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A Real-World Evaluation of Autonomous Emergency Braking and Forward Collision Warning in Australasian Light Vehicles

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A real-world evaluation of Autonomous Emergency Braking and Forward Collision Warning in Australasian light vehicles

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Abstract:
Monash University Accident Research Centre conducted a real-world evaluation of AEB in light vehicles in Australia and New Zealand using police reported crash data in Australia and New Zealand between 2013 and 2017 inclusive. The classification of sensitive crashes, those potentially mitigated by AEB, was based on five existing real-world evaluations of AEB and applied to crashes occurring in Australia and New Zealand. Crashes were considered as narrowly sensitive, broadly sensitive, intersection sensitive and pedestrian sensitive. Narrowly, broadly and intersection sensitive crashes involved car to vehicle incidents, with either a high degree of confidence (narrow sensitivity) or where there was some evidence (broadly and intersection sensitive) that AEB would alleviate or mitigate the crash. Pedestrian sensitive crashes included car to pedestrian and car to bicycle collisions, unless otherwise stated. Of the crash data, 34% of property damage only crashes were found to be narrowly sensitive to AEB. The addition of broad and pedestrian sensitivity increased this to 63%. When injuries from injury crashes were considered, up to 63% of injuries sustained in light vehicle-to-vehicle crashes (considering narrow, intersection and broad crashes combined) and up to 4% of injuries from car to pedestrian crashes were sensitive to AEB. The fitment of AEB to light passenger vehicles has the potential to impact the outcome and to potentially avoid or mitigate up to 67% of the trauma incidents occurring in light vehicle crashes.

Analysis of police reported crash data from Australia using induced exposure methods showed strongly significant estimates of relative risk reductions associated with light vehicle models where some variants are fitted with AEB. Reductions in the risk of trauma from narrowly sensitive crashes were estimated at 27% for fatal and serious injuries and 19% for minor injuries. If all light passenger vehicles in narrowly, broadly and pedestrian sensitive crashed vehicles in Australia were models where some variants had AEB fitted, these estimates of injury reduction in sensitive crashes would translate to injury reductions across all crashes of: **8%** for fatalities, **12%** for serious injuries and **12%** for minor injuries. Furthermore **21%** of no-injury crashes are expected. The value of Australian crash injuries potentially saved in terms of human losses was estimated at $1,513 million ($186 million, $2,569 million).

The results highlight both the proven effectiveness and the significant potential of AEB technology in the reduction of trauma incidents as a result of light vehicle involved crashes.

Key Words:

FCW; AEB; Advanced Autonomous Automatic Emergency Braking; Forward Collision Warning; induced exposure; rear-end crashes; real-world Australian crash data

Disclaimer

This report is disseminated in the interest of information exchange. The views expressed here are those of the authors, and not necessarily those of Monash University

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Preface

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Contributor Statement

- Stuart Newstead: Project oversight and analysis design
- Laurie Budd: Statistical design, analysis and report
- Amanda Stephens: Report

Ethics Statement:

Ethics approval was not required for this project.

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EXECUTIVE SUMMARY

In 2019, the Vehicle Safety Research Group identified the need to evaluate the established vehicle safety technologies of Autonomous Emergency Braking (AEB), Forward Collision Warning (FCW), SUV Rollover Stability Control and Driver Knee Airbags. This report presents current evaluations for AEB and FCW in terms of crash avoidance and injury mitigation through speed reduction.

Method

Crash and crash injury benefits associated with AEB or FCW in light passenger vehicles in Australia and New Zealand were estimated using police reported crash data for a five-year period (2013 to 2017). Almost no vehicles manufactured before 2013 were identified as having AEB or FCW fitted in the crash data, hence analysis was limited to vehicles manufactured from 2013 onward. Police reported crashes were classified into sensitive or non-sensitive crashes based on crash type and the potential for avoidance or mitigation with AEB or FCW. Sensitive crashes were further classified as **narrow**, where there was a high degree of certainty that AEB would mitigate or avoid the crash, or **broad**, where AEB *might* mitigate or avoid the crash. In addition, broadly sensitive crashes involving crossing path **intersection** (referred to as intersection sensitive) and **pedestrian**-to-vehicle crashes (pedestrian sensitive) were also considered.

The potential benefits of AEB and FCW technologies were measured on current fitment levels (modelled across all, some or no model variants fitted with the technology) and also on the assumption of AEB fitment in all light vehicles. Only current fitment was modelled for FCW, as the evaluated savings were small and 100% fitment scenario unlikely. Induced exposure methods were used to compare crash or injury counts in light vehicles with FCW or AEB fitment to similar vehicles without such fitment. Crash avoidance and injury mitigation were modelled across separate analyses. The analyses were further stratified by speed zone (60km/h or lower and above 60km/h) for analysis, which provides a proxy for travel speed.

Percentage of crashes that could have been avoided or mitigated by AEB in the Australian and New Zealand crash data

- Almost one third of all light vehicle crashes occurring in Australia and New Zealand between 2013 and 2017 could, with a high degree of certainty, have been avoided or mitigated by AEB (i.e. were narrowly sensitive); approximately two-thirds of these were from crashes in 60 km/h or lower speed zones.
- A further 29% of all light vehicle crashes in Australia and New Zealand between 2013 and 2017 might have been avoided or mitigated by AEB (i.e. were broadly sensitive); approximately three quarters of these were from speed zones of 60 km/h or lower.
- Approximately 3% of light vehicle pedestrian crashes could have been avoided or mitigated with AEB; 90% of these were from crashes in 60 km/h or lower speed zones.
- Approximately 10% of intersection crashes might have been avoided or mitigated with AEB; 93% of these occurred in low speed zones

A higher percentage of crashes sensitive to AEB and FCW occurred in lower speed zones, than higher speed zones. Consequently, the mandating of AEB in light passenger vehicles is likely to benefit a greater percentage of crashes occurring in lower speed zones.

When the crash outcomes were considered across property damage only (PDO) and injuries resulting from crashes (minor [not requiring hospital admission], serious or fatal), crashes in low speed zones that were classified as sensitive to avoidance or mitigation from AEB or FCW contributed to 43% of all PDO crashes; 39% of fatal and serious injuries and 48% of minor injuries. When proportioned across all speed zones and all crash injuries, up to 52% of all fatal, 63% of all serious injuries and 70% of all minor injuries from light passenger vehicle crashes were likely to be avoided or mitigated with AEB or FCW (i.e. they resulted from crashes classified as sensitive to AEB technology).

AEB and FCW effectiveness in reducing the risk of crash and injury

In crashes where technology would almost certainly avoid or mitigate the crash, AEB and FCW were more effective for reducing the risk of serious and fatal injuries than for minor injuries. The estimated injury risk reduction from AEB was 19% (95%CI: 12%, 25%) for minor injuries and 27% (95%CI: 8%, 42%) for fatal and serious injuries. There was weak evidence to suggest that AEB may be more effective at reducing fatal and serious injuries in low speed zones, and more effective at the reduction of intersection sensitive crashes and associated injuries in high speed zones. For FCW, fatal and serious injuries were reduced by 40% (95% CI: 14%, 59%). There was no evidence of reductions in minor injuries, PDO crashes, pedestrian sensitive crashes and intersection crashes associated with FCW. However, the evaluation of FCW in models without any associated AEB fitment was based on fitment levels at only a fraction of that for AEB, so few inferences may be drawn from the FCW results.

AEB Crash and injury benefits in the light vehicle fleet

The estimated effectiveness of AEB was applied across each sensitive crash type for the Australian and New Zealand crash data. Based on the fitment rate of AEB to all vehicles in the fleet in the last year of the study data (2017), results showed that for the Australian crash data:

- Overall, AEB was estimated to mitigate 0.08% of all fatal, 0.14% of all serious and 0.10% of all minor injuries. This amounted to average annual savings of 1 fatality, 43 serious injuries and 93 minor injuries per year, valued at $16 million in terms of human losses.
- AEB was estimated to avoid 0.13% of all PDO crashes, which amounted to average annual savings of 76 narrowly sensitive, 31 broadly sensitive and 7 intersection sensitive crashes.

For the New Zealand crash data:

- AEB was estimated to mitigate 0.18% of all fatal and 0.09% of all serious and 0.06% of all minor injuries, which amounted to average annual savings 2 fatal and serious and 4 minor injuries.

The average annual savings were also calculated on 100% fitment of AEB in the Australian and New Zealand light passenger vehicle fleet. The results showed that, for the Australian light passenger fleet:

- Full fitment of AEB would lead to an estimated reduction of 8% of fatalities, 12% of serious injuries and 12% of minor injuries. This translates to average annual savings of 126 fatalities, 3,731 serious injuries and 11,017 minor injuries valued in terms of human losses at $1,513 million dollars.
- Half of the potential serious injury savings arise from narrowly sensitive crashes in low-speed zones.
- Most of the fatality savings arise from high speed broadly sensitive crashes (60%).
- Eighty-two percent of the potential minor injury savings arise from narrowly sensitive crashes and 59% of these were from high speed zones. Overall, slightly less than half (47%) of the minor injury savings arise from low-speed crashes.
- Twenty-one percent of PDO crashes could be avoided.
- Overall, 88% of PDO crash savings arise from low-speed zones, and three quarters of the savings are from just intersection and narrowly sensitive low-speed crashes.

The results showed that, for the New Zealand light passenger fleet:

- Full fitment of AEB would lead to an estimated reduction in total injuries being 8% for fatalities, 8% for serious injuries and 7% for minor injuries. This translates to average annual savings of 21 fatalities, 162 serious injuries and 698 minor injuries.
- Half of the potential serious injury savings arise from narrowly sensitive crashes in low-speed zones.
- Most (64%) of the serious injury savings arise from broadly sensitive crashes and about half of the serious injury savings arise from low speed zones.
- Most (76%) of the fatality savings arise from high speed broadly sensitive crashes.
- Two thirds of the potential minor injury savings arise from narrowly sensitive crashes and 63% of these were from high speed zones.
- Overall, half of the minor injury savings arise from low-speed crashes.

It should be noted that these estimates are likely conservative since they are based on estimates of AEB effectiveness in vehicle model groups where only some of the vehicles were fitted with the technology.

Conclusions

Analyses using real-world crash data from Australia and New Zealand from the years 2013 to 2017 evaluated AEB as effective in reducing light vehicle crashes and associated injuries. Estimates of the potential future benefits of AEB in this study for light vehicles are likely to be conservative due to constraints on identifying AEB equipped light vehicles as well as the constant development of the technology being seen to address more crash types, such as those at intersections, in higher speed zones and involving pedestrians or cyclists. However, the results highlight the significant potential benefits of having 100% fitment of AEB in the light passenger vehicle fleet.

1 BACKGROUND AND PROJECT AIMS

In 2019, the Vehicle Safety Research Group identified the need to evaluate the established vehicle safety technologies of Autonomous Emergency Braking (AEB), Forward Collision Warning (FCW), SUV Rollover Stability Control and Driver Knee Airbags. This report presents current evaluations for AEB and FCW in terms of crash avoidance (primary safety benefits) and injury mitigation through speed reduction (secondary safety benefits).

The research design used for this evaluation was based on the analyses conducted by MUARC for the Used Car Safety Ratings (UCSR) program. Through the UCSR program MUARC has successfully evaluated the effectiveness of vehicle safety technologies such as driver airbags, anti-lock braking systems and electronic stability control. Through these evaluations, protocols have been developed for assembly of the data to support the analyses and induced exposure designs have been used and found to provide the most robust statistical analysis outcomes. More recently, with the development of the primary safety index, methods of evaluation for crash avoidance technologies via direct risk methods have also become available.

The current research design required retrospective evaluation of AEB and FCW through the analysis of real-world crash data. This relies on there being enough vehicles fitted with the technologies in the registered fleet and further, these vehicles having been involved in the crashes. MUARC currently monitor the exposure of new vehicle safety technologies in the fleet through the matching of vehicle specification data from RedBook in Australia and through the Right Car information in New Zealand to the crash and registration data in the VSRG research database. On current trends, both AEB and FCW technologies have sufficient exposure to be evaluated under the VSRG program using crash data from 2013 to 2017.

This report therefore presents the real-world evaluation of AEB and FCW crash effectiveness in Australia and New Zealand based on crash data from 2013 to 2017. A preliminary assessment of AEB effectiveness was conducted by MUARC in 2019 for the Australian Commonwealth Government (Newstead, Budd et al. 2020). This evaluation extends that work by using additional crash data (2013-2017 compared to 2013-2016) as well as additional jurisdictions (Newstead et al., considered only Australian crash data). Thus, the new analysis contains an addition 234,961 more light vehicles. These additional data significantly enhance the robustness of the analysis.

For the analyses, both primary and secondary safety benefits were evaluated. Crash avoidance of AEB and FCW were measured using induced exposure methods. Where forward collision warning occurred, the evaluation considered separately the effectiveness of the predecessor, FCW alone, as well as the combination of FCW and AEB. The injury mitigation benefits of AEB and FCW were measured as far as possible by measuring injury risk and severity outcomes in relevant crash types adjusted for the overall crashworthiness characteristics of the vehicle. This was attempted on a broad basis measuring the risk of hospital admission or death in the event of a crash.

2 SCOPE OF ANALYSIS

This project evaluated the crash and crash injury benefits associated with AEB and FCW in crashed light vehicles in Australia and New Zealand over the five-year period from 2013 to 2017. Injuries and crashes saved given the current fitment level were estimated and additionally, future benefits were modelled assuming 100% fitment in the fleet (for AEB only). The evaluation method was the same as was used by Newstead, Budd et al. (2020) but extends this research by considering pedestrian and intersection crashes in addition to narrowly and broadly sensitive crashes.

Sensitive crashes were classified following the set of crashes identified in the literature to benefit through crash avoidance or injury mitigation from AEB fitment. These crashes have been identified through real-world evaluations or simulations and provide the best evidence for classification of a large number of crash types. In all crash scenarios, the benefit of AEB is only achievable with fitment to the striking vehicle.

The analyses were restricted to the benefits of AEB or FCW in light passenger vehicles. Light passenger vehicles were defined as all vehicles with a gross vehicle weight less than or equal to 3.5 tonnes. These vehicles are described in the Australian Design Rules as cars (M1) and utilities and light vans (N1). They were identified by vehicle class, vehicle weight and VIN (vehicle identification number). The full list of makes and models fitted with AEB used in this evaluation are present in Appendix A.2.

3 PREVIOUS RESEARCH ON AEB EFFECTIVENESS: A BRIEF OVERVIEW

A literature review was undertaken to support classification of sensitive crashes. This was the most robust method to identify crash sensitivity based on a large range of crash types. Five studies were found that were based on real-world crash data and simulations and considered to represent the best evidence on which to classify sensitivity (see Table 1). All of these studies were rear-end crash evaluations of AEB effectiveness in light vehicles.

All studies evaluated low speed AEB. While Newstead, Budd et al., (2020) combined high and low speed, the low market penetration of high-speed systems (Figure 1) meant low and high-speed systems could not be separated in the analyses and mostly low speed systems were represented in the data. The study by Newstead et al., also differed from the others in that the makes and models fitted with AEB were not restricted. With the exception of the meta-analysis of Fildes, Keall et al. (2015), and Cicchino (2017), evaluations were only on *Volvo* low speed AEB systems.

Despite using different data sources, the five studies have produced similar findings regarding the overall potential reductions in rear-end crash involvement due to AEB fitment. Fildes, Keall et al. (2015), Isaksson-Hellman and Lindman (2016) and Cicchino (2017) showed that vehicles fitted with low speed AEB had 38%, 27% and 31%, respectively fewer rear-end crashes compared to similarly matched make and model vehicles without AEB fitment. When crash injury or injury crash reductions were considered, AEB fitment was associated with 22% (Newstead, Budd et al. 2020), 35% (Rizzi, Kullgren et al. 2014), 41% (Rizzi, Kullgren et al. 2014) and 30% (Cicchino 2017) less injury related rear end crashes. These point estimates were all associated with overlapping 95% confidence intervals, which provided no evidence for statistical difference.

The evaluation by MUARC reported here represents a significant enhancement on previous research. This is because the analysis included evaluation of the effectiveness of AEB in mitigating pedestrian injuries resulting from frontal collisions. Further, the effectiveness of AEB at crash avoidance or injury mitigation for specific intersection collisions: straight crossing paths (SCP) and right turn across the path of a vehicle approaching from the opposite direction (RTAP/OD) was also evaluated.

Four recently published studies show the potential effectiveness of AEB for mitigation of these crash types (see Table 2 and Table 3). Edwards, Nathanson et al. (2014) and Toshiyuki and Yukou (2017) found that currently available pedestrian AEB systems have the potential of reducing a fifth of pedestrian injury crashes. Similarly, new sensor technology including intersection advanced driver assistance systems (I-ADAS) or intersection movement assist (IMA) and right turn assist (RTA), [known as left turn assist systems in left side drive countries] may be teamed with AEB technology to target SCP and RTAP/OD crashes. Scanlon, Sherony et al., (2017) found that AEB teamed with I-ADAS has the potential to prevent up to 79% of driver injuries in light vehicle SCP crashes when at least one vehicle is fitted. Sander (2017) found that general AEB systems have the potential to avoid up to 59% of RTAP/OD injury crashes when the vehicles involved are travelling at speeds of 40 km/h or less.

Table 1 Summary of five real-world rear-end crash evaluations of AEB in light vehicles

Author	Data source	Period of data	Country of crash data	Exposure	Vehicle restrictions	Speeds evaluated
Newstead, Budd et al. (2020)	5,824 injury and 1,259 property damage Police reported crashes	2012-2016	Australia	Rear end crash struck light vehicle	Matched by year of manufacture, and size as car, SUV or LCV Low or High speed AEB	All speeds, analysis disaggregated by below and exceeding 60 km/h
Cicchino (2017)	23,649 Police reported crashes (7055 injury crashes)	2010-2014	U.S.A, 22 states	the number of insured vehicle years (IVY)	Matched with similar makes and model, yom 2009-2012 Low speed AEB (≤30 km/h) in Volvo models	≤56km/h, 64-72km/h and 80+km/h speed zones
Isaksson-Hellman and Lindman (2016)	454 vehicle insurance claims	2012-2015	Sweden	The number of insured vehicle years (IVY), 48,089 and 52,634 for AEB and no-AEB cars, respectively.	With and without Low speed AEB (≤30 km/h) in Volvo V70 only.	Impact speed <5, 5-15 and >15km/h as defined by repairs needed and equated to crash severity
Fildes, Keall et al. (2015)	3,326 Police reported crashes (not specified to be injury crashes)	2009 onwards	6 countries Meta-analysis	Rear end crash struck vehicle	Vehicles matched by makes and model or by size and similar make and model Low speed AEB (≤30 & 30-50 km/h) in Volvo, VW and Mazda	Any speed zone
Rizzi, Kullgren et al. (2014)	Of the 3,922 Police reported injury crashes, 660 rear-end crashes were used	2010-2014	Sweden	Rear end crash struck vehicle	AEB Vehicles matched with similar vehicles matched by weight. Low speed AEB in Volvos only	≤ 50km/h 60-70 km/h and ≥ 80 km/h speed zones

Table 2 Summary of two intersection crash evaluations of AEB with/without specific warning systems in light vehicles

Author	Data source	Period of data	Country of crash data	Exposure	Vehicle restrictions	Speeds evaluated
Scanlon, Sherony et al. (2017)	448 SCP	2005 - 2007	USA	1 vehicle with/without AEB + intersection SCP warning system	2 vehicles, light-to-light vehicles only	All speed zones
Sander (Sander 2017)	Injury crashes: 770 LTAP/OD, 384 involving just light vehicles	1999 -2015	Germany	1 vehicle with/without Generic AEB system	2 vehicles, light-to-light vehicles only	All speed zones

Table 3 Summary of two pedestrian crash evaluations of Pedestrian AEB in light vehicles

Author	Data source	Period of data	Country of crash data	Exposure	Vehicle restrictions	Speeds evaluated
Toshiyuki and Yukou (2017)	Pedestrian-to-light vehicle frontal injury crashes.	2009-2011	Japan	Vehicle with and without Pedestrian AEB system	Light vehicles	All
Edwards, Nathanson et al. (2014)	2,023 Pedestrian-to-light vehicle frontal injury crashes.	2000 to 2012	Europe- Gemany and UK	Vehicle with and without Pedestrian AEB system Current (2013+) Pedestrian AEB, 2018-2022 technology and 2023 + reference limit of technology	Pedestrian AEB evaluation of frontal collisions with a passenger car which injured pedestrians	All

3.1 Effectiveness of AEB in light passenger vehicles considered across different speed zones

Table 4 shows the evaluations considered across speed zones. The effectiveness of low speed AEB was shown to be stronger in higher speed zones (Cicchino 2017) than when considered across all speeds. Cicchino (2017) suggest the greater injury reductions found for speed zones of 60-70-km/h may be explained by the increased opportunity for rear-end collisions on the road infrastructure in these speed zones (i.e. more intersections). Newstead, Budd et al., (2020) also found greater injury reductions in higher speed zones, which may also result from the infrastructure, or from the potentially higher impact speed in these zones. However, it may be result from statistical variation, given that the difference in estimates by speed zone was not significant (as indeed were many of the other estimates by speed zone of Table 1).

Table 4 Effectiveness of AEB across five rear-end crash evaluations

Author	All severity (or severity not specified)		Injury crashes	
	All speed zones	Separated across speed	All speed zones	Separated across speed zones
Newstead, Budd et al. (2020)	24% (0%-42%) property damage only		22% (13%-30%) of all injuries	All injuries: ≤60Km/h: 19% (8%-29%) >60 Km/h: 27% (12%-39%)
Isaksson-Hellman and Lindman (2016)	27% of all crashes	37% in all crashes striking in <5km/h impact speed		
Rizzi, Kullgren et al. (2014)			41%± 29% Volvos, 35%± 31% non-Volvos	Halving in ≤ 50km/h zones, 57%± 36% cf non-AEB Volvos, 54%± 37% cf non-AEB non-Volvos No statistically significant reductions in speed zones > 50km/h
Cicchino (2017)	Striking: 43% (39%, 47%) Struck: 12% (8%,16%) RD = 31% ± 4%	Striking: ≤ 56km/h zones 40% (35%,45%) 64-72km/h zones 53% (50%,57%) 80km/h + zones 31% (24%, 38%)	Striking: 45% (40%, 48%) Struck: 15% (9%, 21%) RD = 30% ± 8%	Striking: ≤ 56km/h speed zones 40% (31%, 48%) 64-72km/h speed zones 59% (53%, 64%) 80+km/h speed zones 30% (22%, 38%)
Fildes, Keall et al. (2015)	38% (18%, 53%)			

Table 5 Effectiveness of AEB across two intersection crash evaluations

Author	All severity (or severity not specified)	Injury crashes	
	All speed zones	All speed zones	Separated across speed zones
Scanlon, Sherony et al. (2017)	25-29% crashes avoided with I-ADAS automatically braking with and AEB system 0-23% crashes avoided with I-ADAS warning alone	Up to 79% of driver serious injuries were avoided with I-ADAS + AEB Only up to 23% with I-ADAS warning alone	
Sander (2017)		33% to 59% for straight going vehicle, 11-26% for turning vehicle	Crash avoidance not possible at speeds >40 km/h for turning vehicle and >60 km/h for straight vehicle

Table 6 Effectiveness of AEB across two pedestrian crash evaluations

Author	Injury crashes	
	All speed zones	
Edwards, Nathanson et al. (2014)	2018 pedestrian injury reduction: 14.1% fatal, 8.8% serious, 93.6% minor	Current 2013 pedestrian injury reduction: 6.2% fatal ,4.2% serious injury ,12% minor injury
Toshiyuki and Yukou (2017)	20% injuries, 5% fatalities, 12% serious injuries	

4 DATABASE TO SUPPORT THE ANALYSIS

Four complementary data sources were used to evaluate the effectiveness of AEB and FCW fitment in light passenger vehicles. These were, police reported crash data; make, model and market groups of light vehicles assigned to the crash data using methods established in the Used Car Safety Ratings program[i]; and Redbook and Right Car Information safety feature fitment data merged onto the UCSR make and model groups for light vehicles.

