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THE SCHOOL NEIGHBORHOOD ENVIRONMENT FOR CHILDHOOD OBESITY IN A RURAL TEXAS COMMUNITY*

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ABSTRACT

This paper examines the school neighborhood environments related to childhood obesity in a rural community in Texas, focusing on the assessment of three aspects: socioeconomic characteristics, food environment, and physical activity environment. Different methodological approaches were employed to characterize the aspects of the school neighborhood environments. Most public schools in the community were located in low-income neighborhoods. There were disproportionately high concentrations of fast food restaurants and convenience stores within the active travel-to-school zone. Most of the students who lived in the active travel-to-school zone did not walk or bike to school, and student safety was identified as the predominant barrier. Most schools did not have proper guidelines or procedures for walkers and bikers. Moreover, there were heavy concentrations of unhealthy food outlets in the school surroundings where sidewalks were built to encourage students' active travel to school. We conclude that a more comprehensive and balanced approaches should be adopted to increase healthy eating and physical activity, and to reduce childhood obesity.

The prevalence of U.S. childhood obesity has increased by more than three times during the past 30 years (Ogden and Carroll 2010). Reversing the growing childhood obesity epidemic is a high-priority public health issue in the United States (White House Task Force on Childhood Obesity 2010). Despite their significant contributions, biological factors and individual health behaviors, such as unhealthy eating and physical inactivity, have not effectively explained the childhood obesity epidemic (Huang and Glass 2008). Studies have documented societal changes in children's food and physical activity environments, along with increases in the prevalence of childhood obesity (McDonald 2007; Story, Sallis, and Orleans 2009). There have been notable increases in the availability, affordability, and consumption of foods and beverages with excess calories, total and saturated fat, sugar, and sodium (Story et al. 2009). Physical activities and active travel to school have been significantly reduced. According to the Safe Routes to School National Partnership

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(2010), walking or bicycling to school has precipitously declined from 48 percent in 1969 to 13 percent in 2009 among children aged 5–14 years old.

Although health behavior is considered a function of individual choice, the socio-ecological perspective has suggested that individual lifestyle choices and behaviors are influenced by the environment surrounding an individual. Particular attention has been paid to the neighborhood environment in addressing the childhood obesity issue. Studies have found that the socioeconomic characteristics of neighborhoods (e.g., income, poverty, and racial composition) were related to built environments for healthy living, such as supermarket/grocery store proximity, density of convenience stores and fast food restaurants, physical activity amenities (e.g., recreation and fitness facilities, parks), and/or sidewalks and trails for walking/biking (Grow et al. 2010; Moore and Diez-Roux 2006; Morland et al. 2002; Pearce et al. 2007; Simon et al. 2008). Rural neighborhoods are different from urban neighborhoods in terms of socio-demographic and environmental characteristics. Rural areas often have lower incomes, fewer available recreation and fitness facilities, and more convenience stores, which offer lower availability and higher cost for healthy food selections than supermarkets and grocery stores (Bustillos et al. 2009; Choi 2012; Liese et al. 2007; Sharkey 2009). In turn, neighborhood built environments have been found to affect dietary behavior and physical activity, thereby influencing the risk of obesity (Franzini et al. 2009; Gordon-Larsen et al. 2006; Saelens et al. 2012; Singh, Siahpush, and Kogan 2010). Children who lived in a neighborhood with socioeconomic disadvantages and in the proximity of unhealthy food outlets, as well as in a rural area, had a higher risk of obesity and a faster accumulation of weight (Davis and Carpenter 2009; Grow et al. 2010; Howard, Fitzpatrick, and Fulfrost 2011; Jennings et al. 2011; Liu et al. 2008).

School neighborhood environments are crucial for the dietary behavior, physical activity, and weight status of children. Previous studies have found that the school neighborhood food environment was significantly related to children's overweight and obesity (Davis and Carpenter 2009; Howard et al. 2011). For example, a California statewide study showed an increased overweight risk among middle and high school students who attended schools within 800 meters of fast food restaurants (Davis and Carpenter 2009). Another study found (Howard et al. 2011) that proximity of convenience stores within a 10-minute walking distance of a school was related to a higher rate of overweight among students. The Safe Routes to School (SRTS) program, a nationwide federal program aimed at improving safety and encouraging children's active travel (walking and bicycling) to school has been successful. The SRTS participating areas have shown the increased number of

children walking and bicycling to school, along with changes in the built environment of school neighborhoods (National Safe Routes to School Task Force 2008). Children's active travel to school was significantly associated with a higher physical activity level (Davison, Werder, and Lawson 2008).

