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The contribution of various levels of speeding to fatal and serious road trauma

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ABSTRACT

The purpose of this study was to examine the contribution of the different levels of speeding to road trauma by using the speed data derived from the Event Data Recorders (EDRs) of crashed vehicles and recently developed risk curves that relate absolute risk of serious and fatal injury to impact speed. The analysis used 283 'bullet' vehicles from the CASR-EDR database, of which 74 were speeding. Weightings were applied to minimise sampling bias. A model was applied to the EDR data to determine the reduction in impact speed had the speeding vehicles been travelling at the speed limit. The effect of the reduced impacts speed on lowering the probability of fatal and serious injuries (FSIs) was calculated using injury risk curves. Finally, the contribution of speeding to serious and fatal road trauma was estimated by comparing the sum of the probabilities of an FSI with the original travel speeds to the sum of the probabilities of FSI when speeding was eliminated. Speeding contributes to 18% of fatal and serious road trauma. That is, if speeding were eliminated completely, FSIs would be expected to be reduced by 18%. The results suggest that low level speeding is not benign and should remain the focus of various road safety interventions, along with all levels of speeding.

KEYWORDS

Speeding, Road trauma, Event Data Recorder

Summary

Speeding (travelling at a speed in excess of the posted speed limit) is a well known contributing factor to road trauma. The purpose of this study was to examine the contribution of the different levels of speeding to road trauma by using the speed data derived from the Event Data Recorders (EDRs) of crashed vehicles and recently developed risk curves that relate absolute risk of serious and fatal injury to impact speed.

The analysis used 283 'bullet' vehicles from the CASR-EDR database, of which 74 were speeding. Weightings were applied to minimise sampling bias. A model was applied to the EDR data to determine the reduction in impact speed had the speeding vehicles been travelling at the speed limit. The effect of the reduced impacts speed on lowering the probability of fatal and serious injuries (FSIs) was calculated using injury risk curves. Finally, the contribution of speeding to serious and fatal road trauma was estimated by comparing the sum of the probabilities of an FSI with the original travel speeds to the sum of the probabilities of FSI when speeding was eliminated.

Speeding contributes to 18% of fatal and serious road trauma. That is, if speeding were eliminated completely, FSIs would be expected to be reduced by 18%. At current levels, this represents 216 fewer fatalities per year, and 7,132 fewer serious injuries. Low level speeding, speeding by less than 10 km/h, accounted for a quarter of this contribution to fatal and serious injury crashes.

The results suggest that low level speeding is not benign and should remain the focus of various road safety interventions, along with all levels of speeding.

Contents

1 Introduction

Travelling at a speed in excess of the posted speed limit, commonly known as speeding, is thought to be a considerable contributing factor to road trauma and is one of the “Fatal Five” behaviours that are thought to contribute to the majority of road crash related fatalities.

Various studies have shown that an increase in travel speed results in increased crash risk (Elvik, Christensen & Amundsen, 2004; Kloeden, McLean, Moore & Ponte, 1997; Kloeden, Ponte & McLean, 2001). These studies have also been used to calculate the contribution of speed to road trauma by calculating the percentage reduction in road trauma if speeding was eliminated. Kloeden, McLean & Glonek (2002) determined that if speeding were eliminated on metropolitan roads in Adelaide (Australia), injury crashes would be reduced by 20.8%.

