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Built environment characteristics and parent active transportation are associated with active travel to school in youth age 12–15

Jordan A Carlson[1], **James F Sallis**[1], **Jacqueline Kerr**[1], **Terry L Conway**[1], **Kelli Cain**[1], **Lawrence D Frank**[2], and **Brian E Saelens**[3]

[1]Department of Family and Preventive Medicine, University of California, San Diego, California, USA

[2]School of Community and Regional Planning, University of British Columbia, Vancouver, British Columbia, Canada

[3]Department of Pediatrics, Seattle Children's Research Institute, Seattle, Washington, USA

Abstract

Purpose—To investigate the relation of factors from multiple levels of ecological models (ie, individual, interpersonal and environmental) to active travel to/from school in an observational study of young adolescents.

Methods—Participants were 294 12–15-year olds living within two miles of their school. Demographic, psychosocial and perceived built environment characteristics around the home were measured by survey, and objective built environment factors around home and school were assessed in Geographic Information Systems (GIS). Mixed effects multinomial regression models tested correlates of engaging in 1–4 (vs 0) and 5–10 (vs 0) active trips/week to/from school, adjusted for distance and other covariates.

Results—64% of participants reported ≥1 active trip/ week to/from school. Significant correlates of occasional and/or habitual active travel to/from school included barriers (ORs=0.27 and 0.15), parent modelling of active travel (OR=3.27 for habitual), perceived street connectivity (OR=1.78 for occasional), perceived pedestrian safety around home (OR=2.04 for habitual), objective street connectivity around home (OR=0.97 for occasional), objective residential density around home (ORs=1.10 and 1.11) and objective residential density around school (OR=1.14 for habitual). Parent modelling interacted with pedestrian safety in explaining active travel to/from school.

Correspondence to: Dr Jordan A Carlson, Department of Family and Preventive Medicine, University of California, San Diego, 3900 5th Ave Suite 310, San Diego, CA 92103, USA; jacarlson@ucsd.edu.

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Conclusions—Results supported multilevel correlates of adolescents active travel to school, consistent with ecological models. Correlates of occasional and habitual active travel to/from school were similar. Built environment attributes around schools, particularly residential density, should be considered when siting new schools and redeveloping neighbourhoods around existing schools.

Active travel to/from school has been consistently associated with higher total physical activity,[1–3] and there is some evidence supporting its relationship with health-related outcomes such as greater fitness and lower adiposity.[4–7] US studies have documented low rates of active travel to/from school in middle-school-aged youth, between 10% and 25%,[8–11] and these rates have declined substantially from past decades.[12] Increasing active travel to/from school could increase the number of youth meeting physical activity guidelines from the current low rate of 12–15%.[13,14] An increase in physical activity could contribute to reducing the 18.1% of youth aged 12–19 classified as obese.[15]

Cross-sectional studies have generally found that boys,[8,16,17] non-Caucasians[8,10] and youth aged 12–13[10] were more likely to use active travel to/from school than their older and younger counterparts. Parental concerns of safety[9,18–22] and low perceived neighbourhood social capital[18–20] have been related to less active travel to/from school. Built environment factors around youth’s homes and along the route to school, such as walkability (ie, having built environments that support walking),[9,21] land use mix[10,17] and marked street crossings,[18,20] have been positively associated with active travel to/from school. The relationship between street connectivity and active travel to school has been positive in some studies[16,23] and negative in others.[20,21] The strongest and most consistent factor related to active travel to/from school has been distance.[11,17,20,22,24,25] Psychosocial factors hypothesised to be related to active transport to school, such as self-efficacy and social support, have been less studied, with inconsistent findings.[2,20,21,24,25]

Ecological models of behaviour predict that individual, social environment, built environment and policy factors work together to influence physical activity in youth.[26] Policy and environment strategies have a high likelihood for sustainability and reaching large numbers of youth. These strategies may be enhanced by incorporating individual-level supports such as health-oriented attitudes and self-efficacy.[26,27] Safe Routes to School is an example of an intervention that incorporates strategies from multiple levels of influence (eg, classroom education, walking groups and environmental changes such as adding crosswalks). Thus, evaluating how factors from multiple levels of influence are related to active travel to/from school could provide evidence to guide practices such as Safe Routes to School, neighbourhood redevelopment and school siting.

