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Do parental perceptions of the neighbourhood environment influence children's independent mobility? Evidence from Toronto, Canada

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Abstract

Children's independent mobility (CIM), or a child's freedom to explore their neighbourhood unsupervised, is important for their psychological development and potentially enables daily physical activity. However, the correlates of CIM remain under-studied particularly in terms of the influence of the neighbourhood environment. Within this context, children's independent mobility in Toronto, Canada, was examined using linear regression and ordered logit models. Findings demonstrate that a higher level of CIM was correlated with more physical activity. Parental perceptions related to neighbourhood safety, stranger danger and sociability were associated with CIM. A child's independent mobility was also correlated with age, sex, language spoken at home and parental travel attitudes. Interventions to increase CIM should focus on enhancing the neighbourhood social environment. Increasing the independent mobility of girls and of children with diverse ethno-cultural backgrounds are also worthy of particular research and policy attention.

Keywords

children's independent mobility, neighbourhood, parental perception, physical activity, transportation

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Background

Children's independent mobility (CIM) has been defined as a child's freedom to travel around their own neighbourhood or to public places without adult supervision (Hillman et al., 1990; Schoeppe et al., 2013; Tranter and Whitelegg, 1994). Previous research has recognised the importance of independent mobility for a child's psychological development and welfare. For example, CIM may improve a child's spatial, motor and analytical skills (Davis and Jones, 1996; Rissotto and Giuliani, 2006) and social development (Prezza et al., 2001). Children who travel and play on their own may also demonstrate greater knowledge about their neigbourhoods and a more sophisticated sense of community compared with those who are less independent (Gold and Goodey, 1989; Horelli, 2001; Prezza and Pacilli, 2007). A greater sense of community, in turn, may relate to higher sociability and the attenuation of safety concerns (Prezza and Pacilli, 2007).

More recently, CIM has received attention because of its potential link to physical activity. The majority of North American children do not meet current physical activity guidelines of at least 60 minutes of moderate to vigorous physical activity (MVPA) every day of the week (Stone et al., 2013; Troiano et al., 2008). Within this context, an emphasis on CIM is important, because increased freedom with regard to mobility may offer increased opportunities for active travel (conceivably, a child who is travelling independently would walk, cycle or use transit for transportation) and unsupervised play (Page et al., 2010), and contribute to a child's accumulation of physical activity (Carver et al., 2008; Faulkner et al., 2009). Few studies have reported positive association between CIM and physical activity levels (Mackett et al., 2007; Page et al., 2009; Schoeppe et al., 2013). This existing research is largely situated within Europe, less research has been undertaken to explore the relationship between CIM and objective measures of physical activity (e.g. accelerometer-measured physical activity) in a North American context.

Despite the potential importance of independent mobility for a child's physical and mental health, existing evidence suggests a consistent decline in levels of CIM and an increase in adult supervision across the Western world at least over the last four decades (Fyhri et al., 2011; Gaster, 1991; Hillman et al., 1990; O'Brien et al., 2000). Adult surveillance has become a central characteristic of the modern childhood experience (Fotel and Thomsen, 2004). Parental lack of 'environmental trust' is frequently reported as a major reason that has contributed to this phenomenon (Fotel and Thomsen, 2004; Johansson, 2006; Tranter and Whitelegg, 1994). Improvements in the neighbourhood built and social environment, particularly those that may alleviate parental concerns for a child's safety, then, may offer opportunities for increased CIM. Identifying the environmental correlates of CIM is important for developing policies or interventions to promote greater CIM.

Literature review

A small body of research has examined the correlates of CIM, particularly in Europe and Australia. In this existing literature, the socio-demographic influences on CIM are well documented. Previous research has reported that older children are more independent than younger children (Alparone and Pacilli, 2012; Gaster, 1991; Jones et al., 2000; Prezza et al., 2001). Parental perception of a child's maturity (i.e. capability of coping with the potential dangers encountered on streets and in the neighbourhood), which may sometimes relate to a child's age, is also important (Alparone and Pacilli,

2012; Alparone et al., 2003; Johansson, 2003). Adults tend to permit boys greater independent mobility than girls (Brown et al., 2008; Fyhri and Hjorthol, 2009; Hillman et al., 1990; Page et al., 2009). Household auto ownership is largely uncorrelated with CIM (Hillman et al., 1990; Johansson, 2006). In addition, parental mobility experiences during childhood (Prezza and Pacilli, 2007), and social norms around parental control or responsibility over a child (Tranter and Whitelegg, 1994), may influence CIM. Parental perception of the potential benefits of a child's autonomy may also increae the likelihood of CIM (Alparone and Pacilli, 2012; O'Brien et al., 2000). Lastly, cultural factors are potentially important correlates of CIM; cross-cultural differences in CIM have been documented in previous studies (Hillman et al., 1990; Malone and Rudner, 2011; Shaw et al., 2013; Tranter and Whitelegg, 1994).