The risk curves developed by Kloeden *et al.* (1997) and Kloeden, Ponte and McLean (2001) have been used to examine the contribution of various levels of speeding to road trauma. Doecke, Kloeden & McLean (2011) combined travel speed data from speed surveys conducted using pneumatic tubes on a sample of South Australian roads with these risk curves to identify which group of speeding drivers would likely provide the greatest casualty crash reduction potential if their speeds could be lowered by a fixed amount e.g., 1 km/h. They found that on all but 50 km/h rural roads, the greatest reduction in casualty crashes would be obtained if the numbers of drivers exceeding the speed limit by 1 to 5 km/h speed were reduced. However, this study only considered speeding by up to 20 km/h based on the assumption that high level speeding is difficult to influence with media campaigns, and that the accuracy of the risk curves above this point is uncertain. Alavi, Keleher, & Nieuwesteeg (2014) combined speed data from vehicles passing covert mobile speed cameras with the same risk curves used by Doecke *et al*.(2011) to quantify the contribution of low-level speeding to road trauma. They found that speeding by up to 10 km/h, which they defined as low-level speeding, contributed to the majority (79%) of speeding related casualty crashes, with speeding by more than 20 km/h over the speed limit only contributing 4.3%. However, it should be noted that Alavi *et al.* (2014) capped the risk curve at 21 km/h above the mean speed in urban areas, and 41 km/h above the mean speed in rural areas. Both of these analyses used speed data from normal traffic that was not related to a crash, and both had to make allowances for the uncertainty inherent in the risk curves at high speeds, either by excluding these speeds (Doecke *et al.*, 2011) or by capping the risk (Alavi *et al*., 2014).

The purpose of the current study was to examine the contribution of the different levels of speeding to road trauma using a newly available source of speed data from crashed vehicles, Event Data Recorders, and new risk curves that relate absolute risk of serious and fatal injury to speed. This will provide the contribution of speeding to road trauma that is directly linked to real world crashes using risk curves that do not need to be artificially capped at high speeds.

2 Method

An overview of the process by which the contribution of speeding to serious and fatal road trauma was determined is shown in Figure 2.1. The process was as follows:

- A sample of crash data with the necessary details (e.g. travel speed, impact speed, braking time) was extracted from an appropriate database.
- The selected crash data was weighted to minimise sampling bias.
- A model was applied to the crash data to predict the effect eliminating speeding would have on impact speeds.
- The effect of the reduced impacts speeds in lowering the probability of fatal and serious injuries (FSIs) was calculated using injury risk curves.
- The contribution of speeding to serious and fatal road trauma was estimated by comparing the sum of the probabilities of FSI with the original travel speeds to the sum of the probabilities of FSI when speeding was eliminated.

Each of the elements shown in Figure 2.1 will be described in detail in the following subsections.

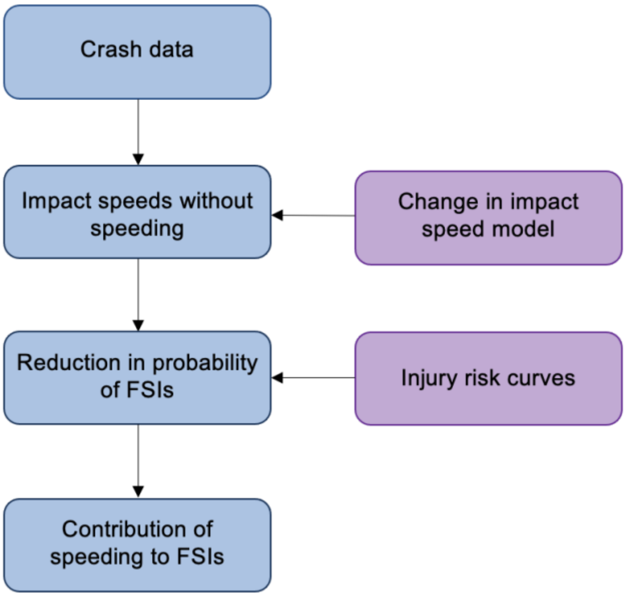

Figure 2.1
Methodological flow of estimating the contribution of speeding to fatal and serious injuries (FSIs)

2.1 Data source and case selection

The data source for the analysis was the CASR-EDR database. This database combines data extracted from the Event Data Recorder (EDR) of crashed vehicles with matched police reports. The cases within the CASR-EDR database are obtained from two sources; a sample of written off vehicles from an auction holding yard and vehicles involved in life-threatening crashes that are investigated by the South Australia Police's Major Crash Unit (Major Crash). More detail on the CASR-EDR database can be found in Elsegood, Doecke & Ponte (2020a).

