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Fragility and crash over-representation among older drivers in Western Australia

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Abstract

This study assessed age-related and gender differences in the relative contribution of fragility and crash over-representation to serious injuries per crash-involved driver in Western Australia. Police-reported crashes for the period 1998–2003 were extracted from the Western Australian Road Injury Database. For each passenger vehicle driver age and gender group, serious injuries per crash-involved driver and driver involvements in crashes per 100 million vehicle-kilometre travelled (VKT) were calculated as the respective measure of fragility and crash over-representation.

Results from the decomposition method of analysis showed that older drivers over the age of 70 sustained serious injury rates more than twice as high as those of the 30–59-year-old drivers. Fragility increased with age, contributing between 47% and 95% for drivers above 65 years, but crash over-representation was the dominant factor for male drivers above 80 years. In contrast, fragility contributed little to the excess injury risk of younger drivers under the age of 30.

The importance of fragility as a contributing factor to the inflated serious injury risk per vehicle-kilometre travelled for older drivers suggested that road safety initiatives should be directed towards the protection of vehicle occupants as well as screening for their driving ability.

Keywords: Decomposition method; Excess injury risk; Fragility; Older drivers; Over-representation

1. Introduction

Older drivers comprise the fastest growing segment of the Australian driving population and represent a larger percentage of the driving public than ever before (Australian Bureau of Statistics, 2003). The proportion of Australians over 65 years will be doubled from 12.5% in 2000 to 25% in 2021 (Australian Institute of Health and Welfare, 2001), leading to more old drivers on the road. This growth will be more pronounced in the 85 years and above age group, with the proportion of people in this age group expected to increase four-fold (Australian Bureau of Statistics, 2003).

The exposure measure to quantify the crash risk is a controversial issue. Rates of crashes per licensed driver are found to be highest amongst young drivers, with a steady decline in age. But when these results are presented in terms of crashes per kilometre traveled, a U-shaped curve is evident, with an increase in rates after the age of 55 (McGwin and Brown, 1999; Holland, 2002). For older drivers, physiological changes associated with increasing age such as decline in vision and reaction time are perceived to increase the risk of a crash (McGwin and Brown, 1999; Lyman et al., 2001; Janke, 2001). In addition, age-related decline in physical health also increases the likelihood of poor outcomes among older drivers involved in a crash. Their risk of being killed or suffering serious injury as a result of a road crash is between two and five times greater than that of a younger person because of their increased fragility (Holland, 2002). Even a minor crash could have more serious implications for an older person than a younger person suffering the same injuries (Burkhardt and McGavock, 1999; Li et al., 2003).

In view of the rising number of older drivers and associated mortality and morbidity, issues related to their safety while ensuring their mobility needs are met must be addressed. Very few studies have examined the role of fragility and over-representation of older drivers in crashes. Li et al. (2003) examined the roles of fragility versus excessive crash involvement

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and their contribution to the high fatality rate among older drivers in the United States. Using multiple national data systems, they found that fragility steadily increased from age 60–64 and accounted for 60–95% of the excess death rate per vehicle mile travelled in older drivers. Quantifying the respective contributions of such risks to the rates of serious injury per vehicle-kilometre of travel is important to understand the nature of the problem and to suggest possible counter measures. Therefore, this study aims to examine age-related and gender differences in the relative contribution of fragility and crash over-representation to serious injury among drivers in the State of Western Australia using the decomposition method of Li and Baker (1996), which have not been reported previously in the literature.

2. Methods

Older drivers (aged 60–64, 65–69, 70–74, 75–79, 80–84 and 85+) and younger drivers (aged 15–19 and 20–29) were compared to drivers aged 30–59, the age group with the lowest death rate per vehicle-kilometre travelled (VKT) (Ryan et al., 1998).

