Macroscopic spatial analysis of pedestrian and bicycle crashes

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A R T I C L E   I N F O

Article history:
Received 5 October 2010
Received in revised form 12 August 2011
Accepted 14 August 2011

Keywords:
Pedestrian crashes
Bicycle crashes
Spatial analysis
Traffic Analysis Zones
Bayesian analysis

A B S T R A C T

This study investigates the effect of spatial correlation using a Bayesian spatial framework to model pedestrian and bicycle crashes in Traffic Analysis Zones (TAZs). Aggregate models for pedestrian and bicycle crashes were estimated as a function of variables related to roadway characteristics, and various demographic and socio-economic factors. It was found that significant differences were present between the predictor sets for pedestrian and bicycle crashes. The Bayesian Poisson-lognormal model accounting for spatial correlation for pedestrian crashes in the TAZs of the study counties retained nine variables significantly different from zero at 95% Bayesian credible interval. These variables were – total roadway length with 35 mph posted speed limit, total number of intersections per TAZ, median household income, total number of dwelling units, log of population per square mile of a TAZ, percentage of households with non-retired workers but zero auto, percentage of households with non-retired workers and one auto, long term parking cost, and log of total number of employment in a TAZ. A separate distinct set of predictors were found for the bicycle crash model. In all cases the Bayesian models with spatial correlation performed better than the models that did not account for spatial correlation among TAZs. This finding implies that spatial correlation should be considered while modeling pedestrian and bicycle crashes at the aggregate or macro-level.

1. Introduction

According to the United States National Highway Transportation Safety Administration (NHTSA), on average a pedestrian is killed almost every 2 h and injured every 9 min in a traffic crash (NHTSA 2009 pedestrian traffic safety fact). Thirteen percent of the overall fatalities in the United States in years 2005 and 2006 were pedestrians and bicyclists (NHTSA, FARS Data). As of 2009, Florida had the highest pedestrian fatality rate (2.51 per 100,000 population) among all states (NHTSA Pedestrian Safety Facts). This is more than double the national average which is 1.33 pedestrian fatalities per 100,000 of the population. This situation for the bicycle fatality rate in Florida is as bad as the pedestrian fatality rate. According to NHTSA bicyclists and other cyclists safety facts, Florida ranks second in pedalycyclist fatality rate (5.77 per million population) (NHTSA web link). This is also more than double the national average (2.05 per million population).

The statistics mentioned above demand specific attention. In the past years a good number of research investigated pedestrian and bicycle safety. However, macro-level pedestrian and bicycle crash modeling with implications for transportation planning were barely researched. LaScala et al. (2000), Loukaitou-Sideris et al. (2007), Wier et al. (2009), and Cottrill and Thakuriah (2010) were among the few to analyze pedestrian crashes at the macro-level. All of them considered census tracts as the base spatial unit of analysis. Spatial heterogeneity is likely to exist in an aggregated data for any geographic entity. Karlaftis and Tarko (1998) referred to this heterogeneity by the presence of persistent site-specific (or area-specific) but unobserved factors. Alternate and/or similar studies, if any, on other geographic units will have the same heterogeneity related problems unless this issue has been specifically accounted for. Note that, heterogeneity may lead to biased coefficient estimates for the models (Greene, 1991).

In this study crashes were aggregated per Traffic Analysis Zone (TAZ) in Hillsborough and Pinellas counties of Florida. A TAZ is a spatial aggregation of census blocks and its size is in part a function of population (Peters and MacDonald, 2004). TAZs are special areas delineated by state and/or local transportation officials particularly for tabulating traffic-related data. They are also defined as part of the Census Transportation Planning Package (US Census Bureau). As cited by You et al. (1997) the most important criteria used to define TAZs include spatial contiguity, homogeneity, and compactness. Homogeneity of a TAZ is defined by a single predominant land use and homogeneous socio-economic characteristics.