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Application of a Walking Suitability Assessment to the Immediate Built Environment Surrounding Elementary Schools

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This study examines the usefulness of applying a walking suitability assessment to a specific geographic area surrounding elementary schools. Streets within a 0.25-mile radius were measured to create a summary walking suitability score for seven schools from high-busing strata and seven from low-busing strata. Summary walking suitability scores were calculated for each school. A Mann–Whitney U *test was conducted to determine any differences in scores between the high- and low-busing schools. The median walking suitability score was 3.7 (a* good *rating); the 25th percentile score was 2.9 (*very good*), and the 75th was 22.3 (*poor*). No statistical differences existed between busing strata. Walking suitability is an important consideration when examining the feasibility of walk-to-school programs within school settings; however, it might not be the main factor limiting children's active commuting to school. Several aspects of the environment were captured that researchers, practitioners, school personnel, and transportation experts may deem useful.*

Keywords: *built environment; walk to school; walking suitability; schools; physical activity*

One potential source of daily physical activity promotion for youth is walking to and from school (Tudor-Locke, Ainsworth, & Popkin, 2001). With a sparse but growing body of literature that indicates children who walk to school have higher levels of overall physical activity compared with those who are chauffeured by private vehicle, walk-to-school programs may be an effective means of promoting daily physical activity (Cooper, Anderson, Wedderkopp, Page, & Froberg, 2005; Heelan et al., 2005; Sirard, Riner, McIver, & Pate, 2005). However, although walk-to-school programs hold promise for increasing physical activity, little is known about environmental factors that potentially affect their feasibility (Braza, Shoemaker, & Seeley, 2004).

With the recent passage of the Safe, Accountable, Flexible, Efficient Transportation Equity Act (SAFETEA; U.S. Department of Transportation, 2005), which allocated funding for Safe Routes to School (SRTS) programs, health and school practitioners will certainly be examining the environmental conditions that need to be addressed locally to foster more active transportation to school. Thus, as research and school-based programs continue to progress, it is increasingly clear that the built environment (defined as physical surroundings that consist of buildings, roads, fixtures, parks, and all other improvements that form the physical character of a city or town) and its relationship to physical activity is important to consider, investigate, and address (Humpel, Owen, & Leslie, 2002; Transportation Research Board, 2005). Potential factors within the built environment surrounding schools include but are not limited to accessible areas conducive to walking to school, traffic patterns, the safety and crime of a neighborhood, sidewalks, presence or absence of curb ramps, pedestrian walkways, aesthetics, weather, and street lights (Humpel et al., 2002).

The built environment can also be described as the extent to which there are incentives or restrictions that inhibit or enable health behaviors (Sallis, Bauman, & Pratt,

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1998). For example, incentive built environments are those that provide the best access to physical activity within the surrounding environment, such as biking and walking trails, adequate sidewalks, pedestrian crossings, accessible routes, and well-planned traffic patterns around schools (Stahl, Rutten, Nutbeam, & Kannas, 2002). In addition to these characteristics, Leyden (2003) examined and described the importance of walkable neighborhoods for building elements of social capital, such as having trust in others, being socially engaged, or knowing your neighbors. In contrast, restrictive built environments limit access or even encourage sedentary behavior (in this case, being chauffeured by private vehicle or school bus). Examples include busy highways, few pedestrian crossways and walking signals, and in-town traffic systems (Stahl et al., 2002).

It is essential to examine the actual walking suitability of a school's immediate surrounding neighborhood (i.e., within a quarter mile, equivalent to a 5-min walk) to determine if issues of the built environment would hamper the success of walk-to-school programs. Walking suitability assesses an estimate of the likelihood of being an active commuter (i.e., a walker) in a specified community environment and can also indicate where improvements in the built environment are needed (Emery, Crump, & Bors, 2003). To date, very few studies or needs assessments have utilized an objective measure to assess the built environment surrounding schools for the specific purpose of informing the development of walk-to-school programs. In addition to an objective measure, ease of use is an important consideration when public health and school health practitioners are examining the built environment around schools. Therefore, the purpose of this study was to examine the application of a walking suitability assessment (previously developed and shown to be valid and reliable) on a specific geographic area surrounding elementary schools by comparing schools in high- and low-bused areas.