The EDRs record pre-crash data, including travel speed and brake use, for up to five seconds preceding a collision. This allows for a detailed understanding of a vehicle's travel speed, impact speed, and braking behaviour, that can be used to model the crash sequence and determine a new impact speed under different vehicle scenarios.

Cases were selected for use in the analysis from the CASR-EDR database when the EDR vehicle was the “bullet” vehicle in a crash. The bullet vehicle in a crash is defined using the DCA code classification system where each crash type is assigned a code and each vehicle in a crash is also assigned a code. For crashes that occur at road intersections, bullet vehicles are defined as the vehicle which has right of way. In rear-end crashes, the rear-most vehicle is the bullet vehicle. In single vehicle crashes the vehicle is always classified as the bullet vehicle, and in head-on crashes both vehicles are classified as bullet vehicles.

2.2 Weighting

The crashes in the CASR EDR database were selected in two ways. The majority of the crashes were selected based on a crashed vehicle with an accessible EDR record being present at the auction yard when CASR attends, to collect data. The other crashes were selected because a vehicle involved in a fatal crash investigated by the South Australian Police’s Major Crash Investigation Unit had an accessible EDR record. Both these methods can introduce a bias that can be accounted for through a basic weighting process. This is done by giving most crashes a weight of one. For crashes that are overrepresented in the sample a weight of less than one is given that reflects the degree of over-representation.

The first bias that needed to be considered was that the selection of cases was vehicle based. A vehicle-based selection, when applied to a crash-based analysis, contains a bias towards crashes with more than one vehicle. However, if only one vehicle in a given crash can be selected (e.g. the at fault vehicle), this bias is removed. By selecting bullet vehicles for the analysis this bias is removed for all crash types except head-on crashes, where both vehicles are considered bullet vehicles. To account for this, head-on crashes (DCA code 120 and 150) were given a weight of 0.5 as they would be twice as likely to be in the sample as in general crash population.

The second bias that needs to be accounted for is the oversampling of fatal crashes. A weighting factor of 0.125 was applied based on the proportion of fatal crashes in the sample being 8 times higher than the proportion in police reported crashes in South Australia.

These weighting factors are multiplicative, meaning that a fatal head on crash had a weight of 0.0625.

2.3 Modelling the change in impact speed when speeding is eliminated

The modelling undertaken in this study repurposes a model from Doecke, Raftery, Elsegood & Mackenzie (2021), that was developed to examine the effects of Intelligent Speed Adaptation by two of this study’s authors (Elsegood and Doecke). In order that the reader need not refer to that publication in order to understand the method of this study the description of the model found in Doecke *et al.* (2021) is reproduced here with text and nomenclature modified to encompass a more general application.

For each case in the study sample, the original travel speed and impact speed are known from the EDR data. The time when braking started and the level of braking can also be calculated from the EDR data. In cases where the vehicle is speeding, the initial travel speed of the vehicle is reduced and set to the posted speed limit. Standard equations of motion are then used to determine a new impact speed, accounting for the start of braking time and the level of braking employed by the driver in the original crash. For cases where the driver of a vehicle applied braking before a crash occurred, the initial start–of–braking time can be calculated using the method outlined in Elsegood, Doecke & Ponte (2020).

The equation used to model the change in impact speed, given a change in travel speed, was developed in the following way. Consider a situation in which a vehicle is travelling along a road in a straight line when a sudden driving challenge arises whereby the driver needs to react and start braking. Such a challenge could be a vehicle turning from a side street or stationary traffic ahead. This situation can be replicated for two distinct scenarios, a vehicle travelling at its actual speed prior to the crash, and a hypothetical travel speed. Figure 2.2 presents a diagram of these two scenarios using the horizontal axis as a representation of distance. The top section refers to a vehicle travelling at its actual speed (1). The bottom section refers to the vehicle travelling at a hypothetical speed (2). Point A represents the distance at which the driver needs to react and start braking, and Point C represents the collision point. Points B1 and B2 represent the locations where the vehicles start braking in each scenario. Point B2 occurs at a greater distance from Point C than Point B1 when travel speed 2 is slower than travel speed 1.

