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Neighborhood-level built environment and social characteristics associated with serious childhood motor vehicle occupant injuries

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ABSTRACT

The effect of residential neighborhood characteristics on a child's risk of serious motor vehicle traffic occupant injuries was evaluated in New York State, USA, for the years 1993–2003, with particular focus on the effect of neighborhood walkability.

Risk increased significantly ($p < 0.0001$) with decreasing street connectivity and as more workers commuted more than 30 min using means other than public transportation, along with more single-parent households and less college attainment in the neighborhood, regardless of whether New York City was in the study.

After adjusting for age, gender and socio-economic community factors, the apparent loss of walkability in a child's neighborhood increases their risk of serious injury as an occupant of a motor vehicle.

1. Introduction

Is the risk of serious injury to children and teens from Motor vehicle traffic (MVT) crashes affected by their place of residence? Answering this question is critical for a comprehensive understanding of the causes behind such tragic events. On one hand, the number of motor vehicle-related deaths per vehicle miles traveled and per population has declined in the United States (US) for all ages since the mid-1960s. This decline is associated with ever-improving safety features and more aggressive law enforcement to prevent driving under the influence of alcohol and other drugs (National Highway Traffic Safety Administration, 2004). While on the other hand, the number of vehicle miles traveled continues to increase (National Highway Traffic Safety Administration, 2006; US Dept. of Transportation, 2011), so the overall public health burden has essentially not declined (Richter et al., 2001). Although there is evidence of a recent decline in the number of fatalities (National Highway Traffic Safety Administration, 2010), MVT crashes remain the leading cause of death in the US for ages 3–34 years old (National Highway Traffic Safety Administration, 2008) and overall crash injuries result in about 500,000 hospitalizations and 4 million emergency department visits annually for all ages (Task Force on Community Preventive Services, 2001). There are clearly factors beyond law enforcement and automobile safety features that need to be addressed.

If risk is proportional to exposure, regardless of safety features, then risk of serious injury from car crashes is expected to increase with increasing time spent in cars and travel speed, both of which may be affected by one's residential built environment (Frumkin, 2002, 2006). Fatalities are well known to be much higher among rural (versus urban) car crashes (Jones et al., 2008; Kmet and Macarthur, 2006; National Highway Traffic Safety Administration, 2007); however, these observations are based on location of crashes, not on location of victim's residences.

Meanwhile, a separate line of research has evolved that addresses the effect of one's residential built environment on physical activity and related health issues (Davis and Jones, 1996; Frumkin, 2002; Frumkin et al., 2004; Handy et al., 2002; Ewing et al., 2006; Frank and Engelke, 2005; Frank et al., 2003, 2004; Nelson et al., 2006; Lopez and Hynes, 2006). These studies support that neighborhoods with well connected local streets and mixed land use, such as older towns and cities, provide a more "walkable" environment than suburban housing developments that are characterized by disconnected streets and homogeneous land use. After adjusting for social and demographic factors, neighborhoods with higher street connectivity and mixed land use tend to have residents who report greater physical activity and less overweight/obesity (Ewing et al., 2006; Frank et al., 2004; Nelson et al., 2006). This effect is especially noted among adults, although it is somewhat limited with childhood ages, which may be from parents driving their children to different

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sporting activities (Nelson et al., 2006). If true, then parents with the best intentions for their children's well being may also be exposing them to increased risk of a car crash.

It is therefore logical to hypothesize that the risk of serious injury or outright death of children of all ages as an occupant in a motor vehicle traffic crash increases as the walkability of a child's residential neighborhood decreases. The theoretical basis is that more time is spent in cars as neighborhood walkability decreases, thus increasing exposure, especially if day-to-day automobile travel is at fairly high speeds. Therefore, one would expect the population-based rate of serious MVT-occupant injuries to increase as residential walkability decreases.

The hypothesis stated above is supported in a study by Ewing et al. (2003), who showed a strong positive association between the degree of "urban sprawl" and both MVT occupant and pedestrian fatalities for all ages, based on a county-level index of sprawl for 448 metropolitan counties in the US. While this was pioneering research, counties are simply too large geographically to represent residential neighborhoods, given the heterogeneity among neighborhoods across most counties. A more detailed study of local authority districts in England and Wales indicated that both fatal and non-fatal injuries decreased with increasing percentage of roads classified as "minor", after adjusting for other multilevel covariates (Jones et al., 2008); however, as the percentage of roads passing through urban areas increased, the risk of fatal injuries decreased while the risk of slight (non-serious) injuries increased. As with the other studies cited above, theirs was based on characteristics of crash site locations, whereas our interest lies with characteristics of where someone lives, particularly children.