METHOD

Design

This was a cross-sectional study. A walking suitability assessment (Emery et al., 2003) designed to examine multiple elements of the built environment was used to determine walking suitability scores of elementary schools. The current study represents one component of a larger environmental assessment study, which included an examination of the bicycling suitability of the same 14 elementary schools. Specific details of the bicycling suitability study are in a separate article (Sisson, Lee, Burns, & Tudor-Locke, 2006).

Sample

Following university review board and school district approval, a purposive sample of 14 elementary schools was identified. Purposive sampling is the process of seeking one or more specific predefined groups (Trochim, 2001). In our case, the purpose behind the identified sample was to recruit schools that represented the two extremes of busing prevalence. To accomplish this, we divided the total number of 56 elementary schools into quartiles, with 14 schools present in each quartile. We theorized that schools with a higher proportion of students bused would be expected to have lower walking suitability compared to those with lower busing proportions, based on the district policy that states if unsafe conditions exist within 1 mile (the distance at which students are permitted to walk or bike) of the child's route to school, he or she must be chauffeured by private vehicle or school bus. Therefore, a total of 14 schools with the highest and lowest busing proportions were selected; 7 schools with busing proportions of 0% to 4% (representing the lowest of the distribution) and 7 schools with 45% to 69% (the highest of the distribution) were recruited for this study.

School-level data (e.g., total number of students, race and ethnicity of students) were obtained for each participating school from the district database. On average, the total population of the participating schools was 739 ± 122 (range = 473–980) students. The year each school was built ranged from 1879 to 2001, and no differences were observed between the year schools were built in the high- versus low-busing quartiles. Overall, compared to low-busing schools, high-busing schools had a higher proportion of non-Hispanic White students in their total student population (53.7% in high-busing schools vs. 36.5% in low-busing schools), a lower proportion of male students (39.8% vs. 53.3%), and a lower proportion of enrollment in free/reduced lunch programs (55.2% vs. 72.1%). Additional participating schools' characteristics stratified by busing category are presented in Table 1.

TABLE 1
Participating Schools' Characteristics

Characteristic	*Low-Busing Strata* (n = 7)	*High-Busing Strata* (n = 7)	*Total* (N = 14)
Total student population	782.0 (122.0)	696.3 (142.4)	739.1 (134.9)
Ethnicity			
White	36.5 (21.1)	53.7 (14.6)	45.1 (19.6)
Hispanic	52.0 (21.5)	30.4 (11.1)	41.2 (20.0)
Native American	4.0 (2.9)	9.1 (6.8)	6.5 (5.7)
African American	5.9 (3.9)	4.7 (2.4)	5.3 (3.2)
Asian	1.5 (0.6)	2.1 (1.2)	1.8 (0.9)
Gender			
Male	53.3 (0.9)	39.8 (0.8)	52.4 (1.6)
Female	46.7 (0.9)	59.7 (1.7)	47.6 (1.6)
Free/reduced lunch enrollment	72.1 (16.7)	55.2 (19.1)	63.7 (19.3)

NOTE: Numbers are reported as mean proportion of students and standard deviations (in parentheses).

Measurement

Walking suitability assessment. The walking suitability assessment focused on the curb zone (i.e., area from the street to where the curb meets the sidewalk) through the walking zone (i.e., the sidewalk). This assessment was constructed by the original authors (Emery et al., 2003) to identify lower scores as representative of higher walking suitability and higher scores reflective of poorer suitability. Specific cutoff points for categorizing walking suitability were developed as follows by transportation experts and public health professionals during the original reliability and validity study of the assessment: *very good* (score of 3.0 or less), *good* (3.0–5.9), *fair* (6.0–8.9), *poor* (9.0–26.0), *no sidewalk on quiet street* (27.0–99.0), *no sidewalk on busy street* (99.0+). Two data collectors and three transportation experts served as coders during the original testing of the reliability and validity of the assessment (Emery et al., 2003). The transportation team used a 7-point Likert-scale instrument to determine the suitability of key variables; the public health research team used the actual walking suitability assessment to assess the exact same street segments. The intercoder reliability (intraclass) correlation for the walking suitability assessment was reported in a previous publication as $r = .79$, and the criterion-related validity (Pearson) correlation was $r = .58$. The reader is referred to the original validity and reliability study for more details of the establishment of categories of walking suitability scores and the process of determining instrument reliability and validity (Emery et al., 2003).