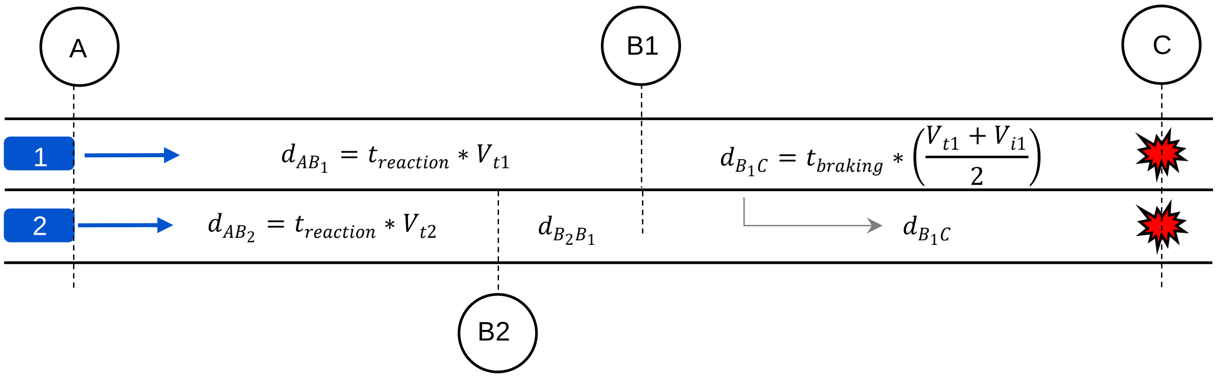

Figure 2.2
Diagram of pre-impact distances and braking points of a crash scenario with a vehicle travelling at its original travel speed (1) and at a new hypothetical speed (2)

The equations below use the principle that distance is equal to velocity multiplied by time, where:

- d_{XY} represents the distance between a point (e.g. point X) and another point (e.g. point Y)
- $t_{reaction}$ is the time it takes for the driver to react to the situation and start braking,
- $t_{braking}$ is the time that the driver spent braking before the collision, as determined from the EDR data (shown in Appendix A),
- V_{t1} is the original travel speed,
- V_{t2} is the new, hypothetical, travel speed
- V_{i1} is the original impact speed.

Simple subtraction between d_{AB_1} and d_{AB_2} allows the calculation of $d_{B_2B_1}$:

$$d_{B_2B_1} = d_{AB_1} - d_{AB_2} = t_{reaction} * (V_{t1} - V_{t2}) \quad (1)$$

The distance from point B2 to point C is calculated using Equation 2:

$$d_{B_2C} = d_{B_2B_1} + d_{B_1C} = \ t_{reaction} * (V_{t1} - V_{t2}) + \ t_{braking} * \left(\frac{V_{t1}+V_{i1}}{2}\right) \quad (2)$$

To calculate the new impact speed, V_{i2}, the following motion equation is used:

$$V_{i2}{}^2 = V_{t2}{}^2 + 2 * a * d_{B_2C} \quad (3)$$

The acceleration, a, is the average deceleration of the vehicle whilst braking, which is assumed to be equivalent to the average deceleration of the vehicle in the original situation:

$$a = \frac{V_{i1} - V_{t1}}{t_{braking}} \quad (4)$$

Combining Equation 4 with Equation 3 gives:

$$V_{i2}{}^2 = V_{t2}{}^2 + 2 * \frac{V_{i1} - V_{t1}}{t_{braking}} * d_{B_2C} \quad (5)$$

And then combining Equation 2 with Equation 5 gives:

$$V_{i2}{}^2 = V_{t2}{}^2 + 2 * \frac{V_{i1} - V_{t1}}{t_{braking}} * t_{reaction} * (V_{t1} - V_{t2}) + \ t_{braking} * \left(\frac{V_{t1} + V_{i1}}{2}\right) \quad (6)$$