4.1 Crash Data

Police reported crash data were sourced from the data collected for calculation of the Used Car Safety Ratings from New Zealand and Australian jurisdictions (Newstead, Watson et al. 2019). These data cover the entirety of New Zealand as well as the five largest Australian States: New South Wales, Queensland, Victoria, South Australia and Western Australia (see Table 7). Although not having total national coverage in Australia (Tasmania, the Australian Capital Territory and Northern Territory data are not included) the database had sufficient coverage of the Australian crash population (95%) to be representative of the national situation. These data include 234,961 more light vehicles than the used in the previous AEB analysis of Newstead, Budd et al. (2020).

Table 7 UCSR Light vehicles in all-severity Australian and New Zealand police reported crashes (2013-2017)

	N	%
New Zealand	101,894	11
New South Wales	238,778	25
Victoria	100,099	11
Queensland	95,850	10
Western Australia	280,290	30
South Australia	131,954	14
Total	948,865	100

Crashes were disaggregated into the severity classes: property damage only, minor injury not requiring admission to hospital, serious injury where hospital admission is required and fatal (death within 30 days of the crash). These classes are defined by at least one crash involved person having sustained injuries meeting the class severity (e.g. a fatal crash is one where at least one person is killed). Data for no-injury, or property damage only (PDO), crashes were only available from jurisdictions other than New Zealand, Victoria and Queensland[1].

[1] Queensland 'property damage only' records ceased in 2012.

Crash details held in the database are extensive and include variables to facilitate the evaluation of safety technology in crash avoidance and injury mitigation. This includes person details of those involved in the crash, road user types and a broad range of crash circumstance information. Crash causation and fault are not included.

Figure 1 shows the penetration of AEB technology into the crashed Australian and New Zealand light vehicle fleet. As can be seen, discernible market penetration did not begin until 2012 and therefore, only crash data from 2013-2017 were included in the analysis. This provided sufficient detail to obtain meaningful average estimates.

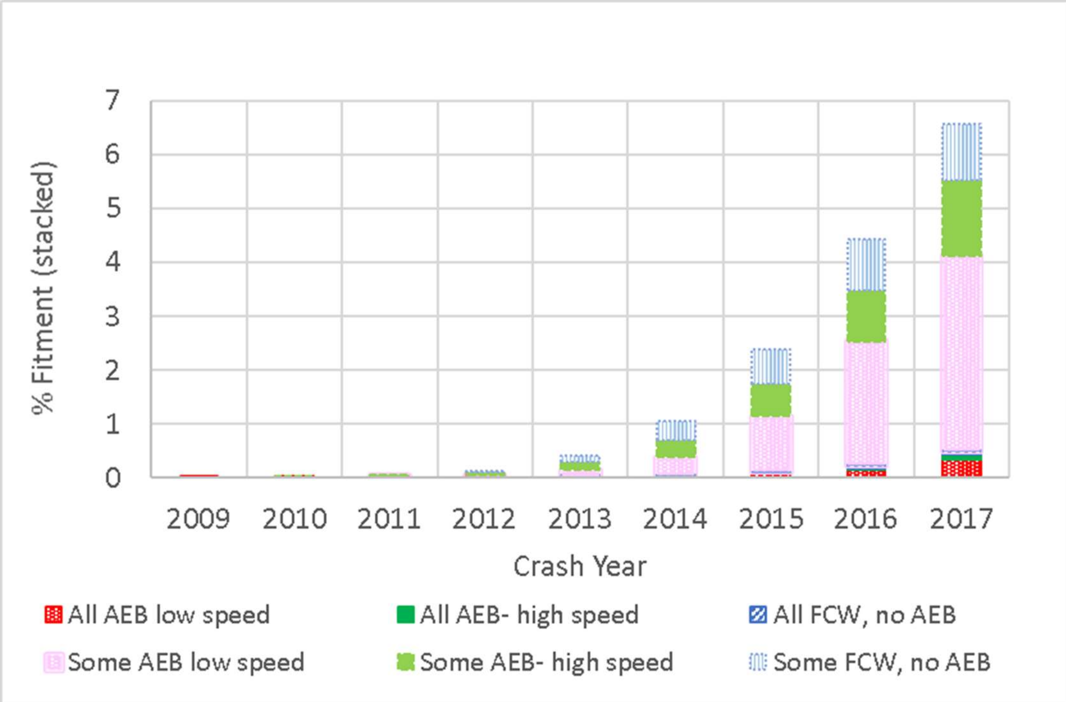

Figure 1 Market penetration of FCW and two types of AEB systems in the Australian and New Zealand crashed light vehicle fleet, by crash year[2]

4.2 Model and Market Group Enhancement

MUARC enhances the UCSR database with specific makes, models and market groups of light vehicles appearing in the crash data through a proprietary process of Vehicle Identification Number (VIN) decoding. Information on light vehicles involved in crashes can be presented with a high degree of specificity. Make and model is identified for all Australian registered light vehicles manufactured since 1982, however because of privacy protection, the VIN is truncated making it impossible for the VIN decoder to identify individual vehicles down to the level of model variant.

[2] See below for description of Redbook data to explain these classes.

4.3 Redbook Data

The light vehicle models identified in the UCSR database were further enhanced with information on whether the following safety features were fitted: ESC, FCW, and both low-speed and high-speed Forward Collision Mitigation (FCM) Systems. FCM is a sub-group of AEB systems that target forward collisions only. The definition of low and high speed varies by manufacturer and system type. For the purposes of this study, low speed systems were expected to perform best in speed zones of 60 km/h and under, and highspeed systems were thought to be optimal in speed zones greater than 60 km/h.

The Redbook standard-fitment data were indexed to the model information of the MUARC VIN decoder. However, RedBook data links safety feature fitment at the model variant level and the MUARC system cannot identify the variant level of models. This means that some MUARC VIN decoder defined model groups may have a mix of variants in them, some with, and some without, a specific safety feature. Therefore, if all model variants for a VIN decoded make and model were fitted with the safety system, the fitment status of "*all"* was awarded to the model. If only some, and not all, of the model variants were fitted with the safety system, the fitment status became, "*some"*. The remaining light vehicles were classified as "*no fitment or unknown fitment".*

4.4 Right Car Information Data

Right-Car Information provided vehicle safety fitment data at the model variant level for New Zealand vehicles. AEB fitment as standard was available for model variants manufactured between 1998 and 2019. Registration data were coded with the *Right-Car* model variant codes which were then linked to the AEB fitment data. Linkage of *Right-Car* AEB fitment to New Zealand crash data was then achieved using registration plates.

Crashed light vehicles identified through this process to be fitted with AEB were analysed within the *"all"* fitment group because of the associated certainty of a standard fitment.

4.5 Australian Crash Cost Data

Australian injury costs were derived from the Bureau of Infrastructure Transport and Regional Economics [BITRE] (2009) report number 118, "Cost of road crashes in 2006". The 2006 human loss value of a fatality was costed at $2.4 million and the human loss of a hospitalisation at $214 thousand. A fatal crash was valued at $2.67 million, a serious injury crash at $266 thousand and a minor injury crash at $14.7 thousand Australian 2006 dollars. BITRE uses a hybrid of the human capital and the willingness-to-pay approaches which is further explained in https://bitre.gov.au/publications/2010/files/sp_003_Risbey_Cregan_deSilva.pdf .

The 2006 social costs of fatal, serious (hospitalised injuries) and minor injury crashes were inflated to 2020 costs using the March consumer price index (Australian Bureau of Statistics 2020) to $ 3.59 million, $36 thousand and $20 thousand respectively. The 2020 Australian dollar value of human losses for a fatality was therefore $3.23 million, a serious injury was $288 thousand, and a minor injury was $ 3 thousand.

5 METHODS

The effectiveness of AEB or FCW is defined as the percentage reduction in light vehicle crashes or associated injuries as a result of the safety technology. Specifically, the effect is not just activation of AEB or FCW, but activation which results in crash avoidance or mitigation. Thus, AEB and FCW will only be effective under certain crash conditions, referred to as sensitive crashes.

The estimates of effectiveness were determined using induced exposure analysis applied to the Australian and New Zealand crash data. The effect measured in the induced exposure analysis was i) the reduction in PDO crashes, or ii) the reduction in injuries, associated with AEB or FCW fitment. This was fitment in the crashed vehicle and for crashes where this fitment was likely to influence the occurrence or injury outcome of the crash (i.e. crash is sensitive to both AEB and FCW). All the types of crashes considered sensitive to AEB were also considered sensitive to FCW and vice versa. Crashes not sensitive to AEB or FCW were used as the *induced exposure*. All non-sensitive crashes were considered not sensitive to both FCW and AEB. This non-sensitive set acts as a comparison group, so that the effects of AEB or FCW in sensitive crashes may be separated from the effects due to exposure. To minimise bias, the non-sensitive group needs to match the sensitive group in as many attributes as possible, including time and location. Furthermore, based on the studies presented in Table 1, covariates of interest, and possible confounding variables were identified and explored with Australian data by Newstead, Budd et al. (2020) through comparison of crash variable distribution within the sensitive and non-sensitive crashed vehicles.

Details of the methods employed follow under the appropriate subheadings. Summaries of the analysis datasets are tabled in appendix A.3.

5.1 Crash Inclusion Criteria: Defining sensitive crashes

The following section details the attributes of a crashes included in the analysis.

5.1.1 Severity of Crash

The light vehicle induced exposure analyses of *injuries* resulting from crashes included only injury-crash data because there is no risk of injury in a PDO crash.

The analysis of light vehicle PDO crashes was carried out in separate induced exposure analyses. This was done because PDO crash data were not available for all jurisdictions.

5.1.2 Speed Zone

Speed zone was used to approximate travelling speed. This was because AEB systems vary in their effectiveness according to travelling speed (Rizzi, Kullgren et al. 2014, Isaksson-Hellman and Lindman 2016, Cicchino 2017), which is not consistently collected within Australian crash data.

As both low speed and high speed AEB fitment data were available, analyses were carried out over the entire speed range and for data disaggregated by speed zone: ≤ 60 km/h and >60 km/h. This division of speed zoning was chosen because it separates high speed, highway and freeway locations from lower speed urban regions and because current literature (Rizzi, Kullgren et al. 2014, Cicchino 2017) has evaluated low speed AEB (effective at speeds up to 50km/h) in light passenger vehicle crashes primarily in speed zones under 60km/h. The summary of previous light vehicle crash analyses in Table 1 gives the speed zone or travelling speed restrictions for these analyses.

5.1.3 Sensitive Crashes

Only crashes sensitive to AEB were included in the analysis. All crashes sensitive to AEB were also considered sensitive to FCW. No additional crash types were considered sensitive to FCW.

Classification of crash sensitivity was based on published prospective evaluations of the potential effectiveness of AEB technology (see Table 8). Crashes strongly sensitive to AEB have been defined as predominately rear-end type crashes. As can be seen in Table 8, some researchers consider only crashes involving two vehicles in their definition (Rizzi, Kullgren et al. 2014, Fildes, Keall et al. 2015), while other studies have also included crashes involving multiple vehicles (Cicchino 2017). Crashes involving reversing vehicles have also been excluded from some AEB sensitive crashes (Cicchino 2017).

Table 8 Identification of sensitive and non-sensitive crashes or crashed vehicles

Author	Sensitive Crashed vehicles	Non-Sensitive Crashed vehicles	Excluded Crashes
Isaksson-Hellman and Lindman (2016)	Striking vehicles (cars) in rear-end crashes	Not studied	
Rizzi, Kullgren et al. (2014)	Striking vehicles (cars) in rear-end crashes	Struck vehicles(cars) in rear-end crashes	Crashes with more than two vehicles No-injury crashes
Cicchino (2017)	Striking vehicles (cars) in front to rear-end crashes. (If more than 2 vehicles, this is all vehicles with front end damage)	Struck vehicles (cars) in front to rear-end crashes. (if more than 2 vehicles, this is the vehicle with rear end damage)	All vehicles in crashes involving reversing. Parked vehicles
Fildes, Keall et al. (2015)	Striking vehicles(cars) in rear-end crashes	Struck vehicles (cars) in rear-end crashes	Crashes with more than two vehicles

Table 8 also shows definitions for vehicle roles involved in the sensitive crashes. In a two vehicle rear-end crash there is a struck vehicle and a striking vehicle. The striking vehicle is the *sensitive* vehicle, meaning that the vehicle would be sensitive to crash risk reduction through the fitment of the vehicle safety technology (Anderson 2011, Rizzi, Kullgren et al. 2014, Fildes, Keall et al. 2015, Isaksson-Hellman and Lindman 2016, Cicchino 2017). In rear-end crashes these are generally defined as the vehicles with frontal damage. In contrast, the struck vehicle is the vehicle (not reversing) that receives rear end damage. Fitment of AEB or FCW in the struck vehicle has no association with crash risk reduction.

The set of struck and striking vehicles in AEB sensitive crashes will differ from the set of struck and striking vehicles in FCW sensitive crashes because the set is made up of vehicles fitted with a technology and vehicles not fitted with a technology. The vehicles without AEB or FCW fitment will be the same in both the AEB and the FCW analyses. However, when considering the struck and striking vehicles with vehicle safety technology fitment, only vehicles associated with AEB fitment will be included in the AEB analysis and only vehicles associated with FCW fitment will be included in the FCW analysis.

Based on the empirical evidence presented above, four types of sensitivity were considered for this analysis: **narrow**, **pedestrian**, **intersection** and **broad**.

Narrowly sensitive crashes were similar to those identified in Table 8. These were crashes in which a forward moving vehicle struck an on-path vehicle which may have been moving in the same direction (any speed, accelerating or decelerating), stopped, parked, double-parked or broken down. The defining feature of the collision was that the front of the striking vehicle, impacted the other vehicle (in the rear if it was moving forward) in a manner similar to the VicRoads DCA descriptions of 130, 131, 132, 141, 145, 160, 161, and 162. The jurisdictional DCA or RUM charts are included in Appendix A1 (section 1). The struck vehicle was a motor vehicle, and the striking vehicle was a light vehicle.

In the Australian and New Zealand crash data:

- Almost one-third of light vehicle crashes were narrowly sensitive to AEB;
- Approximately two-thirds of these were from crashes in 60 km/h or lower speed zones.

Pedestrian sensitive crashes included pedestrian-to-vehicle crashes when the crash type was a single vehicle-to-pedestrian crash (VicRoads DCA descriptions as 100 to 105 and 108 to 109), where the pedestrian was on-path and not on the footpath or median. In addition to foot (pedestrian) traffic, for the purposes of this analysis, bicycle-to-vehicle collisions were considered as equivalent to a pedestrian if the bicycle was on path, either moving in the same direction as the vehicle, or stopped. In these cases, the struck vehicle was a bicycle and it was on-path in a similar manner to the narrowly sensitive crashes (with Victorian DCA's of 130, 131, 132, 141, 160, 161, and 162; see Appendix A.1). Both the motor vehicle and bicycle were the first event (primary impact) of the crash and the striking light motor vehicle had to be moving. Collisions of bicycles with parked or stopped vehicles were not considered sensitive crashes.

In the Australian and New Zealand crash data:

- Approximately 3% of light vehicle crashes were pedestrian sensitive to AEB;
- Most (90%) of these were from crashes in 60 km/h or lower speed zones.

Broadly sensitive crashes were situations where a vehicle crosses the path of a vehicle fitted with safety technology. While less effective, AEB or FCW may mitigate certain intersection crashes, opposite direction crashes, overtaking crashes and U-turn crashes. Typical crash types (with Victorian DCA groups) broadly sensitive to AEB are adjacent direction intersection crashes (110-119), opposite direction crashes including head-on crashes (120-129, 150), same direction U-turn (140), pulling out (152, 154) and cutting-in (153), leaving and entering parking (142 and 143), emerging from a driveway or footpath (147 and 148) and striking a train/plane/tram (192). These crash types were identified as broadly sensitive to forward collision technologies by Anderson (2011). These broadly sensitive *multi-vehicle* crashes were restricted to motor vehicle-to-motor vehicle collisions; motor vehicle collisions with bicycles of these types are considered not likely to be mitigated by AEB in the striking motor vehicle. However, crashes with motorcycles, heavy vehicles and other motor vehicles were included in the analysis if the collision was with a light vehicle.

Typical single vehicle crash types (with Victorian DCA groups) also considered broadly sensitive to AEB were on-path struck object/animal crashes (164-167,193), missile crashes (191) and off end of road/T-intersection (175). These crash types were identified as broadly sensitive to forward collision technologies by Anderson et al (2011).

In the Australian and New Zealand crash data:

- The broadly sensitive light vehicle crashes contributed to 29% of all crashes;
- Approximately three quarters of these were from speed zones of 60 km/h or lower.

Intersection sensitive crashes included straight crossing paths (SCP) and low-speed right turn across path from the other direction (RTAP/OD) collisions. This sub-set of broadly sensitive crashes was not analysed within the broadly sensitive group. These crashes were singled out because they represent a high proportion of fatal and serious injury crashes in Australia and New Zealand, so much so that these intersection crashes outnumbered the narrowly sensitive crashes when outcomes were fatal or serious.

In the Australian and New Zealand crash data:

- Intersection sensitive crashes made up 10% of light vehicle crashes;
- Most (93%) occurred in low speed zones.

Table 9 shows the percentages of crashes and injuries within each of the sensitive crash types for the Australian and New Zealand crash data. These are also presented by low (≤60 km/h) and high (>60 km/h) speed zone. Notably, narrowly sensitive crashes contributed to 2% of all fatal injuries, 15% of all serious injuries and 32% of all minor injuries. When considered across speed zones, the contribution of narrowly sensitive crashes to injury was greater in higher speed zones for serious and minor injuries.

The average annual crash and injury counts over 2013 to 2017 by sensitivity, severity, speed zone and vehicle type are detailed further in Appendix A.7 (Table 30 for Australia and Table 31 for New Zealand). It may be seen from these tables, that crashes and non-fatal trauma are greater for sensitive crashes in low speed zones. Over both jurisdictions, sensitive crashes in low speed zones contribute to 43% of property damage only crashes, 40% of serious injuries and 48% of minor injuries. Overall speed zones, the contribution is respectively 64%, 63% and 70% (Rounding errors apply to table summations.)

Table 9 Percentage of crashes and injuries across sensitivity and speed zone

	Narrow %	Broad %	Pedestrian %	Intersection %
PDO Crashes				
Low speed zone	30	19	0.4	12
High Speed zone	44	20	0.1	2
All	34	20	0.3	9
Fatal Injuries from Injury Crashes				
Low speed zone	3	17	24	9
High Speed zone	2	39	5	4
All	2	33	11	5
Serious Injuries from Injury Crashes				
Low speed zone	13	18	11	21
High Speed zone	20	41	3	6
All	15	26	8	15
Minor Injuries from Injury Crashes				
Low speed zone	31	18	4	18
High Speed zone	34	23	1	4
All	32	20	3	13
All Injuries from Injury Crashes				
Low speed zone	27	18	6	19
High Speed zone	30	28	1	4
All	28	21	4	14

5.2 Vehicle Exclusion and Inclusion Criteria

The following section details the attributes of a sensitive crashed vehicle.

The vehicle sets in sensitive and non-sensitive crashes consisted only of light vehicles as defined above. Vehicle exclusions were based on crash sensitivity to AEB and market penetration of AEB fitment, not make or model.

5.2.1 Vehicle Year of Manufacture

As can be seen in Figure 2, the market penetration of AEB in vehicles manufactured prior to 2013 was not discernible. Therefore, the induced exposure analysis of the effects of AEB in the light vehicle fleet was restricted to vehicles manufactured in 2013 and beyond, so that the vehicles without AEB fitment matched the age of those with. The induced exposure analysis looks at the crash involvement and injuries in vehicles with AEB fitment and compares it to vehicles without such fitment. For the evaluation to produce an unbiased estimate of the injury benefits associated with AEB, the two sets of vehicles must be as similar as possible.

5.2.2 Model Code

As only vehicles VIN decoded with a UCSR model code could be identified as having AEB fitment, the vehicles included in the light vehicle induced exposure study were limited to vehicles with UCSR model codes. Generally, all light vehicles meeting the crash year and year of manufacture inclusion criteria were coded.

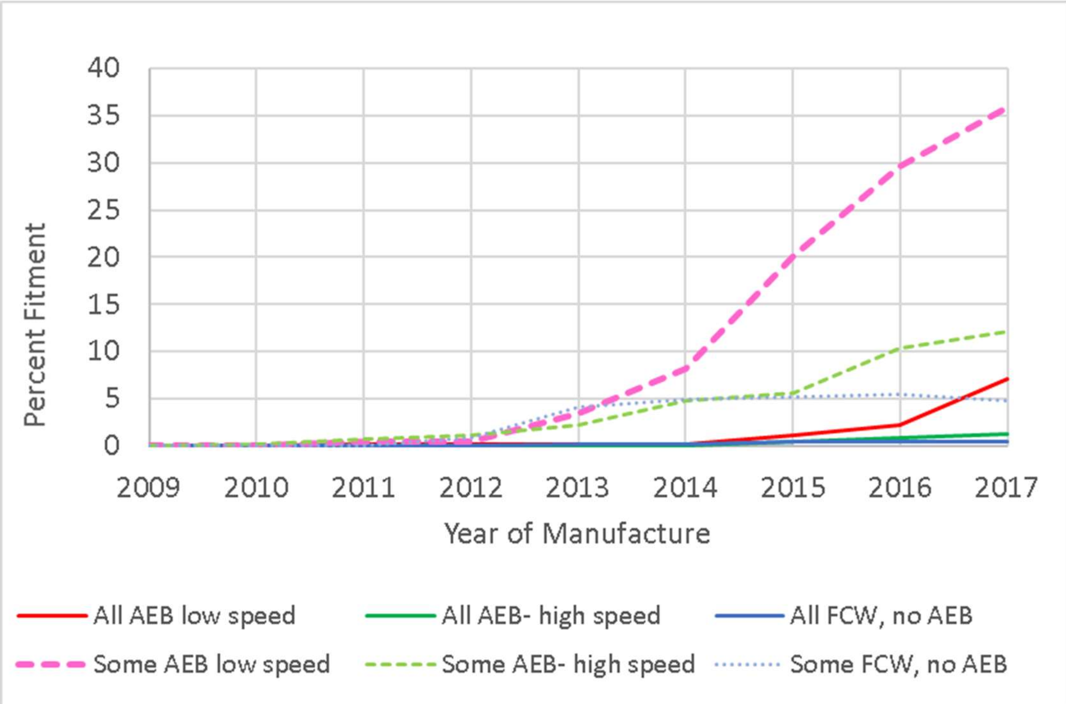

Figure 2 **Market penetration of AEB and FCW in the 2013-2017 Australian and New Zealand light vehicle fleet by year of manufacture**

5.2.3 Striking Vehicles

The forward moving vehicle striking the rear of another vehicle in a narrowly sensitive crash was defined as the striking vehicle from which crash risk reduction could be achieved through AEB (or FCW) technology. Striking vehicles were restricted to only light vehicles.

5.2.4 Pedestrian Striking Vehicles

The *light,* forward moving, striking vehicle of a pedestrian sensitive crash was considered a pedestrian (or bicycle) striking vehicle.

5.2.5 Broadly Sensitive Striking Vehicles

Light, forward moving, vehicles in a broadly sensitive crash were considered broadly sensitive crash striking vehicles.

5.2.6 Non-Striking Crashed Vehicles

Non-striking vehicles were light vehicles, forward moving, stationary, reversing, stopped or parked. They were directly in the path of the striking vehicle of a narrowly sensitive crash.

