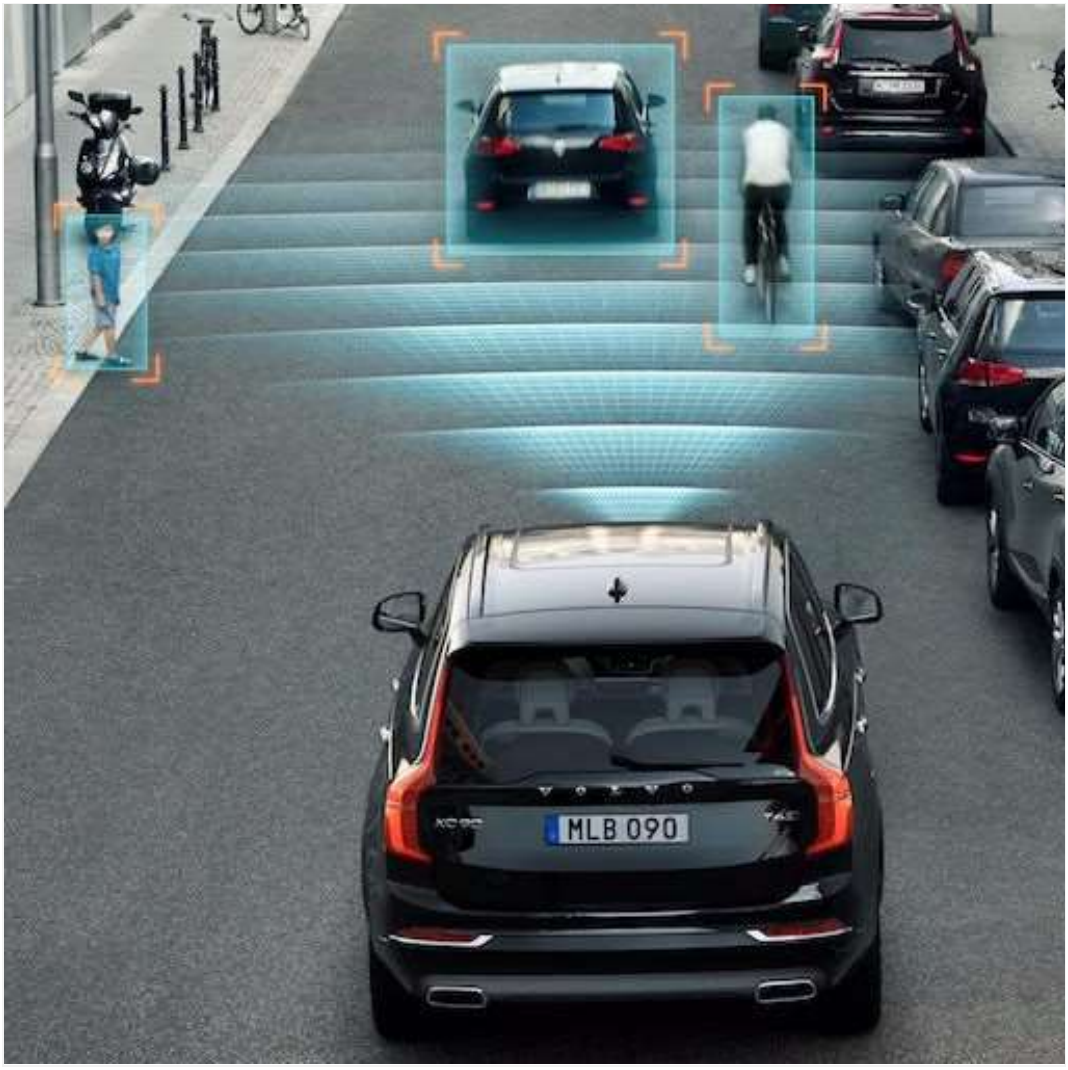
Autonomous Emergency Braking AEB (city, inter-urban)

Please refer to this document as follows: **Saadé, J. (2017), Autonomous Emergency Braking AEB (city, inter-urban), European Road Safety Decision Support System, developed by the H2020 project SafetyCube. Retrieved from www.roadsafety-dss.eu on DD MM YYYY**



Please note: The studies included in this synopses were selected from those identified by a systematic literature search of specific databases (see supporting document). The main criterion for inclusion of studies in this synopsis and the DSS was that each study provides a *quantitative effect estimate*, preferably on the number or severity of crashes or otherwise on road user behaviour that is known to be related to the occurrence or severity of a crash. Therefore, key studies providing qualitative information might not be included in this synopsis.

1 Summary

Saadé, J., September 2017

1.1 COLOUR CODE: GREEN

The bibliographic review on the effectiveness of AEB city & interurban suggests that this is an effective measure. While no studies were found dealing with AEB interurban, five studies were found dealing with AEB city and all suggest that it has a positive effect on road safety.

1.2 KEYWORDS

Autonomous emergency braking; AEB; automatic brake; effectiveness; passenger cars; SUV; HGV; rear-end crashes; frontal crashes

1.3 ABSTRACT

Autonomous Emergency Braking (AEB) is an in-vehicle system that can avoid a crash with another vehicle or mitigate its consequences by automatically applying the brakes. The term AEB is usually followed by the words "city" or "interurban" which designate the environment where it is supposed to be the most efficient. AEB city can work only at low speeds (below 30 or 50 km/h) while AEB interurban can work only at high speeds. Depending on the system supplier or manufacturer, the system may give a warning to the driver and apply the brakes only in case of no driver reaction.
This document presents a literature review of the effects of AEB city and interurban systems in terms of accident numbers and injury severity. A systematic literature search has been conducted and relevant studies have been analysed. No relevant study was found dealing with AEB interurban while five relevant studies were found for AEB city. Four of them undertook retrospective analyses and only one prospective analysis was found. The latter consists of a study of the potential benefit of AEB systems in reducing injuries in frontal crashes between heavy goods vehicles and passenger cars, if the system was designed to work in this configuration. The other studies demonstrated that AEB city is efficient in reducing rear-end crashes and injuries in different environments and on different car models. Essentially Volvo cars were used in the analyses. This is certainly due to the fact that Volvo was the first to make AEB standard on different vehicle models.

