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# Built Environment Predictors of Active Travel to School Among Rural Adolescents

**Madeline A. Dalton, PhD**, **Meghan R. Longacre, PhD**, **Keith M. Drake, BA**, **Lucinda Gibson, MS**, **Anna M. Adachi-Mejia, PhD**, **Karin Swain, MS**, **Haiyi Xie, PhD**, and **Peter M. Owens, PhD**
Community Health Research Program, Hood Center for Children and Families, (Dalton, Longacre, Drake, Adachi-Mejia), the Department of Pediatrics (Dalton, Longacre, Adachi-Mejia), the Department of Community and Family Medicine (Dalton, Xie, Swain) Dartmouth Medical School, Lebanon, New Hampshire; Smart Mobility, Inc., (Gibson, Owens) Norwich, Vermont

## Abstract

**Background—**Most studies of active travel to school (ATS) have been conducted in urban or suburban areas and focused on young children. Little is known about ATS among rural adolescents.

**Purpose—**Describe adolescent ATS in two predominantly rural states and determine if school neighborhood built environment characteristics (BECs) predict ATS after adjusting for school and individual characteristics.

**Methods—**Sixteen BECs were assessed through census data and onsite observations of 45 school neighborhoods in 2007. ATS and individual characteristics were assessed through telephone surveys with 1552 adolescents and their parents between 2007 and 2008. Active travelers were defined as those who walked/cycled to/from school >= 1 day/week. Hierarchic linear modeling was used for analysis, conducted in 2009.

**Results—**Slightly less than half (*n*=735) of the sample lived within 3 miles of school, of whom 388 (52.8%) were active travelers. ATS frequency varied by season, ranging from a mean of 1.7 (SD=2.0) days/week in the winter to 3.7 (SD=1.6) in the spring. Adolescents who attended schools in highly dense residential neighborhoods with sidewalks were most likely to be active travelers. ATS frequency was greater in school neighborhoods with high residential and intersection densities, on-street parking, food outlets, and taller and continuous buildings with small setbacks.

**Conclusions—**BECs that support safe travel may be necessary to allow for ATS, whereas ATS frequency among adolescents may be influenced by a wider variety of design characteristics. Additional strategies to promote ATS and physical activity are needed in rural areas due to long commuting distances for many students.

Address correspondence to: Madeline A. Dalton, PhD, Community Health Research Program, Hood Center for Children and Families, Dartmouth Medical School, HB 7465, One Medical Center Drive, Lebanon, New Hampshire 03756-0001. madeline.dalton@dartmouth.edu.

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## Introduction

Concern about the rapid rise in childhood obesity has focused attention on identifying ways to increase children's physical activity. Active travel to or from school (ATS) can be an inexpensive, convenient strategy for incorporating physical activity into children's schedule. Studies have shown ATS is associated with an increase in daily physical activity levels.[1,2] Although it is not clear whether ATS decreases youth's risk of obesity,[3–5] promoting ATS is one way to help children achieve Healthy People 2010 physical activity goals.[6]

Community density, diversity and design (3Ds) have consistently been linked with personal travel behavior and are considered the most influential built environment factors on active travel.[7–9] Sidewalks, crosswalks, and street connectedness have been associated with more frequent active travel among children[10–13] and commuting distance to school is a primary determinant of ATS.[3,14–17] Consistent with these findings, studies examining barriers to ATS have identified school distance and street safety as important parental concerns.[3,12,18] These factors may be particularly problematic in rural areas, where safe street elements (e.g., sidewalks and bike lanes) are less common than in urban areas and schools are often located far from students' homes. Most ATS studies have been conducted in predominantly urban or suburban areas,[14,18–21] focused on young children,[21–28] or have been limited to students living within 1 mile of school[15,20,29] and so little is known about ATS among rural adolescents. The majority of studies have examined either environmental or individual influences on ATS but not both,[10] limiting the ability to separate out individual characteristics that could confound built environment associations with ATS. Furthermore, many studies have relied on people's perceptions or aggregate environmental measures, which may not accurately reflect objective measures of neighborhood environments.[10,30–32]

The objectives of this study were to describe ATS among adolescents in two predominantly rural states and to determine if objectively measured built environment characteristics (BECs) of school neighborhoods were associated with ATS after adjusting for school distance, town size, and individual and family characteristics.