The analysis requires the inclusion of both vehicles where AEB fitment would reduce the risk of a crash (striking vehicles of sensitive crashes) and a comparison set of vehicles where

AEB fitment would not offer protection from a crash. The comparison set was made up of the struck vehicles in the (AEB or FCW sensitive) rear-end crashes. In order to best match the exposure of the striking light vehicles, the comparison set of struck vehicles excluded struck parked and broken-down motor vehicles, motorcycles, bicycles, heavy vehicles, self-propelled plant equipment and agricultural vehicles. The vehicle types in the set of struck vehicles from sensitive crashes consisted only of light vehicles.

5.3 Induced Exposure Relative Risk of Crash Injuries Regression Model

Following the methodology of previous induced exposure AEB crash risk studies (Rizzi, Kullgren et al. 2014, Fildes, Keall et al. 2015), a Poisson regression model was fitted to the light vehicle sensitive crash data to estimate crash risks in the sensitive vehicles relative to the control (non-sensitive) vehicles. Having established the need to stratify the analysis by speed zone and vehicle size, the form of the analysis model is given by Equation 1.

$$\ln(y_{cvs}) = \propto + \beta_{sf} + \gamma_{sc} + \delta_{sfc} \qquad \text{...(Equation 1)}$$

In Equation 1,

y is the crash injury count

c is the crash type index (sensitive / non-sensitive)

f is the AEB fitment status (fitted / not fitted)

s is the stratum indicator

α,β,γ,δ are parameters of the model.

The injury count was either all injuries, minor injuries or fatal and serious injuries. Given the low number of fatalities in the data, analyses were conducted on combined fatal and serious injuries. For PDO crash analyses, *y* was the crash count.

The crash index type simultaneously compared narrow, pedestrian, intersection and broadly sensitive crashes with the non-sensitive crash set.

The fitment status was modelled with three levels of fitment, *some, all* and no variants of a model fitted with a forward AEB (or FCW) system. The model indicated fitment for all forward AEB (or FCW) systems regardless of whether they were designed for high or for low-speed conditions.

The primary stratification used a binary speed zone (≤60 km/h and >60 km/h) disaggregated by three levels of vehicle type (car, SUV or light commercial vehicle [LCV]). Due to limited quantities of data, the analysis only permitted two levels of stratification. It was decided on the basis of the confounder analysis of Newstead, Budd et al. (2020) that the vehicle size was more likely to introduce bias into the estimate than were the other likely confounders of driver age, driver sex or intersection location, thus overall results have only been presented for analysis using vehicle size and speed zone strata.

AEB systems, particularly in the past, have been designed to function either at high or at low speeds, so stratifying by speed zone, not only captured differences in urbanisation, impact speed, driving styles, crash risk and injury severity between high and low speed zones, it also captured some of the differences in effectiveness specific to high and low speed AEB systems.

The cars included all passenger vehicle types that were not commercial utilities or vans and were not large or medium sports utility vehicles. The SUVs consisted of large and medium sports utility vehicles. The LCVs were commercial utilities and vans. LCVs were omitted from fatal and serious injury analyses (with the primary stratification design) because of limitations to injury counts. AEB fitment in commercial vehicles was rare and removing them from the fatal and serious analysis stabilized the regression.

By stratifying by vehicle size and by matching vehicle age (through year of manufacture exclusions) the evaluation is additionally roughly adjusted for vehicle crashworthiness.

Alternative strata that were explored replaced the vehicle size disaggregation with weather, road surface, intersection location, drivers' sex or drivers' age (so that effectiveness disaggregated by these variables could be explored).

The relative crash risks for each vehicle type were estimated from the δ parameters of the model. By replacing δ_{sfc} with δ_{fc}, the overall effect for AEB fitment may be estimated. In addition, this term was modified to estimate condensed levels of the stratum since the fully saturated model did not have the power to produce precise risk estimates.

Tests for over-dispersion found that no Pearson's scaling of the estimate confidence intervals were required for the AEB analysis.

5.4 Induced Exposure Relative Risk of Crash Regression Model

A similar modelling approach was used with the property damage only crash data of New South Wales, South Australia and Western Australia to estimate the risk of a property damage only crash. In this model, y is the crashed vehicle count.

5.5 Induced Exposure Severity Odds Ratio Regression Model

In addition to the relative risk, an analysis of the odds of a more severe outcome in a light vehicle injury crash was performed. The model is similarly structured (equation 2) however this model had sufficient power to allow for greater levels of stratification or additional covariates.

$$\ln(\pi_{cvs}/(1-\pi_{cvs})) = \propto + \beta_{sf} + \gamma_{sc} + \delta_{sfc} + \zeta + \eta + \theta \qquad \text{...(Equation 2)}$$

π is the probability that a crash for a crashed vehicle is more severe (fatal or hospital admission versus minor injury)

c is the crash type index (sensitive / non-sensitive)

f is the AEB fitment status (fitted / not fitted)

s is the stratum indicator

β,γ,δ are stratified parameters of the model

α,ζ, η ,θ are non-stratified parameters of the model

5.6 Crashes and Injuries Saved

The technology associated risks by crash type (and further disaggregation) were used with the average annual crash counts (2013-2017) by type and fitment status, to estimate the crashes and injuries that are currently being avoided in vehicles fitted with AEB or FCW, for narrow, broad and intersection sensitive crashes. Firstly, the proportion reduced (PR) was calculated from the associated relative risk (RR) using equation 3. Next, the average annual savings were calculated according to equation 4 which applies the proportion reduced to the property damage only crashes or crash injuries associated with the fitted vehicles, by sensitive crash types.

$$PR = 1 - RR \qquad \text{...(Equation 3)}$$

$$\text{Savings} = \frac{PR}{(1 - PR)} \times \text{average annual count from fitted vehicle crashes} \qquad \text{...(Equation 4)}$$

The risks associated with AEB and FCW estimated for fatal and serious injuries were applied to both counts of fatal injuries and counts of serious injuries.

Savings were also estimated by the stratifying variables: vehicle type and crash speed zone, although the risk estimates used in equation 4 were only derived from the overall analysis or the analysis by speed zone.

The 95% confidence interval of the relative risk estimates were used to estimate the upper and lower bounds of the savings. In most instances the confidence intervals were too wide, and the estimate too imprecise to use the '*all' risk* estimates; in these cases, the '*some'* estimate was substituted. Additionally, when the 95% confidence intervals for the overall risk estimates were extremely wide and contained the value one, the risk estimates were considered too imprecise to use, so a 0% reduction was imputed. This was the case for most pedestrian sensitive crashes and most risks associated with FCW.

5.7 Potential Savings

The potential savings offered by AEB fitment were estimated using a scenario of 100% fitment in the striking vehicles of sensitive crashes. The first step in calculating the potential savings was to sum the average annual savings and the average annual counts of the non-saved (all property damage only crashes or crash injuries), regardless of AEB fitment status. This was carried out for each sensitive crash type. Next, the appropriate risk reduction factor was applied to each sum total. Risk reductions by speed zone strata were applied, and the application used the same exclusions for imprecision as were used in the savings calculations. Where statistically significant '*all'* estimates were available, these were used to calculate the potential savings. Where speed disaggregation led to imprecise but otherwise almost identical estimates, the overall speed risk estimate was used. This was the case for calculating fatal and serious potential injury savings from broadly sensitive injury crashes.

The human loss costs of saved Australian fatal and serious injuries were calculated using the Australian dollar 2020 costs described in section 4.5.

6 RESULTS

In this section bracketed values accompanying point estimates are the 95% confidence intervals for the estimate, derived from the regression analysis coefficients.

6.1 Overall Injuries and Crashes Saved

The following section details the crashes and injuries saved through the current, and future (100%) fitment of AEB and FCW.

6.1.1 Australian Savings

Estimated savings, without confidence intervals, are presented by speed zone for current AEB fitment (Table 10) and 100% AEB fitment (Table 11). Table 11 includes the percentage reductions applied by speed zone, sensitivity and severity, as well as the overall percentage that savings make of all crashes or injuries.

6.1.1.1 Fatal and serious injuries

At 2017 levels of fitment in the light vehicle fleet as a whole, AEB was estimated to mitigate 0.08% of all fatal and 0.14% of all serious injuries from Australian light vehicle injury crashes, which amounted to average annual savings of 1 to 3 fatalities and 43 (2, 91) serious injuries valued at $15.6 million ($4 million, $36 million) in terms of human losses (Table 10). If all vehicles were fitted with AEB, the potential average annual savings are estimated at 126 (21, 212) fatalities and 3,731 (399, 6,359) serious injuries which have a human loss value of $1,482 million ($183 million to $2,517 million) and translate to 8% (1%, 13%) and 12% (1%, 21%) of all fatalities and serious injuries respectively from light vehicle injury crashes (Table 11). Half of the serious injury savings arise from low speed intersection and narrowly sensitive crashes, and overall, two thirds of the 100% fitment scenario savings arise from low speed crashes. Most of the 100% fitment scenario fatality savings arise from high speed broadly sensitive crashes (60%).

6.1.1.2 Minor injuries

At 2017 levels of fitment in the fleet, AEB was estimated to mitigate 0.10% of all minor injuries from Australian light vehicle injury crashes, which amounted to average annual savings of 93 (9, 189) minor injuries valued at $0.26 million ($0.03 million, $0.53 million) in terms of human losses (Table 10). If all vehicles were fitted with AEB, the potential average annual savings are estimated at 11,017 (1,167, 18,372) minor injuries which have a human loss value of $31 million ($3 million to $52 million) and translate to 12% (1%, 20%) of all minor injuries from light vehicle injury crashes (Table 11). Eighty-two percent of the potential minor injury savings arise from narrowly sensitive crashes and 59% of these were from high speed zones. Overall, slightly less than half (47%) of the 100% fitment scenario minor injury savings arise from low-speed crashes.

Table 10 Average annual savings in Australia with current level of AEB fitment

	All Records	%savings of ALL	Savings: Narrowly Sensitive	Broadly Sensitive	Pedestrian Sensitive	Intersection sensitive
PDO Crashes						
Low speed	61,872	0.15%	60	27	0	5
High Speed	27,169	0.08%	16	4	0	1
All	89,041	0.13%	76	31	0	7
Fatal Injuries from Injury Crashes						
Low speed	502	0.03%	0	0	0	0
High Speed	1,161	0.10%	0	1	0	0
All	1,664	0.08%	0	1	0	0
Serious Injuries from Injury Crashes						
Low speed	19,928	0.14%	9	8	0	12
High Speed	10,543	0.13%	3	8	0	3
All	30,471	0.14%	12	16	0	15
Minor Injuries from Injury Crashes						
Low speed	62,012	0.10%	42	10	2	5
High Speed	30,043	0.11%	26	2	0	6
All	92,055	0.10%	68	12	2	11

PDO savings for 3 jurisdictions only; injury savings for 5 jurisdictions

6.1.1.3 Property damage only crashes

At 2017 levels of fitment in the fleet, AEB risk reduction estimates translated to avoidance of 0.13% (0.04%, 0.24%) of all light vehicle PDO crashes, which amounted to average annual savings from three jurisdictions of 76 narrowly sensitive, 31 broadly sensitive and 7 intersection sensitive crashes (Table 10). If all vehicles were fitted with AEB, potential average annual savings are estimated at 18,727 (5,710, 27,278) PDO crashes which amount to 21% (6%, 31%) of all light vehicle PDO crashes (Table 11). Overall, 88% of property damage only crash savings from the 100% fitment scenario arise from low-speed zones, and three quarters of the savings are from just intersection and narrowly sensitive low-speed crashes.

Current fitment of FCW in models without AEB was estimated to save 1 fatality, 21 serious injuries and two minor injuries per year in Australia.

Table 11 Average annual savings in Australia with 100% AEB fitment

	AEB % reductions					AEB Savings with 100% fitment of striking vehicles				
	%of all crashes or injuries	Narrowly Sensitive	Broadly Sensitive	Pedestrian Sensitive	Intersection sensitive	All Sensitive	Narrowly Sensitive	Broadly Sensitive	Pedestrian Sensitive	Intersection sensitive
PDO Crashes										
Low speed	**27%**	57%	21%	0%	44%	16,479	10,591	2,479	0	3,409
High Speed	**8%**	15%	8%	0%	25%	2,248	1,725	416	0	107
All	21%					18,727	12,316	2,894	0	3,516
Fatal Injuries from Injury Crashes										
Low speed	**6%**	37%	17%	0%	21%	31	6	15	0	9
High Speed	**8%**	15%	17%	0%	32%	96	4	76	0	16
All	8%					126	10	91	0	26
Serious Injuries from Injury Crashes										
Low speed	**12%**	37%	17%	0%	21%	2,456	984	588	0	884
High Speed	**12%**	15%	17%	0%	32%	1,275	328	755	0	193
All	12%					3,731	1,312	1,342	0	1,077
Minor Injuries from Injury Crashes										
Low speed	**8%**	19%	8%	8%	3%	5,191	3,758	834	191	408
High Speed	**19%**	48%	3%	0%	30%	5,826	5,306	190	0	329
All	12%					11,017	9,064	1,025	191	737

PDO savings for 3 jurisdictions only; injury savings for 5 jurisdictions

6.1.2 New Zealand savings

Estimated savings, without confidence intervals, are presented by speed zone for current AEB fitment (Table 12) and 100% AEB fitment (Table 13) below. Table 13 includes the percentage reductions applied by speed zone, sensitivity and severity and the overall percentage that savings make of all crashes or injuries.

6.1.2.1 Fatal and serious injuries

At 2017 levels of fitment in the fleet, AEB was estimated to mitigate 0.18% of all fatal and 0.09% of all serious injuries from New Zealand light vehicle injury crashes, which amounted to average annual savings of 0 to 1 fatalities and 2 (0, 4) serious injuries (Table 12). If all vehicles were fitted with AEB, the potential average annual savings are estimated at 21 (4, 36) fatalities and 162 (25, 274) serious injuries which translate to 8% (2%, 14%) and 8% (1%, 14%) of all fatalities and serious injuries respectively from light vehicle injury crashes (Table 13). Most (64%) of the 100% fitment scenario serious injury savings arise from broadly sensitive crashes and about half of the serious injury savings arise from low speed zones. Most (76%) of the fatality savings arise from high speed broadly sensitive crashes.

6.1.2.2 Minor injuries

At 2017 levels of fitment in the fleet, AEB was estimated to mitigate 0.06% of all minor injuries from New Zealand light vehicle injury crashes, which amounted to average annual savings of 4 (0, 13) minor injuries (Table 12). If all sensitive crash striking vehicles were fitted with AEB, the potential average annual savings are estimated at 698 (-51, 1,282) minor injuries which translate to 7% (-1%, 13%) of all minor injuries respectively from light vehicle injury crashes (Table 13). Two thirds of the potential minor injury savings arise from narrowly sensitive crashes and 63% of these were from high speed zones. Overall, half of the 100% fitment scenario minor injury savings arise from low-speed crashes.

Current fitment of FCW in models without AEB was estimated to save 1 serious injury per year.

6.1.3 Additional tables of savings for Australia and New Zealand

For further details on crashes and injuries saved, tables of savings, including 95% confidence intervals, expected from current fitment and from 100% fitment, disaggregated by speed zone, vehicle type, sensitivity type and severity are presented for Australia in the appendix tables: Table 32 to Table 35 and Table 40 to Table 42, respectively. Similar tables are presented for New Zealand in the appendix tables: Table 36 to Table 39 and Table 43 to Table 45 respectively.

Table 12 Average annual savings in New Zealand with current AEB fitment

	All Records	%savings of ALL	Savings: Narrowly Sensitive	Savings: Broadly Sensitive	Savings: Pedestrian Sensitive	Savings: Intersection sensitive
Fatal Injuries from Injury Crashes						
Low speed	59	0.000%	0.0	0.0	0.0	0.0
High Speed	206	0.24%	0.0	0.2	0.0	0.3
All	265	0.18%	0.0	0.2	0.0	0.3
Serious Injuries from Injury Crashes						
Low speed	926	0.05%	0.0	0.5	0.0	0.0
High Speed	1,057	0.13%	0.1	1.1	0.0	0.2
All	1,983	0.09%	0.1	1.6	0.0	0.2
Minor Injuries from Injury Crashes						
Low speed	5,289	0.06%	1.1	1.5	0.3	0.2
High Speed	4,205	0.05%	1.3	0.6	0.0	0.3
All	9,494	0.06%	2.4	2.1	0.3	0.4

Table 13 Average annual savings in New Zealand with 100% AEB fitment

	AEB % reductions					AEB Savings with 100% fitment of striking vehicles				
	%of all crashes or injuries									Intersection sensitive
Fatal Injuries from Injury Crashes										
Low speed	5%	37%	17%	0%	21%	3	1	1	0	1
High Speed	9%	15%	17%	0%	32%	18	0	16	0	2
All	8%					21	1	18	0	3
Serious Injuries from Injury Crashes										
Low speed	9%	37%	17%	0%	21%	80	20	43	0	16
High Speed	8%	15%	17%	0%	32%	82	8	61	0	13
All	8%					162	29	104	0	29
Minor Injuries from Injury Crashes										
Low speed	7%	19%	8%	8%	3%	347	172	116	39	20
High Speed	8%	48%	3%	0%	30%	350	291	25	0	34
All	7%					698	463	140	39	55

6.2 Estimates of crash and injury reductions from AEB and FCW (Overall Relative Risk Estimates)

Table 14 and Table 15 present the estimated crash and injury risks associated with AEB and FCW respectively. Given the low number of fatalities, fatal and serious injuries were combined for the analysis. Proportionally few LCVs are fitted with AEB or FCW, so LCVs were excluded from the fatal and serious injury analysis. Some general observations about the overall results are bulleted below, and reductions are reported underneath the risk tables.

Generally, results are limited to the analysis of models with fitment only in some model variants.

There was no evidence of statistically significant reductions in the relative risk of an injury found to be associated with models with all variants fitted with AEB. This was due to the lack of vehicles currently available for analysis (as shown in Figures 1 and 2). However, there was sufficient power in the analysis to yield one strongly significant estimate of property damage only crash avoidance associated with models with all variants fitted with AEB, and to yield significant crash and injury risk reductions associated with 'some' variants AEB vehicle model fitment. For this reason, unless stated otherwise, results are only presented for associations with models with some variant fitment when the crash and injury risk estimates are disaggregated by speed, vehicle size, weather and intersection/mid-block location.

There was no evidence of statistically significant reductions in the relative risk of PDO crashes, nor of minor injuries, found to be associated with models with all variants fitted with FCW. The one exception was a 62% (p=0.04) reduction associated with FCW in fatal and serious injuries from broadly sensitive crashes. Overall significant risk reductions associated with some FCW fitment were only evident for fatal and serious narrowly sensitive crashes.

There was no evidence to suggest that the overall crash or injury risk associated with AEB differs between vehicles with some or all variants fitted with AEB.

Risk estimates for narrow and broad sensitivity crashes were similar across fitment groups. When noticeably different, the tight 95% risk ratio confidence intervals for the 'some' model variant group still fell within the wide 95% confidence interval of 'all' model variant group. Similar findings were noted for the risks associated with FCW and the risks associated with AEB for pedestrian and intersection sensitive crashes, however, when the data thinned, (e.g. minor pedestrian injuries and low speed intersection property damage only crashes), the confidence intervals for crash risk estimates widened so that trends and inferences were more difficult to make.

Overall and by high and low speed zones, no significant crash or crash injury reductions were associated with AEB, nor FCW for pedestrian sensitive crashes.

These results suggest that the technology preventing these sensitive crashes has not yet penetrated the Australian and New Zealand markets in sufficient numbers to produce measurable change.

Greater reductions were generally found for narrowly sensitive crashes than for broadly sensitive crashes, across injury severity and speed zones.

Intersection *injury* reduction associated with AEB fell somewhere between the narrowly sensitive crash estimate and the broadly sensitive crash estimate.

Greater reductions were generally found for higher severity injuries.

The injury risk reductions associated with models with *some* AEB fitment or *some* FCW fitment were generally greater (although not at statistical significance), for serious and fatal injuries than for minor injuries, overall and across low speed zones. However, AEB was found most effective at avoidance of PDO crashes. This was evidenced with the only statistically significant relative risk found overall associated with models with *all* variant fitment; narrowly sensitive property damage only crashes were associated with avoidance rates of 46% (95%CI: 18%, 65%).

Generally, the relative risks associated with FCW and AEB were similar, albeit FCW risks were poorly evidenced.

Only two of the overall FCW relative risk estimates had sufficient evidence to reach statistical evidence and these both referred to fatal and serious injury reduction. A 40% (95% CI: 14%, 59%) reduction in fatal and serious injuries from narrowly sensitive crashes was estimated for FCW fitment. This estimate fell within the 95% confidence interval of the AEB estimates for both some and all fitment. Fatal and serious injuries from broadly sensitive crashes associated with *all* variant fitment reduced by 62% (95% CI: 4%, 85%); the reduction was 18% (95% CI: -4%, 35%) for *some* variant fitment. The reductions associated with *some* variant fitment were very similar for AEB and FCW, however the estimate associated with models with *all* variant fitment of FCW did not fall within the 95% confidence interval of the AEB estimate associated with *some* variant fitment. This estimate for the relative risk associated with '*all'* variant fitment of FCW is based on very few cases, so it is likely that the magnitude and strength of this estimate was a result of statistical variation. The evaluation of FCW in models without any associated AEB fitment (all or some) was based on fitment levels at only a fraction of that for AEB, so few inferences may be drawn from the results. No evidence of reductions in minor injuries, property damage only crashes, pedestrian sensitive crashes and intersection crashes were found associated with FCW.

This study had more robust estimates of overall relative risk than those produced by the previous study by Newstead, Budd et al. (2020).

This study was performed from crash data sources with 234,961 more light vehicles than previously used. As a result, the estimates of this study were less sensitive to statistical variation and have improved precision which is evidenced by the narrower 95% confidence intervals of the relative risk estimates. A comparison of the narrowly sensitive crash estimates is presented in appendix A.4, Table 24. The comparison is not made for crashes of broad and intersection sensitivities due to differences in definitions. Pedestrian sensitive crash results for this study and the previous study are not sufficiently robust to draw meaningful comparison.

Relative risk estimates from narrowly sensitive crashes of this and the previous study of Newstead, Budd et al. (2020) are similar.

The perceived differences in fatal and serious injury risks are not statistically different and may be explained by statistical variation given the scarcity of fatal and serious narrowly sensitive crashes with AEB fitment (Table 24). The remaining more robust estimates of all injury, minor injury and property damage only crash reductions associated with AEB fitment in models with *some* variant fitment are remarkably similar for the two studies.

Table 14 PDO crash risk and injury risk associated with AEB by severity, sensitivity and fitment status

Fitment	All Injuries	Fatal and Serious Injuries	Minor Injuries	PDO crashes
	Narrowly sensitive			
All	0.79 (0.59, 1.07) p = 0.13	0.67 (0.27, 1.67) p = 0.39	0.81 (0.59, 1.10) p = 0.18	0.54 (0.35, 0.82) p = 0.004
Some	0.80 (0.74, 0.87) p = <.0001	0.73 (0.58, 0.92) p = 0.007	0.81 (0.75, 0.88) p = <.0001	0.79 (0.71, 0.87) p = <.0001
	Broadly sensitive			
All	0.92 (0.72, 1.18) p = 0.52	1.13 (0.66, 1.95) p = 0.66	0.88 (0.66, 1.16) p = 0.36	0.88 (0.63, 1.24) p = 0.47
Some	0.91 (0.85, 0.97) p = 0.004	0.83 (0.72, 0.96) p = 0.01	0.94 (0.88, 1.02) p = 0.12	0.84 (0.76, 0.92) p = 0.0002
	Pedestrian sensitive			
All	1.51 (0.96, 2.37) p = 0.07	1.51 (0.68, 3.34) p = 0.31	1.46 (0.82, 2.63) p = 0.2	3.14 (0.42, 23.4) p = 0.27
Some	1.00 (0.87, 1.15) p = 1.00	1.08 (0.86, 1.35) p = 0.52	0.92 (0.77, 1.11) p = 0.39	0.85 (0.42, 1.72) p = 0.65
	Straight Crossing Paths and Low Speed Right Turn across Other Direction			
All	1.11 (0.83, 1.47) p = 0.48	1.15 (0.61, 2.19) p = 0.66	1.09 (0.79, 1.50) p = 0.62	0.60 (0.36, 1.01) p = 0.05
Some	0.89 (0.83, 0.96) p = 0.002	0.77 (0.65, 0.91) p = 0.003	0.93 (0.86, 1.01) p = 0.10	0.97 (0.87, 1.09) p = 0.66

AEB fitment (all model variants) was associated with avoidance of 46% (p=0.004) of narrowly sensitive PDO crashes and 40% of intersection PDO crashes.

