

# **A PRELIMINARY EVALUATION OF PASSENGER AIRBAG EFFECTIVENESS IN AUSTRALIA**

**Andrew Morris, Joanne Barnes and Brian Fildes**

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## **ABSTRACT**

A preliminary case-control study of passenger airbag deployments in frontal crashes (in which a passenger was present) was undertaken. The study was conducted as part of an on-going study of vehicle crash performance and occupant injury at Monash University Accident Research Centre (MUARC). The results of this preliminary study suggest that the US experience of fatalities caused by interaction of the passenger with the deploying airbag is not shared in Australia. This is probably because the seat-belt use in this study was 100%. These preliminary results reinforce the view that such airbags should be used as supplementary restraint systems.

Further studies are planned to monitor the performance of passenger-airbags and to provide more in-depth analyses when more data become available.

## **INTRODUCTION**

A picture is developing about the relative merits of driver-airbag effectiveness in frontal crashes. In countries where restraint use is high, driver airbags have been found to be relatively effective in preventing serious injury to the driver (Fildes et al, 1996; Langwieder et al, 1996; Morris et al, 1996).

However, as Huelke and Reed (1996) have observed, passenger side airbag effectiveness is relatively unknown for infrequently is there a passenger in the front seat when the airbag deploys. Whilst this has no obvious detrimental effect on other occupants of the vehicle including the driver, there are some cost implications particularly if the vehicle is repairable following the crash. Eventually, Australia will see the introduction of 'smart airbags' and such systems may well make use of sensors that detect the presence or absence of a passenger. Therefore in time, technology may well prevent unnecessary deployments.

As a necessary precursor to a more in-depth study, this is a second preliminary study of Australian experience with deploying passenger airbags.

It should be observed that the passenger airbag is not thought to be a device that vehicle manufacturers adopt to meet the Australian Design Rule (ADR) 69 requirement for frontal crash protection. Generally speaking, passengers contact the facia region of the vehicle interior in a minority of cases therefore it is not clear whether the passenger airbag will have a major impact on the prevention of injury in each deployment since injury may well not have occurred anyway. It would seem that passenger airbags are more an issue of equity and regulation, where a safety conscious driver wants to ensure at least equal protection for his or her passenger. However, it should be noted that during the development of the ADR69 regulation in Australia, passenger head contacts with the instrument panel/facia occurred in frontal crash-tests in 4 out of 7 vehicles tested by the Federal Office of Road Safety in Australia (Seyer, 1992). In general though, in most more modern designs of vehicles, passenger head contacts with the instrument panel/facia can be prevented through vehicle structural and restraint design although it could be argued that passenger airbags generally would be beneficial in reducing the likelihood of neck injuries through hyperflexion.

## **METHODOLOGY**

The data in this study were obtained from a sample of crashes that were investigated as part of an on-going study of driver injury and vehicle crash performance by the Accident Research Centre at Monash University. This study examines injuries that were sustained by a sample of drivers involved in frontal impacts in which the Principal Direction of Force (PDOF) was within 60-degrees of head-on. Vehicles were examined at recovery-garages, scrap-yards and panel-beating shops in Victoria, New South Wales, Queensland and Tasmania (depending on accident location) within a few days of the accident. An inspection was performed on each vehicle in accordance with the US National Accident Sampling System (NASS) procedure for retrospective examination of crash-damaged vehicles. Only drivers who wore their seat-belts were included in the study. Determination of seat-belt usage was achieved with a high degree of certainty.

To assess collision severity in this study, Delta-V was calculated where appropriate. Analyses were made to ensure that the collision severity in both airbag-equipped and non-airbag equipped vehicles did not differ significantly.

This study used a “vehicle based” entry criterion. Minimum criteria applied in the case of each vehicle was that it sustained sufficient damage in the crash to warrant a tow-away by a recovery truck from the scene of the crash. A case-control method was also applied in the study. Ethical considerations demanded that the vehicle was included in the study only if the owner and occupants of the vehicle and the repair shop or salvage yard agreed to participate in the study.

Injury data were gathered on each consenting driver known to have been injured in the collision. This was achieved from an inspection of medical records of those injured and hospitalised or from a structured telephone interview by a trained nurse for those not requiring hospital treatment.