Considering that childhood obesity is affected by individual health behaviors and environmental characteristics, assessing obesity-related environments to provide effective interventions for childhood obesity reduction and prevention is important. This paper examines school neighborhood environments related to childhood obesity in a rural community in Texas. This study was a part of a broader project to develop a comprehensive and effective locale-specific community action plan in a rural community. The project will conduct multilevel assessments related to childhood obesity at the student level and the home, school, neighborhood, and community environments in a rural community. This paper focuses on the assessment of three aspects of rural school neighborhood environments: socioeconomic characteristics, the food environment, and the physical activity environment. The assessment provides fundamental information for developing a sustainable community action plan and interventions for combating childhood obesity in the community.

METHODS

Setting

The city of Huntsville is a rural community (USDA-ERS definitions) with a population of 38,548, including 8,489 inmates in seven prisons, in Walker County, Texas (U.S. Census Bureau, 2010a). Walker County is a non-metropolitan, difficult-to-develop county because much of its territory is owned by federal and state governments and is tax exempt. The county commissioners are faced with the challenge of making social services available to a needy population without adequate taxable sources of income. According to 5-year estimates of the 2006-2010 American Community Survey (U.S. Census Bureau 2010b), Huntsville has a much lower median household income (\$26,864) and higher poverty rate of families with children less than 18 years (27.2 percent), than does the State of Texas (\$49,646 median household income, 19.1 percent poverty rate). More than 37 percent of residents are racial minorities. Residential segregation by race and poverty status is prevalent.

As of 2009, 6,291 students attended one of the nine schools in Huntsville – one pre-K center, four elementary schools (grades K-4), one intermediate school (grades 5-6), one middle school (grades 7-8), one high school (grades 9-12), and one Excel

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Center (grades K-8). The racial makeup of students is 49.4 percent White, 22.4 percent Hispanic, 26.0 percent African American, and 1.7 percent from other races. About 62 percent of students are economically disadvantaged compared with 59 percent at the state level (Texas Education Agency 2010).

Data, Procedures, and Analyses

The school neighborhood environment related to childhood obesity in Huntsville was assessed in three aspects: social environment, food environment, and physical activity environment. Different methodological approaches were employed to characterize the aspects of the school neighborhood environments in Huntsville: (1) using government data and statistics to describe the social environment; (2) conducting an analytical review of existing documents related to the physical activity environment of Huntsville; and (3) mapping the food environment (quantity, type, and proximity of food outlets).

The social environment was assessed using several demographic and socioeconomic characteristics of Huntsville, using census tract level data obtained from the 2011 U.S. Census American Fact Finder. The percentages of racial minorities and female householders with children less than 18 years old were based on 2010 census data; and the percentage of people without a high school diploma, the poverty rate of families with children less than 18 years, and the median household income were based on 5-year estimates of the 2006-2010 American Community Survey.

To assess the physical activity environment, several city documents were obtained and reviewed: the Safe Routes to School Plan in Huntsville (Texas Safe Routes to School 2009), the Parks Master Plan (City of Huntsville 2009a), and the Sidewalk Master Plan (City of Huntsville 2009b). First, the level of active travel to school was identified by examining the mode of transportation for home-to-school and school-to-home travel among students who lived in an active travel-to-school zone. The Texas state law (TEC, §42.155(1), as added by House Bill 3506, 82nd Texas Legislature) specifies the eligibility of bussing services to students who live two or more miles from their school or “in a school-board-designated hazardous traffic area within two miles” of their school (Texas Education Agency 2012:2). The two-mile distance from home to school/school to home is often considered as an active travel-to-school zone for walking and bicycling to school. Second, barriers to active travel to school, as well as city and school supports for active travel to school, were identified. Third, school sites participating in the Safe Routes to School (SRTS) program were identified. Lastly, parks and recreational facilities in the City

of Huntsville were identified to provide information about the overall physical activity environment for the city residents.