1.4 BACKGROUND

1.4.1 Introduction to measure and its effect on road safety

In 2014, there were nearly two million police-reported rear-end crashes in the United States (US), representing 32% of all police reported crashes. By automatically applying the brakes, AEB city and interurban can avoid a rear-end crash or mitigate its consequences by reducing the impact speed.

1.4.2 Study methods

Two types of analyses were used in order to determine the efficiency of AEB systems: prospective and restrospective analyses. For the only prospective analysis that was found, the potential benefit of reducing injuries in frontal crashes was studied. The retrospective analyses undertook case control studies. The cases were the striking vehicles in rear-end crashes while the controls depended on the analysis methods. When induced exposure was used, rear-ended vehicles in rear-end crashes

or crossing crashes were used as controls. In the other cases, insured vehicle years were used as controls.

1.4.3 Measures of effect

The effect AEB system has on road safety has been evaluated through the reduction or increase in the number of crashes or injuries. The Abbreviated Injury Scale (AIS) was used in one study.

1.5 NOTES ON ANALYSIS METHODS

The selected studies are relatively recent (2012-2017) and deal with analyses performed on European (mostly Swedish) & US data. Transferability to other countries can be considered but one should be very careful of the fact that the efficiency of AEB may be very sensitive to accident scenarios that are controlled by infrastructure (accident at a straight road, at intersection, with vehicle at high speed, with the presence of environmental masks ...).

The studies where rear-end struck vehicles were used as controls may be biased by the fact that AEB equipped vehicles could be struck more or less often than those that are not equipped.

It should be kept in mind that the vehicles equipped with AEB that were used in the studies might have been equipped with optional safety or driver assist packages, thus affecting the findings. However, take rates are still relatively low. Therefore this was not expected to greatly affect the analyses.

As a consequence of different study designs, the scientific overview part will be constituted of a literature review. No vote-count analysis or meta-analysis could have been achieved.

2 Scientific overview

2.1 LITERATURE REVIEW

Autonomous emergency braking (AEB) has now been present on the market for approximately a decade (introduced in 2006 in the US) and Volvo has even made it standard on its XC60 and V70 models since 2012 and on all its models in 2014. Therefore, some recent studies were able to undertake restrospective analyses in order to find the efficiency of AEB systems in preventing crashes and injuries. Among the retrospective analyses that were found, two studies (Cicchino 2017; Isaksson-Hellman and Lindman 2016) used the number of insured vehicle years as a control variable in order to calculate the efficiency which, in this case, can be expressed as :

$$Efficiency = 1 - \frac{\frac{Nbr\ of\ rear\ end\ crashes\ or\ injuries\ with\ AEB\ equiped\ vehicles}{Nbr\ of\ insured\ years\ for\ AEB\ equiped\ vehicles}}{\frac{Nbr\ of\ rear\ end\ crashes\ or\ injuries\ with\ non\ AEB\ equiped\ vehicles}{Nbr\ of\ insured\ years\ for\ non\ AEB\ equiped\ vehicles}}$$

As the number of insured vehicle years may be hard to estimate, other studies (Fildes et al. 2015; Rizzi, Kullgren, and Tingvall 2014) undertook an alternative approach by using the induced exposure method in order to estimate the efficiency of AEB systems. This consists of choosing a crash configuration that is not sensitive to the use of the system and using the number of crashes or injuries in this configuration as a control variable. The efficiency is then expressed as:

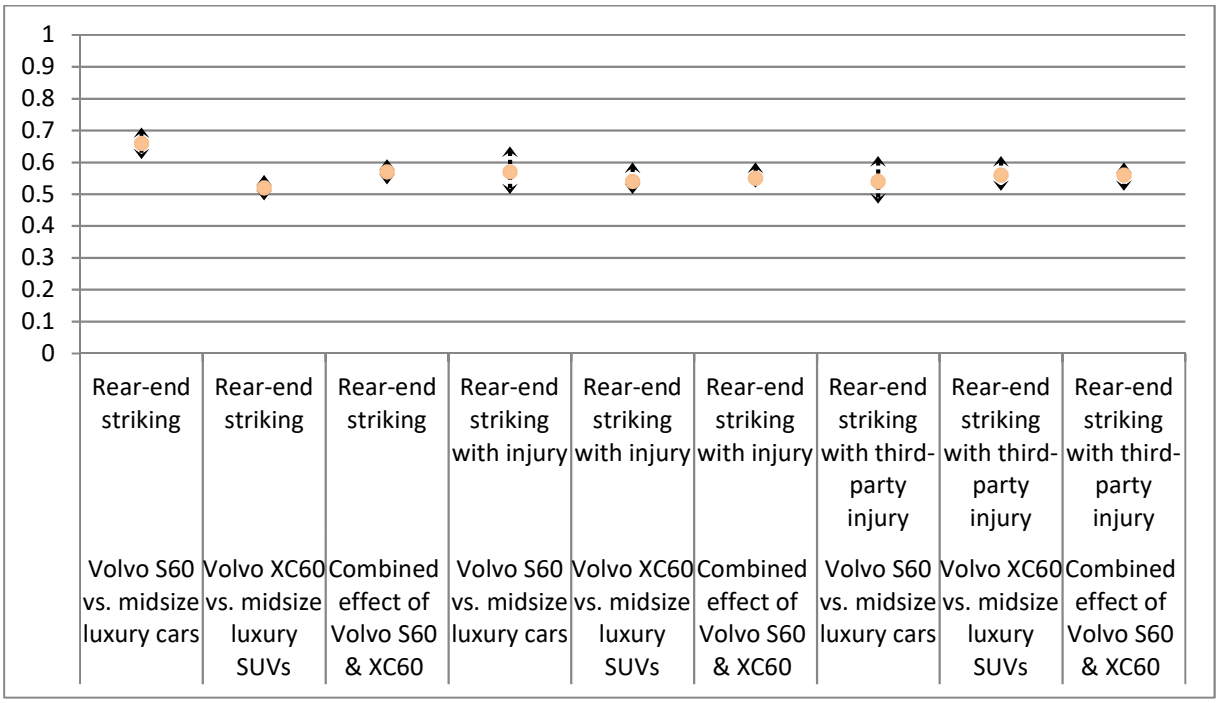
$$Efficiency = 1 - \frac{\frac{Nbr\ of\ AEB\ sensitive\ crashes\ or\ injuries\ in\ AEB\ equiped\ vehicles}{Nbr\ of\ non\ sensitive\ crashes\ or\ injuries\ in\ AEB\ equiped\ vehicles}}{\frac{Nbr\ of\ AEB\ sensitive\ crashes\ or\ injuries\ in\ non\ AEB\ equiped\ vehicles}{Nbr\ of\ non\ sensitive\ crashes\ or\ injuries\ in\ non\ AEB\ equiped\ vehicles}}$$

