

The effect of the social and physical environment on children's independent mobility to neighborhood destinations

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1 **Abstract**

2 **Background:** Relationships between context-specific measures of the physical and social
3 environment and children's independent mobility to neighborhood destination types were
4 examined.

5
6 **Methods:** Parents in RESIDE's 4th survey reported whether their child (8-15 years; n=181) was
7 allowed to travel without an adult to school, friend's house, park and local shop. Objective physical
8 environment measures were matched to each of these destinations. Social environment measures
9 included neighborhood perceptions and items specific to local independent mobility.

10
11 **Results:** Independent mobility to local destinations ranged from 30-48%. Independent mobility to a
12 local park was less likely as the distance to the closest park (small and large size) increased and less
13 likely with additional school grounds ($p<0.05$). Independent mobility to school was less likely as
14 the distance to the closest large park increased and if the neighborhood was perceived as unsafe
15 ($p<0.05$). Independent mobility to a park or shops decreased if parenting social norms were
16 unsupportive of children's local independent movement ($p<0.05$).

17
18 **Conclusions:** Independent mobility appears dependent upon the specific destination being visited
19 and the impact of neighborhood features varies according to the destination examined. Findings
20 highlight the importance of access to different types and sizes of urban green space for children's
21 independent mobility to parks.

22

23 Introduction

24 Children's independent mobility, defined as the license and ability to move around the
25 neighborhood unaccompanied by adults,¹ is increasingly being investigated due to a strong
26 association with beneficial health behaviors, such as active travel and physical activity.^{2,3} Moreover,
27 independent mobility provides additional psychosocial benefits by allowing children the
28 opportunity to socially interact with friends and the local community.^{2,4} Independently mobile
29 children are also more likely to develop mapping and way-finding abilities^{5,6} and learn how to
30 interact with and navigate their local built and natural environments.⁷ Despite the many benefits of
31 independent mobility, studies from various countries report a rapid decline in the 1970-1980's to
32 the current low levels.^{2,8-10} For example, since 2002 only about 40% of UK children 7-13 years have
33 been allowed to commute to school unaccompanied.¹¹ Children are increasingly now driven to
34 school and leisure activities.^{8,11} This trend is partly attributed to an increased number of cars in
35 households, a rise in households where both parents work, increased distances between home and
36 school, and a shift from free play in the neighborhood to organized activities outside the
37 neighborhood where children are escorted, predominantly by car.⁸

38
39 A number of demographic, social and physical environment factors are associated with children's
40 independent mobility. More independent mobility appears to be strongly associated with being male
41 and older (vs. female and younger)^{1,4,6,12} and having siblings and friends.^{4,13-15} Parents oversee their
42 children's travel behavior¹⁶ and thus their perceptions of the social and physical environment
43 impact on their children's freedom to travel independently. "Traffic danger" and "stranger danger"
44 are two main reasons why parents restrict their child's independent mobility.^{1,8,15} However, children
45 living in neighborhoods with well connected, low traffic streets have higher overall independent
46 mobility.¹⁷ Broader community social constructs such as collective efficacy (i.e., mutual trust and
47 the shared willingness of residents to intervene for the public good),¹⁸ and perceptions of social and

48 physical disorder (e.g., vandalism, graffiti, evidence of drug and alcohol use) may also play a role in
49 parent's willingness to grant their children mobility licenses.¹⁵ To date, studies of the environmental
50 correlates of independent mobility have been limited by the lack of objective and context-specific
51 measures of the physical and social environment.^{6,19}