With regard to transportation preferences and attitudes, previous research has reported parental perception of convenience and time-savings as two major motivations for escorted (i.e. accompanied by adult caregivers) school trips (Faulkner et al., 2010; McDonald and Aalborg, 2009). In addition, a parent's attitude toward a child's transportation mode (e.g. a child should be driven in a car) may influence escorted versus independent travel (Johansson, 2006). Researchers have also hypothesised an association between a household's mobility lifestyle, in particular, the overall attitude toward transportation modes for household travel, and CIM (Fotel and Thomsen, 2004; Tranter and Whitelegg, 1994). However, the correlation between these household travel attitudes and CIM has not been empirically examined to date.

An emerging literature, largely set in Europe and Australia, has examined the environmental influences on CIM. The current research indicates some associations between neighbourhood built environment and CIM, although findings are sometimes at odds across studies. For example, Broberg et al. (2013) reported higher levels of CIM both in densely built up residential areas and in remote places. In contrast, other researchers have reported lower levels of CIM in large urban areas compared with small urban/rural areas (Jones et al., 2000; Kyttä, 2002). European case studies have reported that residential development with a courtyard setting likely encourages CIM, since courtyards offer a centralised place for parents to observe children engaged in independent play at 'arms length' (Prezza et al., 2001). In addition, parks or green spaces close to home likely increase opportunities for creative play and social interaction, and improve parental perceptions around a child's capability related to CIM (Alparone and Pacilli, 2012; Prezza et al., 2005). Some researchers have found the presence of play areas to be important determinants of CIM (Gaster, 1991). High number of transit stops and access to retail and recreational facilities may also be the markers of an enabling setting for CIM (Broberg et al., 2013; Villanueva et al., 2012). Lin and Chang (2010) explored independent mobility for school transportation in Taipei, Taiwan. Their results indicated some correlations between high sidewalk coverage, high building density, smaller street blocks, narrow streets, street trees and independent school travel (Lin and Chang, 2010).

Lastly, perceptions of the neighbourhood built and social environments (particularly parental perception) have long been hypothesised to have a major influence on CIM (Alparone and Pacilli, 2012; Fotel and Thomsen, 2004; Hillman et al., 1990; Tranter and Whitelegg, 1994). Empirical evidence of such a relationship, however, is relatively limited. Previous research has indicated some associations between perceived traffic danger and CIM (Fyhri et al.,

2011; Johansson, 2006; Villanueva et al., 2012). Parents' and a child's perception of a neighbourhood's social environment (e.g. friendliness of neighbours, fear of a child witnessing a crime and coming in contact with drugs) is also likely important (Alparone and Pacilli, 2012; Jones et al., 2000; Villanueva et al., 2012; Zwerts et al., 2010). Results related to parental perception of a child's personal safety/stranger danger and CIM remain mixed. While some studies have indicated a relationship between perceived social danger/stranger danger and CIM (Alparone and Pacilli, 2012), other quantitative studies have found no such association (Johansson, 2006; Villanueva et al., 2012).

Research questions

While there exists an emerging body of research examining the correlates of CIM, gaps remain, particularly in terms of the role of the neighbourhood environment and parental attitudes toward travel. In addition, the North American context remains understudied. This paper focuses on children's mobility behaviour in the City of Toronto, Canada, which is the largest city in Canada and fourth largest in North America with a population of 2.6 million (Statistics Canada, 2012). Informed by previous research on children's travel behaviour (e.g. Mitra, 2013; Panter et al., 2008), a social-ecological approach was adopted to explore CIM. We hypothesised multiple levels of influence on CIM, which may include the demographic characteristics of a child, socio-economic characteristics of the household, transportation-related preferences and attitudes, and the neighbourhood environmental qualities (in this context, subjective perceptions of parents). In particular, three research questions with regard to CIM were examined: (1) Is independent mobility associated with children's physical activity levels? (2) Do parental perceptions of the neighbourhood environment influence CIM? and (3) What role do parents' mobility-related attitudes have in influencing CIM?

The paper provides a North American account of the importance, prevalence and the correlates of CIM. This information is necessary to assess, once coupled with findings from the international literature, the presence of any unversally compelling evidence regarding the benefits and correlates of CIM, and more crucially, to inform Canadian and North American policies and interventions that may be designed to increase CIM.

Study design

The study is set in Toronto, Canada. Emphasis is given to the relationship between CIM and a child's age and sex, household's socio-economic characteristics, travel attitudes and parental perceptions of neighbourhood environmental qualities. We hypothesise that the adult caregivers are the primary decision makers, for the age group studied here, regarding a child's travel and out-of-home activity participation (McMillan, 2005; Mitra, 2013). As such, parental travel attitudes and perceptions of neighbourhood environment were explored. However, we do acknowledge that children may have some agency in affecting their mobility outcomes (Faulkner et al., 2010; McMillan, 2005; Mitra, 2013) or informing parental attitudes and/or perceptions.

