Differential Effects of Vehicle Safety Improvements on Fatal and Serious Injury Outcomes

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I. INTRODUCTION

Whilst there has been a long-term trend to reducing fatalities from road crashes in Australia, serious injury trends, as measured by hospital admissions, have not reduced to the same extent, suggesting road safety countermeasures impact fatalities differently to serious injuries. Improvements in the safety of individual light vehicles have led to overall improvement in the crashworthiness of the vehicle fleet. A crashworthiness rating can be calculated, which measures the combined risk of death or serious injury of a light vehicle driver given involvement in a crash. Using this measure, consistent improvements in the crashworthiness rating of the Australasian vehicle fleet by year of manufacture have been demonstrated [1].

As newer, safer, vehicles enter the fleet and older, less safe, vehicles exit, it may be expected that average fleet safety should improve. A comparison of car models launched 1980-1984 with those launched 2015-2018, found that the risk of serious and fatal injury was 58% lower, whilst the risk of fatal injury was 88% lower. The same study found that European New Car Assessment Programme (Euro NCAP) crash test ratings mirror real-world injury outcomes with 5-star rated cars having a 22% lower risk of serious and fatal injury compared to 2-star rated cars, whereas the corresponding risk reduction for fatal injury was 40% [2]. These results suggest that vehicle safety improvements may result in bigger reductions in fatal injuries than serious injuries. Whilst changes to the make-up of the fleet may have differential effects on fatal and serious injury crashes, there may also be differential effects on injury by body region. Vehicle safety features have generally been focused on mitigating injuries to the upper body, especially the head and chest, because such injuries may be regarded as more life threatening. Australasian New Car Assessment Program (ANCAP) assessment protocols [3] are also focused on preventing injury for certain crash types, e.g. frontal impact, side barrier and pole impact. It is possible that differential effects on fatality and serious injury trends are a result of the types of vehicle safety technology implemented and ANCAP assessment protocols that have been utilised.

This study aimed to establish the contribution vehicle safety improvements have made to the observed differential trends in overall fatal and serious injuries, as measured by hospitalisation, as well as other injury severity metrics. This also included examining whether light vehicle safety improvements have been more effective at preventing injury to some body regions compared to others.

II. METHODS

The study utilised Police reported crash data which includes data for each person involved in a crash resulting in at least one person being injured in Victoria, Australia, for the period Jan 2000-Apr 2017. This was linked to insurance injury compensation claims data obtained from the Transport Accident Commission (TAC) which is the Government-owned statutory third-party insurer for road accidents in Victoria. Compared to police crash reports, TAC claims data contains higher resolution injury information in the form of International Classification of Diseases (ICD) injury diagnosis codes. The presence and severity of injury by body region of all claimants was determined by mapping the ICD diagnosis codes into the Abbreviated Injury Scale (AIS).

Logistic regression models were utilised to estimate driver injury severity given crash involvement as per calculation of the Australasian Used Car Safety Ratings [1]. However, analysis here focused only on the risk of the outcome of interest given some level of injury was sustained since this is the only component that would vary with the change in final outcome severity measure. For the current work, models were run for various injury severity outcomes including: Fatality; Serious Injury (hospitalization); Killed or Maximum (M)AIS 3+ (AIS 3 – Serious) injury; and Killed or MAIS2+ (AIS 2 – Moderate) injury by vehicle year of manufacture. The body regions examined included head/neck, face, thorax, abdomen and extremities.

III. PRELIMINARY FINDINGS

Figure 1 shows the relative odds of fatal versus serious injury (requiring hospital admission) for drivers in a crash by year of vehicle manufacture. It is evident that the odds of fatal injury declines for more recent years of

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vehicle manufacture with statistically significant lower odds of fatality compared to serious injury occurring from 2003. An examination of the risk of driver fatality or MAIS 3+ injury and the risk of driver fatality or MAIS 2+ injury by vehicle year of manufacture (Figure 2) show general reductions for vehicles with a newer year of manufacture. Comparison of trends in MAIS 2+ and 3+ injury risk also shows differential trends. Figure 2 shows that the risk of MAIS 2+ injury in a 2017 year of manufacture vehicle is around half that of a vehicle manufactured on 1990. In comparison the reduction in risk of MAIS 3+ injury in a 2017 year of manufacture vehicles compared to one manufactured in 1990 is over 75%.