52
53 The majority of studies of children's independent mobility focus on one type of destination, travel
54 to or from school.² There are fewer studies examining children's independent mobility to leisure
55 activities (e.g., going to the park, visiting friends)⁸ and destinations such as local shops.²⁰
56 Promoting active travel to these types of activities has been identified as a viable strategy to
57 increase children's physical activity.²¹ A recent study reported that the physical environment was
58 correlated with non-school walking journeys (e.g., friends' houses, shops, parks, places of worship
59 and clubs) but not walking to school, highlighting that the physical environment may be more
60 important for discretionary journeys compared with school journeys.^{22,23} There appear to be no
61 studies to date that have investigated neighborhood factors associated with independent mobility to
62 specific destination types, nor how the quality of neighborhood environments influences the type of
63 destination a child visits independently. This research requires the use of context-specific measures
64 of the behavior and the environments¹⁹ and is important for a consistent evidence base to inform the
65 development of more targeted independent mobility interventions. The aim of this study was to use
66 a social-ecological model²⁴ to examine the relationship between context-specific measures of the
67 physical and social environment and children's independent mobility to and from each of the
68 following local destinations: school (a non-discretionary destination), friend's house, park, local
69 shop (discretionary destinations), and overall. We hypothesized that destination-specific features of
70 the physical environment (e.g., presence, type and distance to parks) would be associated with
71 independently mobility to that particular destination (i.e., a local park).

72

73 **Methods**

74 **Sample and procedure**

75 The sample included parents participating in the RESIDential Environments Project (RESIDE).
76 RESIDE commenced in 2003, and is a longitudinal natural experiment of 1813 people building
77 homes in 73 new housing developments across metropolitan Perth, Western Australia.²⁵ Details of
78 the RESIDE study recruitment and design are described elsewhere.²⁵ Briefly, participants moving
79 to a development were invited to participate by the state water authority following a land transfer
80 transaction. The following eligibility criteria were applied: English proficiency; ≥ 18 years;
81 intention to relocate by December 2005; and willingness to complete surveys four times over
82 seven years. Participants were recruited by telephone and one adult from each household
83 randomly selected. Participants were surveyed four times: before relocation (T1 - n=1813); then
84 approximately one (T2 - n=1467), three (T3 - n=1230) and seven (T4 - n=565) years after moving
85 house. This sample was selected from all parents (n=305) who provided data on their children's
86 independent travel at the fourth time point (i.e., T4, Feb 2011-Mar 2012). A total of 181 children
87 who were aged 8-15 years were included. If there were more than one child within this age range in
88 the household, the youngest was included. This age range was selected because it represents when
89 children may be given licenses to move independently around their neighborhood.¹ The University
90 of Western Australia's Human Research Ethics Committee provided ethics approval.

91

92 **Measures**

93 *Independent mobility measure:* Parents reported whether their child was allowed to walk or cycle
94 alone or with other children (without an adult) to or from four neighborhood destinations: school;
95 friends or family house; park, oval or sporting field; and local shop (e.g., deli, newsagent).²⁶
96 Children who were independently mobile to ≥ 3 destinations were coded as having 'overall'
97 independent mobility.

98

99 *Physical environment measures:* Geographic Information Systems (GIS) software was used to
100 calculate objective measures of the physical environment within a 1600m road network buffer
101 around each participant's home.²⁷ Objective measures of the neighborhood environment were
102 matched to three (park, school and shop) of the four destinations of interest (this was not possible
103 for 'friend's house' as an address was not recorded).

104

105 Park-related variables were derived from a spatial public open space layer developed for the Perth
106 metropolitan area in 2011 (n=3463 parks)²⁸ and included distance (m) to closest park by size
107 category (pocket ≤ 0.3 hectares (ha), small $>0.3-\leq 0.5$ ha, medium $>0.5-\leq 1.5$ ha, large >1.5 ha),²⁸
108 count of parks, count of school grounds (ovals, sport and play spaces owned/adjacent to school),
109 presence of playground at closest park, and an attractiveness score of closest park (derived from
110 objective measures of park attributes such as the presence of irrigated lawns, walking paths, trees,
111 sporting facilities, amenities, water features, lighting).²⁹ Park attributes were determined by remote
112 sensing methods (Google Earth) using the Public Open Space Desktop Auditing Tool (POSDAT),
113 which has been shown to be a valid and reliable tool for assessing park quality.³⁰ We hypothesized
114 that larger parks have more attributes and thus children are more likely to independently travel to
115 these destinations compared with smaller parks.