For instance, in these two studies, the number of striking vehicles in rear-end crashes was considered as sensitive to AEB and the number of struck vehicles in rear-end crashes were considered as non-sensitive to AEB. In Rizzi, Kullgren, and Tingvall (2014), the number of crossing crashes were also considered as non-sensitive to AEB. More information on the study designs and methods is available in **Table 3.3**.

One study (Strandroth et al. 2012) undertook a prospective analysis in order to determine the benefit of automatic breaking in the case it was designed to work in frontal crashes between cars and heavy goods vehicles (HGVs). The analysis found that if only HGVs were equipped with AEB, MAIS 2+ injury would be reduced by 52%. If AEB was on both HGVs and cars, MAIS 2+ injury reduction would be reduced by 73%.

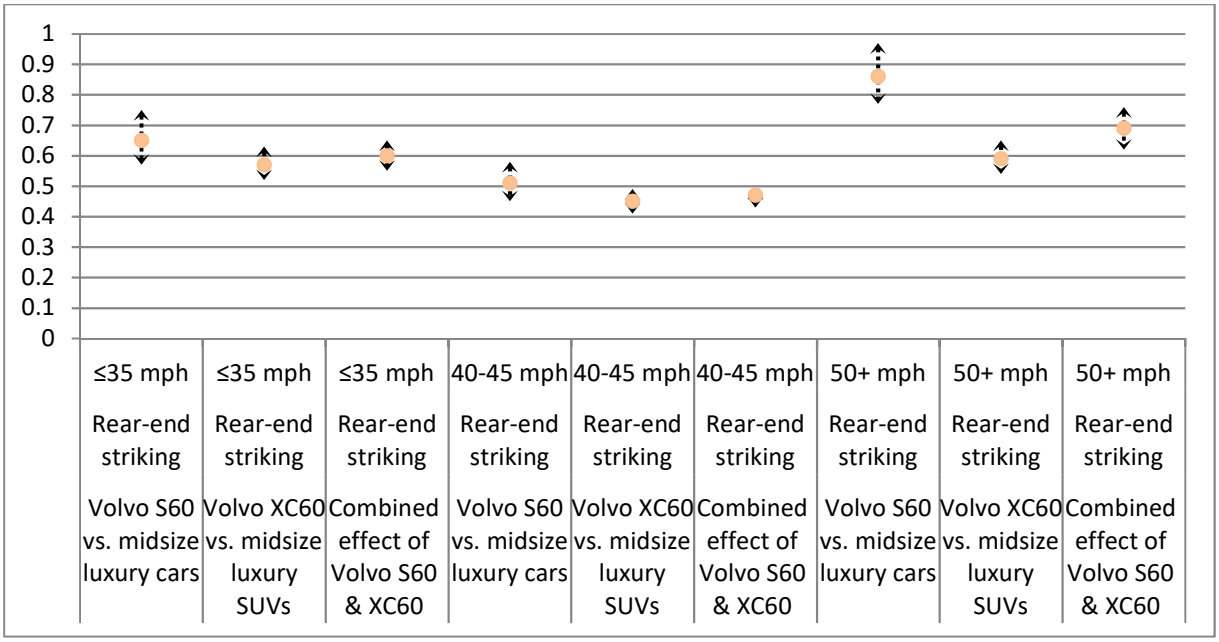
All studies except (Strandroth et al. 2012) investigated the efficiency of low speed AEB (city) in reducing rear-end crashes or injuries in rear-end crashes. Cicchino (2017) examined the effectiveness of Volvo's AEB system that only operates at low speeds in preventing police reported rear-end striking crashes in the United States. As AEB was a standard feature on certain Volvo models, crash involvement rates for Volvo S60 and XC60 models were compared with those for comparable midsize luxury cars and SUVs, respectively, that did not have standard AEB. The system was found to be efficient in reducing crashes with and without injuries (see **Figure 2. 1**).

Figure 2. 1 Adjusted rate ratios (and 95% confidence intervals) examining the effect of low-speed AEB on rear-end striking crash involvement rates with and without injury.



Furthermore, low speed AEB effects were estimated at different speed limit levels (see **Figure 2. 2**, **Figure 2. 3**, and **Figure 2. 4**). It was demonstrated that low speed AEB was effective on all speed limits. It was also demonstrated that it had the weakest effect at speed limits of 50 mph or greater, which was expected, and the strongest effect at speed limits of 40-45 mph, which was surprising, considering that low speed AEB was operational at speeds as low as 19 mph. One reason for this finding may be the high frequency of intersections on these roads, where drivers may often be involved in rear-end crashes while decelerating.

Figure 2. 2 Adjusted rate ratios (and 95% confidence intervals) examining the effect of low-speed AEB on rear-end striking crash involvement rates.



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Figure 2. 3 Adjusted rate ratios (and 95% confidence intervals) examining the effect of low-speed AEB on involvement rates in rear-end striking crashes with injuries.