The aim of the present study was to investigate the relation of factors from multiple levels of an ecological model for active travel to/from school to reported active travel to/from school in youth aged 12–15 years. Psychological and interpersonal factors were grouped together to represent common factors from psychosocial theories (eg, Social Cognitive Theory), while perceived and objective environment attributes were included to represent other levels of influence in ecological models. Built environment attributes around homes and schools were assessed. It was hypothesised that psychosocial and environmental factors would contribute to explaining participants' active travel to/from school and that the

METHODS

Participants

Present analyses used data from the Teen Environment and Neighborhood (TEAN) observational study of neighbourhood environment and physical activity that was conducted in the Baltimore, Maryland-Washington, DC and Seattle-King County, Washington metropolitan areas during 2009–2011. Participants in the larger study were 928 adolescents and one of their parents, selected from census block groups representing high or low walkability and high or low income; that is, four block group types based on GIS measures of walkability and median household income from Census 2000 data, using methods similar to those described in a previous study.[28] Households with adolescents aged 12–16 were identified from a list purchased from a marketing company. Adolescents were recruited by mail and telephone and were considered ineligible if they had a condition affecting their physical activity (eg, physical disability), dietary habits (eg, eating disorder) or ability to participate (eg, developmental disability).

Measures

Active travel to/from school—Adolescents reported the number of days they travelled (1) to and (2) from school by walking, bicycling or skateboarding on an average school week. The measure was adapted from the Centers for Disease Control and Prevention's Kids-Walk-to-School programme.[29] Prior test–retest intraclass correlation coefficients (ICCs) ranged from 0.51 to 0.84, and percentage agreement from 73% to 95%.[2030] The total number of active trips to and from school was split into three categories based on the distribution of the continuous variable, and so environmental correlates of occasional (vs no) and habitual (vs no) active travel to/from school could be compared. The categories were 0 trips to/from school, 1–4 trips to/from school (occasional) and 5–10 trips to/ from school (habitual).

Demographics—Adolescents' age, gender and ethnicity (non-Hispanic Caucasian vs other) were collected from an adolescent survey, and parents' highest level of education (college degree or higher vs other), marital status (married/living together vs other), work status (works full-time outside of the home, yes/no) and number of vehicles per licensed driver in the household were collected from a parent survey.

Psychosocial measures—Six psychosocial constructs were assessed in the adolescent survey and one in the parent survey. The surveys are available at: sallis.ucsd.edu/measure_tean.html.

Self-efficacy for physical activity was assessed with a mean of six items rated on a five-point scale ranging from 1 "I know I can't" to 5 "I know I can" (α=0.76; test–retest ICC=0.71).[31] The items were specific to overcoming barriers (eg, do physical activity even when sad or stressed).

Decisional balance for physical activity was assessed using five pros items (α=0.81; test–retest ICC=0.74) and five cons items (α=0.53; test–retest ICC=0.86) rated on a four-point scale ranging from 1 “strongly disagree” to 4 “strongly agree”.[31] Pros items asked about the benefits of physical activity (eg, is fun) and cons items asked about negative aspects of engaging in physical activity (eg, takes time away from being with friends). A decision balance score was created by subtracting the cons from the pros.

Perceived barriers specific to walking and bicycling to/from school, including those related to psychological/planning (eg, get hot and sweaty), safety (eg, stray dogs) and environmental factors (eg, no sidewalks), were assessed using a mean of 17 items rated on a four-point scale ranging from 1 ‘strongly disagree’ to 4 ‘strongly agree’ (α’s=0.70–0.83; test–retest ICCs=0.60–0.75).[32]

Peer (2 items) and parent (3 items) social support for physical activity was rated on a five-point scale ranging from 0 “never” to 4 “very often”. The items covered instrumental and encouragement types of social support (eg, encourages me to do physical activity, does physical activity with me). These scales were adapted from a previous study (ICC=0.68 and 0.74).[31]

Parent’s self-reported engagement in any vs no active travel was used as a proxy for parental modelling of active travel. The measure consisted of 1 yes/no item from the active transportation section of the Global Physical Activity Questionnaire, which had a test–retest κ of 0.72 and percentage agreement of 88.3%.[33]

Adolescents reported on 14 possible rules (yes/no) their parent(s) had regarding physical activity (α=0.87; test–retest ICC=0.68; data from a prior sample not previously published). Examples included “come in before dark” and “do not ride bike on street”.

