VEHICLE SAFETY TRENDS AND THE INFLUENCE OF NCAP SAFETY RATINGS

Michael Paine
David Paine
Jason Smith
Australasian NCAP, Australia
Michael Case
RACV, Australia
Jack Haley
NRMA Motoring & Services, Australia
Stuart Worden
New Zealand Transport Agency, New Zealand

Paper Number 15-0328

ABSTRACT

In 1999 the Australasian New Car Assessment Program (ANCAP) aligned its test and assessment protocols with Euro NCAP and began issuing safety ratings, with a maximum rating of 5 stars. In effect, to achieve 5 stars, the vehicle needed good frontal offset crash test performance and good head protection in intrusive side impacts. The rating system awards bonus points for intelligent seat belt reminders and, recently, requires certain safety features such electronic stability control (ESC) and emergency brake assist (EBA).

The proportion of models achieving a 5-star safety rating has gradually increased from zero in 2002 to an estimated 75% of models on sale in 2014. This paper presents an analysis of trends with safety ratings and the uptake of key safety features during this period.

This paper also provides estimates of future savings due to the penetration of 5-star vehicles into the Australian vehicle fleet.

INTRODUCTION

The Australasian New Car Assessment Program has conducted consumer crash tests since the early 1990s. These tests cover passenger cars and light commercial vehicles. In 1999 ANCAP aligned its test and assessment protocols with Euro NCAP and began publishing safety ratings with a maximum rating of 5 stars. About half of ANCAP's ratings since then have been based on crash tests conducted by Euro NCAP.

Under these protocols a vehicle needed to perform exceptionally well in three crash tests: frontal offset at 64km/h (maximum 16 points), mobile barrier side impact at 50km/h (maximum 16 points) and side pole impact at 29km/h (maximum 2 points). To score the maximum 5 star rating the combined score also needed to be at least 32.5. The Renault Laguna became the first ANCAP 5-star model in 2001. In 2003 Euro NCAP introduced up to 3 bonus points for intelligent seat belt reminders (SBR). In that year the Mercedes-Benz C-Class achieved a 5-star rating by including driver and front passenger SBR.

It became evident to ANCAP that a vehicle could achieve a 5-star rating without the need for a pole test (and therefore without head-protecting side airbags - head protection technology or HPT). Therefore in 2004 it was made a 5-star requirement that, to be eligible for a 5 star rating, a vehicle must score at least one point (out of 2) in the pole test.

In 2008 ANCAP made it a 5-star requirement that a vehicle has ESC as standard. In 2011 ANCAP published its 2011-2017 Road Map which required minimum performance in pedestrian protection and whiplash protection as well as a range of safety assist technologies (SAT). For example, for a 5-star safety rating in 2013 the vehicle needed driver and front passenger SBR and EBA. In 2014 the side head protection needed to cover the 2nd row outboard seats and in 2015 any 2nd row fixed (non-removable) seats required SBR. The Road Map also requires a minimum number of additional (non-mandatory) SAT and manufacturers are able to choose from a list of more than forty SAT for this purpose.

In Australasia there is a strong demand for vehicles with a 5-star safety rating. For example many fleet buyers now set this as a purchasing requirement. This demand for 5-star vehicles, combined with the increasingly higher requirements for a 5-star rating means that ANCAP has likely accelerated the uptake of safer vehicles and key safety technologies.

This paper sets out the results of an analysis of the trends with safety ratings and the uptake of key safety features during the period 2001-2014. These trends are also projected to 2020 to provide an estimate of the

road trauma savings that can be expected from increasing use of 5-star rated vehicles.

SOURCES OF DATA

ANCAP maintains a database of safety ratings for vehicle models and the key safety features that are available for these models. The database was analysed to provide an estimate of the number of vehicle models available for sale in a particular year that were 5-star rated or not.

It took several years for ANCAP to assign star ratings to a large proportion of all models for sale in Australia and New Zealand. During the period 2001 to 2004 the ratings were dominated by models tested by Euro NCAP. These tended to be luxury models and so the estimates of the uptake of safety features, and star rating are likely to be higher than the actual numbers.

Using data from the VFACTS service, an estimate was also made of the annual sales of each model. From this an estimate was made of the proportion of annual sales that were 5-star models. Note that this is not the same as the proportion of new ANCAP ratings that were 5-stars in any particular year. There are many older models that are still on sale as new vehicles and these are less likely to be 5-stars than new models to the market.