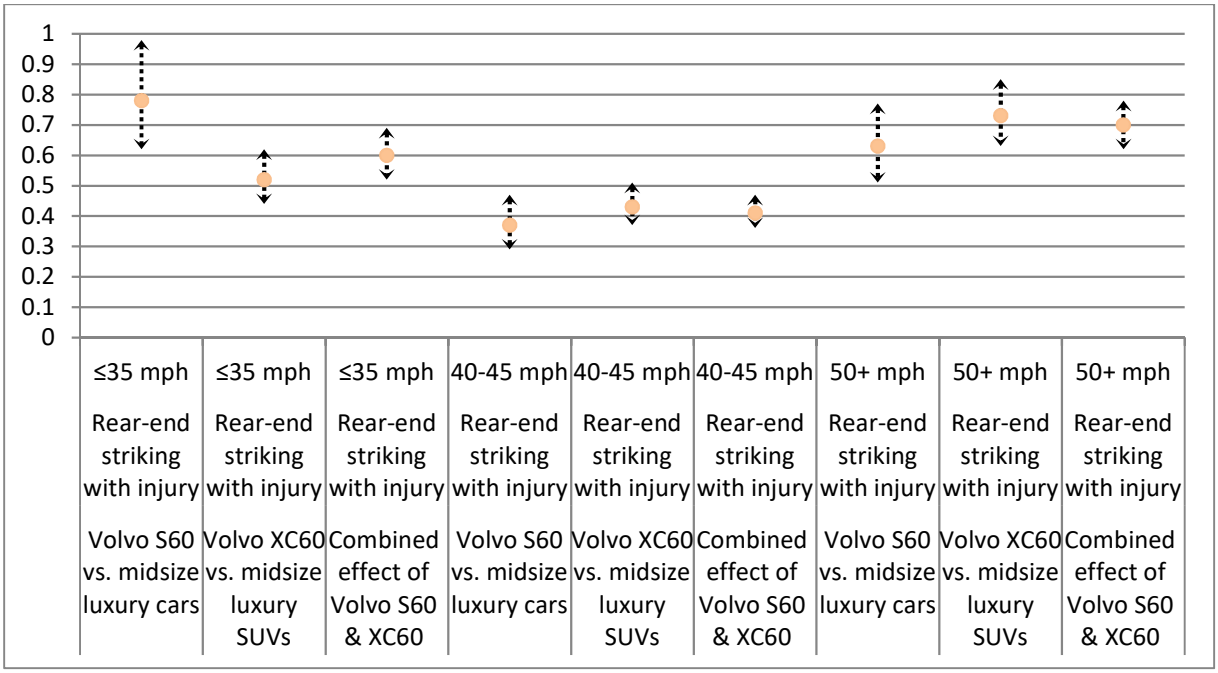
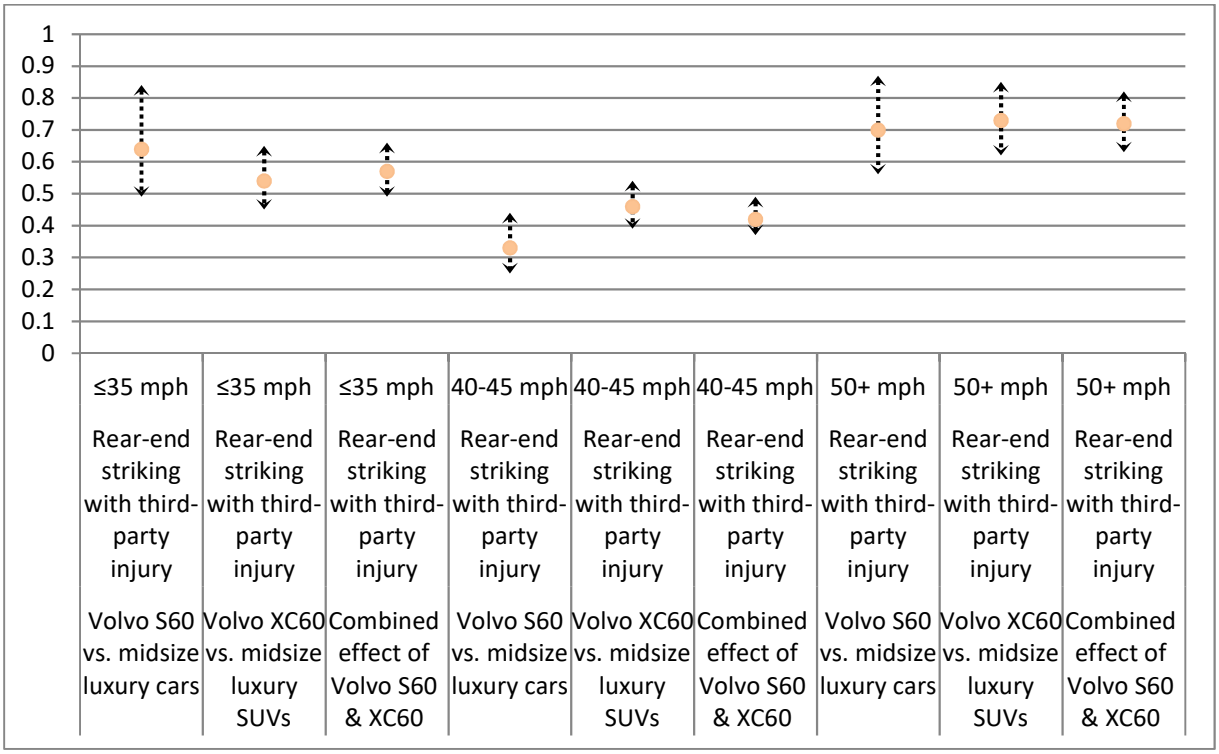
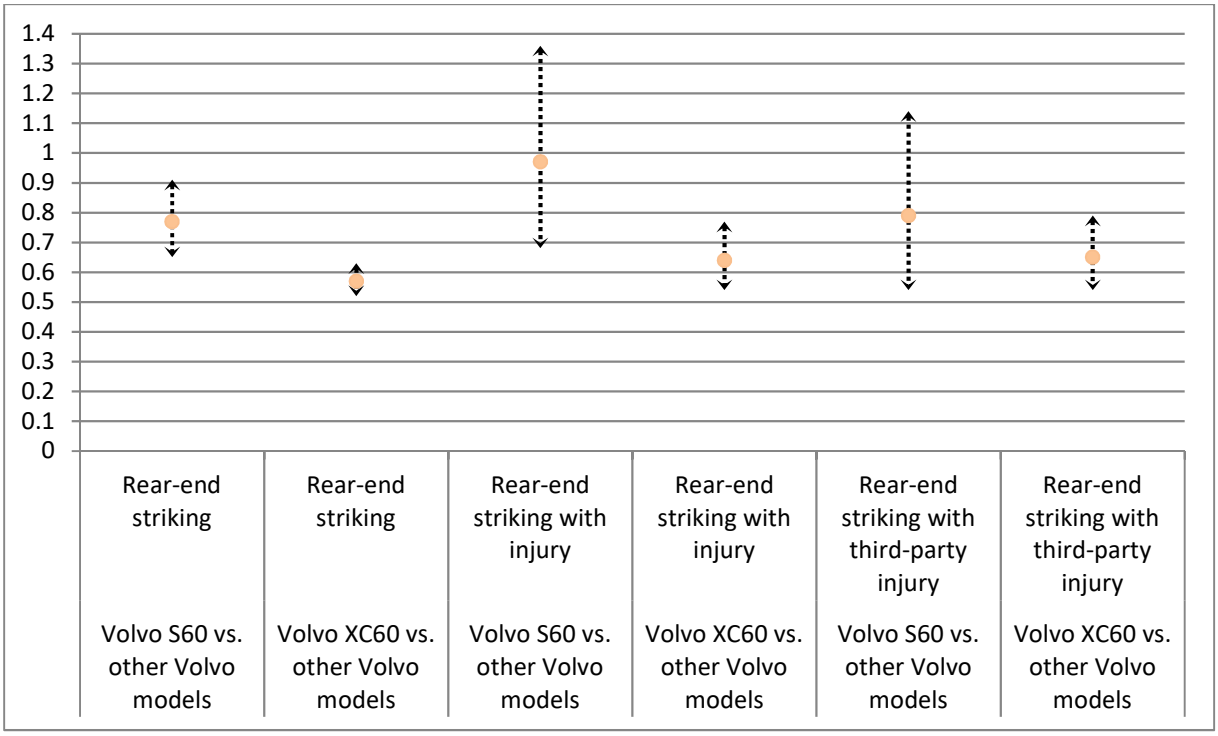