Survey

The data were collected in the City of Toronto between April 2010 and June 2011, as part of Project BEAT (Built Environment and Active Transport; www.beat.utoronto.ca). All elementary/intermediate schools within the Toronto District School Board (TDSB) with Grade 5 and 6 students (n = 469) received an invitation to participate. Of

all schools that expressed an interest in participating, 16 were systematically selected based on their urban locations and neighbourhood incomes. With respect to urban location, half of the schools ($n = 8$) were located in older inner-urban neighbourhoods, the other half ($n = 8$) were located in newer inner-suburban neighbourhoods. In Toronto, the inner-urban neighbourhoods are typically characterised by connected (often gridded) street layout, shorter straight neighbourhood blocks, mixed land use and pedestrian-oriented design. In contrast, the inner-suburban neighbourhoods were typically built after World War II, and can be characterised by curvilinear street layouts, clear street hierarchy, larger blocks, segregated land use and automobile oriented design (Hess, 2009; Mitra and Buliung, 2012; Sewell, 1993). In general, then, these selected neighbourhoods represent both traditional and planned suburban neighbourhood types. However, the built and social environments vary considerably across these 16 neighbourhoods.

With respect to neighbourhood income, four inner-urban and four inner-suburban schools were located in low-income neighbourhoods. A low-income school was identified based on the Dissemination Area (DA; the smallest geographical unit for which census data is collected by Statistics Canada) level median household incomes within 800m straight line distance of the school (Statistics Canada, 2008). Of all TDSB schools, the ones with lower 50th percentile median household incomes were classified as low-income schools. The other eight schools were located in high-income (> 50th percentile income) neighbourhoods.

A total of 1027 parents (i.e. adult caregivers) of children attending grades 5 and 6 gave consent for their children to participate in the study. Both children and their parents took part in a take-home questionnaire survey. In this study, only data from the parental survey were analysed. Parents answered structured questions related to the child who brought the survey home. Children's physical activity data was collected using accelerometry (ActiGraph© GT1M) for a seven-day period (see Stone et al., 2013 for further detail of the accelerometry protocol). A 5 second epoch was used to capture rapid transitions in activity typical in children (Stone et al., 2009a, 2013). Physical activity levels are reported only for those children who recorded accelerometry data for at least three weekdays and one weekend day during the data collection period. Among the 1027 participants, 795 (77.4%) parents completed all the questions relevant for this study. Valid accelerometry data (i.e. at least three weekdays and one weekend day) were available for fewer students ($n = 686$; 66.8%).

Independent mobility

A child's independent mobility was measured using information from the parental survey. Parents were asked the following question regarding their child's independent mobility:

> In general, how often do you allow your child (who gave you this survey) to go out on their own or with friends (without an adult)?

They reported their responses on a four-point ordinal scale: 1 = never; 2 = sometimes; 3 = often; and 4 = always. However, only 2.6% of parents ($n = 21$) indicated that their children were always allowed to go out by themselves. As a result, parental responses were collapsed into three categories: 'never' (survey response = 1), 'sometimes' (survey response = 2) and 'often or always' (survey response = 3 or 4) for the analysis presented in this study.

Physical activity

Child-specific published thresholds of ActiGraph count data were used for the

classification of activity intensity levels (Stone et al., 2009b). Average daily minutes of accumulated moderate to vigorous physical activity (MVPA), obtained from the accelerometry data using a threshold of > 3580 counts/min, was calculated for each child and used as the objectively measured physical activity outcome in this research.

Child's demographic characteristics

Each parent reported the age and sex (boy or girl) of the child who brought the survey home.

Socio-economic characteristics

The parental survey included questions on socio-economic characteristics of the household. Parents reported the number of adult household members (i.e. college age or above) who worked/studied full time, worked/studied part time or had no paid employment. Using these data, a dummy variable '≥ 1 household adults work/study part time or are home makers' (versus all adults work/study full time) was created. Parents also reported the duration of their stay in the current residence; the data was converted into a dummy variable (10 years or more versus up to 9 years) for multivariate analysis. Language that is commonly spoken at home (if English was not the only language) was also reported. The responses were classified into three categories: English or French (i.e. the two national languages in Canada, used as reference), Language spoken in Asian countries (e.g. Arabic, Bengali, Mandarin, Tamil), and Language spoken in other countries (e.g. Albanian, Mandinka, Spanish) (Table 1).

Most parents did not offer household income data. As a result, it was necessary to use area-level household income data to evaluate how CIM might systematically vary by areas differentiated according to household income. This was achieved using the DA-level household income data from the 2006 population census (Statistics Canada, 2008). A child's residential neighbourhood was identified as a low-income neighbourhood when the median of all DA-level median household incomes within a 800 m straight line radius of the home location was less than the 50th percentile (DA-level) median income for the City of Toronto (i.e. < CAD 59,972).