Application of walking suitability assessment. Determination of walking suitability was a multistep process. Using ArcView Geographic Information System (GIS) software, Version 3.2, the attendance area of each school was mapped using local Maricopa County street files. GIS analysis then defined a buffer of a 0.25-mile radius (0.50-mile diameter; approximately a 5-min walk) with the school as epicenter. GIS was also used to determine the length of each street segment within the 0.25-mile buffer around each school and to identify the street names. The annual average daily traffic (AADT) count for each street segment was collected for 2004 by the City of Mesa. These counts are available at http://www.ci.mesa.az.us/transportation. This AADT represents the volume of vehicles using the specified road segment. If a specific street did not have traffic counts, it was recorded as having less than 8,000 AADT, based on the City of Mesa's process for measuring smaller streets that are not considered main arterials.

Once these preliminary materials were prepared for each school, actual field work required walking each street segment identified for each school and recording the following characteristics on the walking suitability assessment form: (a) speed limit (posted visibly on street), (b) number of through lanes (for traffic moving in both directions), (c) presence of a sidewalk (includes continuous or partial), (d) sidewalk characteristics (material, condition, width, problem spots), (e) buffer width (area from the edge of the curb to the beginning of the sidewalk; this measures an area that includes grass between the curb and sidewalk), (f) street lights (total

TABLE 2
Proportion and Number of Schools Falling Within Each Walking Suitability Category

Walking Suitability Category	*No. Schools From Low-Busing Strata % (n)*	*No. Schools From High-Busing Strata % (n)*	*Total No. of Schools % (n)*
Very good (less than 3.0)	14.2 (2)	7.1 (1)	21.4 (3)
Good (3.0–5.9)	35.7 (5)	14.2 (2)	50.0 (7)
Fair (6.0–8.9)	—	—	0
Poor (9.0–26.0)	—	21.4 (3)	21.4 (3)
No sidewalk on quiet street (27.0–99.0)	—	7.1 (1)	7.1 (1)
No sidewalk on busy street (>99.0)	—	—	0
Total	50.0 (7)	50.0 (7)	100 (14)

NOTE: Very good = no improvements needed; good = could be improved through sidewalk condition; fair = could be improved through enhancing or adding buffers and sidewalk condition; poor = broken sidewalk, gravel surfaces, few curb ramps; no sidewalk = unsafe conditions for walking (high speed limit, etc.). All walking suitability scores of the schools were determined by calculating an average of all streets within the schools' measurement areas of a 0.25-mile radius.

number), (g) intersections (crosswalks, walk signals), and (h) traffic counts. Finally, field notes were kept about each street's condition (e.g., uneven pavement or blind corners). One data collector conducted all walking suitability assessments.

Each street within each school's measurement area received a walking suitability score, which was determined by summing the scores (total possible score for each street ranges from −1 to 99+) assigned to each of the characteristics described above. Therefore, each school had multiple street scores, depending on the number of streets lying within the measurement area. A final score (determined by the average of all street scores within each school) represented the walking suitability of each school.

Data Analysis

Walking suitability data were not normally distributed; therefore, an independent samples Mann–Whitney *U* test was conducted to examine differences in walking suitability scores and the individual variables within the assessment between the two busing strata. Additionally, descriptive statistics performed for walking suitability scores included the median and the 25th and 75th percentiles. Analyses were performed using SPSS, Version 12.0.

RESULTS

A total of 164 streets were measured; 12.5 ± 2.2 total streets were assessed per school. Walking suitability scores of all schools ranged from 1.6 to 89.9. The median walking suitability score was 3.7 (a *good* rating, as defined above and in Table 2); the 25th percentile score was 2.9 (*very good*), and the 75th was 22.3 (*poor*). Scores were not statistically different between the busing strata, as indicated by the Mann–Whitney *U* test: $U(12) = 11.0$, $p = .09$. Regarding individual components (i.e., sidewalk, buffer) of the assessment, the average scores for sidewalks (i.e., whether a sidewalk was continuous, partial, etc.) was the only item indicating a significant difference between the high-busing and low-busing schools: 21.7 versus .03, respectively ($p < .01$). This item was scored on the following scale: 0 (*both sides continuous*), 1 (*one side continuous and one side partial*), 2 (*one side continuous*), 3 (*both sides partial*), 4 (*one side partial*), and 99 (*no sidewalk present*; Emery et al., 2003).

