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Exploring pedestrian injury severities at pedestrian-vehicle crash hotspots with an annual upward trend: A spatiotemporal analysis with latent class random parameter approach

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ABSTRACT

Introduction: With the increasing trend of pedestrian deaths among all traffic fatalities in the past decade, there is an urgent need for identifying and investigating hotspots of pedestrian-vehicle crashes with an upward trend. *Method:* To identify pedestrian-vehicle crash locations with aggregated spatial pattern and upward temporal pattern (i.e., hotspots with an upward trend), this paper first uses the average nearest neighbor and the spatial autocorrelation tests to determine the grid distance and the neighborhood distance for hotspots, respectively. Then, the spatiotemporal analyses with the Getis-Ord Gi* index and the Mann-Kendall trend test are utilized to identify the pedestrian-vehicle crash hotspots with an annual upward trend in North Carolina from 2007 to 2018. Considering the unobserved heterogeneity of the crash data, a latent class model with random parameters within class is proposed to identify specific contributing factors for each class and explore the heterogeneity within classes. Significant factors of the pedestrian, vehicle, crash type, locality, roadway, environment, time, and traffic control characteristics are detected and analyzed based on the marginal effects. *Results:* The heterogeneous results between classes and the random parameter variables detected within classes further indicate the superiority of latent class random parameter model. *Practical Applications:* This paper provides a framework for researchers and engineers to identify crash hotspots considering spatiotemporal patterns and contribution factors to crashes considering unobserved heterogeneity. Also, the result provides specific guidance to developing countermeasures for mitigating pedestrian-injury at pedestrian-vehicle crash hotspots with an upward trend.

1. Introduction

Compared to other entities in traffic crashes, pedestrians are more vulnerable to suffer severe injuries. According to one report from the National Highway Safety Administration (NHTSA, 2019), in the United States there were 5,977 pedestrian fatalities in traffic crashes in 2017. From 2008 to 2017, the percentage of pedestrian deaths in total traffic fatalities has constantly increased from 12% to 16%. In recent years, more and more efforts have been put into investigating contributing factors of the pedestrian injury severity at specific hazardous locations (Anderson, 2009; Dai, 2012). Meanwhile, existence of the temporal variation and tendency of the pedestrian crash data might affect the model result in different ways (Behnood & Mannering, 2016), and neglecting the fundamental temporal features could result in erroneous conclusions (Mannering, 2018). One previous research study has identified the instability of different time scales among the pedestrian crashes, and the annual variation mainly shows an increasing/decreasing trend (Dai, 2012). Hence, there is an urgent need to develop a proper approach to identifying the contributing factors at crash hotspots with annual uptrends.

Previous studies have applied several methods to explore the factors to crash severity. A detailed review was summarized in (Mannering & Bhat, 2014), and this review also pointed out that the heterogeneity inherent in the crash observations could result in biased parameter estimations and incorrect inferences. To obtain more accurate and specific model results, it is important to investigate the pedestrian injury severity by considering the heterogeneity both within and between the pedestrian crash observations.

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