Perceived neighbourhood environment (around home)—Parents completed a subset of the Neighborhood Environment Walkability Scale for Youth (NEWS-Y) which assessed perceived land use mix-diversity (20 items), land use mix-access (2 items; eg, parking is difficult near shopping), street connectivity (2 items; eg, many different routes to get from place to place), walking facilities (3 items; eg, sidewalks on most streets), neighbourhood aesthetics (4 items; nice things to look at), traffic safety (3 items; traffic makes it unpleasant to walk), pedestrian safety (3 items; crosswalks on busy streets) and crime safety (5 items; high crime rate). Response options on each scale ranged from 1 to 4 with larger numbers representing greater walkability (some items reverse scored). The exception was the land use mix-diversity scale which required parents to mark, from a list of 20 locations, which locations were within a 10 min walk of their home. Some adaptations were made from the original NEWS-Y: three scales were shortened by one item and two scales were shortened by several items (land use mix-diversity and land use mix-access); and the original ‘pedestrian and automobile traffic safety’ scale was split into separate scales to investigate traffic and pedestrian safety separately. Test–retest ICCs ranged from 0.61 to 0.78.[34]

Objective neighbourhood environment (around home and school)—Data from the county tax assessor, regional land use at the parcel level and street networks were integrated into GIS to derive built environment features within 1 km street network buffers around each participant's home and school. Residential density (housing units per residential parcel), street connectivity (intersections/km^2), retail floor area ratio (building ft^2/parcel ft^2, with higher values reflecting more pedestrian-oriented design), mixed use (includes residential, retail, food and entertainment and office land use types; 0, single use and 1, even distribution across the 5 uses), cul-de-sac density (number of cul-de-sacs/ km^2), and number of parks per km^2, calculated using methods described for a previous study.[35] GIS was used to calculate the shortest street-network distance from home to school in metres.

Analysis

The final sample for analysis was determined by selecting (1) participants who lived within two miles of their school, because adolescents do not typically engage in active travel to school of more than two miles,[1136] and (2) participants who were under age 16, because this is often the age adolescents begin driving. Mixed effects multinomial regression models were conducted using the GENLINMIXED procedure in SPSS V.20.0 with both census block group and school entered as random cluster effects and weekly active travel to/from school (no trips, 1–4 trips and 5–10 trips) entered as the dependent variable. Distance to school was assessed in an initial model and was entered as a covariate in all subsequent models because it was a strong correlate of active travel to school.[111720222425] Independent variables were grouped in accordance with ecological models into five statistical models: demographic, psychosocial, perceived built environment around home, objective built environment around home and objective built environment around school. Demographic variables with $p<0.05$ in relation to active travel to school were entered as covariates in the four subsequent models. Colinearity for independent variables within each model was investigated using interitem correlations, and all were $r<0.5$. Next, significant variables ($p<0.05$) from each level were grand mean centred and entered into a final multivariate model and cross-level interactions were investigated. Interaction terms were tested for the psychosocial X environment and perceived X objective environment variables (8 terms). A backwards stepwise approach was used to test interactions, where all eight terms were entered into an initial model and terms with the largest p value were removed one at a time until only terms with $p<0.1$ remained. A p value of 0.1 was used to interpret significance of interactions. Significant interactions were graphed by plotting the OR for +1 and −1 SD in each variable comprising the interaction.

RESULTS

The final sample size was 294 participants, after excluding those who lived more than two miles from their school (N=568) and those who were at least 16 years (N=66). Thirty-six per cent of participants reported no active travel to/from school, 25% reported 1–4 trips per week to/from school and 39% reported 5–10 trips per week to/from school. The ICC from the empty model suggested that 27% of the variability in active travel to/ from school was attributable to neighbourhood-level and school-level variation (ICC=0.27). Table 1 presents sample demographic characteristics, descriptive statistics for the independent variables and results from the six regression models estimating relations of factors within the tested levels of ecological models to active travel to/from school.

