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Walkable Communities and Adolescent Weight

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Abstract

Background—Neighborhood design features have been associated with health outcomes, including the prevalence of obesity.

Purpose—This study examined the association between walkability and adolescent weight in a national sample of public secondary school students and the communities in which they live.

Methods—Data were collected through student surveys and community observations between February and August 2010, and analyses were conducted in Spring 2012. The sample size was 154 communities and 11,041 students. A community walkability index and measures of the prevalence of adolescent overweight and obesity were constructed. Multivariable analyses from a cross-sectional survey of a nationally representative sample of 8th-, 10th- and 12th-grade public school students in the U.S. were run.

Results—The odds of students being overweight (OR 0.975; 95% CI=0.94, 0.99) or obese (OR 0.971; 95% CI=0.94, 0.99) decreased if they lived in communities with higher walkability index scores.

Conclusions—Results suggest that living in more-walkable communities is associated with reduced prevalence of adolescent overweight and obesity.

Background

Obesity is a problem in the U.S. and worsening. One third of U.S. children are at higher risk for serious health problems because of their weight.¹ Research has shown that part of the problem is caused by the neighborhoods in which we live, work, shop and play.^{2,3} While obesity rates have grown over time, active travel (e.g., walking or bicycling to school) by youth—one form of physical activity—has declined over the past several decades.^{4,5} Results of the National Household Travel Survey show that for trips of only 1–2 miles, Americans still drive 90% of the time.⁶

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Physical activity is proven to have protective effects against both obesity and related health problems.⁷ Research has shown that the presence of sidewalks, public transit, controlled intersection crossings, and mixed land use (a mix of residential, commercial, and recreational destinations) are associated with increased walking and lower prevalence of obesity.^{2,8–19} However, these studies examined only one or a few locations, and those that were conducted nationally relied on secondary environmental data sources rather than street-scale data collected directly from communities.^{2,8–19} The current study builds on existing evidence^{2,8–19} by examining the impact of community-level walkability on the prevalence of adolescent obesity using street data collected on the ground in a national sample of communities; to our knowledge, this is the first study to do this.

Methods

This study combined cross-sectional individual-level data collected in Spring 2010 from 8th-, 10th-, and 12th-grade public school students participating in the Monitoring the Future (MTF) survey.²⁰ In any given year, half the MTF schools are either in Year 1 or 2 of participation. Only the traditional public schools involved in Year 2 of MTF participation were included in this study (N=154 schools, 11,041 students). Community-level environmental measures for the MTF school-enrollment zones, the area from which schools draw their student population (area, in square miles: median size=39.8, range=0.26–1517), were developed through the Community Obesity Measures Project (BTG-COMP), an ongoing, large-scale effort conducted by the Bridging the Gap research team. BTG-COMP identifies local policy and environmental factors that are likely to be important determinants of healthy eating, physical activity and obesity among children and adolescents.²¹ Study procedures were approved by IRBs at the University of Michigan and the University of Illinois at Chicago.

Community Measures

For this study, street segments, defined as two facing sides of a street block, were divided into three sampling strata by street type: streets falling within a 2-mile buffer around the sampled school; residential streets; and arterial (i.e., commercial) streets. Sample sizes were then calculated to provide estimates with 20% width, with 90% CIs. The required sample size was then proportionally allocated between the three strata to preserve the original distribution of street segments for a community. A random sample of street segments was drawn based on the proportion of population of youth (aged 0–17 years) associated with the nearest census block to the street segment and overall proportion of street segments located in each strata. Street segment data were then weighted to account for their probability of selection and then aggregated to construct community-level measures representing, for example, the proportion of streets that have sidewalks in that community.

A walkability index was constructed using data collected April–September 2010 with the BTG-COMP Street Segment Observation Form, which has been shown to have good reliability²² (all measures included in the index had kappas/intraclass correlation coefficients (ICCs) with almost perfect or substantial agreement [0.61–1.00], or >90% agreement between raters). The tool, described in detail elsewhere,²¹ is designed to assess key street-level features of the neighborhood environment that are thought to be related to physical activity behavior. Briefly, an expert panel of researchers who were previously involved in developing or using similar audit tools was formed. Street segment measures were compiled from existing data collection instruments.^{23–28}

After multiple calls with the experts, the final audit tool was developed and includes information on: (1) land use and opportunities for play/physical activity, which included a mix of residential and nonresidential destinations; (2) traffic and pedestrians, including the

presence of sidewalks, shoulders, bike lanes, and traffic calming and control features; (3) physical disorder (e.g., presence of graffiti, litter, yard debris); and (4) aesthetics and amenities (e.g., public transportation, flowers, planters, benches). The walkability index (Cronbach's $\alpha=0.077$) was constructed by drawing on the study's overarching socio-ecologic framework in combination with existing evidence^{2,8-17} showing a connection between built-environment correlates and physical activity behavior and weight. Specifically, these previous studies^{2,8-17} have found that sidewalks and other street characteristics, pedestrian crossings, traffic signals, features that calm/slow traffic, measures of destinations, and presence of public transit were associated with physical activity/walking.