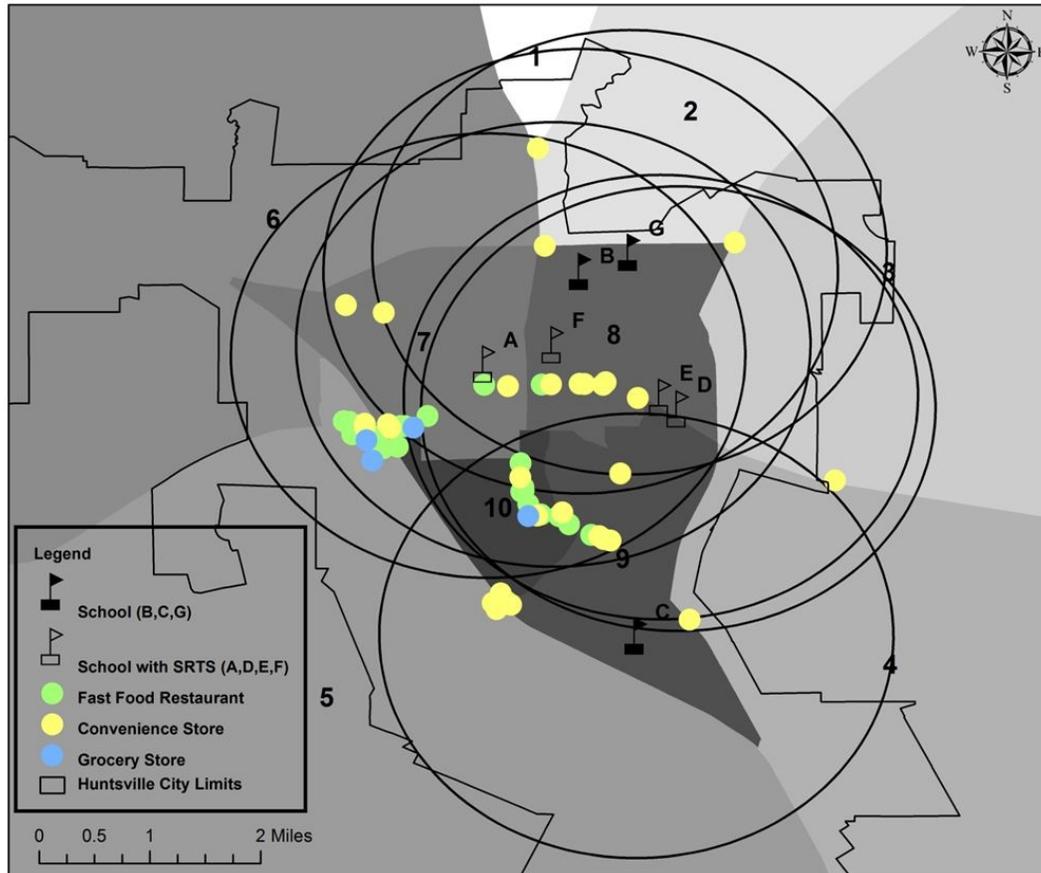
The food environment of school neighborhoods was mapped using Arcmap 10 (ESRI). The base map of Huntsville with census tract boundaries was created using the Topologically Integrated Geographic Encoding and Referencing system (TIGER) data for the 2010 U.S. Census. For the Huntsville city limit, TIGER data from the Texas Natural Resources Information System (TNRIS) were used. School location data were obtained from the Texas Education Agency and then ground-truthed by using a Global Positioning System (GPS) device. Coordinates obtained with the GPS were entered into Arcmap to geocode school locations. A two-mile Euclidian (straight line, circular radius) buffer zone was created around each school as an active travel-to-school zone.

For the food environment assessment, first, a list of food outlets in Huntsville and their locations were compiled from Google map searches. Food outlets in this study included only grocery stores, supermarkets, fast food restaurants, and convenience stores. Based on the literature (Bustillos et al. 2009; Liese et al. 2007), grocery stores and supermarkets were categorized as healthy food outlets, and fast food restaurants and convenience stores were grouped as unhealthy food outlets. Grocery stores/supermarkets sell a large range of foods. Convenience stores sell a very small variety of foods (e.g., soda, chips, and candy bars). National chains and local establishments whose primary menu items were hamburgers, hot dogs, fried chicken, and pizzas were defined as fast food restaurants. After compiling the list of food outlets from Google map searches, the ground-truthing approach was employed to obtain a complete and accurate enumeration of different types of food outlets. Several convenience stores and fast food restaurants were added through ground-truthing. The point locations of the food outlets were geo-coded and entered into Arcmap. Besides mapping food outlets, descriptive statistics of food outlets by outlet type within each active travel-to-school zone were presented.