Rearranging Equation 6 gives the following formula for the impact speed of the vehicle with the new travel speed, V_{i2}:

$$V_{i2} = \sqrt{V_{t2}^2 + 2\left(\frac{V_{i1} - V_{t1}}{t_{braking}}\right)\left(\frac{t_{braking}(V_{t1} + V_{i1})}{2} + t_{reaction}(V_{t1} - V_{t2})\right)} \quad (7)$$

V_{i2} is the new impact speed where:

- V_{t2} is the hypothetical travel speed
- V_{i1} is the original impact speed
- V_{t1} is the original travel speed
- $t_{braking}$ is the original time to collision when braking commenced, and
- $t_{reaction}$ is the reaction time

For the current study, the hypothetical travel speed is the speed limit. The model is only applied to vehicles that were travelling above the speed limit.

A reaction time of 1.5 seconds was used for all cases that involved braking, as suggested by a literature review conducted by Green (2000). This is an average value of those found in experiments. It may be higher for elderly, impaired or inattentive drivers, and lower for young and/or highly attentive drivers.

2.4 Injury risk reduction

The output of the model is a set of new impact speeds that can be compared to the original impact speeds. Impact speed has been shown to have a strong positive relationship to the risk of fatal and serious injuries (FSIs). These relationships can be used to calculate the original risk of FSI in the sample of crashes and with the reduced impact speeds determined by the model. The sum of the individual risks, or probabilities, provide a prediction of the expected number of FSIs in the original crashes, and without speeding. By comparing the predicted number of FSIs with and without speeding the contribution of speeding to FSIs can be estimated.

The risk of FSI varies by impact type (Doecke, Baldock, Kloeden and Dutschke, 2020), and so separate injury risk curves were selected for each impact type included in the sample. These impact types included head on, side, front, rear, hit fixed object, and pedestrian impacts. No single source provided injury risk curves for all impact types.

The risk curves developed by Doecke *et al.*, (2020) were chosen for crashes involving an impact between two vehicles (front, head on, side, and rear impacts). These risk curves were developed from a sample of 1,274 crashes where impact speed and injury details were known. They are also the only risk curves currently available which provide absolute risk of FSI (defined as MAIS3+F) as a function of impact speed for these impact configurations. These risk curves are shown in Figure 2.3 and the equations for these risk curves are shown in Equations 8 to 11.

$$P(v_{impact,front}) = \frac{1}{1+e^{8.1231-0.0548v_{impact,front}}} \quad (8)$$

$$P(v_{impact,headon}) = \frac{1}{1+e^{7.3881-0.0964v_{impact,headon}}} \quad (9)$$

$$P(v_{impact,side}) = \frac{1}{1+e^{10.5583-0.1161v_{impact,side}}} \quad (10)$$

$$P(v_{impact,rear}) = \frac{1}{1+e^{12.1538-0.1119v_{impact,rear}}} \quad (11)$$