AEB in models with *some* variant fitment was strongly associated with mitigation or avoidance of:

- fatal and serious injuries, of which
  - 27% were from narrowly sensitive crashes,
  - 17% were from broadly sensitive crashes and
  - 23% were from intersection sensitive crashes,
- minor injuries, of which 29% were from narrowly sensitive crashes.

AEB in models with *some* variant fitment was weakly associated with mitigation or avoidance of:

- minor injuries, of which
  - 6% were from broadly sensitive crashes, and
  - 7% were from intersection sensitive crashes.

AEB in models with *some* variant fitment was strongly associated with avoidance of:

- property damage crashes estimated to be
  - 21% of all narrowly sensitive and
  - 16% of broadly sensitive crashes.

Table 15 PDO crash risk and injury risk associated with FCW by severity, sensitivity and fitment status

N	All Injuries	Fatal and Serious Injuries	Minor Injuries	PDO crashes
	Narrowly sensitive			
All	0.72 (0.44, 1.18) p = 0.20	0.80 (0.25, 2.50) p = 0.7	0.72 (0.42, 1.23) p = 0.23	1.19 (0.51, 2.76) p = 0.68
Some	1.02 (0.91, 1.15) p = 0.72	0.60 (0.41, 0.86) p = 0.006	1.10 (0.97, 1.24) p = 0.15	1.04 (0.91, 1.19) p = 0.58
	Broadly sensitive			
All	0.95 (0.64, 1.39) p = 0.78	0.38 (0.15, 0.96) p = 0.04	1.16 (0.76, 1.77) p = 0.5	1.18 (0.53, 2.62) p = 0.69
Some		0.82 (0.65, 1.04) p = 0.10	1.00 (0.89, 1.13) p = 1.00	1.14 (1.00, 1.3) p = 0.05
	Pedestrian sensitive			
All	1.33 (0.69, 2.56) p = 0.39	0.76 (0.20, 2.90) p = 0.69	1.68 (0.78, 3.58) p = 0.18	Not available
Some	1.16 (0.94, 1.43) p = 0.18	0.79 (0.53, 1.16) p = 0.22	1.40 (1.08, 1.82) p = 0.01	1.38 (0.54, 3.53) p = 0.5
	Straight Crossing Paths and Low Speed Right Turn across Other Direction			
All	0.83 (0.54, 1.27) p = 0.39	0.55 (0.20, 1.47) p = 0.23	0.92 (0.57, 1.48) p = 0.72	1.87 (0.78, 4.51) p = 0.16
Some	1.04 (0.92, 1.17) p = 0.51	0.78 (0.60, 1.02) p = 0.07	1.12 (0.98, 1.28) p = 0.09	1.08 (0.91, 1.28) p = 0.39

There was evidence that FCW was associated with reductions in fatal and serious injuries. For narrowly sensitive crashes the reduction was a strongly evidenced (p=.0006) and showed a 40% reduction for models with *some* variant fitment.

For broadly sensitive crashes the reduction was

- 62% for models with *all* variant fitment and strongly evidenced, and
- 18% for models with *some* variant fitment and weakly evidenced.

For intersection sensitive crashes the reduction was

- 22% for models with *some* variant fitment and weakly evidenced.

6.3 Analysis by Stratifying Factors

The primary regression model used in this analysis was stratified by broad vehicle type and speed zone. As the analysis could only support two stratifying variables, these factors were chosen to reduce bias after a careful review of the literature of section 1 and the confounder analysis of Newstead, Budd et al. (2020). This means that the vehicles in the exposure, sensitive, fitted and non-fitted groups were matched by high (>60 km/h) and low (≤60 km/h) speed zones and by the broad vehicle groups based on size: LCV, medium and large SUV and the remaining light vehicles (cars).

There was no difference in crash or injury risks associated with AEB across speed zones. This may be observed through the strongly overlapping confidence intervals of the all, low- and high- speed zone risk estimates of Figure 3 for crashes of narrow, broad and pedestrian sensitivity. However, there is a clear trend for lower risks associated with AEB in high speed zones for SCP crashes; a trend which almost reaches significance at the 95% confidence level for minor injury crashes.

The results indicate that general AEB systems were effective at reducing low severity crash and injury risks for intersection sensitive crashes in high speed zones and for reducing fatal and serious injuries from intersections sensitive crashes from any speed zone. There were large, and generally well evidenced, magnitudes of the high-speed zone intersection sensitive risk reduction estimates found across all severities for: 32% fatal and serious injury, 30% minor injury and 25% property damage only SCP crashes. A lack of AEB effectiveness within the dominant low-speed proportion heavily influenced the overall effect so that overall intersection sensitive crashes showed no significant risk reductions of low severity. For both minor injuries and for property damage only crashes, associated reductions in risks were not observed with statistical significance for intersection sensitive crashes within low speed zones.

Figure 3 and Figure 4 additionally presents the crash and injury risks associated with AEB fitment in models with *all* variant fitment. This is presented for property damage only crashes and for minor injuries of narrowly and broadly sensitive crashes; other sensitive crash risk estimates were excluded from these charts because of poor precision. The *all* variant fitment risk estimates are presented in a translucent grey colour with a round marker. The information held in both the '*all*' and in the '*some'* risk estimates for narrowly sensitive property damage only crashes supported evidence of a trend of lesser crash risk associated with lower speed zones which is intuitive considering the greater fitment of low speed AEB systems. This trend also appears in the fatal and serious injury risk reduction estimates associated with the fitment of AEB in models with *all* variant fitment, although these estimates are poorly evidenced (appendix A.5, Table 26). The trend of greater effect in low speed zones was supported by Rizzi, Kullgren et al. (2014) and by Cicchino (2017).

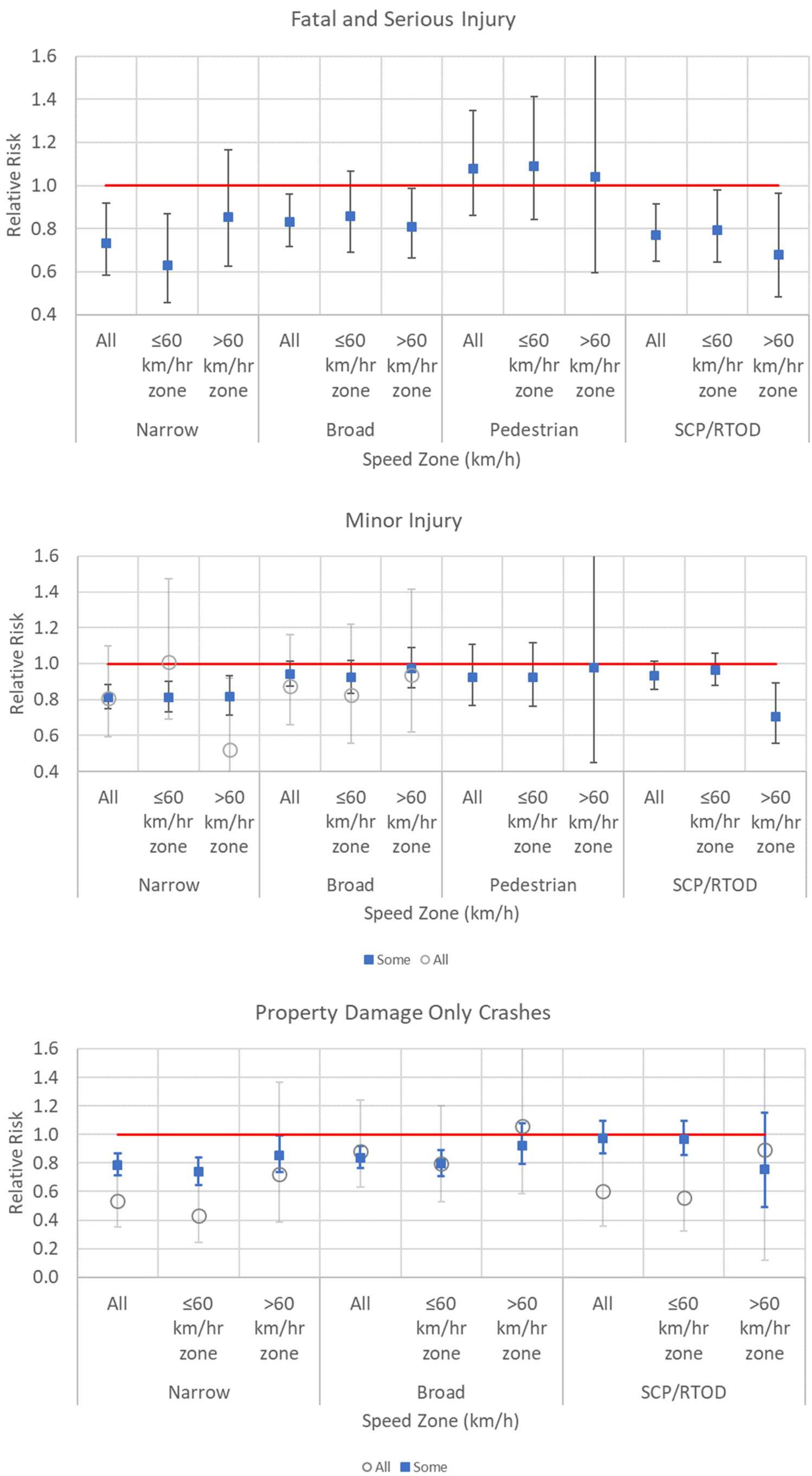

Figure 3 Estimated AEB effectiveness across injury severity and speed zones

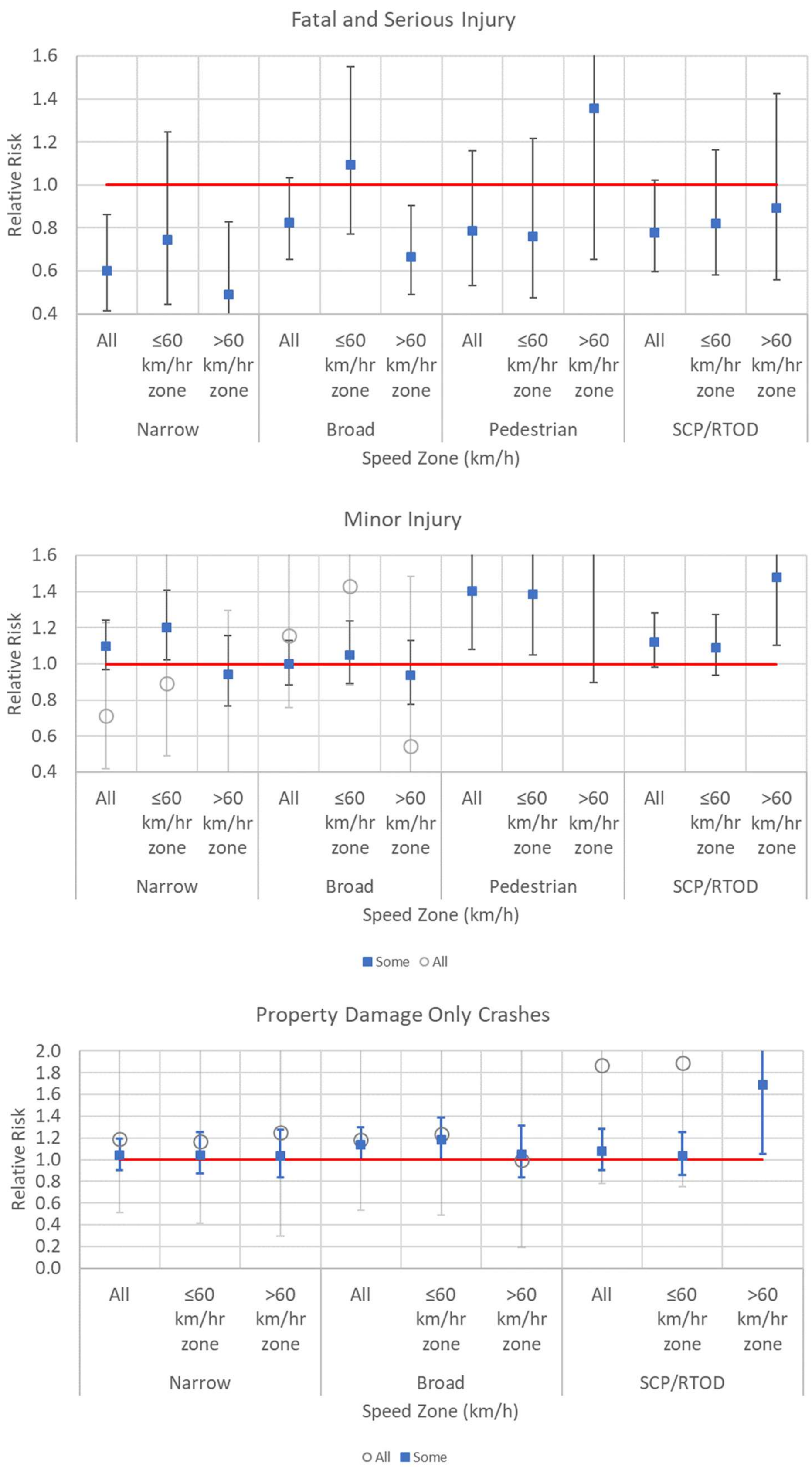

Figure 4 Estimated FCW effectiveness across injury severity and speed zones

This trend of a greater AEB effect in low-speed zones for narrowly sensitive crashes did not extend to minor injury mitigation. A large strongly significant injury risk reduction associated with *all* variant fitment was observed in high speed zones; it was not matched in lower speed zones. This reversed trend was also observed by Newstead, Budd et al. (2020) (Table 4) when examining the *all injury* reduction associated with models with possibly *some* variant fitment. It was not observed for the same statistic in this study (Table 25) which found only a 3% absolute difference in *all injury* reductions between high and low speed zones. For both studies, no risk differences by speed zone reached statistical significance for the minor or all injury reductions of narrowly sensitive crashes.

Both overall estimates and estimates by speed were consistent with those of the previous AEB evaluation of Newstead, Budd et al. (2020). Point estimates generally indicated slightly higher risks in low speed zones and slightly lower risks in high speed zones for narrowly sensitive crashes for this analysis, however these differences were not significant. Furthermore, the low speed, narrowly sensitive crash and injury risk estimates were more strongly evidenced in this analysis, for example the fatal and serious injury risk of this analysis was better evidenced with a p-value of 0.005 compared with the previous analysis p-value of 0.09.

The relationship of the risk associated with FCW in models with *some* variant fitment and speed zone is presented in Figure 4. The lack of precision in the FCW estimates is explained by the fact that there were proportionally very few models of vehicles fitted with FCW alone.

In Table 14 and Table 15, FCW fitment was found to be associated with large and significant reductions in fatal and serious injury. The FCW association for fatal narrowly sensitive crashes appeared to exceed that associated with AEB, although the difference between the two was not significant (Figure 5). When disaggregated by speed zone, it became clear that the difference in relative risk of fatal and serious injuries from narrowly sensitive crashes by technology type appeared to be fuelled by greater effectiveness of FCW on injury crashes in high speed zones. Because FCW relies on a human response, it may be that currently the human response at high speeds has a greater benefit than the autonomous response from the predominately low speed AEB systems.

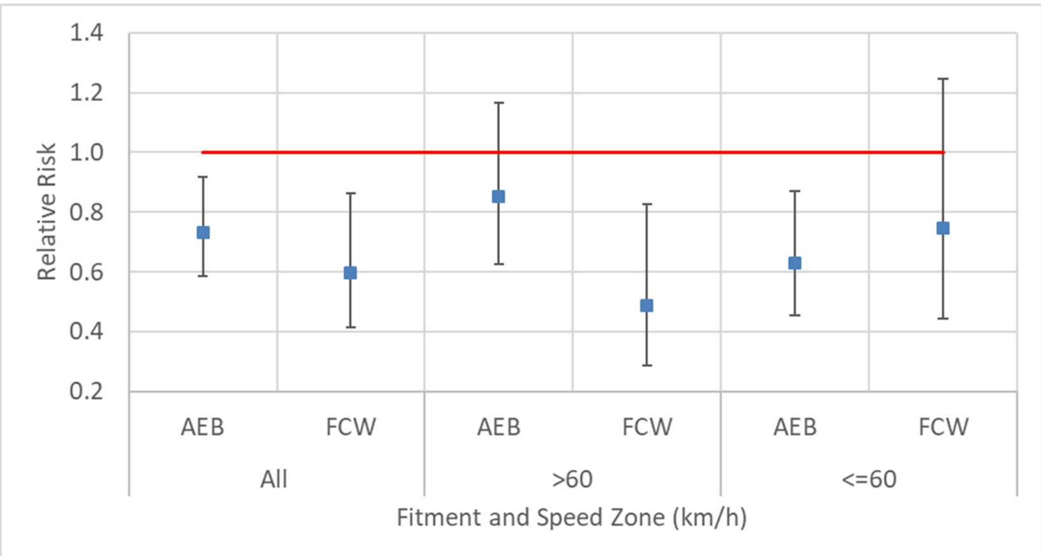

Figure 5 Estimated FCW and AEB effectiveness at reducing fatal and serious injuries of narrowly sensitive crashes, across speed zones

Sensitive crashes involving cars and SUVs did not display significantly different crash or injury risks associated with AEB in models with some variant fitment. This may be observed through the strongly overlapping confidence intervals of the all, car and SUV risk estimates of Figure 6 for crashes of narrow, broad, intersection and pedestrian sensitivity. The same lack of evidence for vehicle size trends was observed for FCW.

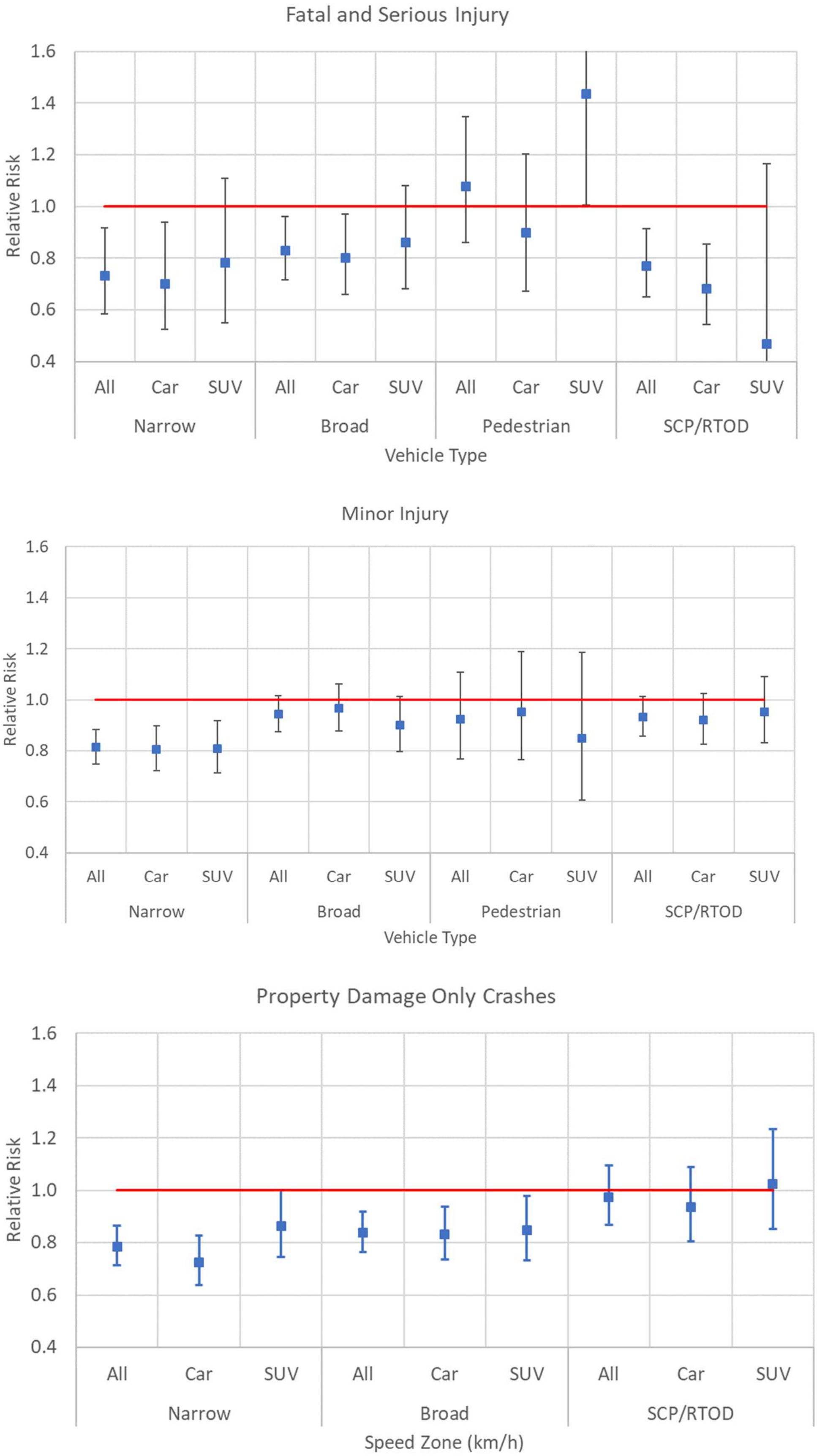

Figure 6 Estimated AEB effectiveness across injury severity and vehicle types

6.4 Analysis of Models with Alternative Stratification

The analysis regression models were carried out with alternative stratification. In these models the vehicle type strata were replaced with strata indicating an intersection location, wet or snowy weather, driver sex and driver age.

6.4.1 Intersection Location

Narrowly, broadly and pedestrian sensitive crashes at intersections and not at intersections did not display significantly different crash or injury risks associated with AEB or FCW. This was evidenced by similar point estimates and strongly overlapping confidence intervals for all sensitivities and severities. However, there was one case with only a small confidence interval overlap for the relative risks by location; this was for the association of AEB with the risk of fatal and serious injuries of broadly sensitive crashes. AEB in models with *some* variant fitment, involved in broadly sensitive injury crashes at mid-block or non-intersection locations were associated with mitigation of 29% (15% to 41%) of fatal and serious injuries, whereas at intersection locations there was no mitigation (-39% to 19%) for this group. This difference is likely due to the fact that most broadly sensitive fatal and serious injury crashes occurring at intersections were grouped within the intersection sensitive group and not within the broadly sensitive group, and those that remained were less sensitive to AEB.

6.4.2 Weather

There was some evidence to suggest that AEB performed better in wet weather. For intersection and pedestrian sensitive crashes, there were large strongly evidenced wet weather risk reductions for minor injuries and property damage only crashes associated with AEB fitment in models with *some* variant fitment. These were greater than their dry weather counterparts. For example, in wet weather, AEB fitment was estimated to reduce property damage only intersection sensitive crashes and minor injuries from intersection sensitive crashes by more than a third. In contrast, respective dry weather reductions were estimated at 0% to 8% and statistical evidence of these weather-related differences was strong, but not as strong for pedestrian sensitive crashes. The evidence of the trend for lower relative risk in wet conditions may be seen in Figure 7 which presents the risks associated with AEB in models with *some* variant fitment.

No evidence of differential performance of FCW in wet and dry weather was found.