RESULTS

Figure 1 is the map of the City of Huntsville, Walker County. There are 10 census tracts, and six of them (#1-#6) are partially included in the Huntsville city limits. The map includes census tracts, the locations of seven public schools with an indication of SRTS participation, the two-mile buffer zone (Euclidian buffer zone) of each school, and food outlets (grocery stores/supermarkets, fast food restaurants, and convenience stores).

FIGURE 1. A MAP OF NEIGHBORHOOD ENVIRONMENTS OF PUBLIC SCHOOLS IN HUNTSVILLE, TEXAS.



NOTES: The city of Huntsville is divided into 10 census tracts. The numbers in the map indicate the census tract numbers. As seen in the map, six census tracts (#1 to #6) are included partially in the Huntsville city limits. The circle indicates an active travel to school zone for each school. A two-mile Euclidian (straight line, circular radius) buffer zone was created around each school as an active travel to school zone.

Social Environment

Overall school neighborhoods are often poor and have low levels of education. Six out of seven public schools were located in the two most socioeconomically disadvantaged areas (census tracts #8 and #9) in Huntsville: one with the highest poverty rate and the lowest median household income; the other with the highest rates of racial minorities, those without a high school diploma, and female householders with children (see Table 1).

TABLE 1. SOCIAL ENVIRONMENT OF HUNTSVILLE BY CENSUS TRACT

CENSUS TRACT #	RACIAL MINORITY ^a	FEMALE HOUSEHOLDER WITH CHILDREN < 18 YRS. ^a	LESS THAN HIGH SCHOOL GRADUATE ^b	MEDIAN HOUSEHOLD INCOME ^b	POVERTY LEVEL (FAMILIES WITH CHILDREN < 18 YRS.) ^b
1	38.8%	5.7%	26.7%	\$43,255	31.4%
2	16.9%	7.1%	19.5%	\$44,118	22.4%
3	23.3%	5.8%	18.1%	\$43,688	33.9%
4	29.6%	6.7%	17.3%	\$41,439	22.0%
5	17.3%	4.2%	5.3%	\$54,988	0.5%
6	38.0%	7.3%	14.2%	\$50,000	28.3%
7	37.5%	6.3%	26.2%	\$30,821	12.1%
8	57.1%	15.4%	32.1%	\$26,959	31.7%
9	35.2%	9.4%	25.4%	\$13,414	36.7%
10	32.2%	6.4%	10.7%	\$19,045	27.0%

NOTES: The census tract numbers in this table match with the census track numbers in Figure 1. ^a 2010 U.S. Census Bureau data; ^b 5-year estimates of the 2006-2010 American Community Survey.

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Food Environment

Within the Huntsville city limits, there were four healthy food outlets and 58 unhealthy food outlets (26 fast food restaurants and 32 convenience stores). Fifty percent of grocery stores were located in the wealthiest and white-dominant neighborhood (Census tract #5) in Huntsville (see Figure 1). There was no grocery store in the most socioeconomically disadvantaged neighborhoods (census tracts #8 and #9). Table 2 shows the food and active travel environments of the two-mile buffer zone of each public school. About 91.4 percent (53 out of 58) of unhealthy food outlets in Huntsville were located within the two-mile buffer zone of public schools. The concentrations of unhealthy food outlets varied across school buffer zones, ranging from a low of 24 percent to a high of 79 percent. Two schools, in particular, had the highest concentration rate (79.3 percent) of unhealthy food outlets: 92.3 percent of fast food restaurants and 68.8 percent of convenience stores for elementary school A; and 88.5 percent and 71.9 percent, respectively, for the middle school E. Simultaneously, all the grocery stores were located in the buffer zones of the two schools (A and E). The high school had the lowest concentration of unhealthy food outlets in its buffer zone.