Figure 2. 4 Adjusted rate ratios (and 95% confidence intervals) examining the effect of low-speed AEB on involvement rates in rear-end striking crashes with third-party injuries.



Additionally, because primary analyses of low-speed AEB compared Volvo vehicles with vehicles from other car manufacturers, secondary analyses compared the performance of Volvos with low speed AEB to other Volvo models without AEB. This helps to assess if primary results reflect characteristics of Volvo drivers rather than the effects of the system.

Figure 2. 5 Adjusted rate ratios (and 95% confidence intervals) examining the effects of low-speed AEB on crash involvement rates, comparing Volvo S60 and XC60 models with AEB to other Volvo models without AEB.



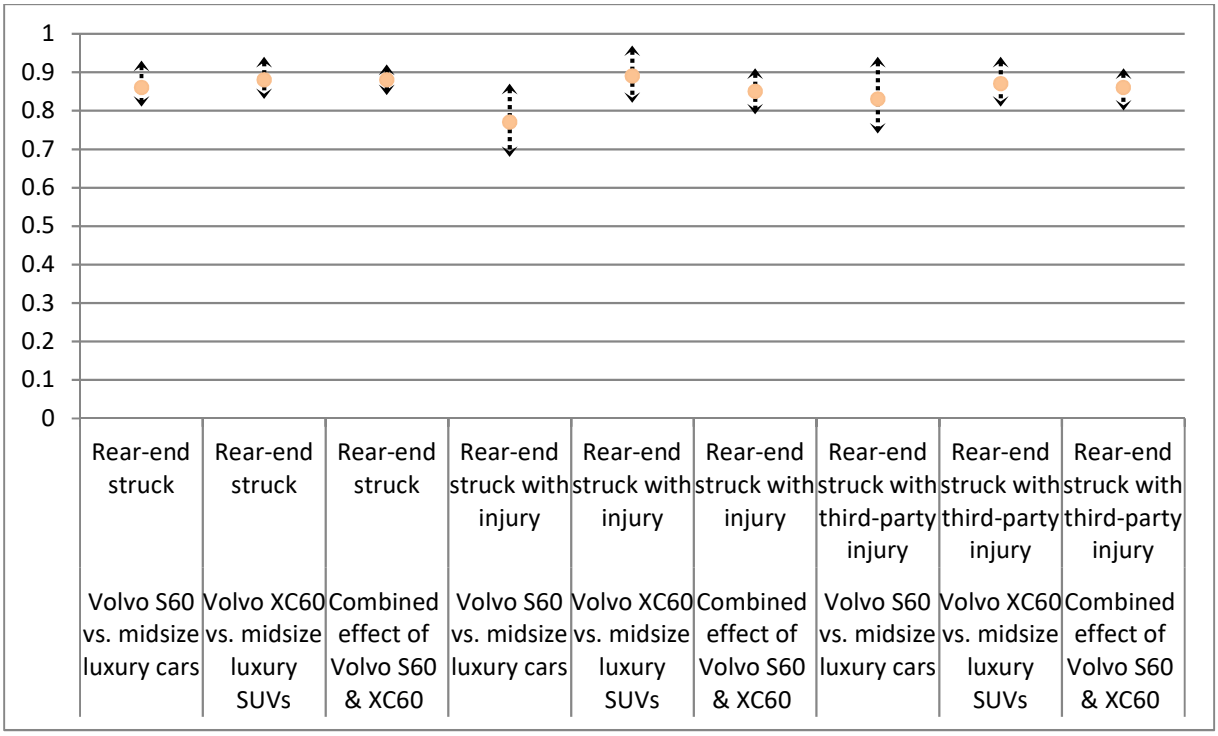
The patterns of results were similar in the primary and secondary analyses, but this was not true for Volvo S60 in the analysis of rear-end striking crashes with injuries (statistically not significant). In this regard it is important to note that the rates of crashes, injuries and deaths vary systematically by vehicle class and that the comparison group of other Volvos for the S60 included vehicles of a range of vehicle classes rather than just passenger cars comparable to the S60.

