



# How do the definitions of urban and rural matter for transportation safety? Re-interpreting transportation fatalities as an outcome of regional development processes



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## ABSTRACT

Urban and rural places are integrated through economic ties and population flows. Despite their integration, most studies of road safety dichotomize urban and rural places, and studies have consistently demonstrated that rural places are more dangerous for motorists than urban places. Our study investigates whether these findings are sensitive to the definition of urban and rural. We use three different definitions of urban-rural continua to quantify and compare motor vehicle occupant fatality rates per person-trip and person-mile for the state of Wisconsin. The three urban-rural continua are defined by: (1) popular impressions of urban, suburban, and rural places using a system from regional economics; (2) population density; and (3) the intensity of commute flows to core urbanized areas. In this analysis, the three definitions captured different people and places within each continuum level, highlighting rural heterogeneity. Despite this heterogeneity, the three definitions resulted in similar fatality rate gradients, suggesting a potentially latent “rural” characteristic. We then used field observations of urban-rural transects to refine the definitions. When accounting for the presence of higher-density towns and villages in rural places, we found that low-density urban places such as suburbs and exurbs have fatality rates more similar to those in rural places. These findings support the need to understand road safety within the context of regional development processes instead of urban-rural categories.

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## 1. Introduction

The idea that rural places are dangerous for travel is well accepted, and the transportation injury record tends to support this claim (Blatt and Furman, 1998). For example, in 2012, 19% of the US population lived in rural areas but these areas accounted for 54% of all traffic fatalities (National Highway Traffic Safety Administration, 2014). In the UK, 70% of all traffic fatalities occurred on rural roads, and the figure is similar for Canada (The Royal Society for the Prevention of Accidents, 2010; Transport Canada, 2011). Explanations of urban-rural road safety disparities focus on dangerous roads, behavioral factors, delays in emergency medical care, and

differences in law enforcement. In the US, explanations also posit class-based rural stereotypes of risk-taking behavior such as speeding, alcohol consumption, and not using seat belts.

Yet, there is no agreed-upon definition of “rural” and “urban” places, and applying a simple urban-rural dichotomy can conceal their complexity in ways that matter for transportation safety analysis. For instance, during the past several decades in the US, urban residents have relocated to non-urbanized areas, beyond suburbs, that are rich in natural and recreational amenities (Johnson, 1999). The changing composition of rural populations contradicts the argument that intrinsic behavioral and cultural characteristics of “rural” residents are a primary cause of transportation injury. This problem supports further investigation of the interaction of road safety outcomes with spatial, social, economic, and demographic factors.

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Our central question is whether transportation fatality differentials are sensitive to the definition of “rural.” To answer this question, we compared urban–rural transportation fatality rate gradients for three definitions of urban–rural continua that are used in the fields of regional studies, transportation, and public health.

## 2. Background and literature about rural places and rural road safety

### 2.1. Urban–Rural transportation injury disparities

The larger problem of rural health disparities provides a broader context for this research about rural road safety. Compared to their urban counterparts, populations in rural counties in the US are more likely to have higher rates of adolescent and adult smoking, alcohol consumption, obesity, physical inactivity, infant mortality, child and young adult mortality, serious mental illness, unintentional injury, and suicide per capita (Meit et al., 2014). There are often regional variations in urban–rural health disparities, and different ways in which local cultural, community, environmental, and economic factors contribute to them (Hartley, 2004). Yet, even when accounting for local context, rural social workers have asserted that rural populations should be considered a vulnerable group because of high poverty rates, low opportunity, educational disparities, and social stigma (Riebschleger, 2007).

Rural populations in the US also have disproportionately high rates of injury, including those due to motor vehicle crashes. An extensive literature exists about the factors contributing to high transportation injury rates in rural areas. These factors include, but are not limited to:

- Lack of investment in general and trauma-related health care resources and training in rural areas to successfully treat transportation injuries (Rutledge et al., 1994);
- Delay in crash discovery and emergency medical care (MacKenzie et al., 2006; National Highway Traffic Safety Administration, 2005, 2012);
- Road design characteristics such as two-lane highways, lack of shoulders, and limited sight distance (National Highway Traffic Safety Administration, 2005; Tay, 2015);
- High travel speeds and high speed limits (National Highway Traffic Safety Administration, 2005, 2014);
- Risk-taking behaviors such as alcohol consumption and lower seat belt and child restraint use (National Highway Traffic Safety Administration, 2005, 2014; Rakauskas et al., 2009; Ward, 2007; Donaldson et al., 2006); and
- Lack of safety-related law enforcement (Peek-Asa et al., 2004).