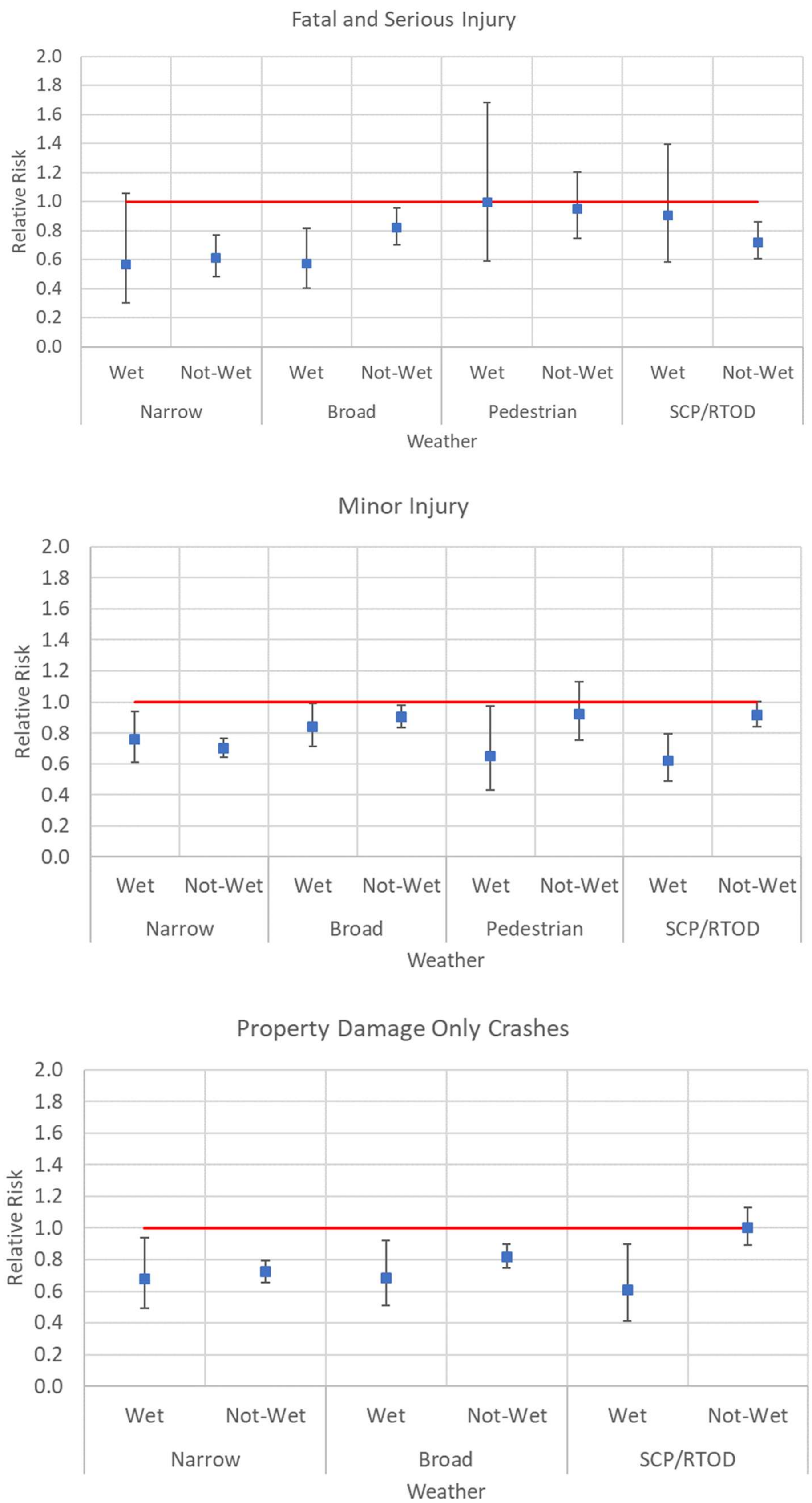

Figure 7 Estimated AEB effectiveness across injury severity and weather

6.4.3 Driver Sex

There was little evidence of a gender effect for AEB or for FCW. However, across severities the risks associated with AEB for females were consistently lower in pedestrian sensitive crashes and the risks associated with AEB for males were lower for intersection sensitive crashes. These differences were not significant.

6.4.4 Driver Age

Some risk trends with increasing age were observed, these are presented in Figure 8 which shows the crash or injury risk associated with models with *some* variant fitment of AEB.

For narrowly sensitive, property damage only crashes, there is a clear trend of increasing AEB associated crash risk with increasing age. However, overall crash sensitivities, there generally appears to be decreasing AEB associated crash injury risk with increasing age.

This suggests that the effectiveness of AEB may be related to the differences in younger and older drivers. For the injury mitigation trend, the AEB effect could be an interaction effect with age-related frailty or it could be from confounding related bias. It is possible that an average reduction in impact speed produced by AEB translates to increased injury mitigation when interacted with the increased frailty that comes with age. For this to occur within an analysis stratified by driver age, the crash injury risk associated with driver age would have to be lower for vehicles not fitted with AEB. The analysis did not consider the age of the injured, just of the driver, so if drivers in both the sensitive and non-sensitive vehicles were injured, age-related confounding would support the observed trend if either the underlying injury or injury crash risk in the non-sensitive group increased with driver age or the underlying injury or injury crash risk in the sensitive group decreased with age. A future analysis of only driver (rather than crash) injuries or a future analysis stratified by the injured person's age may help to clarify this finding.

For pedestrian crashes, the injury is not usually the driver, so in this instance driver frailty is not contributing to the injury risk. This age-injury risk trend for pedestrian sensitive crashes is only seen for the severe injury reduction, but it may be evidence of driver age introducing confounding bias. Regardless, it is weakly evidenced by imprecise estimates which have 95% confidence intervals including 1. Furthermore, the primary regression models provided no certainty that AEB was even associated with the reduction of any pedestrian crash injuries.

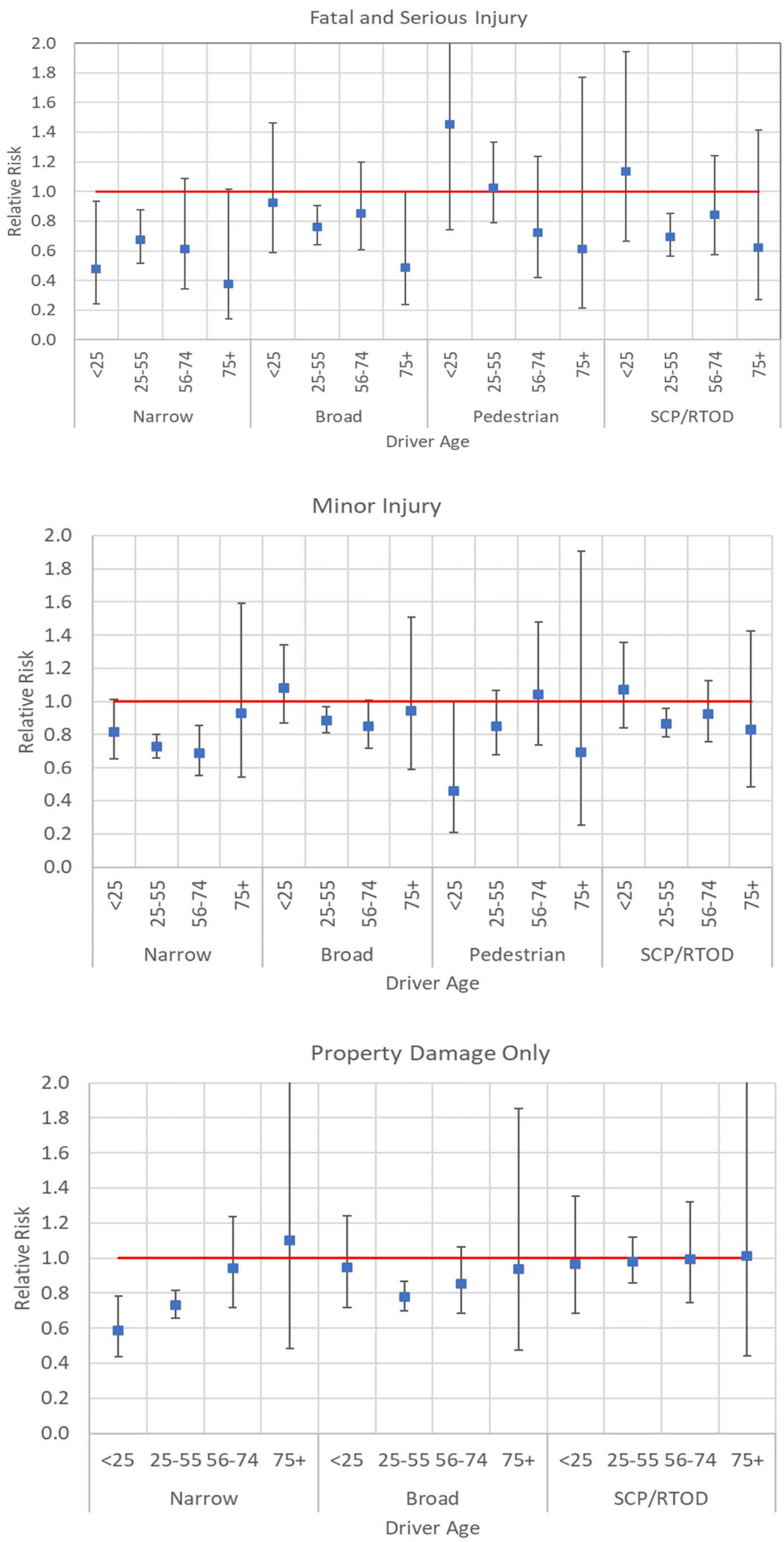

Figure 8 Estimated AEB effectiveness across injury severity and driver age

Injuries are not included in the age-crash risk trend for PDO crashes. However, this trend may be confounded by age related driving skills or even the vehicle types driven. The analysis was stratified by age, so the exposure group should adjust for age related factors, unless there is imbalance between the sensitive and non-sensitive groups and the age-related factors enhance or diminish the effect of AEB.

Vehicle type may be such a factor influencing the age-crash risk in PDO crashes. Younger drivers tend to drive less safe vehicles. These vehicles are likely to be more represented in the group without AEB fitment which would enhance the AEB effect. Bias toward the observed trend may be introduced if the less safe vehicles are more highly represented in the exposure group. However, the PDO trend, although likely to be influenced by vehicle type, is more likely to be influenced by age-related driver behaviour because the analysis was limited to vehicles with at least a 2013 year of manufacture. Factors which increase crash risk, could also increase the potential for AEB to be effective and therefore cause the age trend if less represented in the non-sensitive drivers. Drivers in the non-sensitive vehicles are unlikely to cause a rear-end crash, it is usually the non-attentive or speed related behaviour of the striking vehicle driver, so it is plausible that the sensitive (striking) drivers are more prone than non-sensitive drivers to riskier age-related behaviours. This explanation implies that the greater effectiveness of AEB in crash avoidance observed for younger drivers may be a result of bias.

The high level of stratification made the recognition of trends difficult in the equivalent FCW analysis.

6.5 Severity Analysis

There was no statistically significant evidence found to associated AEB with the odds of a more severe crash in sensitive crashes relative to non-sensitive crashes. For example, a narrowly sensitive crash was found to have a 38% (-93% to 80%) lower odds of being severe if all model variants were fitted with AEB, and for models with only some variant fitment, the odds were 7% (-21% to 29%) lower.

7 DISCUSSION AND CONCLUSIONS

The purpose of this study was to evaluate the effectiveness of AEB and FCW in Australia and New Zealand using real-world crash data. The analyses presented in this report estimated crash and injury reductions associated with AEB and FCW fitment in light vehicle crashes, that were classified as likely to be sensitive to avoidance or reduction through the technology. Estimates of the percentage and absolute average annual savings in terms of road trauma and property damage only crashes avoided were presented based on current fitment and on 100% fitment. The 100% fitment scenario provides evidence of the future road safety benefits which could be derived through a mandated fitment of AEB systems to all new light vehicles sold in Australia and New Zealand, and if allowed sufficient time to completely penetrate the light vehicle fleet. The time from mandating a technology to fleet saturation is usually around fifteen to twenty years, however solid benefits are available prior to reaching the potential maximum (Budd, Newstead et al. 2020). Based on five years of crash data (2013-2017), significant crash and injury risk reductions associated with AEB fitment were evidenced.

The evaluation was based on previous research and used an induced exposure design. Confounder analysis (Newstead, Budd et al. 2020) found the exposure group to be sufficiently similar to the sensitive crashed vehicle set and stratification by speed zone and vehicle size was used to additionally minimise potential bias. Furthermore, bias control was enhanced by using a proportionally large control set of non-fitted vehicles which were matched to the fitted vehicles by manufacture year and crash year. Confounding effects in the narrowly sensitive crash analyses were considered likely to be small and insignificant, however bias was more likely in the estimates presented for broad, pedestrian and intersection sensitive crashes because the exposure set was specifically matched to the narrowly sensitive crashed vehicle set. When considering confounding bias, consideration must be given to the fact that the benefits presented in this report chiefly arise from models with only some variants fitted with AEB. It is therefore more likely that the results for AEB effectiveness presented here under-estimate the true effectiveness. If all variants for a fitted model had AEB, the estimated benefits are likely to be larger.

All analyses were stratified by low (≤60 km/h) and high (>60 km/h) speed zones. AEB systems, particularly those fitted to vehicles in the Australian and New Zealand crashed light vehicle dataset, have been designed to function either at high or at low speeds. Therefore, stratifying by speed zone, not only added control of differences in urbanisation, road type, impact speed and driving styles between high and low speed zones, it also captured some of the differences in effectiveness specific to high and low speed AEB systems. This was important given that most current AEB systems are limited to crash mitigation at low speeds (less than 80km/h). Further, the analysis of crash data showed that a greater percentage of Australian AEB sensitive crashes involving light vehicles occurred in lower speed zones. Given the rapid evolution of AEB technologies, and their improving ability to function at higher speeds (up to and over 100km/h) the benefits of AEB for crashes in high-speed zones are likely to increase.

AEB fitment was associated with significant injury risk reductions. Greater reductions were generally found for narrowly sensitive crashes than for broadly sensitive crashes, across injury severity and speed zones. Greater reductions were also found for higher severity injuries. For example, risk reductions were much greater for serious and fatal injuries than for minor injuries, overall and across speed zones. Furthermore, AEB effectiveness was greater for intersection sensitive crashes when speeds or injury severity were higher. This highlights the increased effectiveness of AEB in more critical situations (i.e. the potential for a crash or serious outcome).

FCW showed less benefits when compared to AEB. However, these findings may be due to the proportionally lower number of vehicles fitted with FCW without AEB. It should be noted though, that fatal and serious injury reductions were significantly associated with FCW. Further, there was evidence of FCW having a greater effect at reducing fatal and serious injuries from narrowly sensitive crashes in high speed zones, when compared to AEB. This finding supports the need for further development and penetration of high speed AEB technology.

Overall and by high and low speed zones, no significant crash or crash injury reductions were associated with AEB, nor FCW for pedestrian sensitive crashes. These results suggest that the technology preventing these sensitive crashes has not yet penetrated the Australian and New Zealand markets in sufficient numbers to produce measurable change. Future evaluations will be required to determine the potential benefits from these technologies.

The evaluation reported here represents a significant enhancement on previous research. The analysis extended Newstead, Budd et a., (2020) by including evaluation of the effectiveness of AEB in mitigating pedestrian injuries resulting from frontal collisions. Also, the effectiveness of AEB at crash avoidance or injury mitigation for specific intersection collisions: straight crossing paths (SCP) and right turn across the path of a vehicle approaching from the opposite direction (RTAP/OD) was evaluated. A more comprehensive dataset was also used (extending the crash period duration and jurisdictions included). These additional data significantly enhance the robustness of the analysis. Consequently, this study had more robust estimates of overall relative risk than those produced by Newstead, Budd et al. (2020). However, interestingly relative risk estimates from narrowly sensitive crashes of this and the previous study of Newstead, Budd et al. (2020) are similar.

The results show clear benefit for AEB fitment across light passenger vehicles. However, these rely on drivers choosing new vehicles including this technology. Previous research has shown not all drivers may readily adopt AEB (Rahman, Strawderman et al. 2018) demonstrating the need for a mandate to include the technology in all vehicles to maximise its potential benefit. As AEB technologies advance, more crash types are likely to become narrowly sensitive to AEB (Sander 2017) and therefore the potential benefits of AEB will increase. The growing market penetration of AEB systems and increased functionality in the technology means that further evaluation of the road safety benefits of AEB is warranted in the future. Future studies may benefit from an evaluation using the primary safety index, which may better evaluate the effects of driver age while adjusting for vehicle crashworthiness. Furthermore, future study designs could also examine the effects of AEB at mitigating injuries by injury type or by the age of the injured; and combinations of AEB with secondary safety technologies such as anti-whiplash seats may also prove to be of interest.

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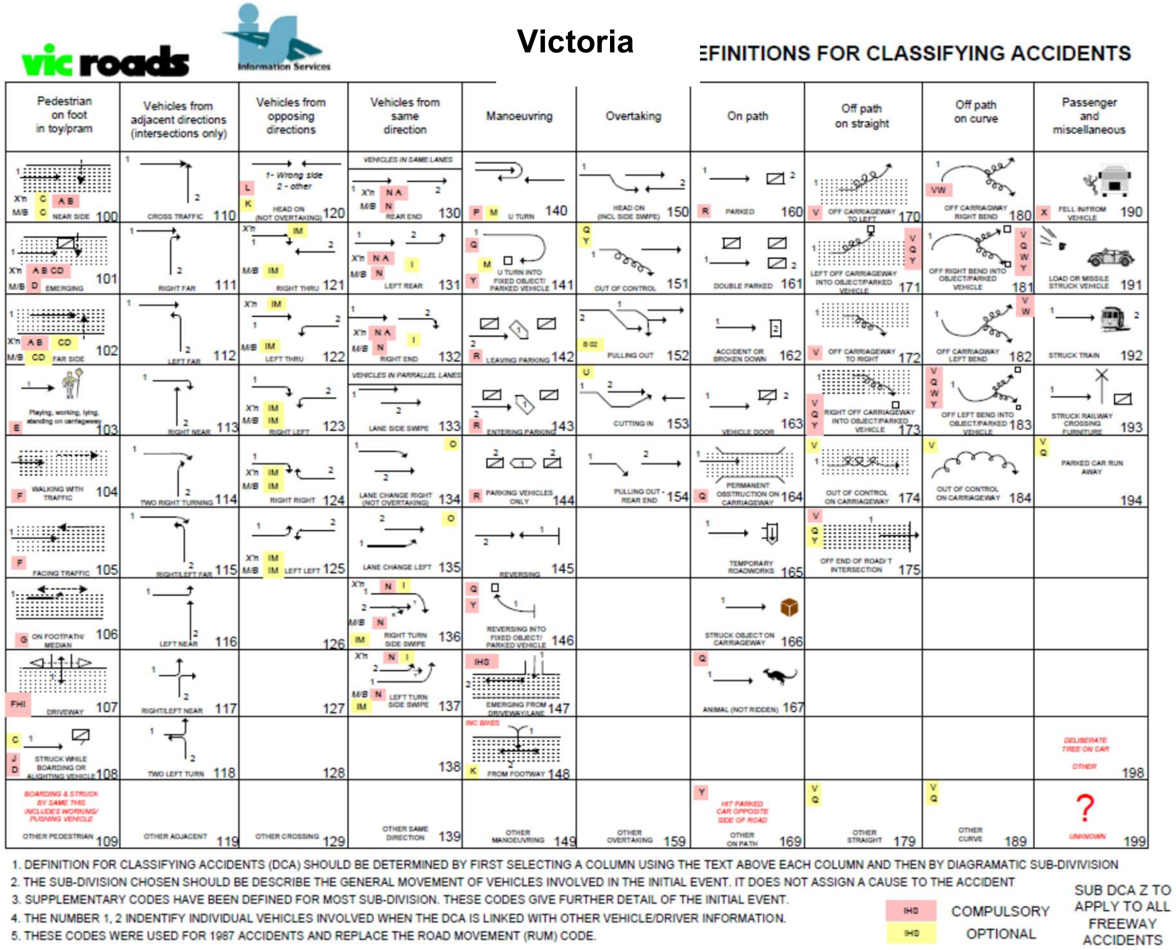
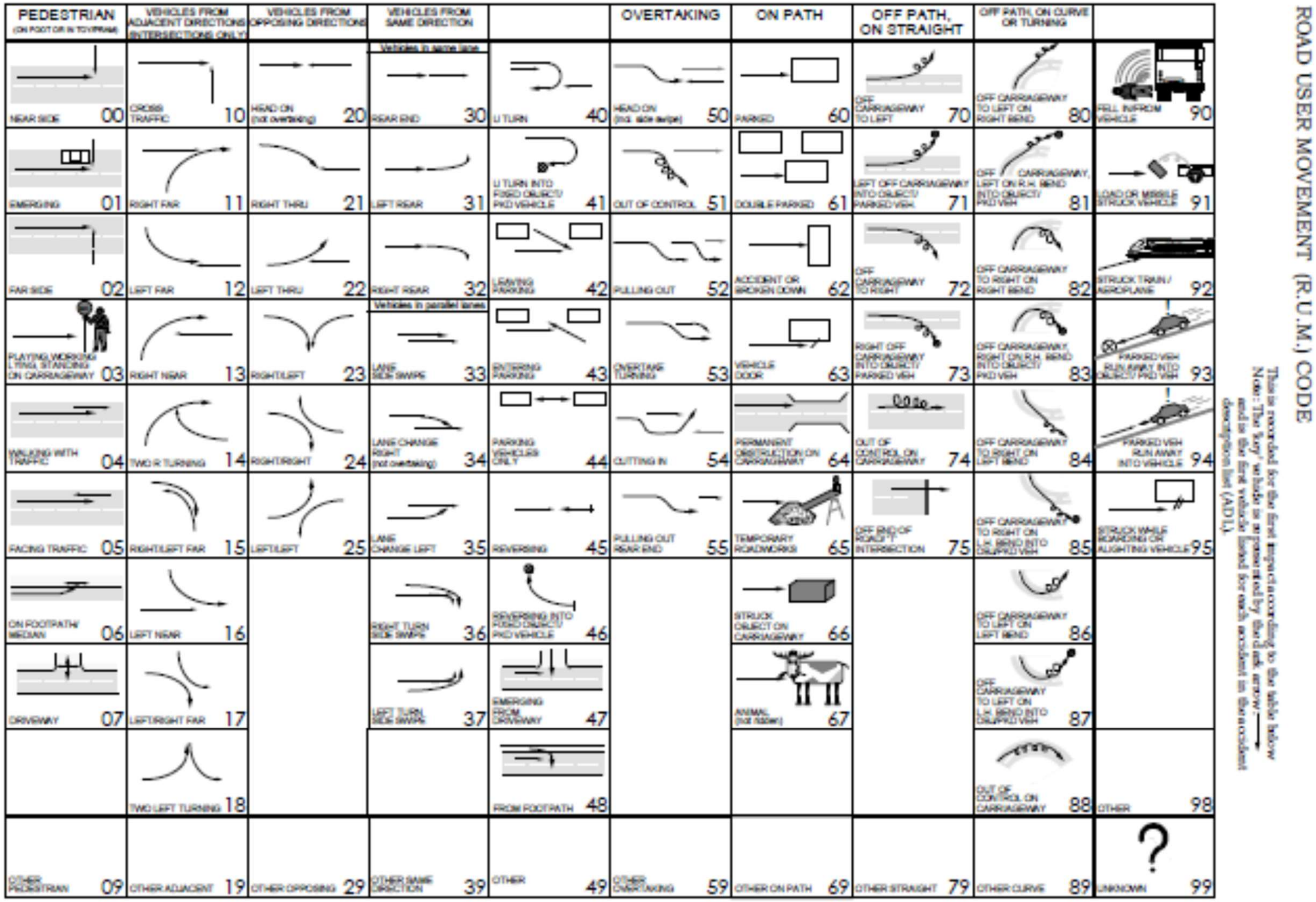
9 APPENDIX