Finally, because it has been suggested that front crash prevention systems may affect the risk of being struck in the rear for vehicles with the systems if they affect the frequency of hard braking events, additional analyses examined the effects of systems on rear-end struck crash involvement rates. Results illustrated in **Figure 2. 6** suggest that vehicles with low-speed AEB experience reductions in the risk of being rear-end struck. This might reflect the fact that AEB systems may lead to earlier, less severe braking than drivers would have performed without them. The same study shows that for vehicles equipped with AEB systems combined with forward collision warning, the risk of getting rear-ended is higher than for vehicles without the two systems. But despite the increased risk of being struck in the rear, the benefits of the system outweigh this risk; vehicles with the system experienced larger reductions in rear-end striking rates (50%) than increases in rear-end struck rates (20%).

Detailed results from Isaksson-Hellman and Lindman (2016), Fildes et al. (2015), Rizzi, Kullgren, and Tingvall (2014), illustrated in **Table 3.4**, and issued from Sweden and other European countries, may confirm the results of the US study (Cicchino 2017) for the fact that low-speed AEB is also efficient on European roads.

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Figure 2. 6 Adjusted rate ratios (and 95% confidence interval) examining the effects of low-speed AEB on rear-end struck crash involvement rates.



3 Supporting document

3.1 METHODOLOGY

3.1.1 Literature search strategy

Four databases have been searched by colleagues from our institution: ***ScienceDirect***, ***Scopus***, ***Google Scholar*** and CEESAR's internal database that is based on *Greenstone* and that includes articles and reports from various road safety journals and conference proceedings. In all databases but Scholar, the search was limited to article titles, abstracts, and keyword fields and afterwards filtered in order to get only recent articles published after the year 1999. No filtering was used in Google Scholar. Eight combinations of keywords were used for the search. **Table 3.1** illustrates these combinations and the number of hits they generated in ScienceDirect, Scopus, Scholar and the internal database. **Table 3.2** gives the number of studies to screen and the number of coded studies.

Table 3.1 Keywords combinations used for the literature search and the number of hits it generated in each database.

Search no.	Search terms / operators / combined queries	Number of hits (ScienceDirect)	Number of hits (Scopus)	Number of hits (Scholar)	Number of hits (internal)
#1	Auto* AND Brak* AND Emergency	11	-	-	-
#2	Auto*AND Brak* AND Emergency AND City	6	-	-	-
#3	Auto*AND Brak* AND Emergency AND interurban	0	-	-	-
#4	"autonomous emergency braking" AND city	11	2	313	-
#5	"autonomous emergency braking" AND interurban	2	1	-	-
#6	"autonomous emergency braking" AND effectiveness	-	20	-	-
#7	"autonomous emergency braking"	-	-	-	60
#8	"AEB"	-	-	-	60

Table 3.2 Screening process.

Screening	Number of studies
All studies to screen (ScienceDirect + Scopus + Scholar + internal database) after removing duplicates	441
Studies left after title and abstract screening	29
Full text obtained	23
Relevant studies (coded)	5

3.1.2 Analysis of study designs and methods

The selected studies are very heterogeneous in sample size and sample selection. They also investigated different exposures and outcomes. **Table 3.3** gives a quick summary of study designs, methods, outcomes, and exposures. Only exposures dealing with AEB have been kept for analysis in this document.

Table 3.3 Quick summary of the study designs.

Author(s), Year, Country	Sample info	Method of analysis	Outcome(s)	Exposure(s)
(Cicchino 2017), US	Police-reported data for crashes from 22 US states between 2010 and 2014.	Retrospective analysis: Poisson regression → rate ratios	- Rear-end frontal crashes - Rear-end rear crashes - Injury in striking vehicle - Injury in struck vehicle	- Low speed AEB in Volvo S60 models - Low speed AEB in Volvo XC60 models
(Isaksson-Hellman and Lindman 2016), Sweden	Insurance company data on rear-end collisions involving Volvo V70 from July 1st, 2012 to June 30th, 2015.	Retrospective analysis → rate difference deduced without regression	- Rear-end frontal crashes - Injury in the struck vehicle	Low speed AEB in Vovlo V70 models
(Fildes et al. 2015), International collaboration (Australia, New Zeland, The Netherlands, Sweden, France, Germany, Italy, UK)	Rear-end crashes from 6 countries.	Retrospective analysis: induced exposure method	Cases: crashes involving a striking vehicle (sensitive to exposure). Controls: crashes involving a struck vehicle (Non-sensitive to exposure).	Low speed AEB
(Rizzi, Kullgren, and Tingvall 2014), Sweden	Swedish STRADA database. Two-car rear-end crashes and crossing crashes that happened between January 2010 and February 2014 and that have at least one injury.	Retrospective analysis: induced exposure method	Cases (sensitive): crashes involving a striking vehicle. Controls (non-sensitive): crashes involving a struck vehicle or crossing crashes.	Low speed AEB

(Strandroth et al. 2012), Sweden	German GIDAS 1999-2007 data	Prospective analysis. Accident reconstruction & replay with simulated system functions.	MAIS 2+ injury in frontal collisions between HGV and passenger car	AEB on HGV and/or passenger car

3.2 DETAILED SUMMARY OF RESULTS

Table 3.4 Detailed summary of results.