116

117 School-related variables including count of primary schools and the presence of secondary schools
118 were determined using GIS (data provided by the Western Australian Department of Education and
119 Department of Planning). We calculated the presence of shops for daily living (i.e., deli, general
120 store, supermarket, produce market, gasoline station, shopping center) using data from a
121 commercial electronic database of services and stores (Sensis Pty Ltd).²⁷ Traffic exposure was
122 calculated using the Western Australian Main Roads 'road function' which is a measure of traffic

123 volume (number of vehicles/day).³¹ The ratio of the total length of heavy road volume types by the
124 total length of all road volume types was determined.

125

126 *Social environment measures:* Parent-report measures of neighborhood problems included scales
127 measuring poor neighborhood maintenance (e.g., littering and dumping of rubbish in public areas);
128 social incivilities (e.g., using or selling drugs); graffiti and vandalism; property crime (e.g.,
129 household burglary); violent crime (e.g., domestic violence); and two single items of loitering
130 teenagers in public places and dangerous or drink driving. All scales/items were rated on a four-
131 point scale (1=not a problem, 4=significant problem) and then dichotomized, with respondents
132 reporting one or more items in the scale as a ‘moderate problem’ classified as perceiving a problem.
133 Details of these measures are reported elsewhere.³²

134

135 A measure of how safe the neighborhood environment was for children to walk or cycle around the
136 neighborhood without adult accompaniment was based on existing items³³ that captured parent
137 perceptions of: parks unsafe; not enough footpaths (2 item sub-scale); too much traffic; (single
138 item) and high level of crime risk or abduction make it difficult for children to safely move around
139 their neighborhood without adult supervision (2 item sub-scale). The two sub-scales and the single
140 item were rated on a five-point scale (1=strongly disagree, 4=strongly agree) and then dichotomized
141 and combined into an ‘unsafe environment’ scale (range 0-3; scores ≥ 1 =unsafe environment).
142 Single items (5 point Likert scale dichotomized to agree vs. disagree) were used to measure poor
143 collective efficacy (‘People in the neighborhood don’t look out for children who move around the
144 area without adult supervision’), and poor parenting social norms (‘Parents shouldn’t let primary
145 school age children move to and from places without adult supervision’).³³

146

147 **Statistical analyses**

148 Logistic regression models adjusting for child age, gender and siblings, and parent age, gender and
149 education, were used to separately examine the relationship between each objective physical
150 environment and each parent perceived social environment variable and independent mobility to
151 each of the four destinations and overall independent mobility. All physical and social environment
152 variables significant at $p \leq 0.1$ were then included in a multivariable logistic regression model.

153

154 **Results**

155 The mean age of children was 10.7 (SD 2.1) years and 45% were boys. Overall, 22% of children did
156 not have a sibling, 35% had a younger sibling (0-7 years), and 56% had an older sibling (8-17
157 years) (Supplementary Table 1). Thirty percent of children were independently mobile to and from
158 school, 40% to a friend's or another family member's house, 48% to a park, oval or sporting field,
159 30% to the local shop and 29% to at least three of these local destinations (i.e., 'overall') (Table 1).

160

161 In multivariable models adjusting for child and parent socio-demographic and all physical and
162 social environment variables significant at $p \leq 0.1$ (see Supplementary Table 2), parent perception of
163 an unsafe neighborhood for children to move around independently significantly decreased the odds
164 of being independently mobile to school (OR=0.25; 95% CI=0.09-0.70) and overall (OR=0.21; 95%
165 CI=0.06-0.70) (Table 2). If parents perceived that parenting social norms were unsupportive of
166 independent mobility, the odds of their child's independent mobility to the local park (OR=0.64;
167 95% CI=0.42-0.97) and shop (OR=0.56; 95% CI=0.34-0.91) significantly decreased. None of the
168 perceived neighborhood problems variables (e.g., social incivilities, violent crime, loitering
169 teenagers in public places, dangerous or drink driving) retained significance in the multivariable
170 models.