## Methods

### Study design

Vermont (VT) is the most rural state in the U.S. based on the percentage of the population living in urban areas, and New Hampshire (NH) is the 11th-most rural. The two states have similar land areas of approximately 9,000 square miles, but the population of NH is about twice that of VT (1.3 million vs 600,000 people, respectively). NH has larger urban centers and a higher median income, whereas VT has a more dispersed population primarily residing in small communities. The school study sites reflect the full range of environments in these two states, from higher-density "urban" areas to very rural low-density communities.

Several data sources were utilized for this study. ATS, resident address, and individual and family characteristics were assessed through adolescent and parent telephone surveys. School neighborhood BECs were assessed through onsite observations by trained coders and GIS-refined census data.[33] The shortest street network distance between each subject's home and school address was calculated using TransCAD, version 9.2 (Caliper Corporation, 2010, Newton MA). School town size was based on the 2000 Census town population.[33] The Committee for the Protection of Human Subjects at Dartmouth College approved this research.

Participants represent a subset of an ongoing cohort study of adolescent health, the methods for which have been described previously.[34] In 2002, 87% of students enrolled in Grades 4–6 at 26 randomly selected NH and VT public schools were surveyed, 71% of whom (*n*=2631) were subsequently enrolled in a longitudinal telephone survey of child–parent dyads. Surveys were administered to children and parents independently by trained interviewers using a computer assisted telephone interviewing (CATI) system. For consistency in the parent survey, mothers were preferentially interviewed.

Data for this analysis was obtained at wave 4, conducted between February 2007 and December 2008, which was the first survey to focus on physical activity. The follow-up rate for this wave was 71.6%, providing a sample of 1885 child–parent dyads. At wave 4, students were in grades 7 through 11 and attended over 100 different schools. Onsite observations were conducted at 45 schools in 29 NH and VT towns in 2007, providing school-level data for the majority (82.3%, *n*=1552) of participants. On average, students lived 4.6 (SD=4.1) miles from school. A priori, 3 miles was determined as the maximum distance for which ATS was likely to occur.[35] Thus, this analysis was limited to 735 adolescents (47.4% of the sample) living within 3 miles of their school.

## Survey measures

ATS was measured by asking students if they walked or biked to or from school in the past 12 months. If yes, students were asked "On average how many days a week do you walk [bike] to or from school in the [Fall/Winter/Spring]?" Students were classified as "active travelers" if they walked/cycled to or from school at least 1 day per week during one or more season. Among active travelers, the average frequency of ATS over the 12-month period was calculated based on the number of days per week students walked/cycled to or from school per season and the estimated number of weeks in each season. Students were also asked how long it took them to walk [bike] to school.

Students were asked to report their school, grade, and if they had a driver's license. Child gender and race had been previously assessed through the baseline child and parent surveys, respectively. Household income was assessed through the parent survey. Household income was imputed for 81 subjects with missing data by assigning the median household income of parents in the sample with similar education levels. Single-parent households were identified by asking parents "Do you have a partner or spouse who lives with you?"

## School neighborhood built BEC measures

Several BECs were assessed to represent the 3Ds, including residential density (density), nonresidential land use (diversity), and intersection density and structural characteristics such as sidewalks and curbs (design). School neighborhoods and BEC measures were delineated using a 1-kilometer radius circle buffer, centered at each school site.36 Residential density was measured by the number of housing units per acre of developed land.37 Housing unit counts were based on census block data and pro-rated for the percentage of each block contained within the school neighborhood. Intersection density, calculated using TransCAD and ArcGIS (ESRI, 2010, Redlands CA), was measured by the number of intersections with three or more legs per acre of developed land.37

A sample of street segments was pre-selected in each school neighborhood to represent key routes from the school to residential neighborhoods, commercial areas, and recreation sites. Trained coders conducted onsite assessments of these street segments using measures adapted from the Irvine Minnesota Inventory for measuring built environment features (Table 1).[38] All measures had a minimum inter-rater agreement of 80%. Gradient, site parking, and setbacks were reverse coded for this analysis because an inverse association with ATS was anticipated. Mean values of each score were calculated for all street segments in the school neighborhood. Street width and number of car lanes were recorded for only the street in front of the school. Bike lanes were not included in the analysis because they were found in only two school neighborhoods.

