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Injury risk for matched front and rear seat car passengers by injury severity and crash type: An exploratory study

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ABSTRACT

Background: The risk of serious injury or death has been found to be reduced for some front compared to rear seat car passengers in newer vehicles. However, differences in injury severity between car occupants by seating position has not been examined. This study examines the injury severity risk for rear compared to front seat car passengers.
Method: A retrospective matched-cohort analysis was conducted of vehicle crashes involving injured rear vs front seat car passengers identified in linked police-reported, hospitalisation and emergency department (ED) presentation records during 2001–2011 in New South Wales (NSW), Australia. Odds ratios were estimated using an ordinal logistic mixed model and logistic mixed models.
Results: There were 5419 front and 4588 rear seat passengers in 3681 vehicles. There was a higher odds of sustaining a higher injury severity as a rear-compared to a front seat car passenger, with a higher odds of rear seat passengers sustaining serious injuries compared to minimal injuries. Where the vehicle occupant was older, travelling in a vehicle manufactured between 1990 and 1996 or after 1997, where the airbag deployed, and where the vehicle was driven where the speed limit was ≥70 km/h there was a higher odds of the rear passenger sustaining a higher injury severity then a front seated occupant.
Conclusion: Rear seat car passengers are sustaining injuries of a higher severity compared to front seat passengers travelling in the same vehicle, as well as when travelling in newer vehicles and where the front seat occupant is shielded by an airbag deployed in the crash. Rear seat occupant protective mechanisms should be examined. Pre-hospital trauma management policies could influence whether an individual is transported to a hospital ED, thus it would be beneficial to have an objective measure of injury severity routinely available in ED records. Further examination of injury severity between rear and front seat passengers is warranted to examine less severe non-fatal injuries by car seating position and vehicle intrusion.

1. Introduction

Worldwide, road trauma accounts for an estimated 1.3 million deaths annually, with road trauma projected to become the third leading cause of the burden of disease by 2030 (World Health Organization, 2008). In Australia, fatal injury as a result of a vehicle crash has declined over time (Australian Transport Safety Bureau, 2003; Bureau of Infrastructure Transport and Regional Economics, 2012), but still represents approximately 1400 deaths and 32,500 serious injuries each year (Henley and Harrison, 2011), costing an estimated $27 billion annually (Australian Transport Council, 2011).

For car occupants, the risk of death and serious injury has historically been found to be lower for rear compared to front seat passengers (Smith et al., 2004; Mayrose and Priya, 2008), but particularly for passenger cars without airbags or if the passengers were not restrained (Smith and Cummings, 2006). There have been improvements in passenger car crashworthiness, such as the inclusion of frontal airbags and improved occupant restraint mechanisms, that have decreased rear seat occupant vehicle protection compared to front seat occupants in recent vehicle models (Sahraei and Digges, 2009; Sahraei et al., 2009, 2010) and that have resulted in reduced risk of injury among front compared to rear seated car occupants (Bilston et al., 2010; Sahraei et al., 2010, 2014). In the United States, a reduced injury risk was shown

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for front seat car occupants aged 16–50 years in newer vehicles (i.e. 1997–2007) compared to rear seat car passengers (Bilston et al., 2010). However, the reduced injury risk for front seat occupants was not evident for younger (9–15 years) or older (51+ years) individuals, nor for all crash types (Bilston et al., 2010). Studies that have specifically examined injury risk and young children's seating position in passenger vehicles have found that risk of death is reduced for children if they are seated in rear passenger seats (Braver et al., 1998; Lennon et al., 2008).

Studies of occupant injuries following vehicle crashes can be affected by confounding factors that can hamper the identification of associations of an outcome of interest with different crash or injury risk factors (Cummings et al., 2003a,b). By matching front and rear seat passengers in the same vehicle in the same crash, a matched cohort study design is able to control for possible vehicle and crash-related confounding characteristics such as vehicle model and vehicle speed (Smith and Cummings, 2006). Many of the vehicle matched-cohort studies have examined risk of death between rear and front seat passengers (Cummings et al., 2003a,b; Smith and Cummings, 2004, 2006) or have examined risk of serious injury and mortality (Bilston et al., 2010). Further work is needed to compare rear and front seat car passengers for finer levels of injury severity (Brown and Bilston, 2014), such as by using detailed injury severity categories (e.g. using six severity categories) or by using broad-level injury severity categories (e.g. using three severity categories). Investigation of whether certain types of injuries are more common in different types of crashes for rear compared to front seat passengers is also warranted. This study aims to examine the risk of injury or death for rear compared to front seat car passengers using both fine and broad levels of injury severity and to examine type of injuries sustained by crash type using a matched-cohort study with linked police-reported road crash, ED presentation and hospital admission data in New South Wales (NSW), Australia.