Table 2 presents the walking suitability scores for all schools in a categorical format (as originally established by the developers of the assessment). Three (21%) of the schools (two from low busing and one from high) fell within the *very good* category of walking suitability (i.e., no repairs needed on sidewalks, sidewalk is made of concrete material). Seven (50%) of the schools fell within the *good* category (five from low busing and two from high). The *good* category represents sidewalks that provide basic access but could use upgrades for better walking, such as enhanced surface material or condition. Three (21%) high-busing schools were categorized as *poor* (i.e., need major improvements to enhance walking environment), and one (7%) high-busing school was categorized as unsafe for walking due to no sidewalk.

DISCUSSION

The immediate built environment is theoretically an important factor to consider when exploring the possibilities of walk-to-school (i.e., active commuting) programs (Braza et al., 2004). Prior to 2003, several "walkability checklists" had been created to explore how neighborhoods surrounding schools rated for walkability. Such checklists (e.g., Partnership for a Walkable America's downloadable assessment at http://www.walkableamerica.org) provide parents, children, and school personnel (i.e., the lay community) with simple methods for identifying various aspects of the built environment that may inhibit or facilitate active commuting behaviors. These checklists can give the community insight into neighborhood streets and sidewalks but are generally subjective in nature and lack quantification necessary for program, research, and evaluation purposes (Moudon & Lee, 2003).

The assessment used in this study provides both practitioners and researchers with a method for determining a quantifiable estimate of walking suitability in any given geographic area. Its purpose is to allow for the examination of walking suitability of the environment in an objective, acceptable format (e.g., multiple variables of interest) (Emery et al., 2003). We utilized this walking suitability assessment to examine its usefulness in measuring the built environment around schools. To date, it has not been used to conduct an assessment within the school setting. In fact, very few studies have utilized an objective method of measuring the built environment around schools to determine either overall walking suitability or its relationship to active commuting patterns of youth.

When conducting a review of the current literature in walking suitability and active commuting among youth, we did not find any other studies that specifically examined the usefulness of an objective measure applied to schools. Also, we are not aware of other studies examining differences between schools based on busing strata. However, we identified two studies that did use an objective method for determining walking suitability in the context of active commuting to school among young people. Braza and colleagues (2004) did examine neighborhood design and its relationship to rates of walking and biking to elementary schools in California. However, these authors defined an objective measure of neighborhood design by using 1990 U.S. Census data, which measured both population density and the number of intersections per street mile. Although useful, this approach is limiting as it does not capture direct and objective characteristics (e.g., sidewalks, buffers, curb cuts, or daily traffic counts). Similar to our study, however, Braza and colleagues (2004) did examine the neighborhood design within the 0.5-mile radius surrounding the schools. More recently, Kerr and colleagues (2006) used an objectively measured form of walking suitability with GIS software to calculate residential density, mixed land use, intersection density, and other variables. Determination of high- or low-walkability neighborhoods was calculated using a detailed mathematical equation that established a walkability index score. This method was validated in previous studies (Frank, Andresen, & Schmid, 2004; Frank et al., 2006; Frank, Schmid, Sallis, Chapman, & Saelens, 2005), but these were adult population studies. Other authors examining neighborhood characteristics as they might relate to active commuting to school have used limited secondary data, such as type of neighborhood (e.g., suburban, rural area, small city, or town; Fulton, Shisler, Yore, & Casperson, 2005).