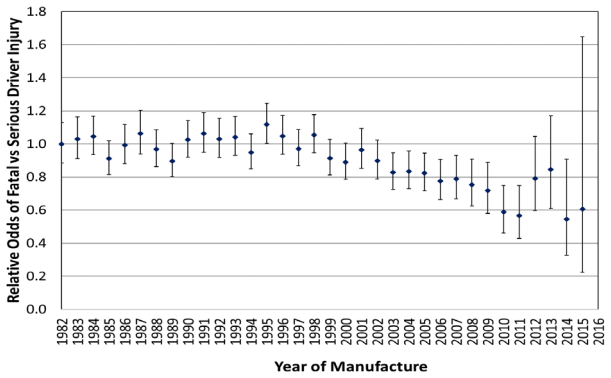

Fig. 1. Relative Odds of Fatal versus Serious Injury

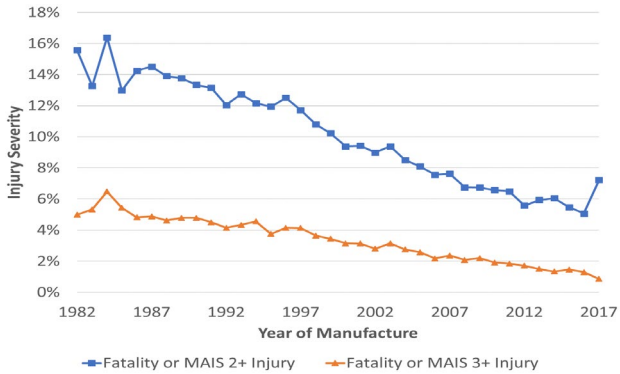

Fig. 2. Risk of Injury by Year of Manufacture

An analysis of the percentage change since 1990 in driver fatality or MAIS 2+ injury by body region by year of manufacture (Figure 3), indicates that changes have been consistent for the chest, head or neck and extremities. Changes to the risk of injuries of the face appear to have seen additional reductions compared to the chest, head or neck and extremities, whereas the risk of abdominal injury has not seen as large a reduction. The high level of prevalence of vehicle airbags in newer vehicles in the fleet may help explain the additional reductions in injury to the face.

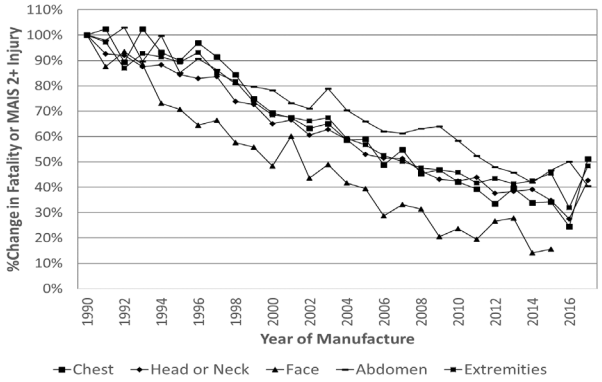

Fig. 3. Percentage Change in Injury by Body Region

IV. DISCUSSION

The results presented suggest that vehicle safety improvements have had a greater impact in reducing fatalities and more serious injury (MAIS 3+), compared to more minor injuries (MAIS 2 and below). This is consistent with the findings that suggest vehicle safety improvements may result in bigger reductions in fatal injuries than serious injuries [2]. These results however extend those findings to show that vehicle safety has also had a greater impact on reducing more serious non-fatal injuries compared to less serious injuries requiring hospitalization.

Vehicle safety features have generally been focused on mitigating injuries to the upper body, especially the head and chest, because such injuries may be regarded as more life threatening. Whilst face and abdominal injuries have shown different trend reductions compared to the chest, head or neck and extremities, it is possible that the differential effects on long-term fatality and serious injury trends are the result of the focus of vehicle safety technology implemented and ANCAP assessment protocols on addressing the most life-threatening crash types. Further research could investigate how specific vehicle safety technologies and crash testing protocols contribute to the differential between fatal and serious injury outcomes.

V. REFERENCES

[1] Newstead, S., et al. 2022. Monash University Accident Research Centre (MUARC): Melbourne, Australia.
[2] Kullgren, A., et al. 2019. ESV, Eindhoven, Netherlands.
[3] ANCAP, 2023. Australasian New Car Assessment Program (ANCAP): Canberra, Australia.