Coders also identified all food outlets in school towns and recorded their location using GPS coordinates, which were then used to identify and count the total number of food outlets located within each school neighborhood.

### Statistical analysis

Hierarchic linear modeling (HLM) was used to conduct two levels of analysis: the school and individual. Intraclass correlation revealed that roughly 21% of the total variance in ATS was explained by cluster membership by school, indicating a multilevel model was appropriate. School-level variables included the primary exposure measures (school neighborhood BECs) and covariates (school distance and town size). All BEC variables were continuous; the measures indicated total units (e.g., residential housing density, intersection density, number of food outlets, street width, and number of lanes), the mean proportion of coded street segments with the BEC of interest (e.g., nonresidential land use, green strip, trees, low onsite parking, small setbacks, continuous buildings, and buildings with three or more stories), or the average of coded values (0–2) across all street segments (e.g., sidewalks, curbs, low gradient, on-street parking).

Three models were developed using each of two separate outcomes: (1) active traveler as a dichotomous outcome; (2) frequency of ATS among active travelers, expressed as a continuous outcome (average number of days per week). Because BECs were highly correlated and not evenly distributed across town size or school distance, each BEC was modeled separately. A system of progressive modeling, in which only variables significantly related to ATS were carried forward to the subsequent model, was used. Model I was unadjusted. Model II was adjusted for school-level covariates. Model III was adjusted for both school-level and individual- level (child gender, grade, household income, single-parent household) covariates.

Generalized linear mixed models were used to calculate ORs for the dichotomous outcome of being an active traveler. Linear mixed models were used for the continuous outcome of ATS frequency using SAS version 9.2 (SAS Institute, 2010, Cary, NC). P-values less than 0.05 were considered significant. As a secondary analysis, the sample was stratified by school distance (<= 1 mile, 1.01 – 2 miles, 2.01 – 3 miles) and generalized linear models were used to examine whether BEC influence on ATS varied by commuting distance. Analyses were conducted in 2009.

## Results

### Sample characteristics

Students' ages ranged from 12 to 17 years with a mean of 14.3 (SD=1.1) years. Half (51.8%) were female and the majority (91.9%) were non-Hispanic white, reflecting the underlying population in northern New England. Only 5.1% (*n*=37) had a driver's license, the majority (64.9%) of whom were in Grade 11. Thirty-eight percent had at least one parent with a bachelor's degree or higher. Slightly more than one third (37.9%) had annual household incomes over $75,000. Nineteen percent of the adolescents lived in a single-parent household. Eighty five percent of the mothers worked outside their home. Students attended 43 schools in 28 towns. The schools were well distributed across town population size: 30.2% (*n*=13) for populations of < 5,000 people; 25.6% (*n*=11) for populations of

5,000–10,000; 18.6% (*n*=8) for populations of 10,000–20,000; and 25.6% for populations >20,000.

### ATS prevalence and frequency

ATS was highest in the fall and spring when 47.9% (*n*=352) and 51.8% (*n*=381), respectively, walked/cycled to/from school at least 1 day per week, versus 27.9% (*n*=205) in the winter. Overall, slightly more than half (52.8%, *n*=388) of the students walked/cycled to/from school at least 1 day per week for one or more seasons, meeting the definition of an active traveler. The majority (68.0%, *n*=264) of active travelers walked; only 7.7% (*n*=30) cycled; approximately one quarter (24.2%, *n*=94) walked and cycled. Students who walked reported an average travel time of 18.4 (SD=13.0) minutes versus 11.0 (SD=9.3) minutes for those who cycled. Active travelers reported an average of 2.7 (SD=1.6) days of ATS per week. Frequency of ATS varied by season, with a mean of 3.2 (SD=1.8) days in fall, 3.7 (SD=1.6) in spring, and 1.7 (SD=2.0) in winter. Only 9.2% (*n*=68) of the students reported daily ATS year-round, the majority (*n* =53) of whom lived within 1 mile of school. However, a substantially greater proportion of students (20.7%, *n*=152) reported daily ATS during fall and spring.