Parental attitudes toward transportation modes

The parental survey asked respondents if they agreed or disagreed with a series of 22 statements related to their attitudes toward travelling and transportation mode choice. Six of these statements were relevant to parental attitude and preference toward household travel (other statements were specific to school transportation), and were analysed in this study (Table 1). For each statement, parents reported their responses on a 5-point Likert scale ranging from 'Strongly Agree' (1) to 'Strongly Disagree' (5). An exploratory principal component analysis of these six variables, using promax rotation with Kaiser normalisation, identified two factors related to travel preferences across 795 parents, which were labelled as 'Car lovers' and 'Active travellers' (Table 2). Two new variables were created using the factor loadings, and were explored in the multivariate analysis.

Perceptions of neighbourhood environment

Neighbourhood environment was assessed by exploring 11 statements that reflected parental perceptions of the social and built environments near a child's residential location (Table 1). Parents reported their observations on a 5-point Likert scale ranging from 'Strongly Agree' (1) to 'Strongly Disagree' (5). A principal component analysis failed to identify meaningful factors. As a result, each

Table 1. Descriptive statistics (n = 795).

	Mean (s.d.)	%
Child's demographic characteristics		
Age	10.48 (0.81)	
Sex		
Boy		46.54
Girl		53.46
Socio-economic characteristics		
$\geq$ 1 household (HH) adults work part time or home maker		
Yes		34.21
No		65.79
Time spent living in current residence		
Up to 9 years		68.43
10 years or more		31.57
Language spoken an home		
English or French		55.35
Asian		10.31
Other		34.34
Low-income neighbourhood		
Yes		46.54
No		53.46
Parental Travel Attitude Statements		
A car is part of a good lifestyle		
Agree		52.45
Neither or disagree		47.55
We prefer to drive whenever possible		
Agree		28.80
Neither or disagree		71.20
Using a car contributes very little to air pollution		
Agree		8.43
Neither or disagree		91.57
We prefer to walk whenever possible		
Agree		78.62
Neither or disagree		21.38
We prefer to bike whenever possible		
Agree		49.94
Neither or disagree		50.06
We prefer to take transit whenever possible		
Agree		38.11
Neither or disagree		61.89
Parental Neighbourhood Perception Statements		
There are not enough sidewalks		
Agree		10.31
Neither or disagree		89.69
There are enough crosswalks or traffic lights to help people cross busy streets		
Agree		62.77
Neither or disagree		37.23
There are major barriers to walking in my neighbourhood		
Agree		10.06
Neither or disagree		89.94

(continued)

Table 1. (Continued)

	Mean (s.d.)	%
There is heavy traffic near my home		
Agree		45.91
Neither or disagree		54.09
Most drivers go too fast while driving in my neighbourhood		
Agree		48.30
Neither or disagree		51.70
The distance between intersections in my neighbourhood is usually short		
Agree		57.36
Neither or disagree		42.64
There are lots of shops and restaurants I can walk to in my neighbourhood		
Agree		63.40
Neither or disagree		36.60
The roads are not attractive enough for a child to walk		
Agree		12.83
Neither or disagree		87.17
I/we am/are worried about my/our child interacting with strangers		
Agree		62.26
Neither or disagree		37.74
People are out and about, talking and doing things with one another		
Agree		61.89
Neither or disagree		38.11
I live in a safe neighbourhood		
Agree		80.50
Neither or disagree		19.50

Table 2. Principal component analysis of parental travel-related attitudes.

	Loadings	
	Factor 1 Car lovers	Factor 2 Active travellers
A car is part of a good lifestyle	0.442	
We prefer to drive whenever possible	0.887	
Using a car contributes very little to air pollution	0.237	
We prefer to walk whenever possible		0.567
We prefer to bike whenever possible		0.851
We prefer to take transit whenever possible		0.388

Note: Principal axis factoring (Promax rotation with Kaiser normalisation).
Kaiser-Meyer-Olkin Measure of Sampling Adequacy: 0.653; Bartlett's test significance: 0.000.

statement was explored as an individual variable. Two of these statements, 'There is heavy traffic near my home' and 'Most drivers go too fast while driving in my neighbourhood', were correlated (Spearman's rank-order correlation coefficient, $\rho = 0.48$). Our preliminary analysis suggested that one of these two variables, 'Most drivers go too fast while driving in my neighbourhood', had a higher impact on the model fit, relative to the other. As a result, this variable was included in the multivariate analysis. The final model specification included ten neighbourhood environment variables. Similar to what has been

done in previous studies (Panter et al., 2010; Timperio et al., 2006), the responses were collapsed into two groups – 'Agree' (1 or 2 on the 5-point scale) and 'Neither or disagree' (3 to 5 on the 5-point scale; used as reference), for multivariate analysis.

Statistical analysis

A linear regression approach was applied to examine the correlation between CIM and physical activity level. CIM (independent variable) was expressed as a categorical variable with three potential outcomes – 'never', 'sometimes' and 'often or always'; the 'never' category was used as the reference. The physical activity level (dependent variable) was expressed in terms of accelerometer-measured MVPA.

Ordered logit models (also known as the proportional odds model) were specified and estimated to explore the correlates of CIM, using NLOGIT 5 (©Econometric Software, Inc.). In these models, a child's CIM (i.e. the dependent variable in the models) was measured using a three-point ordinal scale ('never' versus 'sometimes' versus 'often or always'). A total of two parental travel attitudes (obtained from principal component analysis) and ten environmental perception measures were examined as potential correlates.

