal study design by examining how changes in perceived barriers

are related to changes in travel modes because of the even smaller number of participants who changed travel modes. Future studies should address this research gap to inform the development and refinement of AST interventions. Third, although walking and cycling may have distinct correlates, it was unfeasible to assess the correlates separately. Fourth, analyses were not adjusted for gender and other potential confounders (ie, school, SES, car ownership). Such variables could moderate (or mediate) the relationship between perceived barriers and children's AST.[9] However, the mode share of AST did not differ between boys and girls in the present study. Finally, the low participation rate and the large proportion of parents who were university graduates suggest that the sample may not be representative of the Canadian population. Approval from school principals was mandatory before proceeding with data collection, and all primary schools that granted approval were included in the study. This may have led to a greater participation of schools located in higher SES neighborhoods. The longitudinal study design, and the school board requirement that incentives cannot be offered to participants, may have contributed to the low participation rate.

Nevertheless, the present study has important strengths. Of particular interest, the association between children's travel mode and perceived barriers to AST was examined at the end of primary school and the beginning of secondary school among the same group of participants. Second, no other study has systematically compared the concordance between child- and parent-perceived barriers to AST before and after the school transition. Third, a wide variety of potential correlates of AST were considered, many of which have not been studied extensively. Furthermore, while several prospective studies have shown large decreases in physical activity levels from childhood to adolescence,[26] little is known about the influence of the school transition on AST. Only two studies have examined this question longitudinally[28,65] and both reported a substantial decrease in the mode share of AST.

Conclusion

To our knowledge, this pilot study is the first investigation to examine the correlates of AST immediately before and after the transition from primary to secondary school within the same group of participants. The school transition might be an important period for promoting AST in order to attenuate the age-related decline in physical activity. Significant concordance was found between child- and parent-perceived barriers to AST at baseline, but not at follow-up; this might be due to a novelty effect with respect to the route and the secondary school environment. In line

with other studies, distance between home and school consistently emerged as the strongest barrier to AST. Road safety issues and the perception of having too much stuff to carry were other important barriers to AST. Children were also more likely to engage in AST when their parents reported that they chose their neighborhood so that their children could easily walk or bike to school, indicating that future studies should take parental neighborhood selection into account. Together, the present findings should be useful in stimulating future research on this topic as well as informing the development (and refinement) of policy and program interventions to promote AST in primary and secondary schools.

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