The final index, with a possible range of 0–35, is a sum of the proportion of streets in a community that have: mixed land use; sidewalks; sidewalk buffers; sidewalk/street lighting; other sidewalk elements (e.g., sidewalk continuity, shade); traffic lights; pedestrian signal at traffic light; marked crosswalks; pedestrian crossing and other signage; and public transit. A community physical disorder scale was constructed using street data from the same audit tool as described above and includes dichotomous measures representing the presence of: vacant lots/buildings; bars on windows; broken/boarded-up windows; graffiti/tagging; and yard debris (possible range=0–5). Using existing methods,²⁹ a community compactness index, which includes measures of residential density and street connectivity, was developed to control for urbanization.

Individual-Level Measures

Using self-reported height and weight, age- and gender-specific BMI was calculated. Individuals' body weight status was classified based on BMI for children and teens using the 2000 CDC Growth Chart; overweight was classified as BMI 85th percentile, but <95th percentile; obesity was classified as BMI 95th percentile. Although self-report data have been shown to under-report weight, these data have been shown to reliably predict obesity-related morbidities and behaviors in adolescents.^{30,31}

Data Analysis

Cross-sectional, multivariable logistic regression analyses were conducted in Spring 2012 using survey commands in Stata 12.0 after applying sampling weights to adjust for differential selection probabilities and computing robust SEs by adjusting for student clustering within sites. To explore the relative magnitude of the walkability index on weight, marginal effects were calculated to examine expected changes in the weight-related outcome measures using the coefficients in the models and testing varying ranges of the walkability index (0, 9, 12, and 18) while holding all other independent variables at their mean. All models controlled for gender, race/ethnicity, grade, parental education, community physical disorder scale, presence of bike lanes, presence of off-road trails, student perception of safety going to and from school, community-level median household income, and a community compactness index.

Results

Table 1 includes descriptive statistics. The average prevalence of adolescent overweight and obesity, respectively, across communities was 15% and 12%. The mean walkability index across communities was 6.38 (range: 0.28–18.4, N=154 communities). Table 2 shows the correlations between the control variables and the walkability index. For example, the walkability index is positively correlated with more-urbanized areas and presence of bike lanes, and negatively correlated with communities with lower median household incomes.

Table 3 presents the results of the adjusted logistic models and marginal effects. Communities with more-walkable streets were significantly negatively associated with the prevalence of adolescent overweight (OR: 0.98, 95% CI=0.95, 0.99) and obesity (OR: 0.97, 95% CI=0.95, 0.99). Results of the marginal effects suggest even a modest increase in the presence of street features that support walking in a community (an increase in the mean walkability score of just under seven to nine markers of walkable street features) was associated with a lower obesity rate—10.6% versus 12%. Further analyses were conducted to examine the nonlinear effects of the walkability index by dividing communities into quartiles based on the value of the index. Only the fourth quartile (highest walkability index score) had a significant negative association between the walkability index and prevalence of both overweight and obesity (OR 0.76, 95% CI= 0.61, 0.94 and OR 0.73, 95% CI=0.57, 0.93 respectively; results not shown).

Sensitivity analyses showed the key street features associated with reduced prevalence of obesity were increased presence of sidewalks and public transit, and reduced prevalence of overweight was associated with increased presence of sidewalks, having a pedestrian signal at traffic lights, and presence of marked crosswalks. A test was conducted for interactive effects in the model between micro- (walkability index) and macro-scale (community compactness index) environmental measures, but none was found. Additional analyses that combined the micro- and macro-scale measures into one index were also tested. Results showed a negative association between the combined index and prevalence of both overweight and obesity (OR 0.96, 95% CI=0.92, 0.99; and OR 0.93, 95% CI=0.87, 0.99, respectively).