The ordered logit modelling approach is different from the more commonly used binomial logistic regression approach (e.g. Broberg et al., 2013; Villanueva et al., 2012), and in this case, allowed an examination of multiple 'levels' of CIM reported on an ordinal scale. In an ordered logit model, the relationship between each pair of independent mobility outcomes (i.e. 'never' versus 'sometimes'; 'sometimes' versus 'often or always') is assumed to be the same (Greene, 2007). A coefficient ($\hat{\beta}_i$) from a multivariate model represents the log odds of being in a higher level with regard to CIM, given that all of the other variables in the model are held constant. A proportional Odds Ratio (OR, i.e. exp $\hat{\beta}_i$), then, represents the adjusted correlation between a variable and the odds of a attaining higher levels of CIM.

Results

The independent mobility of 795 children (10.48 ± 0.81 years old) was examined using data from the parental/caregiver survey. Of these children, 53% were girls and 47% were boys (Table 1). Most households (55%) reported a language background at home of English or French; 32% reported having lived in the same residence for more than 9 years.

Most surveys were completed by mothers of children (76%); only 24% of the surveys were completed by fathers or other adult caregivers (Table 3). There was no difference

Table 3. Children's independent mobility (CIM) in Toronto, Canada.

Independent mobility	Survey respondent					
	All		Mother		Father or other	
	Freq	%	Freq*	%	Freq*	%
Never	280	35.22	205	33.88	75	39.47
Sometimes	389	48.93	302	49.92	87	45.79
Often or always	126	15.85	98	16.20	28	14.74
Total	795	100.00	605	100.00	190	100.00

Note: * Test of difference between mothers and other caregivers: $\chi^2 = 1.98$ (d.f. = 2); $p = 0.371$.

Table 4. Correlation between a child's independent mobility and physical activity levels (n = 686).

	MVPA (min/day)		MVPA (min/day) adjusted for age and sex of a child	
	Coef. (S.E.)	Pr(> |t|)	Coef. (S.E.)	Pr(> |t|)
CIM: Sometimes (reference: Never)	**5.34 (1.14)**	**0.000**	**3.57 (1.06)**	**0.000**
CIM: Often or always (reference: Never)	**7.44 (1.55)**	**0.000**	**5.00 (1.45)**	**0.000**
Boy (ref: Girl)			**11.16 (0.96)**	**0.000**
Age			−0.31 (0.58)	0.597
Constant	**25.60 (0.86)**	**0.000**	**24.95 (6.12)**	**0.000**
R^2	0.044		0.202	
F	15.84 (p = 0.000)		43.18 (p = 0.000)	

Note: Coefficients in **bold** are significant at α = 0.05.

in the reported CIM between these two groups (i.e. mothers versus fathers and other caregivers; $\chi^2 = 1.98$; $p = 0.371$). Overall, 35% of all parents reported that they never allowed their children to go out on their own or with friends (i.e. without adult supervision). Only 16% reported that their children often or always went out independently.

On average, children accumulated 29.36± 13.81 minutes of MVPA per day. Linear regression results demonstrated that CIM was positively correlated with physical activity, even when variations in age and sex were controlled (Table 4). Children who were moderately (i.e. sometimes) and highly (i.e. often or always) independent with regard to outdoor mobility were likely to accumulate 3.57 and 5 more minutes of MVPA per day on average (i.e. 14% and 19.5% increase in the daily MVPA), compared with those who were never allowed to go out unsupervised. The results also indicated that boys were more physically active than girls.

The ordered logit analysis suggests that several aspects of the perceived neighbourhood environment were correlated with CIM level (Table 5). A child was less likely to have a higher level of CIM if the parent was worried about strangers (OR = 0.49), and was more likely to have a higher level of CIM when the parent perceived the residential neighbourhood as safe (OR = 1.77). Attractiveness of neighbourhood streets and the presence of other people 'talking and doing things together' were also associated with CIM, although the statistical significance of these effects was weaker (α = 0.10), particularly when parental travel attitudes were added to the model. In addition, parental travel-related attitudes were correlated with children's mobility behaviour. The child of a parent who preferred walking, cycling or transit as modes for travelling was more likely to have a higher CIM level (OR = 1.28).

In addition to the perceived neighbourhood environment and household travel attitudes, boys and older children were more independent compared with girls and younger children. Language spoken at home (i.e. language background) was associated with CIM (Table 5). The time spent living in the same residence was also correlated with independent mobility; higher CIM levels were more common among children who lived in the same place for 10 or more years

Table 5. Ordered logit results of the correlates of independent mobility (n = 795).