### ATS and individual, family and school town characteristics

Lower household income, single-parent households, shorter distance to school, and attending school in a larger town were all significantly associated with a greater likelihood of ATS (Table 2). School distance was associated with the largest variation in ATS; 80.8% of students who lived within 1 mile of school were active travelers versus 30.3% of those who lived 2–3 miles from school. There was no significant difference in the proportion of students who were active travelers by gender, grade or race. Similar associations were observed with ATS frequency, except there was no significant difference by school town size.

### ATS and school neighborhood BECs

Ten of the 16 school neighborhood BECs were significantly associated with ATS in the unadjusted models (Table 3). Students were more likely to actively travel to schools located in neighborhoods with higher residential and intersection densities, more food outlets, sidewalks, curbs and on-street parking; buildings with smaller setbacks; continuous and taller buildings; and fewer trees. After adjusting each BEC for school distance and town size, only higher levels of residential density, sidewalks, and building continuity remained significant. Further adjustment for individual (grade, gender) and family (household income, single-parent household) characteristics did not substantially change these associations. The results for the fully adjusted models stratified by distance to school were similar for students living within 2 miles of school: sidewalks and building continuity were significantly associated with ATS for distances of up to 2 miles; additionally, green strips were significant for distances of 1–2 miles. However, none of the BECs were significantly associated with ATS for students who lived 2–3 miles from school.

### ATS frequency and school neighborhood BECs

Among active travelers (*n*=388), ATS frequency was positively associated with higher residential and intersection densities, a greater number of food outlets, the presence of sidewalks, curbs, on-street parking, small setbacks, continuous and taller buildings (Table 4). All but sidewalks remained significant after adjusting for school distance and school town size; however, the magnitude of the regression estimates was attenuated for each BEC. Further adjustment for individual and family characteristics did not change the significance or substantially change the magnitude of the regression coefficients.

## Discussion

The findings suggest BECs influence both ATS prevalence and frequency among adolescents. Most of the BECs were associated with ATS in the unadjusted models, but many lost significance after adjusting for school distance and town size, indicating these variables are potential confounders in ecologic studies. In contrast, individual and family characteristics were not substantial confounders; this suggests both low- and high-income students would benefit from BEC modifications to promote ATS. Seasonal variation was a significant predictor of ATS frequency, with students reporting almost double the number of days of ATS in fall and spring compared to winter. Seasonal influences on ATS were also observed among Australian youth,[39] indicating this association is not limited to cold climate areas.

Although a minimum number of features to support safe ATS may be necessary to enable rural students to be active travelers, the frequency with which adolescents choose to walk or cycle to school appears to be influenced by a wider variety of design characteristics. ATS was most prevalent for schools located in densely populated residential neighborhoods, as evidenced by the significant associations with sidewalks, residential density and building continuity. In contrast to findings from urban studies of active travel,[30,31,40,41] nonresidential land use and the number of food outlets did not predict whether students were active travelers. However, a greater number of school neighborhood BECs were associated with ATS frequency, including higher residential and intersection densities, on-street parking, food outlets, and taller and continuous buildings with small setbacks. The fact that different characteristics predicted ATS prevalence versus frequency may account for some of the mixed findings of previous studies.[10]

Consistent with prior reports,[20,42] walking was the most common form of ATS and commuting distance was the strongest predictor of ATS.[3,14–17] Although ATS was most prevalent among those who lived within 1 mile of school, almost half the students who lived 1–2 miles from school and 30% of those who lived 2–3 miles from school were active travelers. This was higher than previous reports of ATS;[15,27,35,42–44] which, in part, may reflect the more inclusive definition of an active traveler. ATS to and from school was assessed through one question so it was impossible to determine if BECs had a differential impact on ATS in the morning versus afternoon.