Discussion

This is the first national study to provide evidence that street features collected directly from communities are associated with decreased prevalence of youth weight outcomes in those communities. Results suggest that certain street features, which are less likely to be present in low-income communities (sidewalks and marked crosswalks),³² were important measures associated with weight. Results of combining the walkability and community compactness indices also suggest that living in more-compact, or less-sprawling, areas could have an even greater impact on youth weight outcomes than the presence of certain street features alone. These results, although significant, may be understated due to existing evidence showing that adolescents consistently under-report their weight,^{30,31} and analytic rigor in simultaneously controlling for student perception of safety, community physical disorder and community-level median household income, all of which have been associated with higher prevalence of adolescent obesity.²⁹

Another study limitation is that no direct evaluation could be made of the association of the walkability index with physical activity. In particular, utilitarian travel could not be examined, as it is not available in this data set. Future studies should address this gap in the research.

An additional study limitation is the missing information of home addresses for the students participating in the MTF survey, which could also result in an under-estimation of the association between the walkability index and adolescent weight outcomes. Because this information is unavailable, rather than constructing buffers around individuals' home addresses, data were collected from the entire school-enrollment zone. In some cases, these boundaries are very small, but in very rural communities they can be quite large. However, this limitation is accounted for by employing a proportionate-to-population (aged 0–17 years) sampling strategy to ensure streets were audited where the target youth live. Further, the walkability index was constructed in 2-mile buffers around each school in the sample,

and results were consistent with those analyses using the full sample of street segments (results not shown).

Conclusion

Although this study was cross-sectional and cannot establish causality, these findings provide additional support for the growing evidence base that there is a connection between the built environment, operating either through physical activity and the food environment, or self-selection, and obesity.^{33,34} This is particularly relevant given that recent research has shown the environment can influence youth physical activity behavior independently of parental neighborhood selection preferences,³⁵ and that the largest proportion of moderate-to-vigorous physical activity in adolescents has been associated with active travel.³⁶ The findings from this study can be used to inform any federal Transportation Bill reauthorization debates and policy decisions at all levels of government related to funding for pedestrian and bicycling infrastructure, and they highlight the important role that such infrastructure can play in mitigating adolescent overweight and obesity.

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Table 1

Summary Descriptives, % unless otherwise noted

	M	(SD)
Outcome Variables		
Obese	0.12	0.33
Overweight	0.15	0.36
Explanatory Variable		
Walkability Index ^a	6.38	4.24
CONTROL VARIABLES		
Community Measures		
Presence of Bike Lanes	0.01	0.03
Presence of Off-road Trails	0.01	0.01
Community Physical Disorder Scale ^a	0.37	0.25
Community Compactness Index ^a	−0.02	0.88
High Community Median Household Income	0.59	0.49
Low Community Median Household Income	0.41	0.49
Individual Measures		
Grade 8	0.39	0.49
Grade 10	0.45	0.50
Grade 12	0.16	0.37
Student Perception of Safety	0.10	0.07
White	0.61	0.49
African-American	0.09	0.29
Latino	0.18	0.38
Other Race	0.12	0.32
Male	0.48	0.50
Parental Education (some college or higher)	0.71	0.45

^aVariables are indices.

Table 2

Correlations between Walkability Index and Covariates

	Correlation with Walkability Index
Community Measures	
Presence of Bike Lanes	0.37
Presence of Off-road Trails	−0.05
Community Physical Disorder Scale	0.32
Community Compactness Index	0.57
High Community Median Household Income	0.24
Low Community Median Household Income	−0.24
Individual Measures	
Grade 8	0.05
Grade 10	−0.02
Grade 12	−0.03
Student Perception of Safety	0.19
White	−0.27
African-American	0.04
Latino	0.22
Other Race	0.12
Male	−0.01
Parental Education (some college or higher)	0.02

Table 3

Results of association between Walkability Index and adolescent weight measures

Independent Variables	Overweight		Obese	
	AOR	95% CI	AOR	95% CI
Walkability Index	0.98	0.95–0.99	0.97	0.95–0.99
^a Walkability Index=0	0.170 (0.011)		0.133 (0.009)	
^a Walkability Index=9	0.141 (0.005)		0.106 (0.005)	
^a Walkability Index=12	0.132 (0.008)		0.098 (0.007)	
^a Walkability Index=18	0.115 (0.015)		0.084 (0.011)	

Note: Models controlled for: gender, race/ethnicity, grade, parental education, community physical disorder scale, presence of bike lanes, presence of off-road trails, student perception of safety, community median household income, and local compactness index.

^aResults of predicted probability models are expressed as marginal effects, with SEs in parentheses.