In addition to examining the usefulness of the walking suitability assessment, we used the assessment to compare two busing strata to determine if differences existed. We theorized that schools with a high proportion of students bused to school might have environments surrounding them that were not as suitable for walking as schools with lower proportions of busing. This hypothesis was not supported by these data as there were no significant differences in walking suitability between high- and low-busing strata. Closer examination of the distribution of these data (range = 1.6–89.9), however, revealed that all schools rated as *poor* or worse (according to preset categories) were high-busing schools. Additionally, the examination of each variable on the assessment did indicate that high-busing schools had poorer scores for the sidewalk variable, which examines the presence of a sidewalk and whether it is continuous or partial on both sides of the street. Taking into consideration the school district's policy for transportation (i.e., any student living within 1 mile of school may walk or bike unless road conditions, traffic speeds, etc. are deemed unsafe), we noted that high-busing schools contained more unsafe conditions such as lack of sidewalks or traffic speeds that would affect the proportion of students selecting to ride the bus.

Regardless of busing proportions within schools, an enabling built environment, in combination with school policies, is likely an important consideration for future school construction and SRTS programs. SRTS, a program recently passed as federal legislation that provides every state with more than US$1 million to use within the vicinity of schools (2-mile radius), requires both infrastructure projects (i.e., traffic engineering) and noninfrastructure projects such as safety education, incentive programs to increase active travel or decrease driving, and enhanced enforcement of traffic regulations within the school zone (U.S. Department of Transportation, 2005). These types of changes have the potential to affect positively the built environments surrounding schools and, eventually, rates of active commuting to and from school.

During the next several decades, it is estimated that thousands of new schools will be built in response to a rise in elementary and secondary student populations (National Center for Education Statistics, 1998). This predicted increase in school construction (i.e., the built environment) has numerous implications including increased traffic surrounding schools, compromised air quality, and higher risk for pedestrian and cycling fatalities among youth (Ewing & Greene, 2003). Both Staunton, Hubsmith, and Kallins (2003) and Boarnet, Anderson, Day, McMillan, and Alfonzo (2005) reported that changes to the built environment surrounding schools in California (linked to California's SRTS legislation) were associated with increases in walking and bicycling among third- through fifth-grade students. The emphasis on safe and walkable built environments surrounding schools may prove to play a significant role in decision making for future programming, future school construction, and built environment improvements.

LIMITATIONS

Within the assessment itself, there may be additional environmental, policy, personal, and social factors not captured by the walking suitability scores that could play a role in determining a more diverse and comprehensive understanding of walking suitability. For example, the presence or absence of school crossing guards is not part of the walking suitability assessment. Although this type of environmental factor may be added within the field notes of researchers or practitioners, it may be greatly beneficial to include in the overall scoring system.

Additional nonenvironmental factors that must be considered when assessing the feasibility of walk-to-school programs include peer influences, additional school transportation policies, sociodemographics, and student and parent perceptions (Timperio et al., 2006). For example, Martin and Carlson (2005) reported the results of parent-completed surveys regarding perceived barriers for their children to walk or bike to school. Distance to school, traffic, crime, and weather were the barriers most often reported. Another recent study found that parental concerns (e.g., crime, safety hazards, fast traffic, and time constraints) were strongly associated with commuting modes among youth (Kerr et al., 2006). Fulton and colleagues (2005) found that items such as race and ethnicity (non-Hispanic Black and Hispanic youth actively commute more often than non-Hispanic Whites) and marital status (children of married parents are less likely to commute actively) influenced commuting choices. Finally, a recent study (Kerr et al., 2006) found that parental perception of the walking and bicycling habits of other children in their neighborhood was associated with their own child's commuting. We recognize that the walking suitability assessment used in the current application does not provide for an evaluation of these potentially important additional considerations.

CONCLUSION

Consideration should be given to the walking suitability of elementary schools, particularly as part of determining feasibility of walk-to-school programs. This application study captured several aspects of the built environment by applying an objective, quantifiable assessment that many researchers, practitioners, school personnel, and transportation experts may deem useful and relevant to their local situations. It is recommended that additional factors such as school policies, student and parental attitudes and beliefs about the environment, and sociocultural characteristics are considered as a comprehensive needs assessment.

The study of the built environment and its potential role in and impact on children's transportation modes remains in initial stages. More examination of the interrelationship between human physical activity behavior and the environments we live within is critical to reach public health goals such as those detailed in Healthy People 2010 (National Center for Health Statistics, 2000). Finally, a greater understanding of the immediate built environment, when combined with larger environmental, policy, and sociocultural needs assessments, should play a role in decisions made about walk-to-school programs initiated at the local level.

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