2. Method

A retrospective matched-cohort analysis was conducted. The cohort included fatalities identified in police-reported crash data and non-fatal injuries identified in linked police-reported crash, ED presentation and hospital admission records of passenger car occupants during 1 January 2001 to 31 December 2011. Injury severity of front- vs rear-seated car occupants in the same vehicle were compared. Ethics approval was obtained from the NSW Population and Health Services Research Ethics Committee (2010/10/273).

2.1. Data collections

The Emergency Department Data Collection (EDDC) contains information collected in public hospital EDs in NSW. There are around 150 EDs in NSW and just under 100 (including all the larger EDs) provide information to the EDDC, although numbers have varied over time. During the study time period, 77 hospitals provided data during 2005, 90 during 2006, 95 during 2007, 98 during 2008 and 2009 and 96 during 2010 and 2011. Data collected by the EDs includes patient demographics, arrival and departure dates/times, triage category, type of visit and clinical procedures. A provisional diagnosis assigned by staff when a patient presents to the ED is also included which could either contain diagnostic or external cause information. The ED diagnostic data were categorised using a number of different ICD-based classification frameworks (World Health Organization, 1977, 1992; National Centre for Classification in Health, 2006; National Center for Health Statistics, 2011) or using the Systematized Nomenclature of Medicine—Clinical Terms (Snomed—CT) (International Health Terminology Standards Development Organization, 2011). Information from the EDDC was only available from 1 January 2005.

The Admitted Patient Data Collection (APDC) includes information on all inpatient admissions from all public and private hospitals, private hospital day procedures, and public psychiatric hospitals in NSW. The APDC contains information on patient demographics, source of referral, diagnoses, external cause(s), hospital separation type (e.g. discharge, death) and clinical procedures. Diagnoses and external cause codes are classified using the International Classification of Diseases, 10th Revision, Australian Modification (ICD-10-AM) (National Centre for Classification in Health, 2006).

The CrashLink data collection contains information on all police-reported road traffic crashes on a public road in NSW where a person was unintentionally fatally or non-fatally injured, or at least one motor vehicle was towed away. Information pertaining to the crash and conditions at the incident site, the traffic unit or vehicle, and the vehicle controller and any casualties resulting from the crash are recorded. Each individual is identified as being non-injured, injured or killed (died within 30 days). No information on injury severity is available. Information was not obtained on individuals who were non-injured. Road users selected for this research were limited to passenger car occupants only and were identified using the traffic unit group (i.e. car/ car derivative driver, including 4 wheel drives, panel and passenger vans, utilities, and station wagons).

2.1.1. Data linkage

The EDDC and the APDC were probabilistically linked to the police-reported crashes in CrashLink by the Centre for Health Record Linkage (CHeReL) using ChoiceMaker (Choicemaker Technologies, 2011). The CHeReL uses identifying information (e.g. name, address, date of birth, gender) to create a person project number (PPN), for each unique person identified in the linkage process. A successful link was defined if the PPN matched in the data collections, and the presentation date in the EDDC or the admission date in the APDC was on the same day or the next day as the crash date in CrashLink. Upper and lower probability cut-offs started at 0.75 and 0.25 for a linkage and were adjusted for each individual linkage to ensure false links were kept to a minimum. Record groups with probabilities in between the cut-offs were subject to clerical review. The linkage rates for road traffic-related hospital admissions to police casualty records were 74.1% for drivers and 55.7% for passengers and the linkage rates for ED presentations to police casualty records were 62.8% for drivers and 46.6% for passengers. Road users were identified as died, were injured and hospitalised, were injured and presented to ED (but were not admitted) or were identified by police as injured and not hospitalised.

2.1.2. Injury severity

Injury severity was calculated using the International Classification of Disease Injury Severity Score (ICISS). The ICISS is derived for each person by summing the probability of survival for each injury diagnosis using survival risk ratios (SRR) calculated for each injury diagnosis (Stephenson et al., 2004). In a prior study of all land transport trauma, the diagnosis classifications within hospital records and survival outcome identified from mortality records for 109,843 individuals were used to generate SRRs for all ICD-10 injury codes during 2001 to 2007 (Bambach et al., 2012a,b). For each ICD injury (ICD_i) the SRR was calculated from Eq. (1).