We evaluated the hypothesis stated above by analyzing neighborhood-level rates of deaths and non-fatal inpatient hospitalizations of children from MVT-occupant injuries using postal ZIP codes of residence in New York State (NYS) to approximate neighborhoods (see Fig. 1). Data were obtained from population databases of deaths and hospitalizations for children covering eleven years in NYS. ZIP code-level rates by age and gender were compared to ZIP code-level variables reflecting neighborhood walkability and commuting behavior, after controlling for select demographic and socio-economic characteristics. Street connectivity provided a proxy for walkability, represented as the density of four-way or greater intersections of local roads/streets (Handy et al., 2002; Ewing et al., 2006; Frank et al., 2004; Nelson et al., 2006), as illustrated in Fig. 2.

2. Methods

This cross-sectional study focuses on children in NYS who were 28 days through 18 years old when killed or admitted to a hospital with non-fatal injuries from being the occupant of a motor vehicle that was in a traffic crash from the years 1993 through 2003. The design is intentionally ecologic to evaluate relative risk among neighborhoods defined by different neighborhood-level covariables. The chosen age range stems from a larger project to develop a child death review program (www.childdeathreview.org/) in NYS.

2.1. Cases

Cases were identified from NYS and New York City (NYC) vital records and statewide hospital discharge records. Access to death records was approved by the NYS Department of Health (DOH) Institutional Review Board, along with the DOH Bureau of Biometrics and Health Statistics and the NYC Department of Health and Mental Hygiene, Bureau of Vital Statistics. Inpatient hospital discharge records were obtained through a de-identified version of the NYS Statewide Planning and Research Cooperative System (SPARCS) database, with approval from the DOH Bureau of Biometrics and Health Statistics.

Cases included injuries that resulted in death, as identified from death records, or were non-fatal but required admission to a hospital, as identified by inpatient hospitalizations where the disposition upon discharge was not "expired". A child may be repeated in the database over time since concern is with total injuries, not just total individuals. See the Appendix for codes from the International Classification of Diseases that were chosen

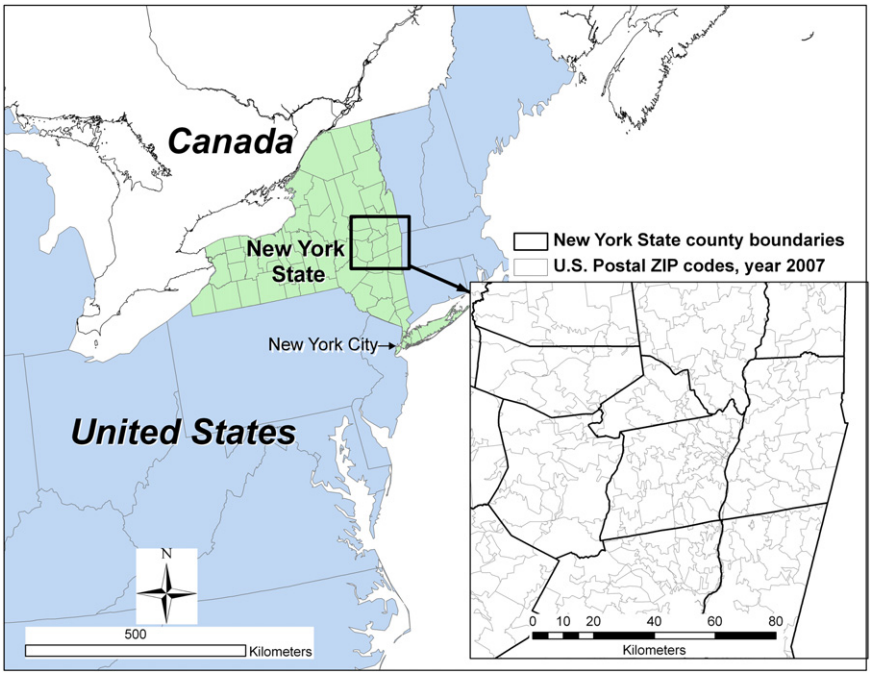

Fig. 1. Location of New York State in the northeast United States, with enlargement of county and postal ZIP code boundaries within New York State.