	Not adjusted for attitudes		Adjusted for attitudes	
	Odds Ratio (95% CI)	p	Odds Ratio (95% CI)	p
Parental perceptions of neighbourhood environment				
There are not enough sidewalks	0.92 (0.57–1.49)	0.751	1.00 (0.61–1.62)	0.987
There are enough crosswalks or traffic lights to help walkers cross busy streets	0.89 (0.67–1.19)	0.432	0.90 (0.68–1.21)	0.495
There are major barriers/obstacles to walking in my local neighbourhood that make it hard to get from place to place	1.12 (0.69–1.80)	0.644	1.08 (0.67–1.75)	0.745
Most drivers go too fast while driving in my neighbourhood	0.87 (0.65–1.17)	0.357	0.89 (0.66–1.19)	0.435
The distance between intersections in my neighbourhood is usually short (100 m or less)	0.98 (0.74–1.31)	0.905	0.96 (0.72–1.28)	0.771
There are lots of shops and restaurants I can walk to in my neighbourhood	1.12 (0.81–1.55)	0.498	1.03 (0.74–1.44)	0.843
The roads are not attractive enough for a child to walk	***0.65 (0.41–1.03)***	***0.068***	***0.64 (0.40–1.01)***	***0.059***
I/we are worried about our child interacting with strangers	**0.49 (0.36–0.65)**	**0.000**	**0.49 (0.37–0.66)**	**0.000**
People are out and about, talking and doing things with one another	**1.43 (1.04–1.96)**	**0.027**	***1.34 (0.97–1.85)***	***0.073***
I think I live in a safe neighbourhood	**1.83 (1.25–2.67)**	**0.002**	**1.77 (1.21–2.60)**	**0.003**
Parental travel attitudes				
Factor 1: Automobile lovers			0.96 (1.27–1.87)	0.642
Factor 2: Active travellers			**1.28 (1.04–1.57)**	**0.017**
Child's demographic characteristics				
Boy (reference: girl)	**1.99 (1.51–2.63)**	**0.000**	**2.02 (1.52–2.67)**	**0.000**
Age	**1.57 (1.29–1.91)**	**0.000**	**1.59 (1.31–1.94)**	**0.000**
Socio-economic characteristics				
$\geq$ 1 HH adults work/study part time or are home makers (reference: all adults work/study full time)	***1.30 (0.97–1.74)***	***0.075***	1.24 (0.93–1.67)	0.146

(continued)

Table 5. (Continued)

	Not adjusted for attitudes		Adjusted for attitudes	
	Odds Ratio (95% CI)	*p*	Odds Ratio (95% CI)	*p*
Living in the same residence for 10 years or more (reference: up to 9 years)	**1.40 (1.04–1.89)**	**0.027**	**1.38 (1.02–1.87)**	**0.036**
Language: Asian (reference: English or French)	0.79 (0.49–1.29)	0.347	0.83 (0.51–1.34)	0.438
Language: Other (reference: English or French)	**0.47 (0.33–0.67)**	**0.000**	**0.52 (0.36–0.75)**	**0.001**
Low-income neighbourhood (reference: High-income neighbourhood)	**1.51 (1.10–2.06)**	**0.010**	**1.47 (1.07–2.00)**	**0.017**
Constant	**0.01 (0.00–0.10)**	**0.000**	**0.01 (0.01–0.09)**	**0.000**
Threshold parameter μ_1	**14.05 (11.07–17.85)**	**0.000**	**14.41 (11.31– 18.35)**	**0.000**
Log likelihood (constant only)	−802.337		−802.337	
Log likelihood (full model)	−726.153		−721.356	
Chi-squared	152.37 (d.f. = 17)	<0.000	161.96 (d.f. = 19)	<0.000
McFadden ρ^2 (adjusted)	0.095		0.101	

Note: Independent mobility: Categorical variable representing how often a child is allowed to go out on their own or with friends (without an adult). 0 = never; 1 = sometimes; 2 = often or always.

Odds Ratios (i.e. OR) in **bold** are significant at α = 0.05; ORs in ***bold italics*** are significant at α = 0.10.

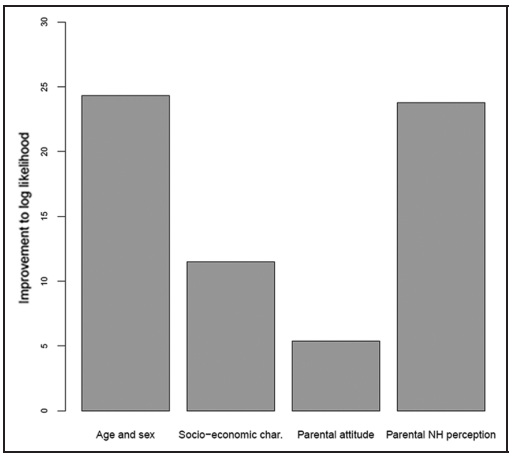

Figure 1. Relative influences on independent mobility. NH: neighbourhood.

(OR = 1.38). Lastly, children living in low-income neighbourhoods were more likely to have higher levels of CIM compared with those who lived in high-income neighbourhoods (OR = 1.47).