A desirable aim for safer vehicles is to increase the proportion of 5-star rated models in the total annual kilometres travelled by light passenger vehicles (vehicle kilometres travelled or VKT). Newer vehicles tend to travel higher annual kilometres than older vehicles and so data published by the Environmental Protection Agency of NSW on VKT by vehicle age for the 2008 calendar year was utilised in the analysis (EPA 2012). A key assumption is that these proportions do not change greatly in earlier or subsequent years. In other words, a 3 year old vehicle in 2008 has the same proportion (8%) of annual light passenger vehicle VKT as a 3 year old vehicle in 2001 or 2014. The VKT data is listed as an appendix.

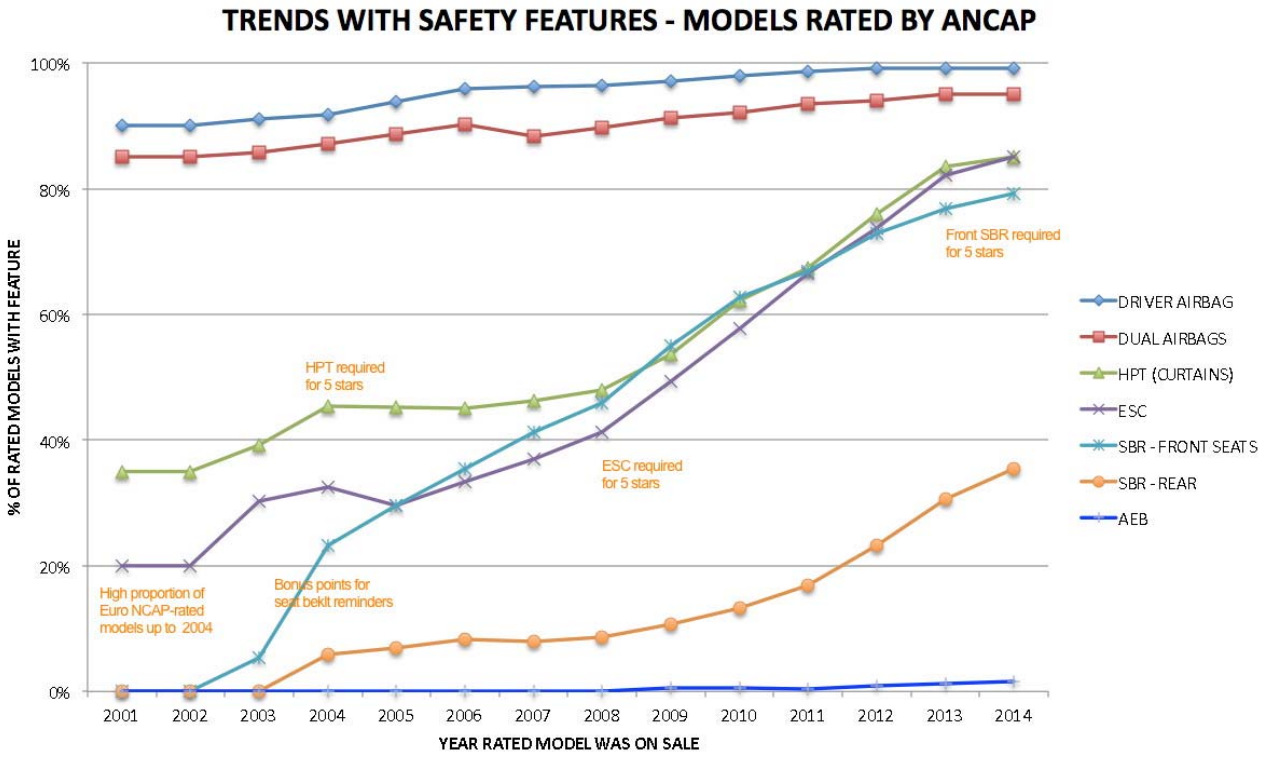
RESULTS

Figure 1 shows the uptake of key safety features of models rated by ANCAP in the period 2001 to 2014. The figure also shows milestones in ANCAP-related policy that likely had an influence on this uptake.

Table 1. Estimated uptake of safety features

Safety Feature	2001*	2007	2014
HPT	35%	46%	85%
ESC	20%	41%	85%
Front Passenger SBR	0%	46%	79%
2nd row SBR	0%	9%	35%
AEB	0%	0%	2%

* Biased towards European models



DISCUSSION - SAFETY FEATURES

Frontal airbags

By 2001 most popular cars already had frontal airbags for the driver and passenger. The 10% of models without a driver airbag in 2001 were mostly light commercial vehicles such as pickups and vans. It is likely that during the following decade ANCAP contributed to the uptake of frontal airbags on these remaining models, or their withdrawal from the market. There were no regulation changes during this period that might have influenced this trend.