171

172 A number of objectively measured physical environment variables were significantly ($p < 0.05$)
173 associated with independent mobility to specific neighborhood destinations (Table 2); increasing
174 access to local school grounds was associated with reduced independent mobility to the park
175 ($OR = 0.77$; 95% $CI = 0.62-0.96$); increasing distance to the closest large sized park was associated
176 with reduced independent mobility to the park and school ($OR = 0.86$; 95% $CI = 0.77-0.95$, $OR = 0.88$;
177 95% $CI = 0.79-0.99$, respectively), and increasing distance to the closest small sized park was
178 associated with reduced independent mobility to the park ($OR = 0.85$; 95% $CI = 0.76-0.96$). A
179 sensitivity analysis (results not shown) to determine if there were any changes in the effects of
180 physical environment variables before and after adjusting for the social environment variables
181 revealed that there was no change and that the same physical environment variables were
182 independently associated with independent mobility regardless of adjustment for social environment
183 variables.

184

185 **Discussion**

186 This study examined the effect of physical and social environment features on children's
187 independent mobility to a number of local destinations (school, park, local shop and friend's house).
188 After adjustment for child and parent socio-demographic variables, parent perceived context-
189 specific measures of the social environment (i.e., neighborhood safety and parenting social norms
190 related to children's independent movement in the neighborhood) were consistently associated with
191 independent mobility to each destination, except a friend's house. Objective neighborhood physical
192 environment features were associated with independent mobility but were dependent on the
193 destination of interest.

194

195 Objectively measured context-specific features of the physical environment were associated with
196 children's independent mobility and varied according to the destination examined. Previous studies

197 show that living nearer a park is positively associated with independent mobility^{4,12,13} and our
198 findings support this; independent mobility to a local park decreased as the distance to both the
199 closest small and large sized park increased, even after adjustment for all other factors. Our findings
200 also suggest that access to both small and larger sized local parks is important for encouraging
201 children's independent mobility. To date, the influence of park size has been primarily limited to
202 adult physical activity outcomes,³⁴ or considered in the context of recreational planning and public
203 open space strategies.³⁵ Most public open space planning guidelines acknowledge the importance
204 of providing different sized parks within local catchment areas,³⁶ however the influence of park
205 proximity and size on children's independent travel remains relatively unknown. Further research is
206 warranted to guide urban green planners and developers on the importance of access, size and
207 attributes of local parks for children's independent mobility, physical activity and other health and
208 development outcomes.

209

210 Our findings highlight the need to consider the social and physical environment influences on
211 independent travel to school and individual discretionary destinations (friend's house, park, shops)
212 separately.²² Somewhat counter intuitively, increased availability of local school grounds was
213 associated with reduced independent mobility to a local park. It may be that parents are less
214 inclined to allow their children to travel independently to the local park if there is a more familiar
215 or child orientated school oval or playground nearby. These findings indicate the need for school
216 grounds to be accessible out of school hours as they provide an important local destination that
217 children can independently travel to and from. Unfortunately this appears at odds with trends,
218 particularly in Australia, towards fencing off and gating of school grounds.³⁷

219

220 A number of studies have examined objectively measured physical environment correlates of active
221 travel to school.^{38,39} We observed that independent mobility to school decreased with increasing

222 distance to the closest large sized park. It is likely that having destinations such as parks en route to
223 and from school provides children with safe places to stop and play as well as cut-throughs away
224 from the main roads thus reducing their exposure to traffic.^{13,17,40} Future studies should explore the
225 multiple built influences on children's independent mobility when more than one destination is
226 visited in a single trip.

