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Older drivers and accidents: A meta analysis and data mining application on traffic accident data

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Abstract

Teenage driving and associated accidents have been thoroughly studied. With the graying of our population in the United States, a focus on senior drivers and related accidents is needed. Unfortunately, there is not one comprehensive study that reviews the major existing studies conducted on senior drivers and accidents. In examining the literature, it also appears that data mining has rarely been applied in studying relationships between senior driver characteristics and accidents. This paper addresses these two needs by providing a meta-analysis of the existing literature on senior drivers and showing how data mining techniques could be used in this application.
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Keywords: Senior drivers; Accidents; Data mining; Meta-analysis

1. Introduction

The senior population is the fastest growing segment among the total population in the United States. From 1993 to 2003, the growth rate of the senior population increased by more than 15% of the total population (NHTSA, 2003). According to the 2001 NHTSA statistics, there were 19.9 million senior licensed drivers, which represented a 29% increase since 1992.

In the United States, more than 40 million older adults will be licensed drivers by 2020 compared to 19.9 million older licensed drivers in 2002 as the baby boomer generation hits 65 years and older (Dellinger, Langlois, & Li, 2002). The number of senior drivers involved in police reported crashes is expected to increase by 178% by 2030. Drivers aged 65 and older will account for more than half of the total increase in fatal crashes and about 40% of the expected increase in all crash involvements. Senior drivers are expected to account for as much as 25% of total driver fatalities in 2030, compared with 14% presently (Lyman, Ferguson, Braver, & Williams, 2002). Older drivers now account for 1 in 6 accident fatalities, and as the elderly population grows, that number is expected to increase to 1 in 4 (Insurance Institute and Highway Safety, 2002). All these studies indicate that safety of senior drivers has become a challenging social problem in the US (NHTSA, 2003; TRB, 1988). However, this also represents a social problem in other countries especially in Europe (Hakamies-Blomqvist & Peters, 2000) due to the increasing number of senior drivers, their high crash rate per mile driven, and their increased likelihood of injury. Accidents involving senior drivers should be diligently examined.

The paper is organized as follows: Section 2 reviews the literature on senior driving patterns and characteristics; Section 3 analyzes the literature by comparing and contrasting the findings of the studies reviewed in the previous section; Section 4 is allocated to data mining applications of traffic accident data including a survey conducted on the Evergreen Society members in Montgomery County (MC), Maryland and its results, and the demonstration of how two data mining techniques may be used for mining traffic accident data to uncover hidden driving patterns; and Section 5 concludes the paper.

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2. Literature review

A number of studies have been conducted on senior driving characteristics analyzing their driving abilities to

reveal unique characteristics of senior drivers and to improve their safety.

We reviewed studies focusing on senior drivers based on the variables most examined. These variables are: the driver, vehicle, occupants and other road users, environmental and geographical conditions, roadway and accidents. These will be thoroughly explained under the meta-analysis section.

Table 1 is a high level representation of the major studies on senior drivers and indicates on which variables were focused and what was concluded as key findings in each. The first column is used for citations of studies. The second column is designated for the 'driver' characteristics. The 'driver' characteristics in the table are narrowed down to age, gender, medical conditions and fragility. The third column is allotted to the 'vehicle' characteristics, which is separated into three subcategories of vehicle type, make, and body. The 'occupants and other road users' column is for studies focusing on the impact of having occupants traveling in a senior driver's car; characteristics of occupants: the characteristics of the other vehicle's driver and the other vehicle's occupants; both drivers' impact on one another; and impacts of pedestrians and other motorized or nonmotorized public on senior drivers. The 'environmental and geographical conditions' column is dedicated to studies examining senior drivers' characteristics under certain environmental conditions such as rain, snow, and darkness, as well as, under specific geographical conditions such as urban versus rural areas. The 'roadway characteristics' column is particularly allocated to studies analyzing intersection-related accidents, and trying to explain why senior drivers fail at junctions. The next column 'accident', divided into two subcolumns 'fatality' and 'injury' to demonstrate which studies examines fatal crashes and which look into injury-crashes. The last column is designated to note a few key findings of each study.

To visualize the similarities and associations among studies, we have used conceptual modeling software called 'PersonalBrain'. PersonalBrain helps to organize all studies by associatively attaching either their websites or their files and linking related studies to each other. In addition, for each study entered in the tool, notes can be taken. Fig. 1 is a snapshot of our study using PersonalBrain software. The software uses an intuitive, dynamic visual interface to facilitate exploration among studies or ideas, and to view associations among the studies clearly. PersonalBrain is particularly helpful tool in bringing small pieces together to demonstrate the big picture as we did when we linked more than 60 studies to display the focus points of each study and their interrelations. More information on the product can be found at http://www.thebrain.com/.

3. Meta analysis of the literature

In this meta-analysis, we used the crash model in Fig. 2. An automobile crash is considered a system with the independent variables: driver; vehicle; environmental and geographical conditions; roadway; occupants and other road users. All these independent variables interact with each other. In the wake of these interactions, many driving scenarios occur. Then, one of these driving scenarios becomes a crash scenario, and subsequent accident information as a dependent variable emerges.

The 'Driver' as an independent variable consists of a driver's information such as age, sex and other relevant information. The 'Vehicle' independent variable is composed of vehicle type and year of vehicle. The 'environmental and geographical conditions' are comprised of information about weather condition, lighting condition, date and time of the day, and area type. The 'Roadway' independent variable consists of road attributes such as road condition and road surface. The 'occupants and other road users' variable represents the type of occupants, the driver of the other vehicle, occupants of the other vehicle, and pedestrians. Also included in the 'other road users' variable are their age, their gender and other characteristics of all other road users which have an impact on crash occurrence. The last variable is the 'accident' dependent variable comprised of data on accident type, severity, number of injuries, number of fatalities, point of impact, and reasons behind an accident.

Some of the studies have focused on the stimulants of traffic accidents and interactions between or among different variables/components of traffic accidents, called pre-crash and crash environments (HSISS, 1990). Some others have focused on the impacts of traffic accidents on different age and/or gender groups, called crash and post-crash environments. The remaining studies have analyzed the entire picture from the causes of a crash, the crash itself, and the impacts of the crash on senior drivers and/or other road users.

3.1. Driver characteristics

According to the NHTSA (National Highway Traffic Safety Administration) report in 2001, in the last 32 years, person miles and vehicle miles traveled has elevated by almost 200%. The number of crashes involving senior drivers has increased per mile driven as the number of licensed drivers older than 65 years old has increased. This age group is the fastest growing segment of the population (NHTSA, 2003).

Older Americans prefer to drive in mid-day between 9 am and 4 pm. Both younger and older adults take fewer trips on Sunday, but take the most trips on Friday (Collia, Sharp, & Giesbrecht, 2003). Age, gender, medical conditions, fragility, driving cessation, and alcohol usage are considered the driver characteristics and will be examined in the following sections.

3.1.1. Age-related issues

When senior drivers are subjected to study, each study has defined its age threshold. Most of the research studies have defined senior drivers as drivers aged 65 years and

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