Models 1 and 2

Distance to school was the sole independent variable in model 1 and was entered as a covariate in each subsequent model. The odds of engaging in 1–4 trips/week (vs none) and 5–10 trips/ week (vs none) decreased by a factor of 0.60 and 0.24 for every additional km in distance to school ($p<0.05$). No demographic factors were associated with active travel to school.

Models 3–6

The odds of engaging in 1–4 trips/week (vs none) and 5–10 trips/week (vs none) decreased by a factor of 0.27 and 0.15 ($p<0.001$) for every additional perceived barrier to active travel to/from school. Parent modelling of active travel was associated with having 5–10 trips/ week (vs none) but was only marginally associated with having 1–4 trips/week (vs none; ORs=3.27 and 2.11). Perceived street connectivity was associated with having 1–4 trips/ week (vs none), whereas perceived pedestrian safety was associated with having 5–10 trips/ week (vs none; ORs=1.78 and 2.04). Regarding objective built environments, the odds of engaging in 1–4 trips/week (vs none) and 5–10 trips/week (vs none) increased by a factor of 1.10 and 1.11 for every additional residential unit per residential parcel around the home. The odds of having 1–4 trips/week (vs none) decreased by 0.97 for every additional intersection/km^2, and the odds of having 5–10 trips/week (vs none) increased by 1.14 for every additional residential unit per residential parcel around the school.

Final model (multivariate+interactions)

Objective residential density around the home was highly correlated with objective residential density around the school ($r=0.68$), so the decision was made to retain only residential density around the home in the final model because it was associated with both levels of the outcome (see table 2). Perceived barriers to active travel to/from school and objective residential density around the home were associated with having 1–4 as well as 5–10 trips/week (vs none). Both perceived and objective street connectivity around the home were associated with having 1–4 trips/week (vs none), while parent modelling of active travel and perceived pedestrian safety around the home were associated with having 5–10 trips/week (vs none).

An interaction was found between parent modelling of active travel and perceived home pedestrian safety in explaining 1–4 as well as 5–10 trips/week (vs none; $p<0.1$). The plot revealed that the association between parent modelling and active travel to/from school was stronger when pedestrian safety was low than when pedestrian safety was high, and the association between pedestrian safety and active travel to/from school was positive when there was no parent modelling and slightly negative when there was parent modelling (see figure 1A,B).

DISCUSSION

Present findings support predictions derived from ecological models. At least one variable from each level of ecological models was associated with active travel to/from school among middle-school-aged youth after accounting for distance. Results indicated that youth who lived closer to their school, had fewer perceived barriers to active travel to/from school, had parents who modelled active travel, had greater perceived pedestrian safety in the home neighbourhood, and had greater residential density around the home and school were more likely to engage in active travel to/from school. There was one cross-level interaction found. Findings suggested that strategies for improving active travel to/from school may be most effective when targeting multiple levels of influence. These findings highlight the importance of interpersonal and environmental factors in facilitating or hindering active travel to/from school.

Although previous studies have had mixed results regarding the association between psychosocial factors and active travel to/ from school,[220212425] the associations found in the present study suggest that perceived barriers to active travel and parent modelling of active travel were important psychosocial correlates of adolescents' active travel to/from school. Our finding that parents who engaged in active transportation have children who are more likely to walk or bike to school has been reported in previous studies,[2] suggesting that targeting parents and youth may increase intervention success. The interaction found between parent modelling and pedestrian safety suggests that lack of active travel by the parent may be a particularly important barrier to youth active travel to/from school in neighbourhoods perceived to have low pedestrian safety. Parents who walk for transportation may be more effective in teaching their adolescents how to navigate unsafe street crossings. It is possible that parents may have been walking to/from school with their child when street crossings were unsafe in the present study. The lack of association between other psychosocial variables and active travel to/from school, such as self-efficacy, could have been because the items referred to general physical activity rather than specifically to active travel to/from school.