A.1 DCA charts and RUM codes across each Australian jurisdiction

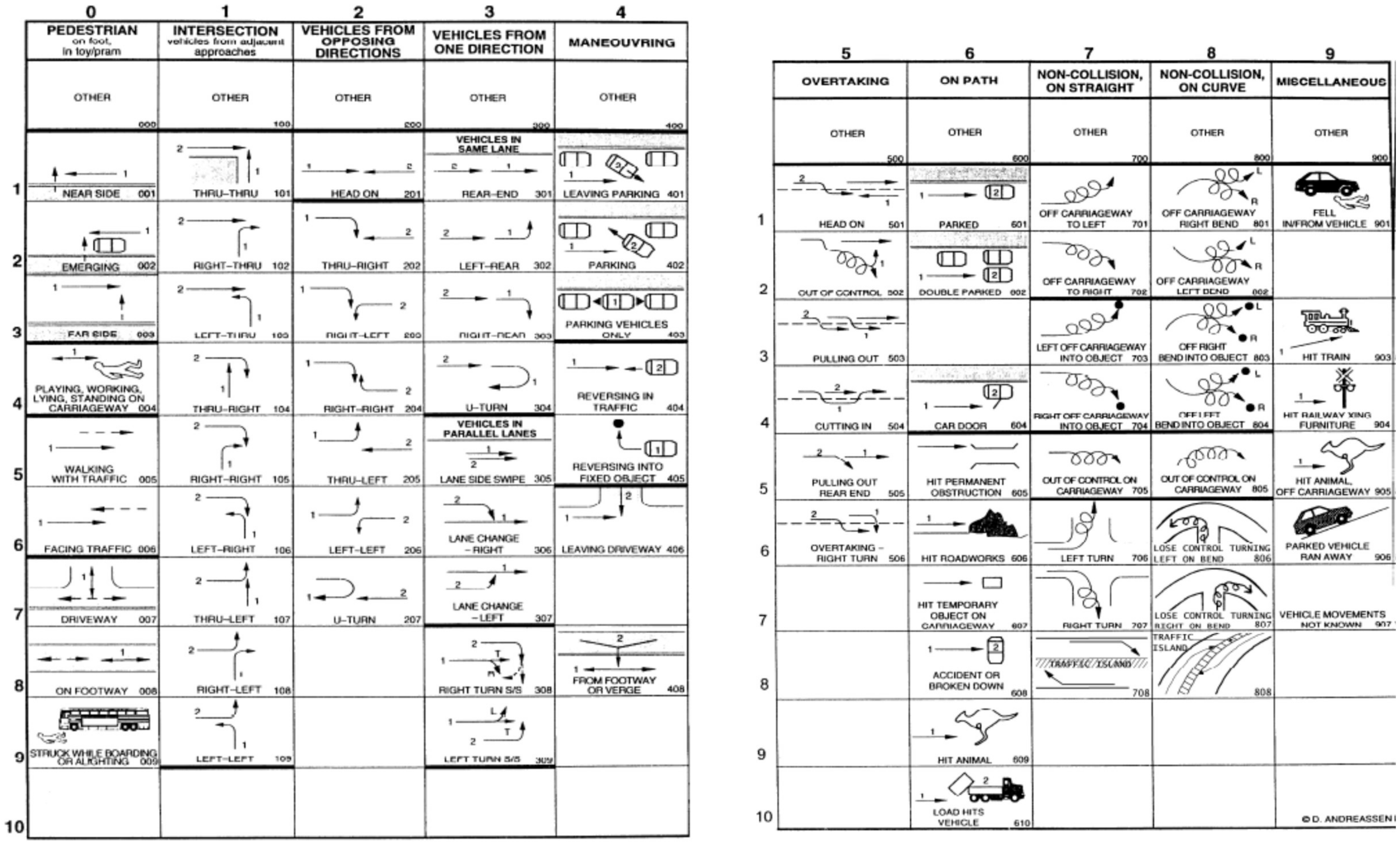
Victoria



NSW


ROAD USER MOVEMENT (R.U.M.) CODE
This is recorded for the first impact according to the table below
Note: The 'key' vehicle is represented by the dark arrow
and is the first vehicle listed for each accident in the accident
description list (ADL).
PEDESTRIAN (ON FOOT OR IN TOY/PRAM)
VEHICLES FROM ADJACENT DIRECTIONS (INTERSECTIONS ONLY)
VEHICLES FROM OPPOSING DIRECTIONS
VEHICLES FROM SAME DIRECTION
OVERTAKING
ON PATH
OFF PATH, ON STRAIGHT
OFF PATH, ON CURVE OR TURNING
Vehicles in same lane
Vehicles in parallel lanes
NEAR SIDE 00
EMERGING 01
FAR SIDE 02
PLAYING, WORKING LYING, STANDING ON CARRIAGEWAY 03
WALKING WITH TRAFFIC 04
FACING TRAFFIC 05
ON FOOTPATH/ MEDIAN 06
DRIVEWAY 07
OTHER PEDESTRIAN 09
CROSS TRAFFIC 10
RIGHT FAR 11
LEFT FAR 12
RIGHT NEAR 13
TWO R TURNING 14
RIGHT/LEFT FAR 15
LEFT NEAR 16
LEFT/RIGHT FAR 17
TWO LEFT TURNING 18
OTHER ADJACENT 19
HEAD ON (not overtaking) 20
RIGHT THRU 21
LEFT THRU 22
RIGHT/LEFT 23
RIGHT/RIGHT 24
LEFT/LEFT 25
OTHER OPPOSING 29
REAR END 30
LEFT REAR 31
RIGHT REAR 32
LANE SIDE SWIPE 33
LANE CHANGE RIGHT (not overtaking) 34
LANE CHANGE LEFT 35
RIGHT TURN SIDE SWIPE 36
LEFT TURN SIDE SWIPE 37
OTHER SAME DIRECTION 39
U TURN 40
U TURN INTO FIXED OBJECT/ PKD VEHICLE 41
LEAVING PARKING 42
ENTERING PARKING 43
PARKING VEHICLES ONLY 44
REVERSING 45
REVERSING INTO FIXED OBJECT/ PKD VEHICLE 46
EMERGING FROM DRIVEWAY 47
FROM FOOTPATH 48
OTHER 49
HEAD ON (incl. side swipe) 50
OUT OF CONTROL 51
PULLING OUT 52
OVERTAKE TURNING 53
CUTTING IN 54
PULLING OUT REAR END 55
OTHER OVERTAKING 59
PARKED 60
DOUBLE PARKED 61
ACCIDENT OR BROKEN DOWN 62
VEHICLE DOOR 63
PERMANENT OBSTRUCTION ON CARRIAGEWAY 64
TEMPORARY ROADWORKS 65
STRUCK OBJECT ON CARRIAGEWAY 66
ANIMAL (not ridden) 67
OTHER ON PATH 69
OFF CARRIAGEWAY TO LEFT 70
LEFT OFF CARRIAGEWAY INTO OBJECT/ PARKED VEH 71
OFF CARRIAGEWAY TO RIGHT 72
RIGHT OFF CARRIAGEWAY INTO OBJECT/ PARKED VEH 73
OUT OF CONTROL ON CARRIAGEWAY 74
OFF END OF ROAD/T INTERSECTION 75
OTHER STRAIGHT 79
OFF CARRIAGEWAY TO LEFT ON RIGHT BEND 80
OFF CARRIAGEWAY, LEFT ON R.H. BEND INTO OBJECT/ PKD VEH 81
OFF CARRIAGEWAY TO RIGHT ON RIGHT BEND 82
OFF CARRIAGEWAY, RIGHT ON R.H. BEND INTO OBJECT/ PKD VEH 83
OFF CARRIAGEWAY TO RIGHT ON LEFT BEND 84
OFF CARRIAGEWAY TO RIGHT ON L.H. BEND INTO OBJ/PKD VEH 85
OFF CARRIAGEWAY TO LEFT ON LEFT BEND 86
OFF CARRIAGEWAY TO LEFT ON L.H. BEND INTO OBJ/PKD VEH 87
OUT OF CONTROL ON CARRIAGEWAY 88
OTHER CURVE 89
FELL IN/FROM VEHICLE 90
LOAD OR MISSILE STRUCK VEHICLE 91
STRUCK TRAIN/ AEROPLANE 92
PARKED VEH RUN AWAY INTO OBJECT/ PKD VEH 93
PARKED VEH RUN AWAY INTO VEHICLE 94
STRUCK WHILE BOARDING OR ALIGHTING VEHICLE 95
OTHER 98
?
UNKNOWN 99

Queensland


0 PEDESTRIAN on foot, in toy/pram
1 INTERSECTION vehicles from adjacent approaches
2 VEHICLES FROM OPPOSING DIRECTIONS
3 VEHICLES FROM ONE DIRECTION
4 MANEOUVRING
OTHER 000
OTHER 100
OTHER 200
OTHER 300
OTHER 400
NEAR SIDE 001
THRU–THRU 101
HEAD ON 201
VEHICLES IN SAME LANE
REAR–END 301
LEAVING PARKING 401
EMERGING 002
RIGHT–THRU 102
THRU–RIGHT 202
LEFT–REAR 302
PARKING 402
FAR SIDE 003
LEFT–THRU 103
RIGHT–LEFT 203
RIGHT–REAR 303
PARKING VEHICLES ONLY 403
PLAYING, WORKING, LYING, STANDING ON CARRIAGEWAY 004
THRU–RIGHT 104
RIGHT–RIGHT 204
U–TURN 304
REVERSING IN TRAFFIC 404
WALKING WITH TRAFFIC 005
RIGHT–RIGHT 105
THRU–LEFT 205
VEHICLES IN PARALLEL LANES
LANE SIDE SWIPE 305
REVERSING INTO FIXED OBJECT 405
FACING TRAFFIC 006
LEFT–RIGHT 106
LEFT–LEFT 206
LANE CHANGE – RIGHT 306
LEAVING DRIVEWAY 406
DRIVEWAY 007
THRU–LEFT 107
U–TURN 207
LANE CHANGE – LEFT 307
ON FOOTWAY 008
RIGHT–LEFT 108
RIGHT TURN S/S 308
FROM FOOTWAY OR VERGE 408
STRUCK WHILE BOARDING OR ALIGHTING 009
LEFT–LEFT 109
LEFT TURN S/S 309
5 OVERTAKING
6 ON PATH
7 NON-COLLISION, ON STRAIGHT
8 NON-COLLISION, ON CURVE
9 MISCELLANEOUS
OTHER 500
OTHER 600
OTHER 700
OTHER 800
OTHER 900
HEAD ON 501
PARKED 601
OFF CARRIAGEWAY TO LEFT 701
OFF CARRIAGEWAY RIGHT BEND 801
FELL IN/FROM VEHICLE 901
OUT OF CONTROL 502
DOUBLE PARKED 602
OFF CARRIAGEWAY TO RIGHT 702
OFF CARRIAGEWAY LEFT BEND 802
PULLING OUT 503
LEFT OFF CARRIAGEWAY INTO OBJECT 703
OFF RIGHT BEND INTO OBJECT 803
HIT TRAIN 903
CUTTING IN 504
CAR DOOR 604
RIGHT OFF CARRIAGEWAY INTO OBJECT 704
OFF LEFT BEND INTO OBJECT 804
HIT RAILWAY XING FURNITURE 904
PULLING OUT REAR END 505
HIT PERMANENT OBSTRUCTION 605
OUT OF CONTROL ON CARRIAGEWAY 705
OUT OF CONTROL ON CARRIAGEWAY 805
HIT ANIMAL, OFF CARRIAGEWAY 905
OVERTAKING – RIGHT TURN 506
HIT ROADWORKS 606
LEFT TURN 706
LOSE CONTROL TURNING LEFT ON BEND 806
PARKED VEHICLE RAN AWAY 906
HIT TEMPORARY OBJECT ON CARRIAGEWAY 607
RIGHT TURN 707
LOSE CONTROL TURNING RIGHT ON BEND 807
VEHICLE MOVEMENTS NOT KNOWN 907
ACCIDENT OR BROKEN DOWN 608
TRAFFIC ISLAND 708
TRAFFIC ISLAND 808
HIT ANIMAL 609
LOAD HITS VEHICLE 610
© D. ANDREASSEN

Western Australia

98	Pedest: Other	33	Same Dirn: Same Lane Right Rear
1	Pedest: Near Side	34	Same Dirn: Same Lane U - Turn
2	Pedest: Emerging From Near Side	35	Same Dirn: Parallel Lanes - S/swipe
3	Pedest: Far Side	36	Same Dirn: Change Lanes - Right
4	Pedest: Play / Work / Stand On Cway	37	Same Dirn: Change Lanes - Left
5	Pedest: Walking With Traffic	38	Same Dirn: Parallel Lanes - Turn Right S/swipe
6	Pedest: Walking Against Traffic	39	Same Dirn: Parallel Lanes - Turn Left S/swipe
7	Pedest: In Driveway	40	Manoeuv: Other
8	Pedest: On Footway	42	Manoeuv: Leaving Parking
9	Pedest: Struck Boarding / Alighting	43	Manoeuv: Parking
10	Intx: Other	44	Manoeuv: Parking Veh Only
11	Intx: Thru - Thru	45	Manoeuv: Reversing In Traffic
12	Intx: Right - Thru	46	Manoeuv: Reverse Into Fixed Obj
13	Intx: Left - Thru	47	Manoeuv: Leaving Driveway
14	Intx: Thru - Right	48	Manoeuv: Loading Bay
15	Intx: Right - Right	49	Manoeuv: From Footway
16	Intx: Left - Right	50	Overtaking: Other
17	Intx: Thru - Left	51	Overtaking: Head On
18	Intx: Right - Left	52	Overtaking: Out Of Control:
19	Intx: Left - Left	53	Overtaking: Pulling Out
20	Opposite Dirn: Other	54	Overtaking: Cutting In
21	Opposite Dirn: Head On	55	Overtaking: Pull Out - Rear End
22	Opposite Dirn: Thru - Right	56	Overtaking: Into Right Turn
23	Opposite Dirn: Right - Left	60	On Path: Other
24	Opposite Dirn: Right - Right	61	On Path: Parked
25	Opposite Dirn: Thru - Left	62	On Path: Double Parked
26	Opposite Dirn: Left - Left	63	On Path: Accident Or Breakdown
27	Opposite Dirn: U - Turn	64	On Path: Open Car Door
30	Same Dirn: Other	65	On Path: Permanent Obstruction
31	Same Dirn: Same Lane Rear End	66	On Path: Temp Roadworks
32	Same Dirn: Same Lane Left Rear	67	On Path: Temp Obj On Cway

Western Australia continued

69	On Path: Hit Animal
70	Off Path On Straight: Other
71	Off Path On Straight: Off Left Cway
72	Off Path On Straight: Off Left Cway Obj
73	Off Path On Straight: Off Rigth Cway
74	Off Path On Straight: Off Right Cway Obj

75	Off Path On Straight: Lost Control On Cway
76	Loss Of Control: Left Turn - Intx
77	Loss Of Control: Right Turn - Intx
80	Off Path On Curve: Other
81	Off Path On Curve: Off Cway Right Bend
82	Off Path On Curve: Off Right Bend In Obj
83	Off Path On Curve: Off Cway Left Bend
84	Off Path On Curve: Off Left Bend In Obj
85	Off Path On Curve: Lost Control On Cway
90	Misc: Passenger Other
91	Misc: Passenger Fell In / From Veh
92	Misc: Load Struck Veh
93	Misc: Struck Train
94	Misc: Struck Rail Xing Furniture
95	Misc: Hit Animal Off Cway
96	Misc: Parked Car Ran Away
97	Misc: Veh Movement Unknown

A.2 Makes, models and manufacture year range of light vehicles fitted with AEB used in the analysis

Table 16 Models with AEB fitted to all variants

	Years of Manufacture	FCW also recorded in Redbook as fitted: All	FCW also recorded in Redbook as fitted: Some
Alfa Romeo Giulietta	13-17	■	
Audi A4/S4 B9	15-17		■
Audi A5/S5/RS5 F5	16-17	■	
Audi Q2	16-17	■	
Audi Q7 4M	15-17	■	
BMW 7 F01/02 09 On	13-15		■
BMW 7 G12	15-17	■	
BMW X6 F16/F86/X6M	14-17	■	
Ford Everest	15-17		■
Ford Kuga	13-13		
Hyundai Genesis	14-17		
Jaguar F-Pace	16-17	■	
Jaguar XE	15-17		
Jaguar XF / XFR	15-17	■	
Kia Optima JF	15-17		
Land Rover Discovery Sport	15-17	■	
Landrover Discovery 5	16-17	■	
Lexus RX350/400h	13-15		■
Mazda CX-5	17-17	■	
Mazda CX-9 TC	16-17	■	
Mercedes GLA-Class X156	14-17		
Mercedes A-Class W176	13-17	■	
Mercedes E-Class W213	16-17	■	
Mini Countryman F60	16-17	■	
Skoda KodiaQ	17-17	■	
Skoda Fabia NJ	14-17	■	
Skoda Superb	15-17	■	
Subaru Levorg V2	17-17	■	
Tesla Model S	14-17	■	
Toyota C-HR	16-17	■	
Volkswagen up!	13-14		
Volvo S60 / V60	13-17		■
Volvo V40 M Series	13-17		
Volvo V70 / XC70	13-17		
Volvo XC60	13-17		
Volvo XC90 L Series	15-17		■
Volkswagen Tiguan	17-17		

Table 17 Models with AEB fitted to some variants

Model	Years of Manufacture	FCW also recorded in Redbook as fitted: All	FCW also recorded in Redbook as fitted: Some
Audi A3 8V/RS3	13-17		■
Audi A4/S4 B8/Allroad/RS4	13-15		
Audi A5/S5	13-16		
Audi A6/S6/Allroad/RS6/A7/S7/RS7 4G	13-17		■
Audi Q5/SQ5	13-17		■
BMW 1 Series F20 11 On	13-17		■
BMW 2 Series F22/F23/F45/F87	14-17		■
Bmw 3 Series F30/F31/F34/M3 F80	13-17		■
Bmw 4 Series F32/F33/F36/M4 F82/M4 F83	13-17		■
BMW 5 Series F07/10/11 10 On	13-17		■
BMW X5 F15/F85/X5M	13-17		■
Chrysler 300/300C	13-17		■
Citroen C4 Picasso / Grand C4 Picasso	13-17		■
Fiat 500/500C / Panda	13-17		
Ford Focus LW / LZ	13-17		■
Ford Mondeo MD	15-17		■
Holden Astra BK	16-17		■
Honda CRV	17-17		■
Honda Accord Gen 9 13 On	13-17		■
Honda Civic Gen 9 Hatch	13-17		■
Honda HR-V	14-17		
Honda Odyssey 40	13-17		■
Hyundai I-30	17-17		■
Hyundai Santa FE DM	13-17		■
Hyundai Tucson TL	15-17		■
Infiniti M/Q70 Y51 Series	13-17		■
Infiniti Q50	13-17		■
Jeep Cherokee Grand WK	13-17		■
Kia Carnival YP/Grand Carnival YP	15-17		■
Kia Sorento UM	15-17		■
Kia Sportage QL	15-17		■
Lexus CT200H	13-17		■
Lexus ES350/300h	13-17		■
Lexus IS200t/250/300h/350	13-17		■
Lexus NX200t/300h	14-17		■
Lexus RC200t/300h/350/RC F	14-17		■
Mazda 2 DJ/DL	14-17		
Mazda 3 BM/BN	13-17		■
Mazda 6 GJ/GL	13-17		■
Mazda CX-3	15-17		
Mazda CX-5	13-16		■
Mercedes CLA-Class C117 / X117	13-17	■	
Mercedes C-Class W205 / S205	14-17	■	
Mercedes CLS W218	13-17		■
Mercedes E-Class W212 / C207 / A207	13-17		■
Mercedes GLC-Class X253	15-17	■	
Mercedes ML / GL / GLE / GLS -Class W166 /	13-17		■
Mercedes S-Class W222 / V222 / C217	13-17		■
Mercedes SLK / SLC R172	13-17		■
Mini MK III Clubman F54	15-17	■	
Mitsubishi ASX XC	16-17		■
Mitsubishi Outlander	13-17		■
Mitsubishi Pajero Sport	15-17		■
Nissan Pathfinder R52 13 On	13-17		■
Nissan Qashqai	14-17		■
Nissan X-Trail T32	14-17		■
Peugeot 208	13-17		■
Peugeot 308 T9	14-17		■
Range Rover LG	13-17		
Renault Koleos XZG	16-17		■
Skoda Octavia Ne	13-17		■
Subaru Forester S4	13-17		■
Subaru Impreza G5	16-17		■
Subaru Levorg V1	16-17		■
Subaru Liberty 09-14	13-14		■
Subaru Liberty B-6	14-17		■
Subaru Outback	17-17		
Suzuki Swift	17-17		■
Tesla Model X	16-17		■
Toyota Camry	13-17		■
Toyota Corolla 182	13-17		■
Toyota Kluger XU50	13-17		■
Toyota Landcruiser 200 Ser	13-17		
Toyota Prado 150 Series	13-17		■
Toyota Prius V	13-17		■
Toyota RAV4	13-17		■
Toyota Yaris	13-17		■
Volkswagen Caddy	13-17		■
Volkswagen Caravelle/Transporter/Multivan T6	15-17		■
Volkswagen Golf VII	13-17		■
Volkswagen Passat B8	15-17		■
Volkswagen Tiguan	16-17		■
Volkswagen Touareg 11 On	13-17		■

Table 18 Models with FCW fitment and AEB fitted to no variants

	Years of Manufacture	All	Some
Chrysler 300/300C	13-17		■
Ford Falcon Ute FG / FG-X	13-17		■
Ford Everest	15-17		■
Holden Statesman/Caprice WM	13-17		■
Holden Commodore VF	13-17		■
Holden Commodore VF Ute	13-17		■
Holden Colorado 7 / Trailblazer	13-17		■
Jeep Cherokee Grand WK	13-17		■
Kia Carnival YP/Grand Carnival YP	15-17		■
Kia Cerato YD	13-17		■
Lexus RX350/400h	13-15		■
Lexus CT200H	13-17		■
Mazda CX-9	13-15		■
Mercedes A-Class W176	13-17	■	
Mercedes Vito / V-Class / Valente	15-17		■
Mercedes CLA-Class C117 / X117	13-17	■	
Mercedes GLC-Class X253	15-17	■	
Nissan Patrol Y62	13-17		■
Nissan Murano Z51	13-15		■
Infiniti M/Q70 Y51 Series	13-17		■
Nissan Juke	13-17		■
Toyota Prius IV	16-17	■	

A.3 Analysis Datasets

The following tables present the data used in each of the regression analyses. Grey shading indicates that the stratum analysis was not possible due to no fitment.

