Poisson Regression Analysis of Highway Fatality Accident Data in Oklahoma

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ABSTRACT

Analysis of fatality automobile accident data can be challenging in rural areas where a relatively small number of such accidents occurs on specific sections of highways. Combining crash data from the Fatality Analysis Reporting System (FARS) and highway networks and design specifications from the Oklahoma Department of Transportation (ODOT), this article employs Poisson regression analysis to determine what roadway characteristics (e.g., grade, geometry, and design) are most associated with fatal accidents on predominantly rural segments of highways in Oklahoma. The results provide information about what combinations of highway design traits have contributed most to past crashes and therefore can identify potentially dangerous road segments system-wide. This information will help transportation engineers evaluate current construction practice and seek ways to address design issues that are shown to contribute significantly to serious crashes.

Keywords: FARS, Fatalities, Highways, Oklahoma, Poisson Regression

INTRODUCTION

This research analyzes the locations of highway fatalities in Oklahoma with a goal of identifying physical characteristics of highways (i.e., grade, geometry, and design) that contribute to higher rates of fatality crashes. This is accomplished by merging data for Oklahoma from the national Fatality Analysis Reporting System (FARS) database with road network and inventory data from the Oklahoma Department of Transportation (ODOT). Agencies such as ODOT can promote driver education and awareness initiatives that discourage unsafe driving (e.g., drunk or distracted driving) and hence reduce fatalities, but ODOT has more control over highway safety via design, construction, and maintenance practices. By identifying design characteristics on state’s roadways that statistically correlate with fatal crashes, the results can inform current highway construction practice and aid in the development of safety treatments.

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“Hot spot” (or black spot) analysis is the most common form of accident analysis in the literature and has been useful in highlighting high crash incidence locations. Due to data limitations, however, all crashes are typically included in such research, which then usually isolates high-frequency, low-severity crashes at urban intersections. While an important area of research that can help reduce property damage, this approach overlooks infrequent, spatially dispersed, but more serious highway crashes that more often have fatalities. Hot spot analysis has therefore been less useful in generating system-wide improvements that could reduce severe crashes. This is particularly critical in rural areas, where run-off-road (ROR) crashes account for more than 50% of all automotive fatalities. Rural ROR crashes often involve high speeds, a single vehicle, and occur on two-lane highways (Transportation Research Board, 2003). However, cross-over, head-on accidents are also a risk on two-lane highways since median cable barriers being installed on many interstate highways are not feasible on these roads.

Additional research is therefore needed that uncovers specific design elements, rather than specific locations, that contribute to elevated accident rates, helping transportation engineers identify corrective measures for existing highways and develop new designs for future (re)construction. This approach is called “systems” analysis because the safety enhancements are done system-wide, rather than targeting the unique traits of specific locations (such as intersections) identified as hot spots. There is evidence that low-cost system-wide treatments, such as shoulder rumble-strips, are very beneficial in reducing ROR crashes and fatality crashes, and similar treatments are sought to further reduce crash rates.

Highway fatalities in most developed countries have been decreasing since reaching a peak in the early 1970s, but fatality tallies tend to trend up and down over time, degrading the quality of statistical trend analyses that attempt to predict highway fatalities (Elvik, 2010). The United States exemplifies this trend, though there has been strong downward trend since 2005 (Sivak & Schoettle, 2010) and a preliminary tally of 32,310 deaths in 2011 represents a decrease of over 10,000 fatalities compared to 2006. While progress has obviously occurred in this area, a 2003 goal to reduce the U.S. highway fatality rate to below 1.00 per hundred million vehicle miles traveled (HMVMT) by the year 2008 was not achieved, as the rate was still 1.09 fatalities per HMVMT in 2011 (National Highway Traffic Safety Administration, 2012).

Oklahoma, the focus of this study, exhibits a similar pattern of declining, but still too high, deaths from highway fatalities, with a 1.40 fatality rate per HMVMT in 2010 (Oklahoma Highway Safety Office, 2012) that exceeds the national rate. Furthermore, Oklahoma is a largely rural state with over 11,000 miles of U.S. and state highways compared to just over 1,200 miles of interstate or turnpike highways (Oklahoma Highway Safety Office, 2012, p. 6).

STUDY AREA AND BACKGROUND

This article examines Oklahoma highway fatalities because ODOT seeks system-wide treatments that can further reduce highway accidents, injuries, and fatalities. Relatively cheap and effective treatments, like shoulder rumble-strips, are highly desirable because they help reduce accident rates system-wide without waiting for hot spots to emerge from accident data. Though this research was neither funded nor supervised by ODOT, the origins of this topic filtered down from the state agency through the Oklahoma Transportation Center (OkTC), an interdisciplinary National University Transportation Center (UTC) that sponsors academic, transportation-related research at several state universities (Langston University, Oklahoma State University, and the University of Oklahoma). The OkTC is partially funded by the federal Research and Innovative Technology Administration (RITA) UTC program. Though the study area is thus limited to Oklahoma, the
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