227

228 In the final multivariate model the only factor significantly associated with independent mobility to
229 a friend's house was child age. It is possible that the other variables may have been statistically
230 significant had we had a larger sample size and hence, they could be considered in future studies.
231 However, it is also possible that independent travel to a friend's house involves a child travelling to
232 a familiar local destination (i.e., one regularly visited) along a familiar route and in a familiar
233 neighborhood. Thus parents may have fewer concerns. Moreover, compared with other destinations,
234 parents can generally easily confirm whether or not their child has arrived safely and this may help
235 to alleviate some of their concerns about the environment being unsafe and poor social norms
236 amongst parents about allowing children to independently travel.

237

238 Aspects of the social environment were also important for children's independent mobility. In the
239 final models only context-specific measures of how safe the neighborhood was for children to move
240 independently and unsupportive parenting social norms about children children's independent
241 movement were associated with reduced independent mobility to each of the destinations (except
242 friend's house) and overall. Parent perceptions of neighborhood safety including safety from traffic
243 and stranger danger are significantly associated with children's physical activity,^{41,42} active school
244 transport³⁸ and overall independent mobility.^{41,43 44} Our findings confirm that parents who perceive
245 the neighborhood environment as unsafe for children to move around independently are less likely
246 to grant their children licenses to independently travel to a number of different local destinations.

247

248 While it appears parent's increased concerns about traffic danger may correspond to evidence of
249 children being at greater risk from traffic accidents,⁴⁵ concerns about stranger danger have been
250 shown to be substantially unfounded⁴⁶ and largely fuelled by a pervasive culture of parental fear
251 and over-protection.⁴⁷ Moreover, parent's perceptions of neighborhood safety may contribute to a
252 social norm that parents shouldn't allow their children (especially those still attending primary
253 school) to move to and from places without adult supervision (i.e., that responsible parenting
254 equates to constant supervision of children).¹² These social norms can be reinforcing and may
255 supersede any benefits arising from a positive collective efficacy surrounding children moving
256 around the neighborhood independently. Strategies aimed at improving the quality of the local
257 physical environment as well as community level indicators such as sense of community and social
258 capital,^{12,48} may improve parent perceptions of the local neighborhood and its residents and increase
259 children's opportunities to develop independent mobility.

260

261 Overall, our findings highlight that the social environment (e.g., parent perceived safety and social
262 norms) influences children's independent mobility regardless of the destination being visited.
263 Programs aimed at educating parents about the real (from actual crime data) versus perceived safety
264 concerns about children travelling independently around the neighborhood are required.⁴⁹ These
265 programs should also emphasize the child benefits derived from developing independence and
266 address the issues of parental peer pressure to constantly supervise children and an underlying risk-
267 averse culture.⁵⁰⁻⁵² Whole of community approaches to improve sense of community and social
268 capital may help to reverse social norms associated with the restriction of children's independent
269 mobility by creating neighborhoods where people look out for children and support the
270 development of their independence.^{50,53} Our findings also highlight that the physical environment is
271 associated with independent mobility to neighborhood destinations even after adjusting for socio-

272 demographic and social environment factors. Our study appears to be one of the first to observe that
273 the influence of objectively-measured physical environment on children's independent mobility is
274 specific to the destination being visited. For example, access to different types (parks and school
275 grounds) and sizes (small and large) of urban green spaces was associated with children's
276 independent mobility to a park. A combined strategies approach is required to provide children with
277 access to a variety of safe neighborhood destinations, allay parent safety concerns and educate
278 children about safely navigating their neighborhoods independently.

279

280 **Study Limitations:** The generalizability of the findings may have been compromised because
281 RESIDE participants live in relatively new housing developments on the urban fringe and thus may
282 not be representative of all parents and children. This study relied on parent-report measures of
283 independent mobility and the social environment. Future studies should consider including child-
284 report measures of independent mobility and their perceptions of the environment as well as
285 objective measures of the social environment (e.g., crime rates and child-related offences).

