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# Social environmental disparities on children's psychosocial stress, physical activity and weight status in Eastern Alabama counties

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ABSTRACT

Social environmental injustice could directly influence children's physical activity and weight, but also indirectly through changing their psychosocial processes. This study aims to assess spatially continuous physical and social environments and to examine the impact of psychosocial stress on the complex interaction between children and obesogenic environments in three Eastern Alabama counties. The obesogenic environment is defined with particular physical, social, and economic characteristics, causing higher risk of being overweight or obese. Survey questionnaires were collected for 690 children in grades K-6 at six schools to measure children's weight, height, socio-demographics, and home locations. Physical activity, psychosocial stress, and family environment were further gathered from a subsample of children aged 8–13 (n = 65) through extended surveys. GIS and statistical methods were used to assess multilevel environments at family, community, and school levels. The associations between children's physical activity, stress, weight, and physical and social environments were examined by a series of multi-level regression models. Of the sample, 42.3% of the participants were measured as overweight or obese, much higher than the national rate of 31.8%. High weight clusters were observed in a variety of block groups with diverse physical and social environments. Community physical and social environments exhibited inconsistent even opposite spatial patterns ($r = -0.18$; $p < 0.05$). The results of multilevel regression models demonstrated the bidirectional causal interactions of physical activity, psychosocial stress, and weight. We also found that family ($p < 0.01$) and school environments ($p < 0.01$) were more influential to children's participation in physical activity, psychological wellbeing, and weight status compared to community environments.



## 1. Introduction

Children living in rural and low-income communities of eastern Alabama have greater prevalence of being overweight or obese, contributing to an increased risk of chronic diseases compared to children across the U.S. (Robinson, Wadsworth, Webster, & Bassett, 2014; Wang, Slawson, Relyea, Southerland, & Wang, 2014). In some rural counties, over 40% of children are overweight or obese, compared to 31.8% nationwide (Li, Robinson, Carter, & Gupta, 2015). Physical inactivity has been considered as one of the most important reasons contributing to the high overweight or obese rates of Eastern Alabama children due to social and environmental disadvantages (Yousefian, Ziller, Swartz, & Hartley, 2009). From a public health perspective, recognizing and examining the underlying factors of health disparities is crucial for improving public health (Gordon-Larsen, Nelson, Page, & Popkin, 2006), particularly for reducing obesity rates of vulnerable populations.

The health disadvantages of Eastern Alabama children can be explained by neo-material (Lynch, 2000; Lynch, Harper, Kaplan, & Smith, 2005), psychosocial mechanisms (Wilkinson, 1996), and ecological models (Bronfenbrenner, 1979). The neo-material mechanism emphasizes multilevel physical environments and overall living standards. Poor people at lower levels of the social hierarchy can only obtain limited and low-quality material support, such as poor housing, limited access to recreational facilities, and overall disadvantageous physical environments. From the psychosocial perspective, inherent disparities in the social environment

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can lead to individual stress and community-level tension and disharmony that exert a detrimental impact on health behaviors (Braveman, 2009; Kawachi & Kennedy, 1997). Similarly, the ecological model supports that children's behaviors and development are influenced by multilevel risk factors, from family and school to economic and social structures (Bronfenbrenner, 1979). The vulnerability to environmental factors increases obesity risks of children through home, school, and community environments (Grow et al. 2010).

Both physical and social environments play key roles in influencing children's physical activity and weight. Previous research has identified the effectiveness of neighborhood parks, public green spaces, walkability, street connectivity, and mixed land use developments in the reduction of sedentary behavior and promotion of physical activities in children (Liu, Wilson, Qi, & Ying, 2007; Zhang, Lu, & Holt, 2011). Community physical environment correlates with socio-demographic factors (Casey et al. 2011; Li et al. 2015). Low-income minority communities have less access to recreational facilities, which decreases the opportunities for energy expenditure of underserved children (Oreskovic, Kuhlthau, Romm, & Perrin, 2009). Low participation in physical activity translates to a sedentary lifestyle that contributes to an increased risk of obesity in disadvantaged communities. In addition to community-level socio-demographics, previous studies have also identified the contextual effects of schools on the associations between unequal physical environments and children's weight status (Cory, 2007; Li et al. 2015; Procter et al. 2008).