Head-protecting side airbags

A new Global Technical Regulation on Pole Side Impact will be introduced under the Australian Design Rules (ADR) in the next few years. This will be the first global regulation that requires head protection in severe side impact crashes.

Since 2001 the Euro NCAP/ANCAP protocols strongly encourage head-protecting side airbags through the side pole test. About one third of the models rated by these organisations in 2001 had HPT. This improved steadily to 46% by 2007 and then uptake increased, with 85% of rated models having the technology by 2014. The demand for 5-star rated models is likely to have contributed to the improved uptake.

Electronic stability control

Subject to the over-representation of prestige European models between 2001 and 2004, there was a gradual uptake of ESC on models rated by ANCAP. Increased uptake is evident from 2008 when ANCAP made ESC a mandatory requirement for the 5-star safety rating. This was at a time when the demand for 5-star rated models increased. Other factors at this time were an industry-based voluntary code for fitting ESC and the announcement of amendments to the Australian Design Rules to require ESC on new models from November 2011.

Despite these regulatory changes there are some models being offered for sale without ESC. To address this ANCAP has made ESC mandatory for a 2-star safety rating from 2014. A vehicle without ESC cannot do better than a 1-star safety rating.

Seat belt reminders - front seats

The Australian Design Rules require a basic warning system for the driver's seat belt but there are no regulations that encourage the fitting of advanced seat belt reminders to vehicles. These devices were only available on a handful of models prior to 2003.

ANCAP and Euro NCAP introduced bonus points for seat belt reminders in 2003 and the uptake was quite dramatic from that time, improving from 20% to 80% of rated models between 2004 and 2014. The bonus points enabled many models to reach a total score sufficient for a 5-star safety rating.

ANCAP made front seat belt reminders mandatory for 5-stars from 2013 and for 4-stars from 2015.

Seat belt reminders - rear seats

Under the protocols a vehicle with seat belt reminders for all rear seats can earn a bonus point. It is apparent that this was not strong incentive for uptake of this technology, despite the protocol only requiring a warning if there was a change in state of the seat belt use (the front passenger seat requires occupant detection). By 2014 only one third of rated models had rear seat belt reminders.

To address the low uptake of rear seat belt reminders the ANCAP Road Map includes them as a mandatory 5-star requirement for 2nd row fixed (non-removable) seats from 2015. The Euro NCAP protocols also strongly encourage seat belt reminders for all seats through the Safety Assist component of the rating system.

Autonomous emergency braking

AEB is a relatively new technology that has excellent potential for reducing road trauma (Anderson 2012).

Less than 2% of the models rated by ANCAP in 2014 had AEB as standard. Several Australasian models had AEB available on higher-priced variants but not on the base variant.

The situation is different in Europe. For example about half of the models rated by Euro NCAP in 2014 earned points for AEB. Since 2013 the Euro NCAP rating system has encouraged the uptake of AEB. The ANCAP Road Map 2011-2017 includes AEB in the list of additional SAT but it is evident that stronger encouragement is needed to reach the levels of uptake seen in Europe.

From 2018 ANCAP will be aligning its protocols with Euro NCAP and this is expected to focus attention on AEB. In the meantime, through media releases and other communications strategies, ANCAP is encouraging consumers to ask for AEB. For example, ANCAP datasheets now indicate if AEB is available in Europe but is not available on any Australasian variant - a measure intended to put pressure on the Australian distributors.

Speed assist systems

The Euro NCAP Safety Assist protocol also encourages manufacturers to fit speed assist systems (Schram 2013). 85% of models rated by Euro NCAP in 2014 earned points for Speed Assist Systems (SAS).

Most of these had a manual speed assist (MSA) function, where the driver sets an upper limit to the vehicle speed. This is similar to the operation of cruise control and many recent MSA systems utilise the same driver controls as cruise control (set, cancel, resume etc).