286 Furthermore, our study did not include all features of the perceived social environment considered
287 important for children's independent mobility. Future empirical studies should also measure the
288 influence of peers, parent level of local walking, dog ownership, parent and child perceptions of
289 appropriate destinations and the value of these local destinations.⁵⁴⁻⁵⁶ However, context-specific and
290 objectively measured physical environment features were strengths of this study. Another strength
291 of this study was its investigation of the social and physical environment features associated with
292 independent mobility to a number of different local destinations. Future studies should use Global
293 Position Systems (GPS) to objectively measure destinations children visit along with a self-report
294 measure (SMS or an app) to determine if the travel has been unaccompanied by adults.^{57,58}

295

296 While this study appears to among the first studies to empirically investigate the physical (and
297 social) environment factors associated with children's independent mobility to a friend's house and
298 local shop, no objectively measured physical environment variables in the final models were
299 significantly associated with independent mobility to these destinations. This may be due to a lack
300 of a context-specific measure for friend's house (e.g., distance to closest friend's house) and the
301 sample size. Future studies should include objective measures of street connectivity, traffic
302 exposure and intersection crossings and investigate the relative influence of social and physical
303 environment factors on independent mobility to different local destinations (stratified by gender)
304 using context-specific objective measures and larger sample sizes.

305

306 **Conclusion:** Parent perceptions of neighborhood safety and parenting social norms were
307 consistently associated with independent mobility to all of the specific destinations examined,
308 except a friend's house. Associations between objective physical environment features and
309 independent mobility were dependent on the destination of interest and remained significant after
310 adjusting for social environment factors. Access to different sized parks as well as school grounds
311 were associated with independent mobility to a park, highlighting that access to different types of
312 urban green spaces is important for children's independent mobility to key non-school destinations
313 and that the influence of physical environment factors on children's independent mobility is specific
314 to the destination being visited. Future research should examine correlates of independent mobility
315 to individual destinations other than school using objective context-specific measures of the
316 physical and social environment. Further evidence of the influence of the physical environment on
317 children's independent mobility to specific destinations when more than one destination is visited in
318 a single commute is also required.

319

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477 Table 1: Physical and social environment and independent mobility characteristics of sample

	N (%) or mean (SD)
Social environment factors	
Poor neighborhood maintenance	70 (38.7)
Social incivilities	46 (25.4)
Graffiti and vandalism	44 (24.3)
Property crime	34 (18.8)
Loitering teenagers in public places	25 (13.8)
Dangerous or drink driving	28 (15.5)
Violent crime	14 (7.7)
Unsafe environment for children to independently move around neighborhood	62 (34.3)
Poor collective efficacy for children to independently move around neighborhood	64 (35.4)
Parenting social norm doesn't support children to independently move around neighborhood	84 (46.4)
Physical environment factors	
Count of primary schools, mean (SD)	1.5 (1.2)
Presence of Secondary school	71 (39.2)
Count of school grounds, mean (SD)	2.7 (2.0)
Count of parks, mean (SD)	13.6 (5.8)
Distance to closest park (any size category) (m), mean (SD)	214.8 (258.6)
Distance to closest pocket size park (m), mean (SD)	920.2 (521.6)
Distance to closest small size park (m), mean (SD)	511.2 (396.0)

Independent mobility to neighborhood destinations

Distance to closest medium size park (m), mean (SD)	728.9 (514.7)
Distance to closest large/district size park (m), mean (SD)	595.1 (467.8)
Attractiveness score of closest park, mean (SD)	37.6 (14.2)
Presence of playground at closest park	101 (55.8)
Presence of shops for daily living (convenience stores)	80 (44.2)
Traffic exposure	16.7 (10.0)

Independent Mobility

Independently mobile to and from:

School	54 (30)
Friends/family house	72 (40)
Park/oval/sporting field	87 (48)
Local shop	55 (30)
Overall Independent Mobility ^a	53 (29)