Both low objective street connectivity (representing areas with few intersections to cross) and high pedestrian safety (representing safety of street crossings) were related to active travel to school. This suggests that improving pedestrian safety, such as adding crosswalks and lighting, may contribute to increasing active travel to/from school at low cost compared to other built environment strategies. Present findings support Safe Routes to School programmes, which often include improvements to pedestrian safety and have evidence for increasing levels of active travel to/from school.[37] Findings are also in agreement with other cross-sectional studies that found an inverse association between street connectivity and active travel to/from school.[2021] These results are in the opposite direction of findings in adults[38] and the expected positive effects of walkability components on active travel in general.[28] Thus, the walkability indices used in adult samples may not be appropriate for adolescents. Notably, perceived street connectivity was positively associated with more active travel to/from school; this finding was in contrast to that in the case of objective street connectivity. The perceived street connectivity questions asked about dead-end streets and having many routes to get from place to place. This variable was not correlated with objective street connectivity, suggesting that the perceived and objective measures of street connectivity in the present study were assessing unique aspects of connectivity, both important to active travel to/from school.

The finding that residential density around the home and school were both associated with active travel to/from school suggests that targeting both settings may be more effective than targeting only one setting. This conclusion is similar to that of previous research investigating built environment characteristics of the route to school but adds to previous findings by assessing residential density.[21–23] While residential density is often associated with distance to school, it was related to active travel to/ from school even after accounting for distance to school and built environment attributes around the home. This result is similar to that of Larsen *et al*[17] and suggests that greater residential density may be a marker of more walking-supportive features such as pedestrian design and more people on the street, thus creating a safer social environment. Thus, residential density should be considered in school siting and neighbourhood redevelopment practices.

The present study did not find overwhelming evidence of differential associations for correlates of occasional as compared to correlates of habitual active travel to school. This is consistent with a previous longitudinal study that found similar correlates of uptake and maintenance of active travel to/from school.[22] In the present study, each significant correlate of one level of active travel to/from school was also a significant correlate or showed a trend ($p<0.1$) for significance in relation to the other level of active travel to/from school, with two exceptions (perceived street connectivity and perceived pedestrian safety). This pattern of results suggests that almost all of the identified correlates are important factors in supporting occasional and habitual patterns of active travel to/from school. Findings that perceived street connectivity was associated with occasional but not habitual active travel to/from school and perceived and objective street connectivity had opposite directions of association with active travel to/from school, suggesting that additional research is needed to clarify the role of street connectivity before recommendations can be made.

Limitations

The present study was cross-sectional and can only support inferences on factors that may be associated with adolescents' active travel to/from school. Intervention studies, such as prospective evaluations of Safe Routes to School,[37] can strengthen evidence of causality. Excluding participants living more than two miles from school led to a significantly reduced sample size, which limits the generalisability of the study results. While objective environment characteristics were measured around the home and school, perceived environment characteristics were only measured around the home, limiting the conclusions that can be drawn regarding perceived environment factors. The present study assessed objective built environments in the home and school neighbourhoods (1 km street-network buffer), but the built environments of the route travelled were unknown. Assessing environment attributes along the shortest route to school can provide greater specificity and validity for identifying environmental correlates of active travel to school, as shown in previous studies.[21–23] While the self-reported active travel to/ from school measure had adequate test–retest reliability in previous studies,[2030] the validity of this measure has not been assessed. Global positioning system (GPS) monitoring could improve measurement by allowing researchers to examine the actual route travelled and providing an objective assessment of levels of active travel to/from school.

Conclusions

Variables across multiple levels of ecological models, including built environment attributes around schools, were related to active travel to/from school and could be targeted for change in intervention studies. Some of these factors are already being targeted in communities, such as through the Safe Routes to School programmes[37] which often improve safety of street crossings and provide support and modelling of active travel. School siting policies need to consider not only how many youth would be within walking and bicycling distance, but also other attributes of the built environment such as residential density and pedestrian design. Present results suggest that increasing active travel to/from school is likely to require efforts that target all levels of ecological models: psychological, social and environmental, in harmony.

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What are the new findings?

- Parent modelling of active travel, as well as characteristics of home and school neighbourhood environments, was related to adolescents' active travel to school. Thus, both parents and officials in planning and transportation agencies can take action to improve active travel to school.
- The strongest correlate of active travel to school was perceived pedestrian safety in the home neighbourhood. This includes actions to keep pedestrians safe like crosswalks and pedestrian lights at intersections.

