Beyond the provision of affordable housing itself, planners and policymakers have raised concerns as to whether subsidized housing developments provide “suitable living environments” for the nation’s poor. Despite numerous concerns regarding unfavorable living environments and the neighborhood context of subsidized housing, we have limited understanding as to whether built environments around subsidized housing ensure pedestrian safety. This study addressed this gap by examining how built environments around Low Income Housing Tax Credit (LIHTC) sites affect pedestrian-vehicle crashes in Austin, Texas. We employed the two-level negative binomial regression to clarify the impacts of street segment-level and neighborhood-level built environments on pedestrian crashes around LIHTC complexes. We found that higher speed roads, traffic-generating land uses, higher transit stop densities, and higher four-or-more-leg intersection densities may hinder pedestrian safety. Conversely, local roads as well as single-family residential parcels and connected sidewalks along street segments may enhance pedestrian safety around LIHTC complexes. Our results may inform planners and policymakers on how to enhance pedestrian safety for subsidized housing by modifying surrounding environments and how to provide better site selection considerations for subsidized housing to ensure pedestrian safety.

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1. Introduction

Planners and policymakers have long faced a dilemma with respect to the implementation of subsidized housing programs. While subsidized housing developments have achieved some success in increasing affordable housing for the nation’s poor, the developments have been criticized for contributing to the concentration of poverty in distressed neighborhoods. Literature from the past decade is replete with studies documenting that subsidized housing tends to be located in disadvantaged neighborhoods, often represented by high poverty and minority populations, concentrated crime, and poor education quality (Ellen, Lens, & O’Regan, 2012; Freeman, 2004; Newman & Schnare, 1997; Oakley, 2008; Van Zandt & Mhatre, 2009). Hence, beyond the provision of affordable housing itself, there has been growing consideration by planners and policymakers about the importance of locating subsidized housing so as to provide “suitable living environments” for the nation’s poor.

Despite numerous concerns for the living environments of subsidized households, little attention has been devoted to the location of subsidized housing and pedestrian safety. Given that low-income families have lower auto ownership rates than high-income families (Murakami & Young, 1997), human-powered travel—i.e., walking—may be the dominant travel mode, particularly for subsidized households (Lee, Ory, Yoon, & Forjuoh, 2013; Wang & Lee, 2010). However, subsidized households may face greater risk of traffic-related injuries because distressed inner-city neighborhoods where subsidized housing is usually located tend to feature high traffic volumes and poor pedestrian infrastructure. Subsidized households, often represented by low-income, minority, or elderly households, may be particularly vulnerable to pedestrian crashes.

The built environment around subsidized housing can be a centerpiece to enhance or hinder pedestrian safety for disadvantaged populations. Pedestrian-friendly community designs with low travel speeds, connected street networks, and non-motorized infrastructure may provide safe environments and promote walking activities. On the other hand, pedestrian-hostile environments with higher speed designs, larger blocks, and lack of non-motorized infrastructure could increase a risk of pedestrians...
being injured and killed. Thus, retrofitting built environments around subsidized housing into pedestrian-friendly designs may ensure pedestrian safety and encourage them to walk, promoting various socioeconomic benefits such as their public health and social cohesion (Saelens, Sallis, & Frank, 2003; Zhu, Lu, Yu, Lee, & Mann, 2013; Kim, 2016; Soltani & Hoseini, 2014).

To our knowledge, no studies examine the impacts of built environments on pedestrian safety around subsidized housing. Our study comprehensively examines the influence of built environments by considering both road and neighborhood environments around subsidized housing. Specifically, this study examines how built environments around Low Income Housing Tax Credit (LIHTC) sites influence pedestrian-vehicle crashes in Austin, Texas. We apply a two-level negative binomial regression to investigate built environments at both street-segment and neighborhood levels. Our research may inform planners and policymakers on how to enhance pedestrian safety for subsidized housing by modifying surrounding environments and how to provide better site selection considerations for subsidized housing to ensure pedestrian safety.

1.1. Uneven geography of opportunity and subsidized housing

Neighborhoods largely affect socioeconomic and environmental opportunities for higher quality of urban life and upward mobility. Distressed neighborhoods are often related with low-performing schools, inadequate access to jobs, high exposure to crime, and unhealthy physical environments, where privileged neighborhoods are associated with quality education, high-paying jobs, safety from crime, and healthier social and physical conditions (Squires & Kubrin, 2005; Van Zandt & Mhatre, 2009). As resources and opportunities are unevenly distributed across neighborhoods, people have unequal access to those resources and opportunities based on where they live (Briggs, 2005; Galster & Killen, 1995). Thus, the spatial concentration of subsidized housing in disadvantaged neighborhoods is a paramount concern.