Harm in this study is defined as a metric for quantifying injury costs from road trauma involving both a frequency and a unit cost component. In its most general form, it is used as a measure of the total cost of the road trauma. The fundamental matrix of Harm for vehicle occupants by body region and injury severity that was used in this analysis was reported earlier (MUARC, 1992).

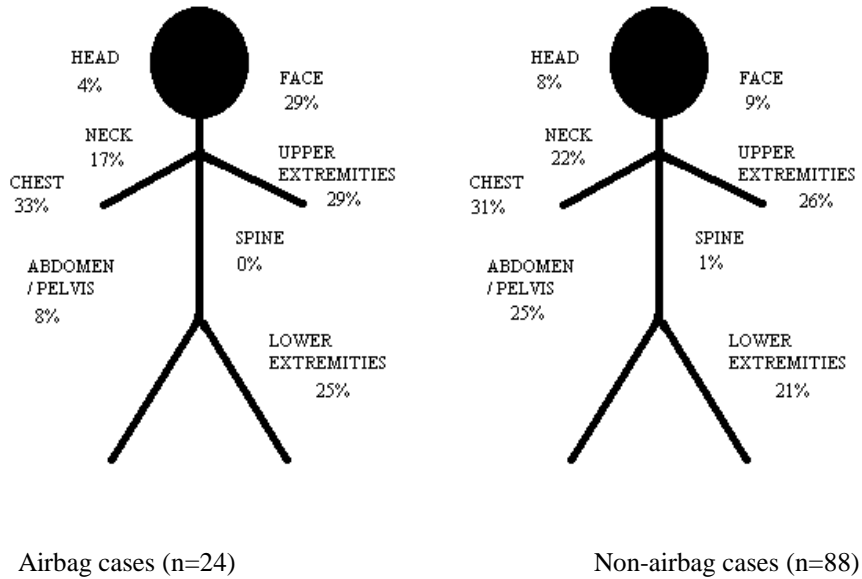
Cases were selected using a baseline curb weight between 1000kgs and 2000kgs and a delta-V distribution (where calculable between 10 and 65kph). A total of 112 belted passengers involved in a crash were included for analysis.

There were no significant differences in occupant characteristics (age, weight, sex and height) or crash severity (as measured by delta-V) between the airbag cases and non-airbag cases. The mean delta-V for the airbag cases was 33kph and non-airbag cases was 37kph ( $p=0.20$ , independent 2 tailed t test). Having established that the two sample groups were matched as far as was practical, it was hypothesised that any differences in injury outcomes in this study could be attributed to the effects of the airbag.

## Results

In this section, the effects of the deploying passenger airbag on the front left seat passenger are analysed. Of the 112 front left seat passengers in the sample, twenty-four (21%) were involved in frontal crashes where the passenger airbag deployed and 88 passengers (79%) were involved in frontal crashes where there was no airbag fitted on the passenger side.

In total 18 passengers in the airbag group and 53 passengers in the non-airbag group sustained injuries following the crash. The main body regions injured were the chest, upper and lower extremities and neck in both groups of passengers. However the airbag group had higher numbers of facial injuries and the non-airbag group a higher number of abdominal injuries (Figure 1). The injury analysis for all levels of injury showed an increase in facial injuries sustained by the airbag group ( $p=0.2$ , Fishers exact) and a trend in the reduction of abdominal injuries ( $\chi^2=3.11$ , df 1,  $p=0.08$ ).