How might it impact on clinical practice in the near future?

- Clinicians can educate parents about the value of active travel to school and encourage them to model walking and bicycling for transportation. They can also become informed advocates for environmental changes that will support active travel to school, such as enhancing the safety of streets and intersections around schools.
- New schools should be built within neighbourhood boundaries so that they are within walking distance for as many students as possible, and redevelopment should be focused around existing schools.
- School programmes can support children to engage in active travel to/from school by assuring safe street crossings and pedestrian infrastructure, removing barriers to active travel to/from school and supporting parents to walk or bike with their child.

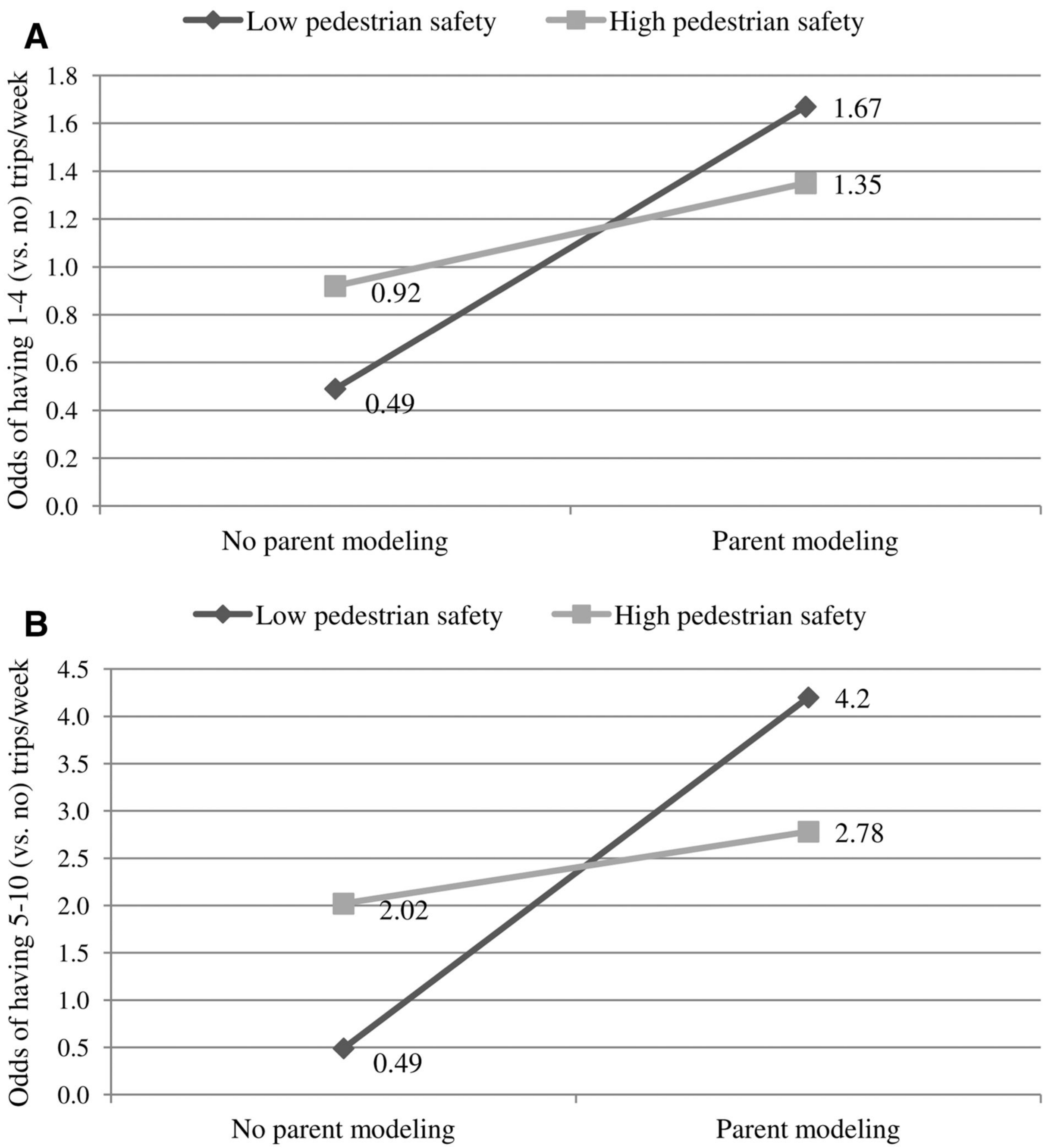

Figure 1.
(A and B) Plots of cross-level interactions explaining active travel to school ($p<0.1$).