From a safety perspective the use of MSA is preferred to cruise control because driver intervention (such as pressing the cancel button) is required in order to slow down a vehicle that is operating under cruise control. This can take several seconds. With MSA the driver simply reduces throttle to slow down and driver intervention is only necessary when the driver wishes to exceed the set speed. This is more practical for typical motorways and busy rural roads where slower moving traffic is frequently encountered but the driver wishes to not exceed a certain speed (preferably the posted speed limit) at other times. It is less complex and much less costly than adaptive cruise control, which is intended to achieve similar outcomes without driver intervention.

The other SAS function rewarded by the Euro NCAP protocols is a Speed Limit Information Function (SLIF). The driver is provided with information about the posted speed limit. This can be done through digital mapping of speed limits, through the recognition of speed limit signs or a combination of these systems. Several models rated by Euro NCAP in 2014 had digital maps or optical sign recognition.

There is good potential for SAS to reduce road trauma (Paine 2013a). The next step is Intelligent Speed Assistance (ISA) where, in effect, the SLIF and MSA are combined so that the maximum vehicle speed is automatically set according to the posted speed limit, unless the driver intervenes. The Euro NCAP SAS protocol awards additional points for ISA but, so far, no models have received these bonus points. This is expected to change as the coverage and reliability of digital mapping improves. For example, during 2014 the New South Wales government released a smartphone application which alerted drivers to speeding throughout NSW, including time-based 40km/h school zones. The government also made the data on posted speed limits available to the private sector for use in navigator applications and other uses.

The ANCAP Road Map 2011-2017 includes SAS as an additional SAT. Historical data about the uptake of SAS is not readily available and so SAS has not been included in Figure 1. However it is expected that manufacturers, fleets and consumers will give greater attention to SAS when ANCAP aligns its protocols with Euro NCAP in 2018.

Fleet purchasing policies

In 2011 the Australian government amended its fleet purchasing policy to require cars to have a 5-star ANCAP safety rating and for light commercials to have a 4-star rating.

In 2012 BHP Billiton, introduced a 5 star NCAP safety rating requirement across its worldwide vehicle fleet. This included light commercial vehicles and followed the release of the 5-star Ford Ranger pickup in late 2011. This generated substantial interest from other pickup manufactures and most popular brands are now available with 5 stars safety ratings.

PROJECTED BENEFITS OF SAFER VEHICLES

Paine (2013b) analysed data from Australasian real-world crashes to track the improvement in occupant safety as vehicle models improve in star ratings. That analysis found that the risk of serious injury to drivers of 5-star models was half of that for drivers of vehicles with the same model name when it was 3-stars or less.

That analysis is considered to be a reasonable approximation for dividing the Australian light vehicle fleet into "5-stars" and "not 5-stars" for the purpose of determining benefits for all light vehicle occupants. The following analysis therefore assumes that if all non 5-star models were replaced by 5-star models then light occupant fatalities and serious injuries would reduce by 50%. This is in the range of values from analysis of real-world crashes in Europe: a reduction of 23% (+/-8%) for serious injuries and 68% (+/-32%) for fatalities (Kullgren 2010). Furthermore, Newstead (2014) reported that a typical 2010 Australian car had 40% lower risk of serious injury to the driver than a 2001 model (based on his Fig 20). It is estimated that 56% of sales in 2010 were 5-star models and that the relative savings from these was around 30%.

It is expected that the sales of 5-star models will level out during the next 5 years. It is assumed that by 2020 95% of sales will be in 5-star models and that two-thirds of VKT will be in 5-star models.

RESULTS

Table 2. Estimated benefits from 5-star models

Parameter	2001	2007	2014	2020
5-star sales	0%	18%	86%	95%
5-star models on the market	0%	33%	75%	82%
% of fleet 5-stars	0%	4%	31%	61%
Annual VKT in 5-stars	0%	5%	34%	67%
KSI relative to 2001	100%	98%	83%	66%

The results are set out in Figure 2.