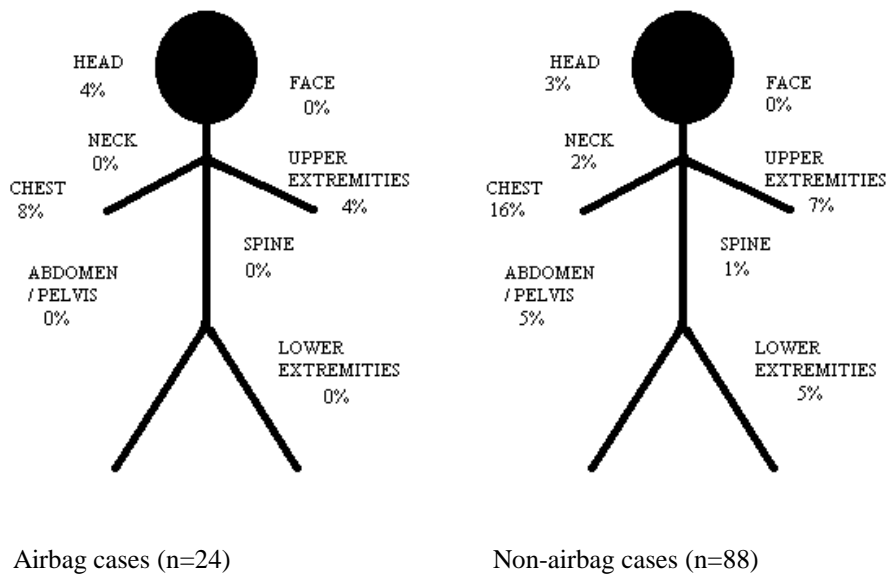


**Figure 1.**

**Distribution of AIS 1+ injuries in belted front left seat passengers**

With regard to injuries sustained at the AIS 2+ level, the main body regions injured were the chest and the upper extremities in the non-airbag group (Figure 2). However, the differences in injury outcomes between

the airbag and non-airbag group were again not found to be statistically significant. It is suggested that this is possibly an effect of the small sample size within the two groups.

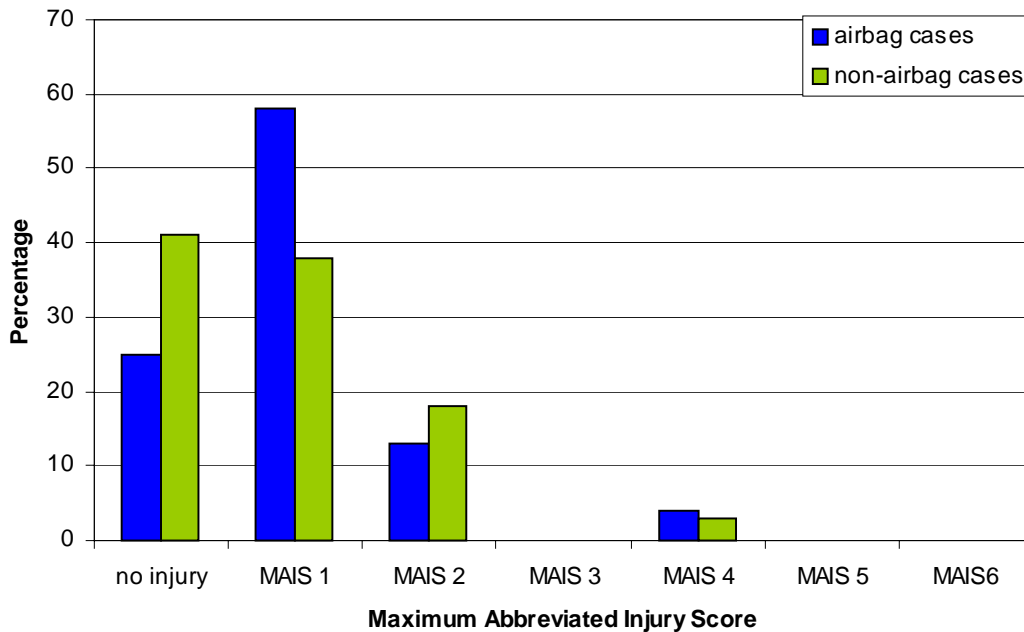


**Figure 2.**

**Distribution of AIS 2+ injuries in belted front left seat passengers**

The Maximum Abbreviated Injury Severity score sustained by the passengers for both groups was 4,

with the majority sustaining injuries at the MAIS 1 and 2 levels (Figure 3).



**Figure 3.**

**Distribution of MAIS in belted front left seat passengers**

Of interest in this analysis is the fact that passengers in the non-airbag group sustained fewer MAIS 1 injuries and were more likely to sustain no injuries (i.e. MAIS 0) given the same crash conditions. 13% of passengers in airbag vehicles sustained injury at the MAIS 2 level compared to 18% in the non-airbag group and this is a reflection particularly of fewer chest, abdominal/pelvic and lower extremity injuries being sustained by passengers at the AIS 2+ level in the airbag group.

**Contact Source**

The main contact sources are shown in table 1. As can be seen from the table, the main source of injury

for both airbag and non-airbag cases proved to be the seat-belt. As with drivers, the airbag proved to be a source of injury at the AIS 1 level but no injuries of AIS 2 or above were observed due to interaction with the airbag which is encouraging. The airbag appears to have an effect in preventing neck injuries due to hyperflexion since since this type of injury was observed to occur twice as frequently in the non-airbag cases. Another frequent source of contact for both groups was the instrument panel (particularly in the case of injuries to the lower extremity). The fact that this contact source occurred more frequently in the airbag group could be explained by the fact that the passenger airbag does not serve any purpose with regard to preventing injuries to the lower extremity at both minor and more serious injury severity levels.