Table 1

Relation of ecological model variables to active travel to/from school (N=294)

		1–4 (vs no) trips/week		5–10 (vs no) trips/week	
	Mean (SD) or per cent	**OR (95% CI)**	**p Value**	**OR (95% CI)**	**p Value**
Model 1: Distance to school (km)	1.85 (0.77)	0.60 (0.38 to 0.94)	0.026*	0.24 (0.15 to 0.38)	<0.001**
Model 2: Demographic variables					
Age (years)	13.46 (1.06)	1.19 (0.88 to 1.60)	0.265	1.17 (0.86 to 1.59)	0.332
Male	52.7%	1.14 (0.61 to 2.12)	0.691	1.48 (0.78 to 2.82)	0.232
Non-Hispanic Caucasian	68.6%	1.09 (0.54 to 2.19)	0.809	0.97 (0.48 to 1.98)	0.940
Parent with college degree	62.2%	0.76 (0.39 to 1.47)	0.415	1.00 (0.51 to 1.96)	0.996
Parent married or living with partner	84.7%	0.92 (0.34 to 2.53)	0.877	0.41 (0.16 to 1.03)	0.058
Parent works full-time	53.1%	1.03 (0.54 to 1.97)	0.931	1.22 (0.63 to 2.37)	0.559
Vehicles/driver in household	1.07 (0.39)	1.22 (0.55 to 2.72)	0.629	1.46 (0.65 to 3.94)	0.364
Model 3: Psychosocial variables					
Self-efficacy for physical activity	3.54 (0.97)	0.73 (0.48 to 1.12)	0.151	0.70 (0.45 to 1.10)	0.119
Decisional balance for physical activity	2.03 (0.76)	1.21 (0.71 to 2.03)	0.484	1.05 (0.61 to 1.81)	0.870
Barriers to active travel to/from school	1.92 (0.52)	0.27 (0.13 to 0.56)	<0.001**	0.15 (0.07 to 0.33)	<0.001**
Peer support for physical activity	2.05 (1.17)	1.09 (0.79 to 1.51)	0.587	1.16 (0.83 to 1.63)	0.379
Parent support for physical activity	2.26 (0.98)	1.09 (0.72 to 1.63)	0.693	0.83 (0.55 to 1.26)	0.376
Parent modelling of active travel	26.7%	2.11 (0.95 to 4.67)	0.064	3.27 (1.46 to 7.32)	0.004*
Rules related to physical activity	9.17 (2.83)	1.03 (0.91 to 1.17)	0.610	1.00 (0.88 to 1.13)	0.985
Model 4: Perceived built environment variables (around home)					
Land use mix-diversity	8.44 (5.32)	1.04 (0.97 to 1.11)	0.306	1.03 (0.97 to 1.11)	0.375
Land use mix-access	2.46 (0.54)	1.33 (0.73 to 2.44)	0.347	0.94 (0.50 to 1.73)	0.830
Street connectivity	2.76 (0.59)	1.78 (1.03 to 3.08)	0.038*	1.18 (0.67 to 2.10)	0.569
Walking facilities	2.72 (0.80)	0.96 (0.61 to 1.50)	0.843	1.09 (0.69 to 1.73)	0.707
Neighbourhood aesthetics	3.11 (0.65)	1.00 (0.58 to 1.71)	0.994	1.28 (0.73 to 2.23)	0.386
Traffic safety	2.65 (0.62)	1.07 (0.58 to 1.97)	0.828	1.57 (0.84 to 2.92)	0.156
Pedestrian safety	2.84 (0.58)	1.37 (0.76 to 2.47)	0.298	2.04 (1.11 to 3.77)	0.023*
Crime safety	2.95 (0.72)	1.22 (0.73 to 2.03)	0.441	0.67 (0.41 to 1.12)	0.130
Model 5: Objective built environment variables around home					