Table 19 Fatal and serious injury analysis with primary stratification- AEB

		All AEB fitment	Some AEB fitment	No AEB Fitment
		Narrowly sensitive		
≤60 km/h zone	Car	1	31	251
	SUV	1	26	98
	LCV			
>60 km/h zone	Car	3	36	240
	SUV	1	29	82
	LCV			
		Broadly sensitive		
≤60 km/h zone	Car	13	123	753
	SUV	6	90	249
	LCV		2	285
>60 km/h zone	Car	15	153	1030
	SUV	2	150	476
	LCV			
		Pedestrian sensitive		
≤60 km/h zone	Car	3	64	363
	SUV	7	60	97
	LCV			
>60 km/h zone	Car		11	54
	SUV		6	17
	LCV			
		Straight Crossing Paths and Low Speed Right Turn across Other Direction		
≤60 km/h zone	Car	18	140	1024
	SUV	5	133	336
	LCV		0	303
>60 km/h zone	Car		24	180
	SUV		23	93
	LCV		0	161
		No Fitment		
≤60 km/h zone	Car	5	114	530
	SUV	5	80	219
	LCV		0	161
>60 km/h zone	Car	8	109	619
	SUV	3	93	225
	LCV		0	197

Table 20 Minor injury analysis with primary stratification - AEB

		All AEB fitment	Some AEB fitment	No AEB Fitment
Narrowly sensitive				
≤60 km/h zone	Car	24	344	2330
	SUV	18	278	865
	LCV		8	1129
>60 km/h zone	Car	7	185	1241
	SUV	8	181	517
	LCV		1	833
Broadly sensitive				
≤60 km/h zone	Car	22	468	2781
	SUV	16	314	848
	LCV		3	739
>60 km/h zone	Car	19	329	1704
	SUV	17	255	688
	LCV		2	847
Pedestrian sensitive				
≤60 km/h zone	Car	10	97	561
	SUV	3	47	135
	LCV			
>60 km/h zone	Car		6	27
	SUV		2	8
	LCV			
Straight Crossing Paths and Low Speed Right Turn across Other Direction				
≤60 km/h zone	Car	41	559	3223
	SUV	19	379	947
	LCV		2	881
>60 km/h zone	Car		47	361
	SUV		45	151
	LCV			
No Fitment				
≤60 km/h zone	Car	42	801	4287
	SUV	34	607	1557
	LCV		1	994
>60 km/h zone	Car	35	534	2975
	SUV	29	469	1061
	LCV		1	1024

Table 21 Property damage only analysis with primary stratification - AEB

		All AEB fitment	Some AEB fitment	No AEB Fitment
		Narrowly sensitive		
≤60 km/h zone	Car	13	213	1656
	SUV	2	186	523
	LCV		2	685
>60 km/h zone	Car	10	142	1093
	SUV	3	170	408
	LCV			
		Broadly sensitive		
≤60 km/h zone	Car	20	325	2362
	SUV	17	251	638
	LCV		1	642
>60 km/h zone	Car	11	158	915
	SUV	5	123	353
	LCV			
		Pedestrian sensitive		
≤60 km/h zone	Car	1	5	29
	SUV		4	13
	LCV			5
>60 km/h zone	Car			
	SUV		1	2
	LCV			
		Straight Crossing Paths and Low Speed Right Turn across Other Direction		
≤60 km/h zone	Car	11	257	1537
	SUV	6	207	432
	LCV		1	374
>60 km/h zone	Car	1	14	105
	SUV		13	42
	LCV			
≤60 km/h zone	Car	29	525	2888
	SUV	34	465	1004
	LCV	1	1	827
>60 km/h zone	Car	22	394	2272
	SUV	15	353	840
	LCV			

Table 22 Injury analysis with primary stratification-FCW

		Fatal and Serious Injuries			Minor Injuries		
		All FCW	Some FCW	No Fitment	All FCW	Some FCW	No Fitment
Narrowly sensitive							
≤60 km/h zone	Car	1	12	238	16	163	2151
	SUV		8	90		87	778
	LCV		1	112		32	1097
>60 km/h zone	Car	3	9	228	2	94	1145
	SUV		5	77		33	484
	LCV		4	203		14	819
Broadly sensitive							
≤60 km/h zone	Car	6	54	693	30	168	2583
	SUV		14	235	2	66	780
	LCV		16	269		27	712
>60 km/h zone	Car	1	46	983	5	109	1590
	SUV		41	435		46	642
	LCV		17	526		29	818
Pedestrian sensitive							
≤60 km/h zone	Car	3	21	339	8	45	508
	SUV		3	94		11	124
	LCV		3	130		7	115
>60 km/h zone	Car		5	49		5	22
	SUV		3	14		1	7
	LCV		1	20			18
Straight Crossing Paths and Low Speed Right Turn across Other Direction							
≤60 km/h zone	Car	7	43	974	26	194	3003
	SUV		36	300		74	873
	LCV		6	297		44	837
>60 km/h zone	Car	0	14	166	1	35	325
	SUV		9	84		21	130
	LCV		2	98		3	152
No Fitment							
≤60 km/h zone	Car	3	33	494	34	253	4000
	SUV	1	21	197	1	117	1439
	LCV		3	158		29	965
>60 km/h zone	Car	8	55	556	16	222	2737
	SUV		16	209		72	989
	LCV		8	189		26	998

Table 23 Property damage only analysis with primary stratification - FCW

		All FCW fitment	Some FCW fitment	No FCW Fitment
		Narrowly sensitive		
≤60 km/h zone	Car	6	123	1527
	SUV		63	460
	LCV		18	667
>60 km/h zone	Car	3	73	1017
	SUV		59	349
	LCV		10	604
		Broadly sensitive		
≤60 km/h zone	Car	9	175	2178
	SUV		95	543
	LCV		27	615
>60 km/h zone	Car	2	74	839
	SUV		35	318
	LCV		10	381
		Pedestrian sensitive		
≤60 km/h zone	Car		3	26
	SUV		1	12
	LCV			
>60 km/h zone	Car			
	SUV		1	1
	LCV			
		Straight Crossing Paths and Low Speed Right Turn across Other Direction		
≤60 km/h zone	Car	9	101	1427
	SUV		53	379
	LCV		18	356
>60 km/h zone	Car		13	92
	SUV		6	36
	LCV		2	37
≤60 km/h zone	Car	9	190	2689
	SUV		123	881
	LCV		28	799
>60 km/h zone	Car	5	149	2118
	SUV		106	734
	LCV		21	841

A.4 A comparison of overall results with Newstead et al. (2020) for narrowly sensitive crashes

Table 24 Property damage only crash risk and injury risk associated with AEB by severity, sensitivity and fitment status from two studies

Fitment	All Injuries	Fatal and Serious Injuries	Minor Injuries	PDO crashes
	This study			
All	0.79 (0.59, 1.07) p = 0.13	0.67 (0.27, 1.67) p = 0.39	0.81 (0.59, 1.10) p = 0.18	0.54 (0.35, 0.82) p = 0.004
Some	0.80 (0.74, 0.87) p = <.0001	0.73 (0.58, 0.92) p = 0.007	0.81 (0.75, 0.88) p = <.0001	0.79 (0.71, 0.87) p = <.0001
	Newstead et al. (2020)			
All	0.80 (0.53, 1.21) p=0.29	0.37 (0.08, 1.67) p=0.20	0.86 (0.56, 1.32) p=0.49	0.84 (0.29,2.39) p=0.74
Some	0.78 (0.70, 0.87) p=<.0001	0.64 (0.48, 0.86) p=0.002	0.81 (0.72, 0.90) p=0.0002	0.76 (0.58, 1.00) p=0.047

A.5 Disaggregated Regression Relative Risk Estimates, associated with models having only *some* variant AEB fitment

Table 25 PDO crash risk and injury risk associated with AEB by severity, sensitivity and speed zone for models with *some* variant fitment status

	All Injuries	Fatal and Serious Injuries†	Minor Injuries	Property Damage only Crashes
	Narrowly sensitive			
≤60 km/h zone	0.79 (0.72, 0.88) p = <.0001	0.63 (0.45, 0.87) p = 0.005	0.81 (0.73, 0.90) p = <.0001	0.74 (0.65, 0.84) p = <.0001
>60 km/h zone	0.82 (0.73, 0.93) p = 0.002	0.85 (0.63, 1.16) p = 0.32	0.82 (0.71, 0.93) p = 0.003	0.85 (0.74, 0.99) p = 0.04
	Broadly sensitive			
≤60 km/h zone	0.91 (0.84, 1.00) p = 0.04	0.86 (0.69, 1.07) p = 0.17	0.92 (0.84, 1.02) p = 0.10	0.79 (0.71, 0.89) p = <.0001
>60 km/h zone	0.90 (0.82, 0.99) p = 0.04	0.81 (0.66, 0.99) p = 0.04	0.97 (0.87, 1.09) p = 0.64	0.92 (0.79, 1.08) p = 0.31
	Pedestrian sensitive			
≤60 km/h zone	1.01 (0.87, 1.17) p = 0.90	1.09 (0.84, 1.41) p = 0.51	0.92 (0.76, 1.12) p = 0.41	0.81 (0.39, 1.69) p = 0.57
>60 km/h zone	1.00 (0.64, 1.56) p = 1.00	1.04 (0.59, 1.81) p = 0.89	0.98 (0.45, 2.14) p = 0.96	1.17 (0.11, 12.96) p = 0.90
	Straight Crossing Paths and Low Speed Right Turn across Other Direction			
≤60 km/h zone	0.93 (0.85, 1.01) p = 0.08	0.79 (0.65, 0.98) p = 0.03	0.97 (0.88, 1.06) p = 0.46	0.97 (0.85, 1.1) p = 0.61
>60 km/h zone	0.69 (0.57, 0.84) p = 0.0002	0.68 (0.48, 0.97) p = 0.03	0.70 (0.56, 0.89) p = 0.004	0.75 (0.49, 1.15) p = 0.19

† Light commercial vehicles were not included in this analysis

Table 26 PDO crash risk and injury risk associated with AEB in narrowly sensitive crashes by severity and speed zone for models with *ALL* variant fitment status

	All Injuries	Fatal and Serious Injuries†	Minor Injuries	Property Damage only Crashes
	Narrowly sensitive			
≤60 km/h zone	0.95 (0.66, 1.37) p = 0.78	0.43 (0.09, 1.97) p = 0.28	1.01 (0.69, 1.47) p = 0.97	0.43 (0.25, 0.76) p = 0.004
>60 km/h zone	0.59 (0.35, 0.97) p = 0.04	0.95 (0.3,0 3.00) p = 0.93	0.52 (0.30, 0.92) p = 0.02	0.73 (0.38, 1.37) p = 0.32

Table 27 PDO crash risk and injury risk associated with AEB by severity, sensitivity and vehicle type for models with *some* variant fitment status

	All Injuries	Fatal and Serious Injuries†	Minor Injuries	PDO crashes
	Narrowly sensitive			
car	0.79 (0.71, 0.88) p = <.0001	0.70 (0.52, 0.94) p = 0.02	0.81 (0.72, 0.90) p = <.0001	0.73 (0.64, 0.83) p = <.0001
SUV	0.81 (0.71, 0.91) p = 0.0004	0.78 (0.55, 1.11) p = 0.17	0.81 (0.71, 0.92) p = 0.001	0.86 (0.74, 1.00) p = 0.05
LCV	4.39 (0.95, 20.34) p = 0.06		4.30 (0.93, 19.96) p = 0.06	2.41 (0.22, 26.68) p = 0.47
	Broadly sensitive			
car	0.92 (0.85, 1.01) p = 0.07	0.80 (0.66, 0.97) p = 0.02	0.97 (0.88, 1.06) p = 0.49	0.83 (0.74, 0.94) p = 0.002
SUV	0.88 (0.79, 0.97) p = 0.01	0.86 (0.68, 1.08) p = 0.2	0.90 (0.80, 1.01) p = 0.08	0.85 (0.73, 0.98) p = 0.02
LCV	3.71 (0.77, 17.91) p = 0.1		3.26 (0.63, 16.84) p = 0.16	1.29 (0.08, 20.63) p = 0.86
	Pedestrian sensitive			
car	0.95 (0.80, 1.13) p = 0.55	0.90 (0.67, 1.20) p = 0.47	0.95 (0.77, 1.19) p = 0.67	0.98 (0.38, 2.54) p = 0.96
SUV	1.10 (0.87, 1.39) p = 0.41	1.44 (1.00, 2.06) p = 0.05	0.85 (0.61, 1.19) p = 0.34	0.74 (0.27, 2.04) p = 0.56
LCV				
	Straight Crossing Paths and Low Speed Right Turn across Other Direction			
car	0.86 (0.78, 0.95) p = 0.003	0.68 (0.54, 0.85) p = 0.001	0.92 (0.83, 1.02) p = 0.129	0.94 (0.80, 1.09) p = 0.39
SUV	0.93 (0.83, 1.05) p = 0.27	0.91 (0.70, 1.18) p = 0.47	0.95 (0.83, 1.09) p = 0.49	1.03 (0.85, 1.23) p = 0.79
LCV	1.26 (0.17, 9.07) p = 0.82		1.56 (0.21, 11.4) p = 0.66	2.21 (0.14, 35.45) p = 0.58

† Light commercial vehicles were not included in this analysis

A.6 Disaggregated Regression Relative Risk Estimates, associated with models having only *some* variant FCW fitment

Table 28 PDO crash risk and injury risk associated with FCW by severity, sensitivity and speed zone for models with *some* variant fitment status

	All Injuries	Fatal and Serious Injuries†	Minor Injuries	PDO Crashes
	Narrowly sensitive			
≤60 km/h	1.15 (0.99, 1.34) p = 0.07	0.74 (0.45, 1.25) p = 0.26	1.2 (1.02, 1.41) p = 0.02	1.04 (0.87, 1.25) p = 0.65
>60 km/h	0.85 (0.70, 1.03) p = 0.09	0.49 (0.29, 0.83) p = 0.008	0.94 (0.77, 1.15) p = 0.56	1.04 (0.84, 1.28) p = 0.75
	Broadly sensitive			
≤60 km/h	1.07 (0.93, 1.24) p = 0.36	1.09 (0.77, 1.55) p = 0.61	1.05 (0.89, 1.24) p = 0.54	1.18 (1.00, 1.39) p = 0.05
>60 km/h	0.86 (0.73, 1.01) p = 0.06	0.67 (0.49, 0.9) p = 0.009	0.94 (0.78, 1.13) p = 0.49	1.05 (0.84, 1.31) p = 0.68
	Pedestrian sensitive			
≤60 km/h	1.14 (0.90, 1.44) p = 0.29	0.76 (0.47, 1.22) p = 0.25	1.39 (1.05, 1.83) p = 0.02	1.16 (0.41, 3.28) p = 0.78
>60 km/h	1.74 (1.01, 3.01) p = 0.05	1.36 (0.65, 2.81) p = 0.41	2.14 (0.90, 5.08) p = 0.09	7.22 (0.45, 116.12) p = 0.16
	Straight Crossing Paths and Low Speed Right Turn across Other Direction			
≤60 km/h	1.03 (0.90, 1.19) p = 0.66	0.82 (0.58, 1.16) p = 0.27	1.09 (0.94, 1.27) p = 0.26	1.04 (0.86, 1.26) p = 0.71
>60 km/h	1.30 (1.01, 1.66) p = 0.04	0.89 (0.56, 1.42) p = 0.63	1.48 (1.10, 1.98) p = 0.009	1.69 (1.05, 2.73) p = 0.03

† Light commercial vehicles were not included in this analysis

Table 29 PDO crash risk and injury risk associated with FCW by severity, sensitivity and vehicle type for models with *some* variant fitment status

	All Injuries	Fatal and Serious Injuries†	Minor Injuries	PDO crashes
	Narrowly sensitive			
car	1.03 (0.89, 1.20) p = 0.68	0.54 (0.33, 0.88) p = 0.01	1.12 (0.96, 1.31) p = 0.16	1.09 (0.91, 1.31) p = 0.34
SUV	1.16 (0.93, 1.46) p = 0.18	0.86 (0.44, 1.66) p = 0.65	1.22 (0.96, 1.55) p = 0.11	1.06 (0.84, 1.35) p = 0.61
LCV	0.79 (0.54, 1.14) p = 0.21		0.84 (0.56, 1.24) p = 0.38	0.73 (0.45, 1.16) p = 0.18
	Broadly sensitive			
car	0.89 (0.78, 1.02) p = 0.09	0.71 (0.53, 0.96) p = 0.02	0.95 (0.81, 1.10) p = 0.49	1.18 (0.99, 1.4) p = 0.07
SUV	1.01 (0.82, 1.24) p = 0.94	0.89 (0.57, 1.38) p = 0.60	1.02 (0.8, 1.30) p = 0.89	1.06 (0.84, 1.34) p = 0.61
LCV	1.36 (0.99, 1.88) p = 0.06		1.32 (0.9, 1.92) p = 0.15	1.18 (0.76, 1.83) p = 0.45
	Pedestrian sensitive			
car	1.21 (0.94, 1.56) p = 0.14	0.81 (0.51, 1.29) p = 0.37	1.44 (1.06, 1.96) p = 0.02	1.66 (0.50, 5.51) p = 0.41
SUV	0.92 (0.56, 1.53) p = 0.76	0.63 (0.26, 1.54) p = 0.31	1.13 (0.61, 2.08) p = 0.7	1.08 (0.24, 4.81) p = 0.92
LCV				
	Straight Crossing Paths and Low Speed Right Turn across Other Direction			
car	0.93 (0.80, 1.08) p = 0.35	0.60 (0.42, 0.86) p = 0.006	1.04 (0.88, 1.23) p = 0.65	1.08 (0.86, 1.35) p = 0.53
SUV	1.24 (0.99, 1.56) p = 0.06	1.32 (0.82, 2.11) p = 0.25	1.18 (0.91, 1.53) p = 0.22	0.99 (0.73, 1.36) p = 0.97
LCV	1.27 (0.88, 1.85) p = 0.20		1.53 (1.02, 2.30) p = 0.04	1.46 (0.84, 2.53) p = 0.18

† Light commercial vehicles were not included in this analysis

A.7 Average Annual Injury and Crash counts, 2013-2017

Table 30 Average Annual counts from Australian crash records

		All Records	Non-Sensitive Crashes	All Sensitive	Narrowly Sensitive	Broadly Sensitive	Pedestrian Sensitive	Intersection sensitive
PDO Crashes								
Low speed		61,872	23,322	38,550	18,648	12,004	238	7,660
High Speed		27,169	9,411	17,758	11,880	5,420	23	435
All		89,041	32,734	56,307	30,527	17,424	261	8,095
	Striking Vehicle							
Low speed	Car			27,533	12,910	8,791	173	5,660
	SUV			6,080	3,009	1,819	39	1,213
	LCV			4,936	2,729	1,394	26	787
High Speed	Car			11,463	7,615	3,543	17	289
	SUV			3,199	2,122	998	4	75
	LCV			3,096	2,142	879	3	72
Fatal Injuries from Injury Crashes								
Low speed		502	228	274	17	88	124	46
High Speed		1,161	583	578	25	443	60	50
All		1,664	811	852	41	531	184	96
	Striking Vehicle							
Low speed	Car			185	12	64	78	31
	SUV			44	1	12	22	8
	LCV			45	3	12	23	7
High Speed	Car			361	15	278	37	32
	SUV			108	3	84	10	10
	LCV			109	7	81	13	8
Serious Injuries from Injury Crashes								
Low speed		19,928	7,493	12,435	2,644	3,441	2,064	4,285
High Speed		10,543	3,027	7,516	2,217	4,414	285	600
All		30,471	10,520	19,951	4,861	7,856	2,350	4,885
	Striking Vehicle							
Low speed	Car			8,672	1,753	2,441	1,453	3,025
	SUV			2,054	427	575	343	709
	LCV			1,709	464	425	268	552
High Speed	Car			4,743	1,405	2,772	199	366
	SUV			1,366	373	827	44	122
	LCV			1,408	439	816	42	112
Minor Injuries from Injury Crashes								
Low speed		62,012	17,027	44,985	20,019	10,714	2,471	11,781
High Speed		30,043	10,670	19,374	11,102	6,964	198	1,109
All		92,055	27,697	64,359	31,121	17,678	2,669	12,891
	Striking Vehicle							
Low speed	Car			31,803	13,417	7,924	1,866	8,595
	SUV			7,372	3,441	1,644	354	1,933
	LCV			5,810	3,160	1,146	251	1,254
High Speed	Car			12,602	7,077	4,674	130	721
	SUV			3,440	1,949	1,252	38	201
	LCV			3,332	2,076	1,038	29	188

PDO crashes for 3 jurisdictions only; injuries for 5 jurisdictions.

Table 31 Average Annual counts from New Zealand crash records

		All Records	Non-Sensitive Crashes	All Sensitive	Narrowly Sensitive	Broadly Sensitive	Pedestrian Sensitive	Intersection sensitive
Fatal Injuries from Injury Crashes								
Low speed		59	31	28	2	9	13	4
High Speed		206	93	113	3	94	11	6
All		265	124	141	5	103	24	10
	Striking Vehicle							
Low speed	Car			20	2	6	9	3
	SUV			3	0	1	1	1
	LCV			5	0	1	3	0
High Speed	Car			77	1	66	6	3
	SUV			14	1	11	1	1
	LCV			22	1	16	4	1
Serious Injuries from Injury Crashes								
Low speed		926	368	559	55	253	172	79
High Speed		1,057	585	472	56	355	21	40
All		1,983	952	1,031	110	608	193	119
	Striking Vehicle							
Low speed	Car			437	42	198	135	62
	SUV			57	5	27	15	10
	LCV			65	8	28	22	7
High Speed	Car			330	40	249	15	26
	SUV			59	4	48	2	5
	LCV			84	12	59	4	9
Minor Injuries from Injury Crashes								
Low speed		5,289	1,789	3,500	917	1,486	507	589
High Speed		4,205	2,549	1,655	610	904	26	116
All		9,494	4,338	5,155	1,526	2,391	533	705
	Striking Vehicle							
Low speed	Car			2,807	727	1,208	414	457
	SUV			359	88	152	49	70
	LCV			334	102	126	44	62
High Speed	Car			1,170	446	628	19	76
	SUV			218	71	124	3	19
	LCV			268	92	152	4	21

A.8 Average Annual Injury and Crash Savings with Current Fitment

Table 32 Average Annual savings in Australia with current AEB fitment estimate

		%savings of ALL	Narrowly Sensitive	Broadly Sensitive	Pedestrian Sensitive	Intersection sensitive
PDO Crashes						
Low speed		0.15%	60	27	0	5
High Speed		0.08%	16	4	0	1
All		0.13%	76	31	0	7
	Striking Vehicle					
	Car		32	14	0	3
Low speed	SUV		28	13	0	2
	LCV		0	0	0	0
High Speed	Car		8	3	0	1
	SUV		8	2	0	1
	LCV		0	0	0	0
Fatal Injuries from Injury Crashes						
Low speed		0.03%	0	0	0	0
High Speed		0.10%	0	1	0	0
All		0.08%	0	1	0	0
	Striking Vehicle					
	Car		0	0	0	0
Low speed	SUV		0	0	0	0
	LCV		0	0	0	0
High Speed	Car		0	1	0	0
	SUV		0	0	0	0
	LCV		0	0	0	0
Serious Injuries from Injury Crashes						
Low speed		0.14%	9	8	0	12
High Speed		0.13%	3	8	0	3
All		0.14%	12	16	0	15
	Striking Vehicle					
	Car		5	5	0	6
Low speed	SUV		4	3	0	6
	LCV		0	0	0	0
High Speed	Car		2	3	0	1
	SUV		2	4	0	1
	LCV		0	0	0	0
Minor Injuries from Injury Crashes						
Low speed		0.10%	42	10	2	5
High Speed		0.11%	26	2	0	6
All		0.10%	68	12	2	11
	Striking Vehicle					
	Car		23	5	2	3
Low speed	SUV		19	4	1	2
	LCV		0	0	0	0
High Speed	Car		14	1	0	3
	SUV		12	1	0	3
	LCV		0	0	0	0

PDO savings for 3 jurisdictions only; injury savings for 5 jurisdictions.