**Table 1.**  
**Contact source for injury for belted front left seat passengers**

Source of Injury	Airbag cases (n= 24)		Non-airbag cases (n=88)	
	All AIS	AIS 2+	All AIS	AIS 2+
Seat belts	38%	4%	43%	3%
Airbag	33%	Nil	Nil	Nil
Instrument panel	25%	4%	18%	1%
Steering assembly	4%	Nil	Nil	Nil
Deceleration	8%	Nil	16%	1%
Floor and toe pan	Nil	Nil	5%	2%
Side window and frame	4%	4%	1%	Nil
A pillar	Nil	Nil	1%	Nil
B-pillar	Nil	Nil	1%	1%
Exterior other object/vehicle	4%	Nil	Nil	Nil
Other occupant	Nil	Nil	1%	Nil
Seat	Nil	Nil	2%	Nil

**Injury Severity Score and Harm Analysis**

The mean ISS was low for both passenger groups which is as expected in a sample where very few injuries above the MAIS 2 level were sustained by passengers (table 2). The mean Harm for all passengers was also calculated and this differed by a nominal amount.

**Table 2.**  
**Mean ISS and Harm for belted front left seat passengers**

Passengers	Number of cases	Mean ISS	Mean Harm (\$1000s)
Airbag cases	24	2	8.98
Non-airbag cases	88	2.42	10.09

The mean Harm for individual body regions was calculated, with the maximum costs attributed to the chest and upper extremity injuries in both groups of passengers (Table 3).

**Table 3**  
**Mean Harm (\$ 000s) for body regions in belted front left seat passengers**

Body region	Airbag cases (n=24)	Non-airbag cases (n=88)
Head	.93	.54
Lower extremity	.5	1.7
Upper extremity	2.7	2.5
Chest	3.2	3.04
Abdomen/pelvis	.14	1.09
Neck	.4	.7
Face	1.06	.3
Spine	0	.21

**Discussion**

Preliminary experience of passenger airbag deployments in Australia has shown that such systems do not contribute to detrimental injury outcomes to restrained front seat passengers. This is

particularly important when considering that there have been cases of severe injury outcomes through contact with a deploying passenger airbag in other countries, notably North America. Anecdotally in this study, minor surface injuries to the face and forearms have been observed but these may be trade-off injuries against more severe outcomes that may have been experienced without the airbag deployment. This preliminary study again reinforces the widely held view that the seat-belt should always be worn when a passenger airbag is present.

It should be stressed that the results are preliminary and may not be wholly conclusive for a number of reasons. Firstly, there were insufficient cases on which to base rigorous statistical analysis. Secondly, in some cases, it was debatable whether the deploying airbag provided any additional protection over what may be expected of the 3-point seat-belt system. This is so particularly where there was an absence of compartmental intrusion at the facia-level and where the collision severity was relatively minimal. Approximately one-third of the cases investigated may fall into this category. Whilst there is some suggestion that passenger airbags do not offer significant additional protection to passengers protected by 3-point belt systems, the study by Seyer (1992) which found a definite risk of passenger head contacts with the facia should be considered.

Some differences in injury patterns were however observed among passengers where a passenger airbag was fitted. The most substantial injury reductions at the AIS1+ level amongst passengers in airbag vehicles occurred to the head, neck and abdomen/pelvis. To counter this, increases in the numbers of facial injuries were observed to the passengers in the passenger airbag vehicles although the majority of these were minor abrasive type injuries, which may have cosmetic significance but are less important in terms of 'threat-to-life'. At higher injury severities, no significant differences were observed between the two groups possibly because of the sample size.

There were several cases of passenger airbag deployment in the study overall, which occurred in the absence of a passenger. Whilst this has no obvious detrimental effect on other occupants of the vehicle including the driver, there are some cost implications particularly if the vehicle is repairable following the crash.

Eventually, Australia will see the introduction of 'smart airbags' and such systems may well make use of sensors that detect the presence or absence of a

passenger. Therefore in time, technology may well prevent unnecessary deployments.

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