A relative comparison of the potential influence of various aspects that were explored in our multivariate analysis, namely (1) age and sex of a child, (2) household's socio-economic characteristics, (3) parental travel attitudes and (4) perceived neighbourhood environment, is presented in Figure 1. The contribution of each of these aspects (more specifically, of a set of variables that represents each aspect) on the model fit or the improvement of the log likelihood was identified and then compared against each other. The results indicate that child's age and sex likely were the most important factors associated with independent mobility, followed by adult perceptions of neighbourhood environmental quality. The socio-economic characteristics of a household had a relatively smaller effect on the model fit. Of the four aspects that were explored in this study, parental travel attitudes had the smallest contribution in explaining CIM.

Discussion and conclusion

This paper explored CIM in Toronto, Canada. To our knowledge, this is the first North American and Canadian study that quantitatively examines the correlation between parental perceptions of the neighbourhood environment and CIM in general; existing research has examined independent mobility in the context of school travel (Faulkner et al., 2010; Mammen et al., 2012) and park-based play (Floyd et al., 2011). In addition, this paper is likely the first empirical work to have explored the association between a household's mobility lifestyle and CIM.

The results presented here suggest that 65% of grade 5 and 6 children in Toronto were allowed out without adult supervision at least some of the time. This observed rate of CIM is lower than what has been reported in European studies on children of similar age. For example, Mackett et al. (2007) reported that 78% of all 10–11 year old children in Cheshunt, UK, enjoyed at least some CIM.

From a public health perspective, our findings build on the limited evidence base indicating that CIM supports a child's daily accumulation of physical activity (Mackett et al., 2007; Page et al., 2009; Schoeppe et al., 2013). CIM was associated with up to 19.5% increase in a child's daily MVPA on average. In addition, we found that this result was persistent across age and sex categories (Table 4). This finding fills an important gap in North American literature where empirical data on the association between CIM and a child's physical activity level are particularly scarce. Although caution is required given the cross-sectional nature of this research, targeting an increase in opportunities for CIM, both in terms of travel and play, might be a novel approach for interventions attempting to increase children's physical activity. Such interventions,

however, would need to address some of the factors that are associated with more or less independent mobility of children.

With regard to these factors of potential influence, our results indicate that the perceptions of built environment qualities such as the presence of sidewalks, cross walks, fast vehicular traffic or shops/restaurants and long street blocks, are largely uncorrelated with CIM. This finding contrasts with some previous studies set in Europe and Australia that indicated perceived traffic danger and the absence of street crossings as major barriers to CIM (Fyhri et al., 2011; Hillman et al., 1990; Johansson, 2006; Villanueva et al., 2012). Instead, we found that in Toronto, the perceived social qualities of the neighbourhood, in particular, parental concerns around stranger danger (OR = 0.49; p = 0.000) and neighbourhood safety (OR = 1.77; p = 0.003), have potentially major influences on CIM levels. It is conceivable that parental assessment of neighbourhood safety may include elements of traffic conditions and neighbourhood design. However, in our sample, the survey response related to neighbourhood safety was not correlated (i.e. $\rho < 0.25$ in all cases) with responses about traffic conditions, land use mix (i.e. presence of shops/restaurants) or neighbourhood design (i.e. long street blocks). As previously discussed in the literature review, findings from European and Australian studies, related to the influence of parental concerns around a child's personal safety on CIM, remain mixed. While some have reported a correlation between perceived personal safety and CIM (Alparone and Pacilli, 2012; Prezza, 2007), others have found no statistical association between personal safety/stranger danger concerns and CIM for non-school travel (Johansson, 2006; Villanueva et al., 2012). This study, then, presents important contextual evidence to inform North American, especially Canadian, policy focused on children's mobility and physical activity.

The model results also indicate that when a parent preferred walking, cycling and transit as their modes of transportation (i.e. 'active traveller'), their child was more likely to have a higher level of CIM (Table 5). This kind of result points toward a potential generational production of a culture of mobility, wherein we see the modelling or transacting of mobility behaviour between parents and their children. The exact causal relationship between household travel attitudes and CIM could not be established and remains the subject of future research. However, two informed speculations can be offered that may explain this observed correlation. First, household members may be captive travellers of active modes, in other words, may have limited or no access to private automobiles to escort their children everywhere, because of income or for other reasons (for example, those who despite having sufficient income prefer to avoid automobile ownership and use altogether). Second, a parent who prefers walking, cycling and transit as travel modes would likely be more aware of the benefits of active mobility and physical activity for their child(ren), and consequently, would allow him/her to go out on their own more often.

Several interesting findings also emerged with regard to the demographic and socioeconomic characteristics that suggest that CIM is not experienced uniformly by children and their caregivers, and that interventions to promote CIM may need to recognize and address diversity (e.g. gender, class, race/ethnicity/culture, social adaptation) in children's mobility. First, our results confirmed previous observations in suggesting that parental decision around CIM is gendered, and that boys enjoy significantly higher CIM than girls (Brown et al., 2008; Fyhri and Hjorthol, 2009; Hillman et al., 1990; Page et al., 2009; Valentine, 1997). The more complex issue with regard to gendered mobility involves the need to more

closely study the context within which these gendered differences in CIM emerge (Hanson, 2010; Murray, 2009).