Less than 50% of the students in the sample lived within 3 miles and only 14% lived within 1 mile of school. This percentage is consistent with a previous study of Georgia 9$^{th}$ grade students in which 13% lived within a 1-mile radius of school, which was defined as a safe and reasonable walking distance.[45] The stratified analysis in this study showed that school neighborhood BECs were significantly associated with ATS only for students who lived within 2 miles of school. This suggests characteristics of the home neighborhood and/or route to school may outweigh the influence of school neighborhood BECs on ATS for children who have longer commuting distances. In addition to development patterns that create more housing and walkable environments near schools, other strategies for promoting ATS in rural areas should be considered.

Programs and infrastructure to support safe cycling to school, including visibly marked bicycle lanes and mixed transportation models, could promote ATS among students who live further from school, at least during Fall and Spring. Three to five miles may not be an unreasonable distance for older children to travel by bicycle if there is a safe route.[46] Safe Route to School programs can be successfully implemented in rural communities by establishing drop-off points where students who are driven to school can walk the last half mile on a safe walking route.[47] Quasi- or natural experimental studies will be needed to examine the impact of such strategies on ATS. Alternatively, providing opportunities for physical activity on school grounds immediately before or after school hours may be a less expensive and more inclusive way to promote physical activity among all students in rural areas, especially during winter when ATS is less frequent.

Several unique strengths of this study contribute to the validity of the findings, including the objective measurements of school neighborhood BECs and exact geocoding of students' home addresses. Child/parent surveys allowed for adjustment of sociodemographic characteristics at the individual level rather than relying on aggregate measures. Several limitations of the study are also important to note. Parents' or students' perceptions of school neighborhood BECs were not measured and so it is not known how well they aligned with the objective measures. Some students may live in areas with environments less conducive to walking/cycling than the school neighborhood. Because ATS may not be an option for these students, regardless of the BECs near the school, the results may underestimate the importance of sidewalks, curbs and other BECs that support ATS. If students split their time between two households, school distance was calculated from the home where they spent the most time. It is possible that some students reported ATS that occurred while they were at a different residence. Finally, the higher prevalence and frequency of ATS among students living within 1 mile of school may, in part, reflect distance requirements for school bus service, which were not ascertained in this study.

In summary, slightly more than half the students who lived within 3 miles of school were active travelers, especially during the fall and spring. ATS was highest for schools located in highly dense residential neighborhoods with sidewalks. Because the majority of students lived long distances from school, school siting policies alone are unlikely to benefit most rural students. Additional strategies are needed to promote ATS and physical activity among all students in rural areas.

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**Table 1**

Coded values for school neighborhood built environment characteristics (BECs)

| Characteristic | Values | | |
|---|---|---|---|
| | 0 | 1 | 2 |
| Primary land use (nonresidential land use) | Residential | Other | — |
| Sidewalks | None | Continuous on one side | Continuous on both sides |
| Curbs | None | Continuous on one side | Continuous on both sides |
| Bike lane | No | Yes | — |
| Green strip between sidewalk and street | No | Yes | — |
| Trees | Few/some | Many | — |
| Gradient (low gradient) | Steep | Moderate | Minimal |
| On-street parking | None | On one side | On both sides |
| Parking between buildings and street (low-site parking) | A lot | Little to none | — |
| Average setback for buildings (small setback) | >20 feet | <=20 feet | — |
| Building continuity | Scattered | Adjacent | — |
| Building height | 1–2 stories | >=3 stories | — |

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## Table 2

Prevalence and frequency of active travel to school (ATS) by individual-, family- and school-level characteristics