2.1. The Western Australian road injury database

Police-reported crash data from 1st January 1998 to 31st December 2003 were retrieved from the Western Australian Road Injury Database which is maintained by the Injury Research Centre at The University of Western Australia. This database contains detailed information on all crashes reported to the police, hospital discharge records of persons admitted to hospital as the result of a road crash injury (extracted from the Hospital Morbidity Data System maintained by the Department of Health, Western Australia), and the Registrar General's death records.

For the purpose of this study, the definition of a crash is "any apparently unpremeditated collision reported to the police which resulted from the movement of at least one road vehicle on a road open to and used by the public and involving death or injury to any person, or property damages" (Legge et al., 2001). It is mandatory in Western Australia to report a crash to the police if a person is injured or if property damage exceeds $1000. Crashes that occur on public roads are also required to be reported to the police (Legge et al., 2001). Serious injury refers to an injury where the driver was recorded as being admitted to the hospital or death within 30 days of the crash. The analysis undertaken was restricted to driver whose crashes (both single and multi-vehicle) occurred within the Perth metropolitan area, involving cars, sedans, station wagons, utilities, pick-up and multi-seater vans. The restriction was imposed to coincide with the available driving exposure data.

2.2. Perth and regions travel survey

Estimates of exposure to driving were obtained from the Perth and Regions Travel Survey 2003 (Department of Planning and Infrastructure, 2004). This survey of day-to-day travel included the collection of vehicle-kilometre travelled by age and gender for a representative sample of households across the Perth metropolitan region. Travel patterns were assumed to be stable throughout the 6-year study period.

2.3. Analysis by the decomposition method

Li and Baker (1996) and Li et al. (2003) used the decomposition method to investigate the relative contributions of different component rates to cause-specific injury morbidity rates for various populations. In this study, three measures of driving safety are considered: serious driver injuries per million vehicle-kilometre travelled, serious driver injuries (I) per driver involved in police-reported crashes, and driver involvement (C) in police-reported crashes per 100 million VKT. The relationship between these measures is given by:

$$\frac{I}{\mathrm{VKT}} = \frac{I}{C} \times \frac{C}{\mathrm{VKT}}.$$

The outcome measure 'serious driver injuries per million VKT' is a morbidity rate per unit of exposure to quantify driver injury risk. It is decomposed into two contributing rates. The number of serious driver injuries per driver involved in all police-reported crashes reflects the risk of serious injury or death to a driver when involved in a crash. As such, this measure is considered to be a marker of fragility. The definition relies on the assumption that vehicle and crash characteristics are constant. The number of drivers involved in police-reported crashes per million VKT represents the tendency for drivers to be involved in crashes and may be considered as a marker of crash over-representation. This measure assumes that travel exposure characteristics are constant across age groups.

According to Li et al. (2003), the differences in serious driver injury rates per unit of travel between two age groups can be expressed as a ratio of rates for the two age groups as:

$$\begin{aligned}\text{Injury rate ratio} &= \frac{(I/\mathrm{VKT})_1}{(I/\mathrm{VKT})_2} = \frac{(I/C)_1}{(I/C)_2} \times \frac{(C/\mathrm{VKT})_1}{(C/\mathrm{VKT})_2} \\ &= \mathrm{Ratio}_a \times \mathrm{Ratio}_b,\end{aligned}$$

where Ratio_a = fragility rate ratio, and Ratio_b = over-involvement rate ratio. It can then be determined quantitatively how much more likely older drivers are seriously injured in a crash, given their exposure, when compared to the 30–59 reference age group. Similarly, excess fragility and over-representation can be determined using Ratio_a and Ratio_b for comparison between age groups.

The relative contribution of each element (fragility and crash over-representation) to the overall excess injury risk per unit of travel for a particular age group over a reference group is given by:

$$\mathrm{RC}_i = \frac{|\ln(\mathrm{Ratio}_i)|}{\sum_{i=a}^{b} |\ln(\mathrm{Ratio}_i)|} \times 100\%$$

where $i = a$ (fragility) or b (over-representation), assuming no other factors are involved.

Caution must be taken when interpreting these measures (Li et al., 2003). A high relative contribution does not necessarily