Physical Activity Environment

Active travel to school. To encourage students' active travel to school, the Student Rider and Route Service Eligibility in Texas requires at least a two-mile distance from home to school except in hazardous traffic areas (Texas Education Agency 2012). To abide by the state regulation, the Huntsville Independent School District Transportation Division offers bussing services only to students who live two miles or more from their school, except elementary school students (Texas Safe Routes to School 2009). Students who live within two miles of their school commute via either private vehicle drop-off/pick-up or walking/bicycling.

According to the parent survey conducted in six public schools (all public schools except the high school) in Huntsville (Texas Safe Routes to School 2009), about 30 percent of students (ranged from 23 percent to 36 percent) lived within two miles of their school, that is, the active travel-to-school zone. Among them, relatively small proportions were walkers or bikers (see Table 2). The levels of active travel to school varied by school classification (elementary, intermediate, and middle school), school location (close to a highway or not), and whether the travel was to or from school. Compared to intermediate and middle school students, elementary school students were less likely to walk or ride a bicycle to and/or from school. Among elementary school students, a much higher percentage of walkers

TABLE 2. FOOD AND ACTIVE TRAVEL ENVIRONMENT OF TWO-MILE BUFFER ZONE OF PUBLIC SCHOOLS IN HUNTSVILLE, TEXAS

SCHOOL	FOOD ENVIRONMENT ^a			ACTIVE TRAVEL ENVIRONMENT ^b				
	UNHEALTHY FOOD OUTLETS			GROCERY / SUPERMARKETS n=4	LIVING WITHIN 2-MILES	WALKING / BIKING TO SCHOOL	WALKING / BIKING FROM SCHOOL	SRTS PROGRAM ^c
	FAST FOOD n=26	CONVENIENCE n=32	TOTAL n=58					
Elementary A. . .	92.3%	68.8%	79.3%	100%	28%	8%	7%	Yes
Elementary B. . .	26.9%	43.8%	36.2%	25%	24%	15%	1%	No
Elementary C. . .	38.5%	43.8%	41.4%	25%	36%	9%	8%	No
Elementary D. . .	46.2%	56.3%	51.7%	25%	26%	14%	29%	Yes
Intermediate E.	42.3%	53.1%	48.3%	50%	23%	13%	25%	Yes
Middle F.	88.5%	71.9%	79.3%	100%	24%	30%	40%	Yes
High school G.	7.7%	37.5%	24.1%	0%	NA	NA	NA	No

NOTES:^a There are 26 fast food restaurants, 32 convenience stores, and 4 grocery stores within the city limits of Huntsville, TX. Some food outlets are located within the 2-mile buffer zone of more than one school. ^b The data for active travel environment were excerpted from the Safe Routes to School Plan in Huntsville (2009). ^c The information was retrieved from the National SRTS State Project List: Program State Project List Search Results (National Center for Safe Routes to School 2012).

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and bikers was found among school D students. The active travel rate was comparable to that of its neighbor school, the intermediate school E (see Figure 1 and Table 2). Interestingly, both schools were located on a major highway. There was a difference in the rates of walkers/bikers between home-to-school and school-to-home travels. Overall, the active travel rates were higher in home-to-school than school-to-home travel.

The Safe Routes to School Plan in Huntsville (Texas Safe Routes to School 2009) reported that parents in Huntsville identified the traffic safety issue along the routes to school as the primary barrier to walking/biking to school. Other barriers included distance to school, age of the child (too young), bad weather, high speed vehicles, scary people, lack of sidewalks, unfriendly dogs, and the lack of a safe place to cross the street. All the public schools in Huntsville had arrival and dismissal procedures for private vehicle drop-off/pick-up and school buses. Most schools provided or planned to provide support for a safety environment around the school, such as crossing guards, staff presence during drop-off/pick-up, and school traffic safety plans. However, there were limited information and guidelines to support students' active travel. Only one school had the procedures for pedestrians and bicyclists.

The City of Huntsville has tried to provide an environment to encourage physical activity and active travel. The city developed a Sidewalk Master Plan for the community in 2009. The Safe Routes to School (SRTS) program was implemented in 2010 through five awards (a \$1,134,935 investment overall) to four public school surroundings to improve walkability for students and to ensure a safe trip to school by building sidewalks (National Center for Safe Routes to School 2012). In Figure 1, the four schools with the SRTS program funding are indicated. The two schools (schools D and E) on a major highway were included in the SRTS program. Interestingly, the four SRTS participating schools had the highest concentrations of unhealthy food outlets.