| | | **Active Travelers**[a] | **Frequency of ATS**[b] | |
|---|---|---|---|---|
| ***Characteristics*** | ***n*** | **%** | **M # days/week** | **(SD)** |
| Gender | | | | |
| Female | 381 | 50.4 | 2.7 | (1.6) |
| Male | 354 | 55.4 | 2.8 | (1.6) |
| Grade in school | | | | |
| 7–8 | 295 | 52.9 | 2.7 | (1.5) |
| 9 | 249 | 54.6 | 2.8 | (1.6) |
| 10–11 | 191 | 50.3 | 2.8 | (1.7) |
| Race | | | | |
| White | 670 | 52.8 | 2.7 | (1.6) |
| Nonwhite | 59 | 50.8 | 3.0 | (1.6) |
| Household income | | ** | *** | |
| <= $35,000 | 139 | 63.3 | 3.1 | (1.5) |
| $35,001–75,000 | 314 | 51.9 | 2.8 | (1.6) |
| > $75,000 | 276 | 47.8 | 2.3 | (1.5) |
| Single-parent household | | *** | * | |
| No | 564 | 48.7 | 2.6 | (1.6) |
| Yes | 135 | 67.4 | 3.0 | (1.6) |
| Distance to school (miles) | | *** | *** | |
| <= 1 | 219 | 80.8 | 3.5 | (1.4) |
| 1.01–2 | 298 | 48.7 | 2.2 | (1.5) |
| 2.01–3 | 218 | 30.3 | 1.9 | (1.2) |
| School town size (population) | | *** | | |
| < 5,000 | 139 | 43.2 | 2.7 | (1.6) |
| 5,001–10,000 | 278 | 50.4 | 2.7 | (1.6) |
| 10,001–20,000 | 120 | 56.7 | 2.8 | (1.6) |
| > 20,000 | 198 | 60.6 | 2.8 | (1.6) |
| Total | 735 | 52.8 | 2.7 | (1.6) |

* $p<0.05$;

** $p<0.01$;

*** $p<0.001$

[a] Active travelers are defined as those who walked/biked to or from school at least 1 day per week for one or more seasons (*n*=388)

[b] Among active travelers

**Table 3**

Association between school neighborhood built environment characteristics and active travel to school (ATS)

| | Active Travelers[a] n=388 | | Not Active Travelers n= 347 | | Model I[b] | Model II[bc] | Model III[bcd] |
|---|---|---|---|---|---|---|---|
| ***School neighborhood built environment characteristics*** | **M** | **SD** | **M** | **SD** | **OR (95% CI)[e]** | **OR (95% CI)[e]** | **OR (95% CI)[e]** |
| Residential housing density[f] | 1,367.35 | 1,142.83 | 882.98 | 749.49 | 1.84 (1.46, 2.30)*** | 1.63 (1.18, 2.25)** | 1.58 (1.14, 2.20)** |
| Intersection density | 91.02 | 53.37 | 71.57 | 41.42 | 1.01 (1.01, 1.02)*** | 1.01 (1.00, 1.01) | |
| Nonresidential land use | 0.71 | 0.24 | 0.68 | 0.23 | 1.52 (0.40, 5.81) | | |
| Number of food outlets | 17.30 | 19.64 | 11.16 | 12.97 | 1.10 (1.01, 1.05)** | 1.01 (0.99, 1.02) | |
| Street width in front of school | 34.59 | 12.48 | 32.75 | 11.36 | 1.01 (0.99, 1.04) | | |
| Number of lanes in front of school | 2.58 | 4.08 | 2.48 | 3.53 | 1.01 (0.95, 1.07) | | |
| Sidewalks | 1.26 | 0.62 | 0.90 | 0.73 | 2.27 (1.61, 3.20)*** | 1.61 (1.10, 2.36)* | 1.63 (1.11, 2.38)* |
| Curbs | 1.21 | 0.67 | 0.90 | 0.76 | 1.96 (1.34, 2.86)*** | 1.49 (0.97, 2.29) | |
| Green strip | 0.36 | 0.29 | 0.26 | 0.27 | 2.46 (0.92, 6.61) | | |
| Trees | 0.10 | 0.16 | 0.13 | 0.16 | 0.14 (0.02, 0.94)* | 0.82 (0.14, 4.90) | |
| Low gradient | 1.70 | 0.25 | 1.66 | 0.30 | 2.07 (0.75, 5.71) | | |
| On street parking | 0.55 | 0.49 | 0.37 | 0.44 | 2.56 (1.40, 4.70)** | 1.52 (0.85, 2.70) | |
| Low site parking | 0.84 | 0.21 | 0.84 | 0.19 | 1.10 (0.25, 4.86) | | |
| Small setbacks | 0.23 | 0.21 | 0.15 | 0.20 | 8.21 (2.29, 29.40)** | 2.88 (0.91, 9.16) | |
| Building continuity | 0.69 | 0.30 | 0.56 | 0.31 | 4.69 (2.08, 10.56)*** | 2.92 (1.35, 6.32)** | 3.01 (1.37, 6.59)** |
| Building height | 0.16 | 0.21 | 0.10 | 0.17 | 9.77 (2.24, 42.72)*** | 2.75 (0.60, 12.48) | |

[a] Active travelers are defined as those who walked/biked to or from school at least 1 day per week for one or more seasons.