Table 33 Average Annual savings in Australia with current AEB fitment -lower bound of 95% confidence interval

		%savings of ALL	Narrowly Sensitive	Broadly Sensitive	Pedestrian Sensitive	Intersection sensitive
PDO Crashes						
Low speed		0.06%	29	13	0	-6
High Speed		-0.01%	1	-4	0	-1
All		0.04%	30	9	0	-7
Low speed	Car		15	7	0	-3
	SUV		14	6	0	-3
	LCV		0	0	0	0
High Speed	Car		0	-2	0	0
	SUV		0	-1	0	0
	LCV		0	0	0	0
Fatal Injuries from Injury Crashes						
Low speed		0.004%	0	0	0	0
High Speed		0.02%	0	0	0	0
All		0.01%	0	0	0	0
Low speed	Car		0	0	0	0
	SUV		0	0	0	0
	LCV		0	0	0	0
High Speed	Car		0	0	0	0
	SUV		0	0	0	0
	LCV		0	0	0	0
Serious Injuries from Injury Crashes						
Low speed		0.02%	2	2	0	1
High Speed		-0.01%	-3	2	0	0
All		0.01%	-1	3	0	1
Low speed	Car		1	1	0	1
	SUV		1	1	0	0
	LCV		0	0	0	0
High Speed	Car		-1	1	0	0
	SUV		-1	1	0	0
	LCV		0	0	0	0
Minor Injuries from Injury Crashes						
Low speed		0.01%	20	-2	-3	-8
High Speed		0.01%	7	-6	0	2
All		0.01%	27	-8	-3	-7
	Striking Vehicle					
Low speed	Car		11	-1	-2	-5
	SUV		9	-1	-1	-3
	LCV		0	0	0	0
High Speed	Car		4	-3	0	1
	SUV		4	-3	0	1
	LCV		0	0	0	0

PDO savings for 3 jurisdictions only; injury savings for 5 jurisdictions.

Table 34 Average Annual savings in Australia with current AEB fitment -upper bound of 95% confidence interval

		%savings of ALL	Narrowly Sensitive	Broadly Sensitive	Pedestrian Sensitive	Intersection sensitive
PDO Crashes						
Low speed		0.26%	101	43	0	20
High Speed		0.18%	33	13	0	4
All		0.24%	134	56	0	24
	Striking Vehicle					
Low speed	Car		54	22	0	11
	SUV		46	20	0	9
	LCV		0	0	0	0
High Speed	Car		17	8	0	2
	SUV		16	5	0	2
	LCV		0	0	0	0
Fatal Injuries from Injury Crashes						
Low speed		0.05%	0	0	0	0
High Speed		0.21%	0	2	0	1
All		0.16%	0	2	0	1
	Striking Vehicle					
Low speed	Car		0	0	0	0
	SUV		0	0	0	0
	LCV		0	0	0	0
High Speed	Car		0	1	0	1
	SUV		0	1	0	0
	LCV		0	0	0	0
Serious Injuries from Injury Crashes						
Low speed		0.29%	18	15	0	26
High Speed		0.31%	12	15	0	6
All		0.30%	30	30	0	31
	Striking Vehicle					
Low speed	Car		10	9	0	14
	SUV		8	6	0	12
	LCV		0	0	0	0
High Speed	Car		6	7	0	3
	SUV		6	9	0	3
	LCV		0	0	0	0
Minor Injuries from Injury Crashes						
Low speed		0.19%	67	22	9	20
High Speed		0.23%	48	12	0	11
All		0.20%	115	34	9	31
	Striking Vehicle					
Low speed	Car		36	13	6	12
	SUV		31	9	3	8
	LCV		1	0	0	0
High Speed	Car		26	6	0	6
	SUV		22	5	0	5
	LCV		0	0	0	0

PDO savings for 3 jurisdictions only; injury savings for 5 jurisdictions.

Table 35 Average Annual savings in Australia with current FCW fitment without AEB

		Narrowly Sensitive	Broadly Sensitive	Pedestrian Sensitive	Intersection sensitive
PDO Crashes					
Low speed		0	0	0	0
High Speed		0	0	0	0
All		0	0	0	0
	Car	0	0	0	0
Low speed	SUV	0	0	0	0
	LCV	0	0	0	0
High Speed	Car	0	0	0	0
	SUV	0	0	0	0
	LCV	0	0	0	0
Fatal Injuries from Injury Crashes					
Low speed		0	0	0	0
High Speed		0	1	0	0
All		0	1	0	0
	Car	0	0	0	0
Low speed	SUV	0	0	0	0
	LCV	0	0	0	0
High Speed	Car	0	0	0	0
	SUV	0	0	0	0
	LCV	0	0	0	0
Serious Injuries from Injury Crashes					
Low speed		2	0	1	3
High Speed		6	7	0	1
All		8	7	2	4
	Car	1	0	1	2
Low speed	SUV	1	0	0	1
	LCV	0	0	0	0
High Speed	Car	3	5	0	0
	SUV	2	2	0	0
	LCV	1	1	0	0
Minor Injuries from Injury Crashes					
Low speed		2	0	0	0
High Speed		0	0	0	0
All		2	0	0	0
	Striking Vehicle				
	Car	2	0	0	0
Low speed	SUV	0	0	0	0
	LCV	0	0	0	0
High Speed	Car	0	0	0	0
	SUV	0	0	0	0
	LCV	0	0	0	0

PDO savings for 3 jurisdictions only; injury savings for 5 jurisdictions.

Table 36 Average Annual savings in New Zealand with current AEB fitment estimate

		%savings of ALL	Narrowly Sensitive	Broadly Sensitive	Pedestrian Sensitive	Intersection sensitive
Fatal Injuries from Injury Crashes						
Low speed		0.000%	0	0	0	0
High Speed		0.24%	0	0	0	0
All		0.18%	0	0	0	0
	Striking Vehicle					
Low speed	Car		0	0	0	0
	SUV		0	0	0	0
	LCV		0	0	0	0
High Speed	Car		0	0	0	0
	SUV		0	0	0	0
	LCV		0	0	0	0
Serious Injuries from Injury Crashes						
Low speed		0.05%	0	0	0	0
High Speed		0.13%	0	1	0	0
All		0.09%	0	2	0	0
	Striking Vehicle					
Low speed	Car		0	0	0	0
	SUV		0	0	0	0
	LCV		0	0	0	0
High Speed	Car		0	1	0	0
	SUV		0	0	0	0
	LCV		0	0	0	0
Minor Injuries from Injury Crashes						
Low speed		0.06%	1	2	0	0
High Speed		0.05%	1	1	0	0
All		0.06%	2	2	0	0
	Striking Vehicle					
Low speed	Car		1	1	0	0
	SUV		0	0	0	0
	LCV		0	0	0	0
High Speed	Car		1	0	0	0
	SUV		0	0	0	0
	LCV		0	0	0	0

Table 37 Average Annual savings in New Zealand with current AEB fitment -lower bound of 95% confidence interval

		%savings of ALL	Narrowly Sensitive	Broadly Sensitive	Pedestrian Sensitive	Intersection sensitive
Fatal Injuries from Injury Crashes						
Low speed		0.000%	0	0	0	0
High Speed		0.03%	0	0	0	0
All		0.02%	0	0	0	0
	Striking Vehicle					
	Car		0	0	0	0
Low speed	SUV		0	0	0	0
	LCV		0	0	0	0
High Speed	Car		0	0	0	0
	SUV		0	0	0	0
	LCV		0	0	0	0
Serious Injuries from Injury Crashes						
Low speed		0.01%	0	0	0	0
High Speed		0.02%	0	0	0	0
All		0.01%	0	0	0	0
	Striking Vehicle					
	Car		0	0	0	0
Low speed	SUV		0	0	0	0
	LCV		0	0	0	0
High Speed	Car		0	0	0	0
	SUV		0	0	0	0
	LCV		0	0	0	0
Minor Injuries from Injury Crashes						
Low speed		-0.01%	0	0	0	0
High Speed		-0.03%	0	-2	0	0
All		-0.02%	1	-2	0	0
	Striking Vehicle					
	Car		0	0	0	0
Low speed	SUV		0	0	0	0
	LCV		0	0	0	0
High Speed	Car		0	-1	0	0
	SUV		0	-1	0	0
	LCV		0	0	0	0

Table 38 Average Annual savings in New Zealand with current AEB fitment -upper bound of 95% confidence interval

		%savings of ALL	Narrowly Sensitive	Broadly Sensitive	Pedestrian Sensitive	Intersection sensitive
Fatal Injuries from Injury Crashes						
Low speed		0.000%	0	0	0	0
High Speed		0.51%	0	0	0	1
All		0.39%	0	0	0	1
	Striking Vehicle					
Low speed	Car		0	0	0	0
	SUV		0	0	0	0
	LCV		0	0	0	0
High Speed	Car		0	0	0	0
	SUV		0	0	0	1
	LCV		0	0	0	0
Serious Injuries from Injury Crashes						
Low speed		0.10%	0	1	0	0
High Speed		0.27%	0	2	0	0
All		0.19%	0	3	0	0
	Striking Vehicle					
Low speed	Car		0	1	0	0
	SUV		0	0	0	0
	LCV		0	0	0	0
High Speed	Car		0	2	0	0
	SUV		0	0	0	0
	LCV		0	0	0	0
Minor Injuries from Injury Crashes						
Low speed		0.13%	2	4	1	1
High Speed		0.15%	2	3	0	0
All		0.14%	4	7	1	1
	Striking Vehicle					
Low speed	Car		1	2	1	0
	SUV		1	1	0	0
	LCV		0	0	0	0
High Speed	Car		1	2	0	0
	SUV		1	1	0	0
	LCV		0	0	0	0

Table 39 Average Annual savings in New Zealand with current FCW fitment without AEB

		Narrowly Sensitive	Broadly Sensitive	Pedestrian Sensitive	Intersection sensitive
Fatal Injuries from Injury Crashes					
Low speed		0	0	0	0
High Speed		0	0	0	0
All		0	0	0	0
	Car	0	0	0	0
Low speed	SUV	0	0	0	0
	LCV	0	0	0	0
High Speed	Car	0	0	0	0
	SUV	0	0	0	0
	LCV	0	0	0	0
Serious Injuries from Injury Crashes					
Low speed		0	0	0	0
High Speed		0	1	0	0
All		0	1	0	0
	Car	0	0	0	0
Low speed	SUV	0	0	0	0
	LCV	0	0	0	0
High Speed	Car	0	1	0	0
	SUV	0	1	0	0
	LCV	0	0	0	0
Minor Injuries from Injury Crashes					
Low speed		0	0	0	0
High Speed		0	0	0	0
All		0	0	0	0
	Striking Vehicle				
	Car	0	0	0	0
Low speed	SUV	0	0	0	0
	LCV	0	0	0	0
High Speed	Car	0	0	0	0
	SUV	0	0	0	0
	LCV	0	0	0	0

A.9 Average Annual Injury and Crash Savings with 100% Fitment

Table 40 Average Annual savings in Australia with 100% AEB fitment estimate

			AEB % reductions					AEB Savings with 100% fitment of striking vehicles				
			%of all	Narrowly Sensitive	Broadly Sensitive	Pedestrian Sensitive	Intersection sensitive	All	Narrowly Sensitive	Broadly Sensitive	Pedestrian Sensitive	Intersection sensitive
PDO Crashes												
Low speed			27%	57%	21%	0%	44%	16,479	10,591	2,479	-	3,409
High Speed			8%	15%	8%	0%	25%	2,248	1,725	416	-	107
All			21%					18,727	12,316	2,894	-	3,516
		Striking Vehicle										
	Low speed	Car						11,659	7,327	1,814	-	2,518
		SUV						2,637	1,720	377	-	540
		LCV						2,182	1,545	287	-	350
	High Speed	Car						1,448	1,106	272	-	71
		SUV						404	309	77	-	18
		LCV						396	311	67	-	18
Fatal Injuries from Injury Crashes												
Low speed			6%	37%	17%	0%	21%	31	6	15	-	9
High Speed			8%	15%	17%	0%	32%	96	4	76	-	16
All			8%					126	10	91	-	26
		Striking Vehicle										
	Low speed	Car						22	4	11	-	6
		SUV						4	0	2	-	2
		LCV						5	1	2	-	1
	High Speed	Car						60	2	47	-	10
		SUV						18	0	14	-	3
		LCV						17	1	14	-	3
Serious Injuries from Injury Crashes												
Low speed			12%	37%	17%	0%	21%	2,456	984	588	-	884
High Speed			12%	15%	17%	0%	32%	1,275	328	755	-	193
All			12%					3,731	1,312	1,342	-	1,077
		Striking Vehicle										
	Low speed	Car						1,693	652	417	-	623
		SUV						406	160	98	-	147
		LCV						358	172	72	-	113
	High Speed	Car						799	208	474	-	118
		SUV						237	55	142	-	39
		LCV						239	65	139	-	36
Minor Injuries from Injury Crashes												
Low speed			8%	19%	8%	8%	3%	5,191	3,758	834	191	408
High Speed			19%	48%	3%	0%	30%	5,826	5,306	190	-	329
All			12%					11,017	9,064	1,025	191	737
		Striking Vehicle										
	Low speed	Car						3,576	2,518	617	144	297
		SUV						871	648	128	27	67
		LCV						744	592	89	19	43
	High Speed	Car						3,723	3,381	128	-	214
		SUV						1,029	935	34	-	60
		LCV						1,074	990	28	-	55

PDO savings for 3 jurisdictions only; injury savings for 5 jurisdictions.

Table 41 Average Annual savings in Australia with 100% AEB fitment - lower bound of 95% confidence interval

		AEB % reductions -Low					AEB Savings-Low with 100% fitment of striking vehicles				
		%of all	Narrowly Sensitive	Broadly Sensitive	Pedestrian Sensitive	Intersection sensitive	All	Narrowly Sensitive	Broadly Sensitive	Pedestrian Sensitive	Intersection sensitive
PDO Crashes											
Low speed		10%	24%	11%	0%	5%	6,094	4,412	1,313	-	368
High Speed		1%	1%	-8%	0%	-15%	-383	103	-420	-	-66
All		6%					5,710	4,515	893	-	302
	Striking Vehicle										
Low speed	Car						4,286	3,052	961	-	272
	SUV						975	716	200	-	58
	LCV						834	644	152	-	38
High Speed	Car						-253	66	-275	-	-44
	SUV						-70	18	-77	-	-11
	LCV						-60	19	-68	-	-11
Fatal Injuries from Injury Crashes											
Low speed		1%	13%	4%	0%	2%	7	2	3	-	1
High Speed		1%	-16%	4%	0%	3%	15	-4	17	-	2
All		1%					21	-2	21	-	3
	Striking Vehicle										
Low speed	Car						5	2	2	-	1
	SUV						1	0	0	-	0
	LCV						1	0	0	-	0
High Speed	Car						9	-2	11	-	1
	SUV						3	-0	3	-	0
	LCV						2	-1	3	-	0
Serious Injuries from Injury Crashes											
Low speed		3%	13%	4%	0%	2%	572	342	133	-	96
High Speed		2%	-16%	4%	0%	3%	-173	-365	171	-	21
All		1%					399	-22	304	-	117
	Striking Vehicle										
Low speed	Car						389	227	94	-	68
	SUV						94	56	22	-	16
	LCV						89	60	16	-	12
High Speed	Car						-111	-231	107	-	13
	SUV						-25	-62	32	-	4
	LCV						-37	-72	32	-	4
Minor Injuries from Injury Crashes											
Low speed		1%	10%	-2%	-12%	-6%	803	1,965	-179	-288	-695
High Speed		1%	8%	-9%	0%	11%	364	879	-636	-	121
All		1%					1,167	2,845	-816	-288	-574
Low speed	Car						459	1,317	-133	-218	-507
	SUV						156	339	-28	-41	-114
	LCV						187	310	-19	-29	-74
High Speed	Car						212	560	-427	-	79
	SUV						63	155	-114	-	22
	LCV						90	164	-95	-	20

PDO savings for 3 jurisdictions only; injury savings for 5 jurisdictions.

Table 42 Average Annual savings in Australia with 100% AEB fitment - upper bound of 95% confidence interval

		AEB % reductions -High					AEB Savings-High with 100% fitment of striking vehicles				
		%of all	Narrowly Sensitive	Broadly Sensitive	Pedestrian Sensitive	Intersection sensitive	All	Narrowly Sensitive	Broadly Sensitive	Pedestrian Sensitive	Intersection sensitive
PDO Crashes											
Low speed		37%	75%	29%	0%	68%	22,801	14,100	3,518	-	5,183
High Speed		16%	26%	21%	0%	51%	4,477	3,125	1,131	-	221
All		31%					27,278	17,225	4,649	-	5,404
	Striking Vehicle										
	Car						16,158	9,754	2,575	-	3,829
Low speed	SUV						3,646	2,289	536	-	822
	LCV						2,997	2,057	408	-	532
High Speed	Car						2,889	2,003	739	-	147
	SUV						806	560	209	-	38
	LCV						782	563	183	-	36
Fatal Injuries from Injury Crashes											
Low speed		10%	55%	28%	0%	35%	50	9	25	-	16
High Speed		14%	37%	28%	0%	52%	162	9	126	-	26
All		13%					212	18	151	-	43
	Striking Vehicle										
	Car						36	7	18	-	11
Low speed	SUV						7	1	3	-	3
	LCV						7	2	3	-	2
High Speed	Car						101	6	79	-	17
	SUV						31	1	24	-	5
	LCV						30	3	23	-	4
Serious Injuries from Injury Crashes											
Low speed		20%	55%	28%	0%	35%	3,952	1,448	980	-	1,524
High Speed		23%	37%	28%	0%	52%	2,407	835	1,258	-	314
All		21%					6,359	2,283	2,238	-	1,838
	Striking Vehicle										
	Car						2,729	960	695	-	1,075
Low speed	SUV						653	235	164	-	254
	LCV						569	253	121	-	195
High Speed	Car						1,510	529	790	-	191
	SUV						442	141	237	-	64
	LCV						455	165	232	-	58
Minor Injuries from Injury Crashes											
Low speed		15%	27%	16%	24%	12%	9,129	5,374	1,754	587	1,414
High Speed		31%	70%	13%	0%	44%	9,243	7,821	928	-	494
All		20%					18,372	13,195	2,682	587	1,908
	Striking Vehicle										
	Car						6,372	3,601	1,297	443	1,032
Low speed	SUV						1,513	927	270	84	232
	LCV						1,244	847	187	59	150
High Speed	Car						5,927	4,984	623	-	321
	SUV						1,635	1,378	167	-	90
	LCV						1,681	1,459	138	-	83

PDO savings for 3 jurisdictions only; injury savings for 5 jurisdictions.

Table 43 Average Annual savings in New Zealand with 100% AEB fitment estimate

		AEB % reductions					AEB Savings with 100% fitment of striking vehicles				
		%of all	Narrowly Sensitive	Broadly Sensitive	Pedestrian Sensitive	Intersection sensitive	All	Narrowly Sensitive	Broadly Sensitive	Pedestrian Sensitive	Intersection sensitive
Fatal Injuries from Injury Crashes											
Low speed		5%	37%	17%	0%	21%	3	1	1	-	1
High Speed		9%	15%	17%	0%	32%	18	0	16	-	2
All		8%					21	1	18	-	3
	Striking Vehicle										
Low speed	Car						2	1	1	-	1
	SUV						0	0	0	-	0
	LCV						0	-	0	-	0
High Speed	Car						13	0	11	-	1
	SUV						3	0	2	-	1
	LCV						3	0	3	-	0
Serious Injuries from Injury Crashes											
Low speed		9%	37%	17%	0%	21%	80	20	43	-	16
High Speed		8%	15%	17%	0%	32%	82	8	61	-	13
All		8%					162	29	104	-	29
	Striking Vehicle										
Low speed	Car						62	16	34	-	13
	SUV						8	2	5	-	2
	LCV						9	3	5	-	1
High Speed	Car						57	6	43	-	8
	SUV						11	1	8	-	2
	LCV						15	2	10	-	3
Minor Injuries from Injury Crashes											
Low speed		7%	19%	8%	8%	3%	347	172	116	39	20
High Speed		8%	48%	3%	0%	30%	350	291	25	-	34
All		7%					698	463	140	39	55
	Striking Vehicle										
Low speed	Car						278	136	94	32	16
	SUV						35	17	12	4	2
	LCV						34	19	10	3	2
High Speed	Car						253	213	17	-	22
	SUV						43	34	3	-	6
	LCV						54	44	4	-	6

Table 44 Average Annual savings in New Zealand with 100% AEB fitment - lower bound of 95% confidence interval

		AEB % reductions -Low					AEB Savings-Low with 100% fitment of striking vehicles				
		%of all	Narrowly Sensitive	Broadly Sensitive	Pedestrian Sensitive	Intersection sensitive	All	Narrowly Sensitive	Broadly Sensitive	Pedestrian Sensitive	Intersection sensitive
Fatal Injuries from Injury Crashes											
Low speed		1%	13%	4%	0%	2%	1	0	0	-	0
High Speed		2%	-16%	4%	0%	3%	3	- 0	4	-	0
All		2%					4	- 0	4	-	0
	Striking Vehicle										
Low speed	Car						1	0	0	-	0
	SUV						0	0	0	-	0
	LCV						0	-	0	-	0
High Speed	Car						2	- 0	3	-	0
	SUV						0	- 0	0	-	0
	LCV						0	- 0	1	-	0
Serious Injuries from Injury Crashes											
Low speed		2%	13%	4%	0%	2%	19	7	10	-	2
High Speed		1%	-16%	4%	0%	3%	6	- 9	14	-	1
All		1%					25	- 2	24	-	3
	Striking Vehicle										
Low speed	Car						14	5	8	-	1
	SUV						2	1	1	-	0
	LCV						2	1	1	-	0
High Speed	Car						4	- 6	10	-	1
	SUV						1	- 1	2	-	0
	LCV						1	- 2	2	-	0
Minor Injuries from Injury Crashes											
Low speed		1%	10%	-2%	-12%	-6%	- 29	90	- 25	- 59	- 35
High Speed		1%	8%	-9%	0%	11%	- 22	48	- 83	-	13
All		1%					- 51	138	- 108	- 59	- 22
	Striking Vehicle										
Low speed	Car						- 24	71	- 20	- 48	- 27
	SUV						- 4	9	- 3	- 6	- 4
	LCV						- 1	10	- 2	- 5	- 4
High Speed	Car						- 14	35	- 57	-	8
	SUV						- 4	6	- 11	-	2
	LCV						- 4	7	- 14	-	2

Table 45 Average Annual savings in New Zealand with 100% AEB fitment - upper bound of 95% confidence interval

		AEB % reductions -High					AEB Savings-High with 100% fitment of striking vehicles				
		%of all	Narrowly Sensitive	Broadly Sensitive	Pedestrian Sensitive	Intersection sensitive	All	Narrowly Sensitive	Broadly Sensitive	Pedestrian Sensitive	Intersection sensitive
Fatal Injuries from Injury Crashes											
Low speed		8%	55%	28%	0%	35%	5	1	2	-	1
High Speed		15%	37%	28%	0%	52%	31	1	27	-	3
All		14%					36	2	29	-	4
	Striking Vehicle										
	Car						4	1	2	-	1
Low speed	SUV						1	0	0	-	0
	LCV						1	-	0	-	0
High Speed	Car						21	1	19	-	2
	SUV						4	0	3	-	1
	LCV						5	0	5	-	0
Serious Injuries from Injury Crashes											
Low speed		14%	55%	28%	0%	35%	130	30	72	-	28
High Speed		14%	37%	28%	0%	52%	144	21	102	-	21
All		14%					274	51	174	-	49
	Striking Vehicle										
	Car						101	23	56	-	22
Low speed	SUV						14	3	8	-	3
	LCV						15	4	8	-	2
High Speed	Car						99	15	71	-	13
	SUV						18	2	14	-	3
	LCV						26	4	17	-	5
Minor Injuries from Injury Crashes											
Low speed		13%	27%	16%	24%	12%	680	246	243	120	71
High Speed		14%	70%	13%	0%	44%	601	429	120	-	52
All		13%					1,282	675	364	120	122
	Striking Vehicle										
	Car						546	195	198	98	55
Low speed	SUV						69	24	25	12	8
	LCV						66	27	21	10	7
High Speed	Car						432	314	84	-	34
	SUV						76	51	17	-	9
	LCV						94	65	20	-	9

[i] Howsafeisyour car.com.au:

Further information

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