Author	Exposure	Outcome	Effects on road safety
(Isaksson-Hellman and Lindman 2016)	Low speed AEB, Volvo V70	Rate of high severity rear-end collisions per 1000 insured vehicle years (IVY)	Rate difference between no-AEB cars and AEB cars = 0.02; 95% CI (-0.3, 0.4); Statistically not significant.
(Isaksson-Hellman and Lindman 2016)	Low speed AEB, Volvo V70	Rate of medium severity rear-end collisions per 1000 IVY	Rate difference between no-AEB cars and AEB cars = 0.02; 95% CI (-0.3, 0.4); Statistically not significant.
(Isaksson-Hellman and Lindman 2016)	Low speed AEB, Volvo V70	Rate of low severity rear-end collisions per 1000 IVY	Rate difference between no-AEB cars and AEB cars = 0.7; 95% CI (0.2, 1.2); Statistically significant; Positive effect.
(Isaksson-Hellman and Lindman 2016)	Low speed AEB, Volvo V70	Rate of minor severity rear-end collisions per 1000 IVY	Rate difference between no-AEB cars and AEB cars = 0.7; 95% CI (0.2, 1.2); Statistically significant. Positive effect.
(Isaksson-Hellman and Lindman 2016)	Low speed AEB, Volvo V70	Rate of injured occupants in struck vehicles in high severity rear-end collisions per 1000 insured vehicle years (IVY)	Rate difference between no-AEB cars and AEB cars = -0.12; 95% CI (-0.26, 0.04); Statistically not significant.
(Isaksson-Hellman and Lindman 2016)	Low speed AEB, Volvo V70	Rate of injured occupants in struck vehicles in medium severity rear-end collisions per 1000 IVY	Rate difference between no-AEB cars and AEB cars = -0.07; 95% CI (-0.22, 0.08); Statistically not significant.
(Isaksson-Hellman and Lindman 2016)	Low speed AEB, Volvo V70	Rate of injured occupants in struck vehicles in low severity rear-end collisions per 1000 IVY	Rate difference between no-AEB cars and AEB cars = 0.03; 95% CI (-0.12, 0.17); Statistically not significant.
(Isaksson-Hellman and Lindman 2016)	Low speed AEB, Volvo V70	Rate of injured occupants in struck vehicles in minor severity rear-end collisions per 1000 IVY	Rate difference between no-AEB cars and AEB cars = 0.13; 95% CI (0.00, 0.26); Statistically significant; Positive effect.

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Author	Exposure	Outcome	Effects on road safety
(Fildes et al. 2015)	Low speed AEB in 1st country	Rear-end crashes Cases: striking vehicles Controls: struck vehicles	OR= 0.54; 95% CI: 0.32, 0.89; Statistically significant; Positive effect.
(Fildes et al. 2015)	Low speed AEB in 2nd country	Rear-end crashes Cases: striking vehicles Controls: struck vehicles	OR= 0.45; 95% CI: 0.05, 4.03; Statistically not significant.
(Fildes et al. 2015)	Low speed AEB in 3rd country	Rear-end crashes Cases: striking vehicles Controls: struck vehicles	OR= 0.75; 95% CI: 0.36, 1.57; Statistically not significant.
(Fildes et al. 2015)	Low speed AEB in 4th country	Rear-end crashes Cases: striking vehicles Controls: struck vehicles	OR= 0.66; 95% CI: 0.43, 1.03; Statistically not significant.
(Fildes et al. 2015)	Low speed AEB in 5th country	Rear-end crashes Cases: striking vehicles Controls: struck vehicles	OR= 0.57; 95% CI: 0.28, 1.14; Statistically not significant.
(Fildes et al. 2015)	Low speed AEB in 6th country	Rear-end crashes Cases: striking vehicles Controls: struck vehicles	OR= 1.93; 95% CI: 0.17, 21.69; Statistically not significant.
(Fildes et al. 2015)	Low speed AEB in all 6 countries	Rear-end crashes Cases: striking vehicles Controls: struck vehicles	OR= 0.62; 95% CI: 0.47, 0.82; Statistically significant; Positive effect.
(Rizzi, Kullgren, and Tingvall 2014)	Low speed AEB Volvos vs non-AEB Volvos in speed areas ≤50 km/h	Cases: striking vehicles in rear-end crashes Controls: struck vehicles in rear-end crashes	Effectiveness = 57% ± 36%; Statistically significant; Positive effect.
(Rizzi, Kullgren, and Tingvall 2014)	Low speed AEB Volvos vs non-AEB others in speed areas ≤50 km/h	Cases: striking vehicles in rear-end crashes Controls: struck vehicles in rear-end crashes	Effectiveness = 54% ± 37%; Statistically significant; Positive effect.
(Rizzi, Kullgren, and Tingvall 2014)	Low speed AEB Volvos vs non-AEB Volvos in speed areas of 60-70 km/h	Cases: striking vehicles in rear-end crashes Controls: struck vehicles in rear-end crashes	Effectiveness = 42% ± 56%; Statistically not significant.
(Rizzi, Kullgren, and Tingvall 2014)	Low speed AEB Volvos vs non-AEB others in speed areas of 60-70 km/h	Cases: striking vehicles in rear-end crashes Controls: struck vehicles in rear-end crashes	Effectiveness = 35% ± 61%; Statistically not significant.
(Rizzi, Kullgren, and Tingvall 2014)	Low speed AEB Volvos vs non-AEB Volvos in speed areas ≥80 km/h	Cases: striking vehicles in rear-end crashes Controls: struck vehicles in rear-end crashes	Effectiveness = 25% ± 61%; Statistically not significant.
(Rizzi, Kullgren, and Tingvall 2014)	Low speed AEB Volvos vs non-AEB others in speed areas ≥80 km/h	Cases: striking vehicles in rear-end crashes Controls: struck vehicles in	Effectiveness = 12% ± 67%; Statistically not significant.