The LIHTC program was established in 1986 to create affordable housing through an equity contribution by housing developers (Eriksen & Rosenthal, 2010). By forming a partnership between public and private sectors, LIHTC developments have created a channel for private investment in affordable housing (Woo & Joh, 2015). The LIHTC program has been considered an effective strategy for providing higher quality housing units and maintaining neighborhood vitality, and hence it has grown into the largest place-based subsidized housing program in the U.S. (Woo & Joh, 2015). However, many previous studies have empirically revealed that LIHTC housing tends to be located in distressed and disadvantaged neighborhoods, especially in terms of higher minority populations, poverty, unemployment, and inferior education opportunities (Freeman, 2004; Newman & Schnare, 1997; Oakley, 2008; Van Zandt & Mhatre, 2009; Woo & Kim, 2016). Due to such uneven geography of LIHTC housing, concerns about whether LIHTC developments provide “suitable living environments” for subsidized households have continued. Further, even though planners and policymakers continue raising concerns about the location of subsidized housing and their unfavorable neighborhood characteristics, we have limited understanding as to how these built environments affect pedestrian safety around LIHTC housing, which is the aim of this research.

1.2. Built environments and pedestrian safety

There is a growing consensus that the different characteristics of built environments in neighborhoods may increase or decrease urban crash incidence (Abdel-Aty, Chundi, & Lee, 2007; Dumbaugh & Li, 2010; Ewing & Dumbaugh, 2009). A careful review of the literature reveals that built environments at different scales, especially in terms of macro (neighborhood) and micro (street) levels, may provide different motivators or barriers to walking. For instance, Neckerman et al. (2009) revealed that high poverty neighborhoods in New York City have better macro-level environments for walking, but those neighborhoods face worse micro-level environments due to poorer maintained streets and a lack of street trees and sidewalks. Similarly, Zhu and Lee (2008) found contrasting relationships between the macro-level and the micro-level environments for walking around elementary schools in Austin, Texas: high poverty and Hispanic neighborhoods had better neighborhood-level environments for walking, but they included poorer built environments at the street segment level. We address such issues by specifying built environments on different scales (i.e., street segment and neighborhood levels) around subsidized housing.

Micro-level environments represent various roadway environments, such as non-motorized infrastructures and surrounding land uses. Many previous studies have supported the notion that micro-level environments, especially in terms of high-speed multi-lane roadways and missing sidewalks, may increase pedestrian crashes (Abdel-Aty et al., 2007; Larsen, Buliu, & Faulkner, 2013; Yu, 2015a,b). Additionally, Yu (2015a,b) showed that roadways with greater commercial access increased child pedestrian crashes while those with residential land uses decreased pedestrian crashes around elementary schools. Transit stops along streets may be another safety-related environmental characteristic affecting pedestrian crashes: transit stops may cause traffic conflicts between pedestrians and vehicles because they generate pedestrian activities (Ukkusuri, Miranda-Moreno, Ramadurai, & Isa-Tavarez, 2012).

Macro-level environments signify various community environments, such as neighborhood street connectivity, intersection densities, and land use types. A number of studies showed that neighborhood-level built environments affect pedestrian crashes by corresponding with changes in traffic volumes, speeds, and conflicts (Dumbaugh, Li, & Joh, 2013; Wier, Weintraub, Humphreys, Seto, & Bhatia, 2009; Yu & Zhu, 2016). Roadway types, particularly their densities in neighborhoods, may be associated with pedestrian safety at the macro-level by influencing overall traffic speeds in neighborhoods (Dumbaugh et al., 2013; Miles-Doan & Thompson, 1999; Wier et al., 2009). Additionally, different proportions of land use type in neighborhoods appear to be associated with pedestrian crashes. Previous studies showed that a higher proportion of commercial and retail use is positively associated with pedestrian crashes by increasing the volume of traffic in the neighborhood (Clifton & Kreamer-Fults, 2007; Dumbaugh et al., 2013; Yu, 2015a,b). Although our study follows previous studies to account for the land use type with pedestrian crashes, we further specify the residential land use into single- and multi-family uses; multi-family use with high density designs may have a different impact on pedestrian crashes compared to single-family use with low density and car-oriented designs. Additionally, sidewalk completeness—the percentage of streets lined by sidewalks—at the neighborhood level may influence the overall exposure to pedestrian crashes. Yu and Zhu (2016) examined the relationships between school-aged pedestrian crashes and neighborhood built environments around elementary schools in Austin, Texas, and found that sidewalk completeness in the buffers around schools is negatively associated with pedestrian crash rates. Also, numerous empirical studies showed that neighborhood intersection density is another important factor that may influence pedestrian crashes (Dumbaugh & Rae, 2009; Dumbaugh et al., 2013; Ladron de Guevara, Washington, & Oh, 2004; Lovegrove & Sayed, 2006; Yu & Zhu, 2016).

Given that subsidized housing tends to be located in dense urban
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