478 ^a Independently mobile to and from three or all four of the destinations

479 Table 2: Multivariate models of the socio-demographic, social and physical environment factors associated with independent mobility to specific
 480 destinations and overall

	School	Friends or family house	Park/oval or sporting field	Local shop	Overall Independent Mobility ^a
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Socio-demographic factors					
Child age	1.61 (1.28-2.02)***	2.02 (1.58-2.58)***	1.94 (1.48-2.56)***	2.64 (1.91-3.64)***	2.45 (1.82-3.30)***
Child gender (Ref=girl)	0.76 (0.34-1.67)	1.61 (0.73-3.58)	3.78 (1.53-9.32)***	2.40 (0.94-6.10)*	2.10 (0.83-5.30)
Parent age	0.94 (0.87-1.02)	0.99 (0.92-1.06)	0.98 (0.90-1.07)	1.02 (0.93-1.12)	1.00 (0.91-1.09)
Parent gender (Ref=male)	1.64 (0.65-4.12)	1.23 (0.53-2.87)	1.16 (0.46-2.95)	1.83 (0.65-5.17)	1.87 (0.68-5.14)
Parent education (Ref=Bachelor degree or higher)	1.00	1.00	1.00	1.00	1.00
Trade/Certificate/Diploma	2.56 (0.92-7.13)*	1.00 (0.40-2.56)	1.82 (0.63-5.26)	1.11 (0.37-3.31)	0.70 (0.24-2.06)
Secondary school	1.87 (0.65-5.33)	0.67 (0.24-1.83)	1.00 (0.32-3.23)	0.53 (0.16-1.79)	0.33 (0.10-1.12)*
Older sibling of same gender	2.63 (1.09-6.32)***	-	-	6.17 (2.07-18.34)***	2.77 (1.02-7.52)**

Independent mobility to neighborhood destinations

Number of older siblings	-			-	-
(Ref=none)		1.00	1.00		
one		2.24 (0.94-5.35)*	7.29 (2.57-20.68)***		
≥two		0.75 (0.22-2.60)	0.98 (0.27-3.53)		
Physical environment factors					
Count of Primary schools	-	-	-	1.59 (0.89-2.84)	-
Presence of Secondary schools	1.46 (0.62-3.46)	-	-	-	-
Count of school grounds	1.10 (0.90-1.36)	-	0.77 (0.62-0.96)**	1.05 (0.77-1.42)	-
Distance to closest small size park (100m), mean (SD)	-	-	0.85 (0.76-0.96)***	-	-
Distance to closest large/district size park (100m), mean (SD)	0.89 (0.79-0.99)**	-	0.86 (0.77-0.95)***	0.93 (0.83-1.04)	-
Attractiveness score of closest park	1.01 (0.98-1.05)	-	-	-	1.03 (0.99-1.07)
Presence of shops for daily living (convenience stores)	-	0.52 (0.23-1.19)	-	-	-

Social environment factors

Social incivilities	-	-	0.63 (0.20-2.01)	-	-
Loitering teenagers in public places	-	0.54 (0.14-2.11)	0.44 (0.10-1.92)	-	-
Dangerous or drink driving	0.34 (0.09-0.70)	-	-	-	-
Violent crime	-	0.38 (0.05-3.14)	-	-	-
Unsafe environment for children to independently move around neighborhood	0.25 (0.09-0.70)***	0.45 (0.17-1.20)	0.63 (0.22-1.80)	0.37 (0.12-1.16)*	0.21 (0.06-0.70)**
Parenting social norm doesn't support children to independently move around neighborhood	0.80 (0.54-1.19)	0.76 (0.52-1.12)	0.64 (0.42-0.97)**	0.56 (0.34-0.91)**	0.68 (0.43-1.07)*

481 IM=Independent Mobility; Ref=Reference category; *p≤0.1; **p≤0.05; ***p≤0.01

482 ^a Independently mobile to ≥three destinations



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