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		rear-end crashes	
(Rizzi, Kullgren, and Tingvall 2014)	Low speed AEB Volvos vs non-AEB Volvos in speed areas >50 km/h	Cases: striking vehicles in rear-end crashes Controls: struck vehicles in rear-end crashes	Effectiveness = 32% ± 42%; Statistically not significant.
(Rizzi, Kullgren, and Tingvall 2014)	Low speed AEB Volvos vs non-AEB others in speed areas >50 km/h	Cases: striking vehicles in rear-end crashes Controls: struck vehicles in rear-end crashes	Effectiveness = 22% ± 46%; Statistically not significant.
(Rizzi, Kullgren, and Tingvall 2014)	Low speed AEB Volvos vs non-AEB Volvos in all speed areas	Cases: striking vehicles in rear-end crashes Controls: struck vehicles in rear-end crashes	Effectiveness = 41% ± 29%; Statistically significant; Positive effect.
(Rizzi, Kullgren, and Tingvall 2014)	Low speed AEB Volvos vs non-AEB others in all speed areas	Cases: striking vehicles in rear-end crashes Controls: struck vehicles in rear-end crashes	Effectiveness = 35% ± 31%; Statistically significant; Positive effect.
(Rizzi, Kullgren, and Tingvall 2014)	Low speed AEB Volvos vs non-AEB Volvos in speed areas ≤50 km/h	Cases: striking vehicles in rear-end crashes Controls: crossing crashes	Effectiveness = 31% ± 52%; Statistically not significant.
(Rizzi, Kullgren, and Tingvall 2014)	Low speed AEB Volvos vs non-AEB others in speed areas ≤50 km/h	Cases: striking vehicles in rear-end crashes Controls: crossing crashes	Effectiveness = 50% ± 37%; Statistically significant; Positive effect.
(Rizzi, Kullgren, and Tingvall 2014)	Low speed AEB Volvos vs non-AEB Volvos in speed areas of 60-70 km/h	Cases: striking vehicles in rear-end crashes Controls: crossing crashes	Effectiveness = 26% ± 70%; Statistically not significant.
(Rizzi, Kullgren, and Tingvall 2014)	Low speed AEB Volvos vs non-AEB others in speed areas of 60-70 km/h	Cases: striking vehicles in rear-end crashes Controls: crossing crashes	Effectiveness = 27% ± 68%; Statistically not significant.
(Rizzi, Kullgren, and Tingvall 2014)	Low speed AEB Volvos vs non-AEB Volvos in speed areas ≥80 km/h	Cases: striking vehicles in rear-end crashes Controls: crossing crashes	Effectiveness = 22% ± 87%; Statistically not significant.
(Rizzi, Kullgren, and Tingvall 2014)	Low speed AEB Volvos vs non-AEB others in speed areas ≥80 km/h	Cases: striking vehicles in rear-end crashes Controls: crossing crashes	Effectiveness = 10% ± 92%; Statistically not significant.
(Rizzi, Kullgren, and Tingvall 2014)	Low speed AEB Volvos vs non-AEB Volvos in speed areas >50 km/h	Cases: striking vehicles in rear-end crashes Controls: crossing crashes	Effectiveness = 13% ± 59%; Statistically not significant.
(Rizzi, Kullgren, and Tingvall 2014)	Low speed AEB Volvos vs non-AEB others in speed areas >50 km/h	Cases: striking vehicles in rear-end crashes Controls: crossing crashes	Effectiveness = 16% ± 54%; Statistically not significant.
(Rizzi, Kullgren, and Tingvall 2014)	Low speed AEB Volvos vs non-AEB Volvos in all speed areas	Cases: striking vehicles in rear-end crashes Controls: crossing crashes	Effectiveness = 8% ± 43%; Statistically not significant.

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(Rizzi, Kullgren, and Tingvall 2014)	Low speed AEB Volvos vs non-AEB others in all speed areas	Cases: striking vehicles in rear-end crashes Controls: crossing crashes	Effectiveness = 25% ± 34%; Statistically not significant.
(Strandroth et al. 2012)	AEB on HGV in a frontal collision with a car	MAIS 2+ injury	52 % reduction of injury
(Strandroth et al. 2012)	AEB on HGV and the car in a frontal collision	MAIS 2+ injury	73 % reduction of injury

3.3 FULL LIST OF STUDIES

Cicchino, Jessica B. 2017. "Effectiveness of Forward Collision Warning and Autonomous Emergency Braking Systems in Reducing Front-to-Rear Crash Rates." *Accident Analysis and Prevention* 99. Elsevier Ltd: 142–52. doi:10.1016/j.aap.2016.11.009.

Fildes, B., M. Keall, N. Bos, A. Lie, Y. Page, C. Pastor, L. Pennisi, M. Rizzi, P. Thomas, and C. Tingvall. 2015. "Effectiveness of Low Speed Autonomous Emergency Braking in Real-World Rear-End Crashes." *Accident Analysis and Prevention* 81. Elsevier Ltd: 24–29. doi:10.1016/j.aap.2015.03.029.

Isaksson-Hellman, Irene, and Magdalena Lindman. 2016. "Evaluation of the Crash Mitigation Effect of Low-Speed Automated Emergency Braking Systems Based on Insurance Claims Data." *Traffic Injury Prevention* 17 (sup1). Taylor & Francis: 42–47. doi:10.1080/15389588.2016.1186802.

Rizzi, Matteo, Anders Kullgren, and Claes Tingvall. 2014. "Injury Crash Reduction of Low-Speed Autonomous Emergency Braking (AEB) on Passenger Cars." *IRCOBI Conference Proceedings*, 656–65.

Strandroth, Johan, Matteo Rizzi, Anders Kullgren, and Claes Tingvall. 2012. "Head-on Collisions between Passenger Cars and Heavy Goods Vehicles: Injury Risk Functions and Benefits of Autonomous Emergency Braking." *IRCOBI Conference Proceedings*, 342–51.