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ScienceDirect

Transportation Research Procedia 22 (2017) 551–560

Transportation Research Procedia

www.elsevier.com/locate/procedia

19th EURO Working Group on Transportation Meeting, EWGT2016, 5-7 September 2016, Istanbul, Turkey

Age-Based Stratification of Drivers to Evaluate the Effects of Age on Crash Involvement

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Abstract

Traffic crashes imperil roadway users and impose a considerable economic burden on society. Previous studies have investigated several aspects of traffic crashes such as severity, frequency, and influential factors, yet the causal and spatial differences between crashes involving drivers from different age groups remain unclear. In this paper, we illustrate the causal, spatial and temporal variations in crash involvement patterns of different age groups, including age 16-49, 50-64, and 65+. Furthermore, we stratified the aging drivers (65+) in order to explore the age-specific differences within this group, considering that the changes brought by aging may differ tremendously at different stages. For this purpose, we implemented an approach with two distinct phases: (a) a geographic information system (GIS)–based spatiotemporal analysis, and (b) a multinomial logistic regression analysis. Results indicate that crashes of different age groups differ not only in terms of influential factors but also spatially and temporally on the roadway network. The findings of this study will be eminently useful for public and/or private agencies to identify and address problematic issues particularly for aging drivers, and thus will enhance the safety and mobility of aging roadway users as well as entire population.

Peer-review under responsibility of the Scientific Committee of EWGT2016.

Keywords: Crash Analysis; Safety Modeling; Aging Populations; Geographic Information Systems; Spatiotemporal Density Analysis

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Peer-review under responsibility of the Scientific Committee of EWGT2016.
10.1016/j.trpro.2017.03.044

1. Introduction

In the transportation and traffic safety field, spatial and causal analysis of crashes is one of the most important issues on which researchers focus their efforts. Several studies have investigated the critical aspects of traffic crashes such as severity and frequency considering various methods ranging from basic descriptive analysis to complex regression models (Lord and Mannering, 2010; Mannering and Bhat, 2014; Yasmin et al., 2014). Researchers have also been interested in distinguishing the effects of spatial, temporal, environmental, traffic, roadway and driver-related factors that influence the crashes as well as the correlations between them (Moore et al., 2011; Rifaat et al., 2011). From a traffic safety perspective, this issue becomes even more complex when aging populations are considered, due to their health, behavioral, physical and cognitive limitations. Note that the term "aging," as used in this study, refers to persons 65 years and older. Furthermore, a better examination of aging population-involved crashes compels stratification of older population into subgroups since changes brought by growing old differ tremendously at different stages of aging (Sifrit et al., 2010). Indeed, Braver and Trempel (2004), and Griffin (2004) found statistically significant increase in the fatality probability by increasing age in older drivers. This implies that different age segments of older drivers may have divergent crash involvement characteristics, which are unique to each segment. For instance, a differentiation between 65-69, 70-74, and 75+ seniors would be especially beneficial, since in the early periods of older adulthood (close to the age of 65), deterioration of sight and reflexes is not as evident as it is in the following years (Alzheimer's Disease Facts and Figures, 2009; Dementia: Hope Through Research, 2013). This older age group stratification has not been done in the literature before, which is a significant contribution of this paper. There are many studies that investigated the influence of age and aging on crashes. Bayam et al. (2005) provides an exhaustive review of these studies. Yet, spatiotemporal differences between crash involvement patterns of aging drivers and other age groups, as well as intra-group variations within the aging (65+) drivers are not fully understood.

According to 2014 estimates, aging people are 14% and 18% of the total population in U.S. and Florida respectively (A Profile of Older Americans: 2014; Florida Estimates of Population, 2014). Since this population growth among aging Floridians is expected to continue in the state of Florida (even faster than the overall U.S.), it becomes crucial to investigate the nature of the crashes involving aging populations. In addition, persons 50-64 years old, who can also be referred to as Baby Boomers, are also of critical importance since the 65+ population in the U.S. is expected to increase by 79% due to the aging of the Baby Boom generation in the next two decades (Koffman et al., 2010). As such, the number of aging road users and crashes involving aging drivers on Florida roadways are expected to increase, which makes studies on aging population-involved crashes even more critical. Therefore, it is significant to comprehend the spatiotemporal factors causing these aging population-involved crashes, and identify hazardous situations that jeopardize the well-being of aging drivers, passengers and other roadway users. This paper is an important step towards filling this gap.

2. Methodology

The goal of this study was twofold. First, we aimed to disclose the differences between crashes involving 50-64 and 65+ drivers in terms of involvement characteristics, spatial distribution, and significant factors causing those crashes. Then, we divided aging drivers into three subgroups (65-69, 70-74 and 75+) in order to explore these differences among aging drivers, who are oftentimes evaluated as a homogeneous group. We explored the differences in crash involvement between stratified age groups via two main approaches: (a) spatiotemporal analysis to identify crash hotspots and explore spatial changes in these crash hotspots throughout the day, and (b) regression analysis to delve into the nature of those crashes. We adopted the Comap method (Asgary et al., 2010; Bačkalić, 2013; Brunsdon et al., 2007; Kilamanua et al., 2011) in order to illustrate the variation in crash hotspots with a focus on the following four time spans: AM peak hour (6:00 AM – 9:00 AM), midday (9:00 AM – 4:00 PM), PM peak hour (4:00 PM – 7:00 PM), and night (7:00 PM – 6:00 AM). Moreover, we incorporated a density ratio method, first proposed by Ulak et al. (2015), with comaps to examine the spatiotemporal variation of crash hotspots with respect to different time spans and age groups. Following the spatiotemporal analysis, multinomial regression analyses were conducted to discover the effects of crash-influencing factors among different age groups.