		1–4 (vs no) trips/week		5–10 (vs no) trips/week	
	Mean (SD) or per cent	**OR (95% CI)**	**p Value**	**OR (95% CI)**	**p Value**
Residential density (housing units/parcel)	7.27 (10.59)	1.10 (1.01 to 1.20)	0.024*	1.11 (1.02 to 1.21)	0.013*
Street connectivity (intersections/km^2)	77.21 (17.82)	0.97 (0.95 to 0.99)	0.008*	0.98 (0.96 to 1.00)	0.092
Retail floor area ratio (building : parcel ft^2)	0.17 (0.19)	4.72 (0.42 to 53.50)	0.209	4.99 (0.44 to 56.76)	0.194
Mixed use (0=single 1=mixed)	0.17 (0.20)	0.63 (0.09 to 4.38)	0.642	2.15 (0.36 to 13.02)	0.402
Cul-de-sac density (cul-de-sacs/km^2)	16.32 (12.98)	1.02 (0.99 to 1.06)	0.120	1.02 (0.99 to 1.06)	0.163
Number parks (parks/km^2)	1.50 (1.61)	1.23 (0.98 to 1.55)	0.079	1.03 (0.81 to 1.30)	0.833
Model 6: Objective built environment variables around school					
Residential density (housing units/parcel)	7.16 (6.40)	1.08 (0.99 to 1.19)	0.086	1.14 (1.04 to 1.24)	0.005*
Street connectivity (intersections/km^2)	73.30 (20.16)	0.98 (0.96 to 1.00)	0.106	0.99 (0.96 to 1.01)	0.175
Retail floor area ratio (building : parcel ft^2)	0.20 (0.23)	1.98 (0.29 to 13.46)	0.485	1.58 (0.20 to 12.68)	0.666
Mixed use (0=single 1=mixed)	0.16 (0.19)	0.43 (0.06 to 3.04)	0.393	1.62 (0.24 to 10.82)	0.615
Cul-de-sac density (cul-de-sacs/km^2)	14.22 (10.70)	1.00 (0.96 to 1.03)	0.787	1.01 (0.97 to 1.05)	0.582
Number parks (parks/km^2)	1.72 (1.53)	0.96 (0.75 to 1.23)	0.722	0.95 (0.74 to 1.21)	0.667

Distance to school was entered as covariates in each subsequent model;

** p<0.001;

* p<0.05.

Table 2

Multivariate relations of ecological model variables to active travel to/from school and cross-level interactions (N=294)

	1–4 (vs no) trips/week			5–10 (vs no) trips/week		
	Coefficient	OR (95% CI)	p Value	Coefficient	OR (95% CI)	p Value
Intercept	−0.18	0.83 (0.55 to 1.25)		0.33	1.39 (0.94 to 2.04)	–
Distance to school	−0.56	0.57 (0.35 to 0.95)	0.030*	−1.44	0.24 (0.14 to 0.40)	<0.001**
Barriers to active travel to/from school	−1.25	0.29 (0.14 to 0.59)	0.001*	−1.66	0.19 (0.09 to 0.40)	<0.001**
Parent modelling of active travel	0.80	2.22 (0.96 to 5.11)	0.062	1.23	3.42 (1.47 to 7.94)	0.004*
Home perceived street connectivity	0.63	1.88 (1.05 to 3.36)	0.033*	0.36	1.43 (0.77 to 2.65)	0.254
Home perceived pedestrian safety	0.35	1.42 (0.78 to 2.60)	0.255	0.79	2.20 (1.16 to 4.17)	0.016*
Home objective residential density	0.10	1.10 (1.03 to 1.19)	0.008*	0.11	1.12 (1.04 to 1.20)	0.004*
Home objective street connectivity	−0.03	0.98 (0.95 to 1.00)	0.020*	−0.02	0.98 (0.96 to 1.00)	0.083
Interactions						
Parent modelling of active travel X home perceived pedestrian safety	0.73	3.45 (0.82 to 14.58)	0.092ϯ	1.57	4.78 (1.09 to 21.05)	0.039*

All variables were grand mean centred;

** p<0.001;

* p<0.05;

ϯ interaction p<0.1.