Community amenities for physical activity. According to the Huntsville Parks Master Plan (City of Huntsville 2009a), there were 27 parks in Huntsville: four city parks, 14 neighborhood parks, six passive parks, and three green space parks.¹ There were deficits of park spaces and facilities. In particular, the city had a

¹According to the Parks and Recreation Department, there are four types of parks: city, neighborhood, passive and green space. A *city* park is a large park with ball fields, pools, soccer fields, etc. A *neighborhood* park is a medium-sized park with limited amenities (e.g., play module, picnic table, open space, etc). A *passive* park is a minimal park left in a natural state with few or no amenities. A *green space* park does not possess amenities (City of Huntsville 2009a).

significant shortage of neighborhood parks that provided recreation amenities to the neighborhoods. Huntsville offers only a quarter of an acre of neighborhood park per 1,000 people, whereas the National Recreation and Park Association standards recommend at least 2 acres per 1,000 people (City of Huntsville 2009a).

DISCUSSION AND CONCLUSIONS

In this study, we found that most public schools in Huntsville were located in low-income neighborhoods. There were disproportionately high concentrations of fast food restaurants and convenience stores within the active travel-to-school zone (within two miles of a school). Studies have found that neighborhoods with socioeconomic disadvantages and/or built environments unfavorable to healthy diet and physical activity often had higher childhood obesity prevalence (Grow et al. 2010; Saelens et al. 2012). Proximity of convenience stores and fast food restaurants to children's residences and schools was associated with increased risks of unhealthy, dietary behavior and overweight/obesity (Davis and Carpenter 2009; Howard et al. 2011; Jennings et al. 2011). Thus, the socioeconomic disadvantage and unhealthy food environments of school neighborhoods in Huntsville might increase the risks for unhealthy students' dietary behavior and obesity.

Active travel to school through walking or bicycling is an important part of children's physical activities. In our study, however, most of the students who lived in the active travel-to-school zone did not walk or bike to school. Student safety was identified as the predominant barrier for active travel to school, similar to other studies (Ahlport et al. 2008; Centers for Disease Control and Prevention 2005; Kerr et al. 2006). The presence of crossing guards, sidewalks, walking paths/trails, bicycle supports, speed zones, traffic speeds, as well as shorter distances to school could facilitate students' active travel to school (Ahlport et al. 2008; Boarnet et al. 2005; Fesperman et al. 2008). While most schools in Huntsville have provided some safety supports, such as crossing guards and staff presence during drop-off/pick-up, they did not have proper guidelines or procedures for walkers or bikers. Thus, more safety supports for walkers and bikers, in particular, are necessary to encourage active travel to school among students.

To ensure students' physical activity, creating a school neighborhood environment where students can enjoy physically-active and safe travel to school is important. In the past few years, sidewalks have been built in four public school surroundings in Huntsville through the Safe Routes to School Program. Building sidewalks around schools could increase students' physical activities by improving walkability and facilitating safe trips to school. However, the food environment

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immediately surrounding school campuses should be considered. Studies found that the presence, proximity, and types of food outlets, as well as the characteristics of the child's route to school, could make significant contributions to overall physical activity and children's weight status (Choi 2012; Day and Pearce 2011). Borradaile and colleagues (2009) reported that students frequently shopped for and bought inexpensive sugar-sweetened drinks, chips, and candy at convenience stores near schools before and after school. In our study, we found that there were heavy concentrations of convenience stores and fast food restaurants in the four public school surroundings where sidewalks were built through the SRTS program. Such unfavorable food environments of school neighborhoods could offset the potential positive effects of active travel to school on child weight status.

Our study is part of the multilevel assessment of a rural community designed to develop a feasible, sustainable, locale-specific community action plan to reverse current childhood obesity. We conclude that the school neighborhoods in Huntsville do not have favorable social, food, or physical activity environments. More comprehensive and balanced approaches should be adopted to increase healthy eating and physical activity, and to reduce childhood obesity. That is, strategies and interventions should be focused not only on the active travel environment to school such as trails, sidewalks, and bicycle paths, but also on the food environment through regulating the density of convenience stores and fast food establishments along routes to school to effectively address childhood obesity. In addition, greater effort should be made to address the socioeconomically disadvantages of school neighborhoods.

AUTHOR BIOGRAPHIES

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