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Social inequalities in child pedestrian traffic injuries: Differences in neighborhood built environments near schools in Austin, TX, USA

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ABSTRACT

There have been many efforts to enhance pedestrian safety for children because school-aged children are one of the most vulnerable groups to traffic injury. However, we have limited understanding as to how the built environment affects child pedestrian safety around schools. Further, most previous studies have overlooked the fact that the built environment that support child pedestrian safety may vary across neighborhood heterogeneity. This study addresses these gaps by examining the impacts of the built environments on child pedestrian crashes around schools in Austin, Texas, USA. We use the binary logistic regression model with Firth's penalized likelihood method to estimate the impacts of built environments on child pedestrian crashes at the street segment level. This study finds that longer block lengths, missing sidewalks, crosswalk density, and commercial land uses around schools may hinder child pedestrian safety. Moreover, we find that socioeconomically disadvantaged children may have little to no protection against the risk of pedestrian crashes, especially due to lack of sidewalks and well-designed crosswalks. Our results may help planners, policymakers, and public health professionals better understand how to enhance child pedestrian safety around schools by improving surrounding built environments based on different neighborhood characteristics.

1. Introduction

Walkable built environments may provide various public health benefits, especially in terms of reducing obesity (McCormack and Shiell, 2011), cardiovascular disease (Ahmed et al., 2012), and mental health disorders (Dunn and Jewell, 2010). These health benefits are attributed to the fact that walking is the easiest form of physical activity to undertake as it can be incorporated into daily activities (Lee et al., 2013). There is growing consensus among researchers and public health professionals that a quality pedestrian environment encouraging active travel may be particularly significant for growing children and teenagers because they require physical activity in order to achieve biological maturation and normal bone and behavior developments (Loucaides and Jago, 2008; Sirard and Slater, 2008). Hence, various policy initiatives have been implemented to promote non-motorized travel among school-aged children, most notably the Safe Routes to School (SRTS) Program, providing a dedicated funding stream of $1.2 billion over 7 years for implementation through state transportation departments to improve pedestrian infrastructure and through education and promotion campaigns (National Center for Safe Routes to School, 2015). Another initiative to promote safer streets is the 30 km/h zone, which is aimed at reducing speed limits to a safe level that would foster pedestrian activity. These zones have been widely implemented in European countries, and to a lesser extent in the United States. For example, the Netherlands and Switzerland

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introduced 30 km/h zones in local areas—primarily residential—to ensure safe interactions between pedestrians and vehicles on the street (Lindenmann, 2005; Vis et al., 1992). In both cases, the introduction of 30 km/h zones improved traffic safety, reducing vehicle speed and traffic volume as well as accident frequency and severity.

Despite various health benefits of walkable built environments, pedestrian safety concerns for school-aged children remain a paramount issue. Children are exposed to greater risks of traffic accidents than other age groups, due to their physical vulnerability (Peden et al., 2004). According to the National Center for Health Statistics (NCHS), the leading cause of death in the U.S. between 2010 and 2014 for children and youths aged 5 through 19 was unintentional injuries, and more notably, 60.4 percent of those injuries resulted from motor vehicle traffic accidents. In 2014, children aged between 5 and 14 years old had the highest percentage of injured pedestrians among all other different age groups (NHTSA, 2016). Furthermore, traffic injuries resulted in approximately 70% of deaths of school-aged children aged 5 to 19 years in the U.S. and the U.K. (Keppel-Benson et al., 2002). Besides fatalities, motor vehicle-pedestrian crash for children is one of the major causes of disabilities (Peden et al., 2008). In response, there has been a convergence of support among planners, policymakers, and public health professionals to promote safe pedestrian environments for children.

Retrofitting built environments around schools into pedestrian-friendly designs may ensure children safety and encourage them to walk to school, thereby garnering greater health benefits. Schools, where children spend most of their time, play a key role in contributing to children's education as well as their social and recreational activities (Haug et al., 2010). In addition, pedestrian-oriented environments facilitating walking to school may provide opportunities for children to engage in daily physical activities improving their physical health (Loucaides and Jago, 2008; Sirard and Slater, 2008). On the other hand, pedestrian-hostile environments, which include roads with poor sidewalk coverage, high speed limits, and lack of traffic-control devices, may increase the risk of children being injured and killed. Such environments discourage children from walking to school which has a negative impact on physical activity and health. Despite numerous concerns regarding the built environment for children, we have limited understanding as to how these built environments affect child pedestrian safety around schools. Thus, one of the objectives of this study is to explore what factors affect the risk of child pedestrian crashes in the neighborhoods around schools.

Socioeconomically disadvantaged children are particularly vulnerable to pedestrian crashes due to unfavorable environments. Given that children from low-income families are more likely to walk to school than children from high-income families (Gavin and Pedroso, 2010; McDonald, 2008), pedestrian safety concerns are particularly acute among minority and/or low-income school-aged children. Although Latino and African-Americans comprise only about 25% of the U.S. population, they account for around 36% of pedestrian deaths (Ernst, 2004). In addition, low-income neighborhoods tend to have higher traffic risks due to poor built environments (Black and Macinko, 2008; Gavin and Pedroso, 2010). Hence, ensuring social justice for disadvantaged children is a significant goal of pedestrian safety for planners and public health professionals. This underscores the importance of examining the impact of built environments around schools by classifying neighborhoods based on socio-demographic characteristics, such as income and race/ethnicity. Therefore, this study investigates whether and how the built environment in different neighborhoods in terms of income and race/ethnicity characteristics may play a role in determining child pedestrian crashes around schools.

This study comprehensively examines the impacts of built environments around schools on child pedestrian crashes in Austin, Texas. We also compare the impacts of built environments around schools across different neighborhoods classified by household income and Hispanic population to determine how impacts of built environments around schools differ across low- and high-Hispanic as well as low- and high-income school-neighborhoods. We employ a logistic regression model to specify various built environments at the street-segment level. Our results will help planners, policymakers, and public health professionals better understand how to enhance child pedestrian safety around schools by improving surrounding built environments based on different neighborhood characteristics.

2. Methodology

2.1. Study area and unit of analysis

This study investigates the impacts of built environments around schools on child pedestrian crashes in Austin, the capital of Texas and the 14th largest city in the U.S. with a population of 864,218 in 2014 (US Census Bureau, 2014). We selected Austin as our primary study area because of its relatively high rate of pedestrian fatalities. In 2013, it had a traffic fatality rate of 2.37 per 100,000 population, considerably higher than the state average of 1.81 per 100,000 population (NHTSA, 2015).

To identify the spatial location of schools in the analysis, we used the National Center for Education Statistics (NCES) data. Based on the data, we selected public schools across all grade levels within the Austin Independent School District (AISD) which operated 119 regular campuses and 10 special campuses/alternative education centers in 2013.[1] We excluded 5 schools/campuses from the analysis due to the lack of enrollment information or only a few number of students in 2013.[2] As a result, we focused on the remaining 124 public schools in the study (see Fig. 1).

While many previous studies used Euclidean buffer zones of particular points (e.g., location of crashes or schools) to identify the characteristics of surrounding built environments, this study employed quarter-mile street network buffer zones around school parcel

[1] AISD is not contiguous with the city of Austin boundaries, as part of the AISD is also in unincorporated Travis County (Fig. 1).

[2] Schools with fewer than 10 students were excluded in the study.