Based on the above analysis, the childhood obesity epidemic is associated with multiple factors at multiple levels. In recent years, researchers raised some fundamental question like what is the role that place plays in explaining the complexity and multi-scale nature of health problems (Blacksher & Lovasi, 2012), and further pointed out the "spatial turn in health research" with the development of geographic science (Richardson et al. 2013). A focus of geographical research on obesity is interrogating the concept of obesogenic environment, defined as a wide range of physical, social, and economic characteristics that influence an individual's healthy lifestyle (Colls & Evans, 2014; Foresight, 2007). Such an environment is considered to contribute to the propensity of people to be or to become overweight or obese, including physical layout and land use (e.g. pavements/sidewalks, green spaces, walkability), locations of food outlets and leisure facilities, crime and safety, and cleanliness etc (Colls & Evans, 2014). Some scholars have attempted to measure and examine children's exposure to and interaction with obesogenic environments in terms of place-based process. Wall et al. (2012) complied a geospatial database with objective measurements of the environment and used spatial latent-class analysis to identify the spatially clustered obesogenic neighborhoods. Bethlehem et al. (2014) assessed urban neighborhood environmental characteristics in relation to socioeconomic status and residential density with the SPOTLIGHT-Virtual Audit Tool (SVAT). Among these environmental characteristics, the development of measurements of connectivity and walkability have become well-accepted indicators that greatly influence levels of physical activity (Ellis, Hunter, Donnelly, & Kee, 2016). For instance, Frank et al., 2010 proposed an integrated walkability index based on transportation and urban planning literature and examined the impact of urban transportations and on physical activity. Lowry, Dixon, and Kingsbury (2012) introduced a novel measurement assessing the street completeness with a four-dimensional audit for automobile, transit, pedestrian, and bicycle users and plotting the street's "status quo profile".

However, the contextual effects of neighborhood physical and social environments have various influences on individual children, no matter whether they study in the same school, live in the same neighborhood, or even in the same household (Gundersen et al., 2011). Besides the direct effects, the physical and social environments can indirectly affect children's behavior by changing children's psychosocial processes (Gundersen et al., 2011). Stress is considered as one potential risk factor for childhood obesity (Koch, Sepa, & Ludvigsson, 2008). Conversely, obese children might be unhappy with their weight status as a wide range of psychological problems have been found to be related to obesity (Warschburger, 2005). Stress-obesity research is still in the early stage and few studies have examined the bidirectional causality (Gundersen et al., 2011). Additionally, the impacts of socioeconomic inequalities on childhood obesity may be conveyed by the cumulative risk factors, which have greater impacts than the sum of singular factors (Evans, 2003).

This research assesses both physical and social environments in three Alabama counties with GIS and statistical methods, and examines the complex interactions between children's physical activities, psychosocial stress, weight status, as well as social and environmental injustice with mixed methods. Three hypotheses were investigated through spatial analysis and multilevel regression models: (1) the community physical environment is positively correlated with social environment; (2) multilevel environments influence children's physical activity directly and also indirectly through psychosocial stress; (3) disadvantageous multilevel environments, less physical activity, and severe psychosocial stress cause a higher risk of being obese or overweight in eastern Alabama.

## 2. Methods

### 2.1. Study area

Two rural counties (here after R1 and R2) and one urban county as a comparison (here after U3) in eastern Alabama were chosen as the study cases (Fig. 1). The two counties were selected because of their primarily rural landscape, high poverty rate, low median household incomes, and high minority population, predominantly African American. These three counties represent counties with low, medium, and high median family incomes and various racial composition in this region. According to the 2010 U.S. census data, the median household income of the two rural counties were $21,180 and $27,492 respectively, lower than that of the urban county ($40,894). The gap of their median family income was even larger among R1 ($28,511), R2 ($34,004), and U3 ($59,112). The populations of the three counties were 21,452, 52,947, and 140,247, with respective African American populations of 82.6%, 41.8%, and 22.7%.

### 2.2. Analytical framework

First, we propose a novel theoretical framework by integrating psychosocial and neo-material pathways as well as ecological models in this research (Fig. 2). Individual stress is considered as a node, which is treated as both an output of physical and social environments and as a factor influencing children's physical activity and weight status. Physical and social environments have both direct and indirect associations with children's behaviors and weight status; individual stress is a medium reflecting the indirect effect. Considering the influences of children's weight status on their behaviors and psychological functioning, the reverse causality is examined as well. Second, the multi-scale and multi-mechanism nature is highlighted to better understand the complex structure of obesogenic environments. Besides individual stress and behaviors, physical and social environments will be examined at family-, neighborhood-, and school-levels so as to assess the spatially