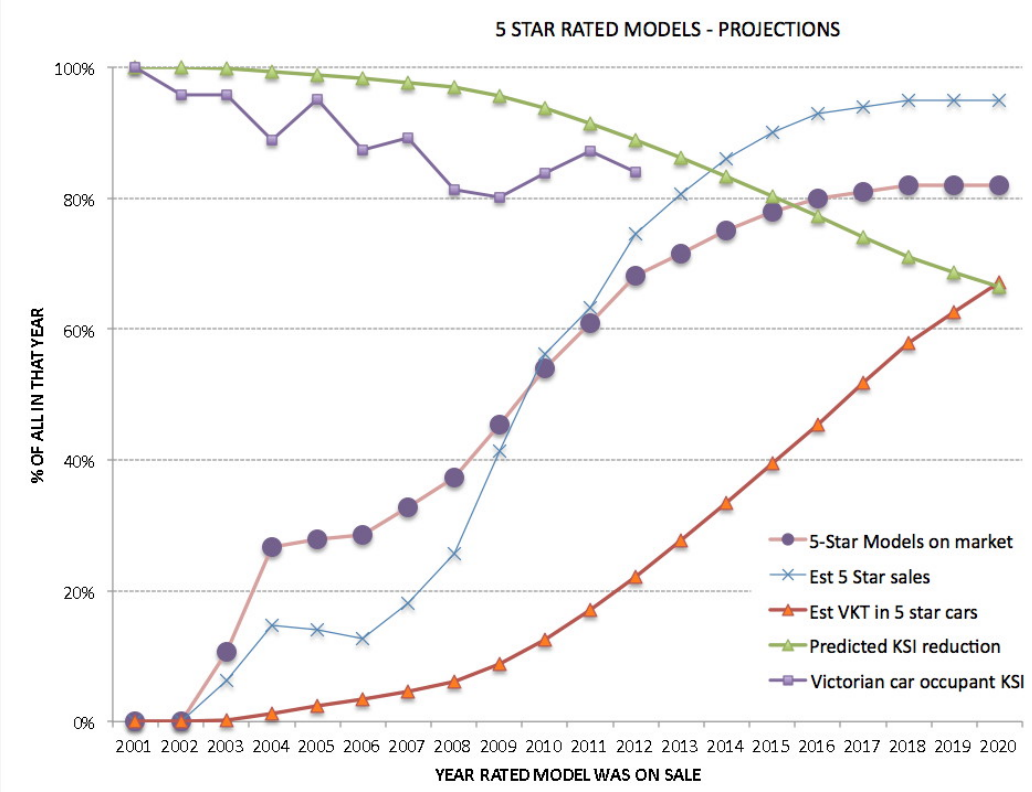


Figure 2. Trends will 5-star models and projected savings

DISCUSSION OF POTENTIAL BENEFITS

Light vehicle occupant casualties (killed and seriously injured) are likely to have dropped by 17% between 2001 and 2014 due to the uptake of 5-star rated vehicles.

There are very few sources of data about actual occupant casualties in Australia during this period. Once source is the TAC online database for Victoria for the period 2001-2012 (see appendix). These data are also shown in Figure 2. The Victorian data show that light vehicle occupant KSI reduced by 16% during this period. The estimated reduction due to VKT in 5-star vehicles in 2012 is 11%.

There were many other road-safety initiatives that contributed to the reduction in overall road crash casualties during the period studied. However an indication of the benefits of 5-star models can be obtained by applying the 2014 fleet composition to the 2001 Australian road toll. Extrapolating the TAC data for Victoria, it is estimated that there were 1200 fatalities and 17400 serious injuries to *occupants of light vehicles* in 2001(when no vehicles were 5-stars). If 34% of VKT (the 2014 estimate) had been in 5-star models during 2001 then there would have been 200 fewer fatalities and 2900 fewer serious injuries to light vehicle occupants. The societal cost savings would have been in excess of one billion dollars (based on BITRE 2009).

The forward projections are somewhat speculative but it is evident that the benefits from the increase in sales of 5-star models over the past 5 years are resulting a replacement of older models with newer, safer vehicles. It is estimated that in 2014 34% of VKT were in 5 star models and that this will double by 2020. As a result it is predicted that light vehicle occupant KSI will have reduced to 66% of the 2001 value.

LIMITATIONS

Reliable information about the availability of safety features during the study period is not available. This analysis is based on ANCAP historical data and the assumption that there is very little uptake of optional safety features. Additionally it is difficult to determine when some safety features became standard on certain models. This uncertainty will also affect the estimate of 5-star models sold.

Assumptions about VKT by age of vehicle are based on EPA estimates for 2008 and may have changed by 2014.

There is limited information about the number of serious injuries to light vehicle occupants in Australia during the study period.

CONCLUSIONS

Since 2001 ANCAP made a major contribution to the uptake of several important safety features on light vehicles. Regulation initiatives for these safety features either do not exist or lag ANCAP initiatives by five years or more.

The proportion of the light vehicle sales with a 5-star ANCAP safety rating has increased strongly from 2008. As a result older vehicles are being replaced by safer 5-star vehicles at an increasing rate. It is predicted that, by 2020, this effect will result in a saving of approximately 34% in light vehicle occupants killed and seriously injured, compared with a vehicle fleet that had the same crashworthiness as that in 2001. Societal cost savings are estimated to be more than AU$2 billion per year (that is, twice that estimated for 2014).