[b] Each built environment characteristic (BEC) was modeled separately using SAS GLIMMIX Type III Test for Fixed Effects. Only BECs significantly associated with ATS were carried forward to the next model. Models I were unadjusted; Models II were adjusted for school-level covariates (distance to school and school town size); Models III were adjusted for school-level and individual/family covariates (child gender, grade, household income, single-parent household).

[c] Distance to school was inversely associated with ATS at p<0.001 in all models; School town size was not significant in any of the models.

[d] Boys were more likely to be active travelers than girls (p<0.05) in all models; household income, single-parent household and grade in school were not significant.

[e], * p<0.05;

** p<0.01;

*** p<0.001

*f* Residential density was logged in model analysis to tighten an overly wide distribution, but the actual M and SD are reported.

**Table 4**

Association between school neighborhood built environment characteristics and frequency of ATS among active travelers ($n$=388)[a]

| *School neighborhood built environment characteristics* | **Model I[b]** Regression Coefficients (95% CI) | **Model II[bc]** Regression Coefficients (95% CI) | **Model III[bcd]** Regression Coefficients (95% CI) |
|---|---|---|---|
| Residential housing density[f] | 0.45 (0.21, 0.68)*** | 0.38 (0.08, 0.67)* | 0.34 (0.06, 0.62)* |
| Intersection density | 0.69 (.0.30, 1.09)** | 0.52 (0.06, 0.97)* | 0.53 (0.12, 0.94)* |
| Nonresidential land use | −0.21 (−1.44, 1.02) | | |
| Number of food outlets | 0.02 (0.01, 0.04)*** | 0.01 (−1.13, 0.66)* | 0.01 (−0.51, 0.37)* |
| Street width in front of school | 0.16 (−0.01, 0.04) | | |
| Number of lanes in front of school | 0.001 (−0.05, 0.06) | | |
| Sidewalks | 0.66 (0.32, 1.01)*** | 0.33 (−0.04, 0.70) | |
| Curbs | 0.58 (0.22, 0.94)** | 0.46 (0.10, 0.81)* | 0.37 (0.01, 0.73)* |
| Green strip | −0.03 (−1.00, 0.94) | | |
| Trees | −1.47 (−3.20, 0.26) | | |
| Low gradient | 0.72 (−0.24, 1.67) | | |
| On-street parking | 1.05 (0.63, 1.46)*** | 0.61 (0.22, 1.00)** | 0.56 (0.17, 0.94)** |
| Low site parking | 0.56 (−0.73, 1.85) | | |
| Small setbacks | 2.41 (1.55, 3.27)*** | 1.34 (0.52, 2.16)** | 1.37 (0.60, 2.14)** |
| Building continuity | 1.30 (0.55, 2.05)** | 0.80 (0.09, 1.50)* | 0.90 (0.31, 1.48)** |
| Building height | 2.18 (1.13, 3.23)*** | 1.33 (0.38, 2.29)** | 1.32 (0.33, 2.32)* |

[a]Active travelers are defined as those who walked/biked to or from school at least 1 day per week for one or more seasons

[b]Each built environment characteristic (BEC) was modeled separately using SAS PROC MIXED. Only BECs significantly associated with ATS were carried forward to the next model. Models I were unadjusted; Models II were adjusted for school-level covariates (distance to school and school town size); Models III were adjusted for school-level and individual/family covariates (child gender, grade, household income, single-parent household).

[c]Distance from school was inversely associated with active travel $p<0.0001$ in all models; school town size was not significant.

[d]Gender, grade and single-parent household were not significant. ATS was significantly more frequent for students in the lowest category for household income compared to those in the higher-income categories ($p<0.05$).

[e], *$p<0.05$;

**$p<0.01$;

*** p<0.001

[f] Residential density was logged in model analysis to tighten an overly wide distribution.


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