Taken together, this literature suggests two root causes of rural transportation injury. The first is environmental: rural road infrastructure lacks sufficient protection, travel speeds are high, and emergency medical services and trauma care in low-density areas are limited. The second root cause is behavioral: people who live in rural areas exhibit more risk-taking behaviors.

### 2.2. Reasons to reconsider the rural road safety framework

Despite the clear evidence of urban–rural health and safety disparities, there are reasons to reconsider the idea that rural populations are a disadvantaged group with a cohesive set of transportation safety vulnerabilities. Research about rural health has called attention to the variation in health outcomes and behaviors among rural residents. For example, a literature review of urban–rural health disparities that included studies from Australia, New Zealand, Canada, the US, the UK, and certain western European

countries, did not find a consistent pattern in urban–rural differences in health outcomes. In addition to variation across countries, the review found that the “intra-rural health differential can be as pronounced as those between rural and urban areas” (Smith et al., 2008).

Similarly, with respect to injury risk factors, Zwerling et al. (2005) found that behavioral risk factors for injury are not uniformly distributed among rural residents. Residents of Keokuk County, Iowa (n = 1583) varied in their likelihood of wearing seat belts, consuming alcohol, firing a gun, driving an all-terrain vehicle, and riding a bike depending on their gender and residential location (whether they lived in town, in the country, or on a farm).

Literature from rural studies and regional science offers additional reasons to reframe the problem of rural health disparities. During the past 30 years rural populations and landscapes have transformed as a result of increasing *peri*-urban employment and housing, changes in agricultural production, and tourism-based economic development strategies (Johnson, 1999; Fuguitt, 1995; Beale and Johnson, 1998; Johnson and Beale, 2002; Ottone, 2006; Chi and Marcouiller, 2012). Such changes result in the conversion of forest and agricultural lands into commercial, residential, and recreational land uses, and major roads are often the “point of entry” for this type of development (Ottone, 2006; Chi and Marcouiller, 2012). Therefore, in facilitating larger economic and demographic phenomena, travel behavior, traffic patterns, and road infrastructure may also change in ways that matter for safety outcomes.

### 2.3. Implications for rural road safety research

The operational definition of “rural” is also an important facet of the validity of research about rural places (Hart et al., 2005; Hall et al., 2006). For instance, a study of the prevalence of teenage smoking behavior in urban, suburban, and rural places compared four different operational definitions of urban and rural, and found that the estimates of smoking prevalence depended on which definition was used (Brady and Weitzman, 2007).

Outside of research, road safety and emergency medicine professionals have been revising the urban–rural dichotomy to reflect contemporary needs. The state of Indiana created a new place-based categorization of transportation injuries (urban, suburban, exurban, and rural) based on a location’s distance from core urban areas (Newby, 2011). Emergency medical service providers in Minnesota created a new definition of rural places that aligned with the actual costs of providing emergency medical service (Rural Health Resource Center, 2004). These examples demonstrate a practical need to define rural in ways that capture underlying spatial, social, and functional relationships.

## 3. Data and methods

### 3.1. Study area

The study area is the state of Wisconsin (population 5.7 million) in the United States and the study period is from 2001 to 2009 (US Census, 2016). Wisconsin has important large and small urban regions, as well as significant rural industrial and agricultural economies and natural resources. Wisconsin’s population continues to urbanize, and the fastest growing areas of development are located at the edge of the region’s larger cities (Wisconsin Department of Natural Resources, 2006).

### 3.2. Metrics to define urban–rural continua

Because “urban” and “rural” are social constructs, we need to convert them into operational definitions for this analysis. Our

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