NCAPs are now encouraging the uptake of the latest crash avoidance technologies, such as autonomous emergency braking and improved protection for vulnerable road users struck by light vehicles. These should result in further casualty savings for a wider range of road users.

This analysis shows that NCAP programs are highly cost-effective.

REFERENCES

Anderson R, Doecke S, Searson D (2009) *Vehicle age-related crashworthiness of the South Australian passenger fleet* , Centre For Automotive Safety Research, CASR0106 April 2012

Anderson R, Doecke S, Mackenzie J , Ponte G, Paine D & Paine M (2012) Potential benefits of forward collision avoidance technology, Centre For Automotive Safety Research, CASR0106 April 2012

BITRE (2009) *Cost of Road Crashes in Australia in 2006,* Dept Infrastructure and Transport, Canberra

EPA NSW (2012) *Air Emissions Inventory for the Greater Metropolitan Region in New South Wales 2008 Calendar Year - On-Road Mobile Emissions: Results*, Technical Report 7, Environment Protection Authority of NSW, Sydney

Kullgren A., Lie A. and Tingvall C. (2010) *Comparison between Euro NCAP test results and real-world crash data*, Traffic Injury Prevention, 11:587-593, 2010

Lie A., Kullgren A. and Tingvall C (2001) *Comparison of Euro NCAP test results with Folksam car model safety ratings*, *Proceedings of 17th ESV,* Netherlands

Newstead S, Watson L and Cameron M (2014) *Vehicle safety ratings estimated from police reported crash data: 2014 update Australian and New Zealand crashes during 1987-2012,* Report 323, Monash University Accident Research Centre, Australia

Paine M., Griffiths M., Haley J and Newland C. (2009) *Injury and structural trends during 12 years of NCAP frontal offset crash tests*, Proceedings of 19th ESV, Washington

Paine D, Paine M, Wall J & Faulks I (2013a) *Development of an assessment protocol for after-market speed limit advisory devices*, Proceedings of 23rd ESV, Seoul

Paine D, Paine M, Case M, Haley J, Newland C and Worden A (2013b) *Trends with ANCAP safety ratings and real-world crash performance for vehicle models in Australia*, Proceedings of 23rd ESV, Seoul

Schram R, Williams R, van Ratingen M, Strandroth J, Lie A & Paine M (2013) *NCAP Test and Assessment Protocols for Speed Assistance Systems, a first in many ways*, Proceedings of 23rd ESV, Seoul

APPENDIX

Estimated Vehicle Kilometres Travelled by Vehicle Age in 2008 (EPA 2012).

Vehicle Age (Years)	% of light vehicle fleet	% of total annual light vehicle VKT
New	6.25%	4%
1	6.34%	8%
2	6.77%	8%
3	6.88%	8%
4	7.05%	7%
5	6.77%	7%
6	5.56%	6%
7	5.03%	6%
8	5.25%	6%
9	5.78%	6%
10	4.93%	5%
11	3.98%	5%
12	3.75%	5%
13	3.46%	5%
>13	27%	13%

Notes

These values reflect changes in the total number of vehicle sales each year, due mainly to economic issues. This is not expected to have major effect on the analysis since the contribution of any one year is relatively small.

The mean age of the Australian light vehicle fleet in 2008 was 10 years (Anderson 2009)

Victorian car occupant casualties 2001-2012

(http://www.tac.vic.gov.au/road-safety/statistics/online-crash-database)

Year	Killed or seriously injured	% of 2001
2001	4525	100%
2002	4337	96%
2003	4332	96%
2004	4025	89%
2005	4307	95%
2006	3951	87%
2007	4035	89%
2008	3677	81%
2009	3627	80%
2010	3792	84%
2011	3948	87%
2012	3799	84%

Notes

There is no adjustment for exposure in these data

Used Car Safety Ratings (Newstead 2014 Fig 20)

Risk of serious injury to driver

Vehicle type	1997-2001	2002-2006	2007-2012
Large car *	66%	53%	35%
Small car*	77%	54%	48%
Utility*	63%	50%	40%
Large car #	100%	80%	53%
Small car#	100%	70%	62%
Utility#	100%	79%%	63%
Average#	100%	76%	60%

* Relative to 1982-86

Relative to 2001