Second, it appears that a child living in a low-income neighbourhood was more likely to be allowed out without adult supervision, compared with a child living in a high-income neighbourhood.

Third, previous research hypothesised that children who live in households where both parents work full time, or in single parent households, would be less independent (Fyhri et al., 2011; Tranter and Whitelegg, 1994). Our multivariate analysis provides empirical evidence that supports this hypothesis, and indicates a positive correlation between lower parental paid workforce engagement (i.e. at least one adult household member worked/studied part time or were home makers, versus all full time workers/students) and higher CIM levels. However, this statistical association disappeared once parental travel-related attitudes were taken into account (Table 5).

Fourth, our results demonstrated that those who lived in the current residence for a longer period ($>$ 9 years) were likely to allow more CIM. The result possibly indicates that parental trust in the neighbourhood social and built environment, as it relates to their child's independent mobility outside of home, is developed through day to day exposure/experience, and the acquisition of environmental knowledge over time. Previous research has also reported cross-cultural differences in CIM (Hillman et al., 1990; Mammen et al., 2012; O'Brien et al, 2000; Shaw et al., 2013; Tranter and Whitelegg, 1994). In our study, CIM was associated with the language spoken at home. Children were likely to have lower CIM levels in the households where other languages (than English, French or landugages spoken in Asian countries) were spoken. While this finding may suggest ethnic or cultural differences in CIM as others have previously reported, we recognise that ethnicity and culture are social constructs that are more complex than can be reasonably explained by a household's spoken language. More research is clearly needed to improve our understanding about children's mobility and freedom across different ethnicities and cultures; this is a particularly salient issue within many North American cities, and Toronto specifically, where population growth depends largely on immigration.

Findings from the relative comparison of the potential influences on CIM (Figure 1) support our initial hypothesis that perceptions of the neighbourhood environment significantly explained variations in CIM levels. In comparison, the socio-economic condition of a household had a relatively smaller effect on the model fit. Parental travel attitudes also had a limited influence in explaining independent mobility of a child. The overall model fit, however, was low ($\rho^2 = 0.101$), suggesting that many other potential inflences on CIM remains unexplained. Nevertheless, our findings indicate that speculatively an improvement in perceptions of the neighbourhood environment could be an effective way of improving CIM, and through that, the physical activity levels of Canadian children.

However, the results from this study should be interpreted only so far as the data permit. Adult respondents were asked to reflect on how often they allow their children out on their own or with friends. There is a conceptual similarity coupled with a lack of specifity regarding action and place when we compare this study with the work of Hillman et al. (1990) and others (Tranter and Whitelegg, 1994; Watson et al., 2013). We have probed the issue of adults producing CIM by granting permission to their children to be without them.This permission is the beginning of locating children within a setting that is increasingly believed to enable their psychological and physiological

development (Alparone and Pacilli, 2012; Page et al., 2010; Prezza, 2007). We have not looked into the specific points of intersection between permission and particular actions such as crossing main roads or travelling to school without adult supervision. The results from this study, then, are not directly comparable with those where independent mobility is examined at the micro-scale of specific childhood activities in particular places (e.g. Mackett et al., 2007). An exploration of CIM at the scale of individual activities and mobilities scattered across space and time remains a topic of our ongoing work in Toronto.

As a second limitation, the paper purposefully explored parental perceptions of the neighbourhood environment; objectively measured built environment characteristics were not examined. The results from our analysis, then, do not represent the effects related to the objectively measurable physical environment of a neighbourhood.

Lastly, this study hypothesises that adult caregivers are the primary decision makers regarding a child's mobility (Faulkner et al., 2010; McMillan, 2005). However, we recognise that children may play an important role in their mobility decisions, particularly as they develop and mature both cognitively and through repeated exposure to the neighbourhood environment (Bronfenbrenner, 1989; Mitra, 2013; Panter et al., 2008). A child's agency in household decisions regarding their outdoor mobility was not directly explored in this study.

This study makes an important contribution to an emerging literature on children's mobility and physical activity, and the findings have important implications for future policies focused on children's health and wellbeing. Improvement in the neighbourhood environment is an important area on which future interventions should concentrate. However, our results indicate that physical environmental interventions, such as installations of new sidewalks or implementation of traffic calming measures, may not be perceived by adults in Toronto, Canada, or more broadly, in a large North American city, as offering sufficient cause to let their children have more independent mobility. Instead, social qualities of the environment may enable CIM. As such, urban planning and public health initiatives may focus on interventions that enable the production and maintenance of social capital among neighbours, community safety programmes, and other neighbourhood-level surveillance strategies related to a child's environmental safety. Such interventions may also need to be tailored in addressing the concerns of different types of households, for example, those where both parents work, or who have recently moved to a neighbourhood, those with different ethnic and cultural backgrounds, or caregivers of girl(s). Given the demonstrated benefits of independent mobility for children, CIM warrants greater policy and research attention.

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