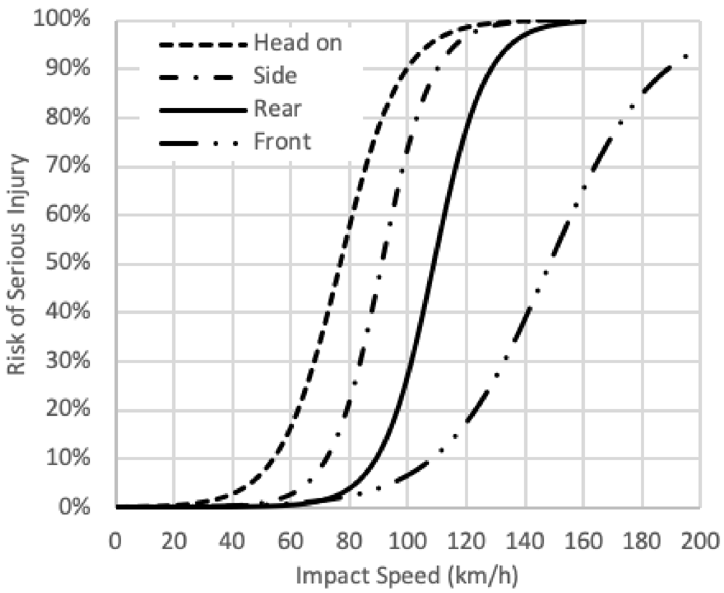

Figure 2.3
Risk curves from Doecke *et al.* (2020) relating risk of fatal and serious injury to impact speed, by impact configuration (Note that the y-axis says serious injury, but as MAIS3+F was used to define serious injury it also includes fatalities)

The Doecke *et al.,* (2020) injury risk curves must be applied separately for each vehicle involved in a collision. For example, in a rear-end crash there is one vehicle that has a front impact and one that has a rear impact. To calculate an overall injury risk for a multi-vehicle crash, the individual per-vehicle risks can be summed according to Equation 12.

$$P(FSI_{crash}) = P(\,FSI_{unit\ 1}) + P(FSI_{unit\ 2}) - P(\,FSI_{unit\ 1}) \times P(FSI_{unit\ 2}) \qquad (12)$$

As Doecke *et al.,* (2020) uses closing impact speed for rear end crashes and average impact speed for head on crashes some assumptions regarding the other vehicles speed needed to be made. For rear end collisions the median speed of struck vehicles across all the rear end collisions in the EDR database was 5km/h. This median value was subtracted from the impact speed of each bullet vehicle in this study to represent the closing impact speed in rear end collisions. For head on crashes the average impact speed of the two involved vehicles was assumed to match the impact speed of the bullet vehicle.

For collisions with fixed objects, the risk curve from Augenstein *et al*., (2003), that relates the change in velocity (delta-v) to risk of fatal and serious injury (AIS3+) was used (Equation 13). Note that in Equation 13, delta-v is in miles per hour.

$$P(\Delta v_{fixed\ object}) = \frac{1}{1+e^{4.1373-0.1228\Delta v_{fixed\ object}-0.3144}} \quad (13)$$

The CASR-EDR data contained the delta-v for each crashed EDR vehicle which was used to calculate the original probability of fatal and serious injury according to Equation 13. Equation 14 was used to calculate the new delta-v which was then used in Equation 13 to determine the probability of fatal and serious injury with the new, hypothetical reduced impact speed.

$$\Delta v_{new} = \frac{\Delta v_{original} \times v_{new}}{v_{original}} \quad (14)$$

The output of this step is a probability of fatal and serious injury for each crash with speeding, and without speeding.

There were two crash types in the sample for which a relationship between impact speed and injury severity has not been shown; roll-over crashes and hit animal crashes. Rollover crashes were given a probability of fatal and serious injury based on the rate found in the sample of crashes used in Doecke *et al.* (2020), 0.094, and hit animal crashes were given a nominal probability of 0.0001. These probabilities did not change with a change in impact speed.

2.5 Determining the contribution of speeding to serious and fatal road trauma

The final step of the process was to use the results of Sections 2.2 to 2.4 to determine the contribution of speeding to serious and fatal road trauma from the whole sample of crashes. These sections have described how a probability of FSIs can be calculated for each case using the original impact speed, and the new impact speed. To determine the overall benefit, the probabilities are multiplied by their weighting factor and are summed to produce the predicted number of fatal and serious injuries in the sample. The same is done for all the crashes using the new impact speeds produced by the model. By comparing the predicted number of fatal and serious injuries with and without speeding the contribution of speeding to serious and fatal road trauma is estimated.

2.6 Example case

The following is an example of how this method worked for one of the crashes in the sample.

A vehicle was involved in a rear end crash (See Figure 2.4). The EDR download from the vehicle, (shown in Figure 2.5) revealed that it was travelling at 66 km/h 2.1 seconds before impact. The matched police report revealed that this crash occurred in a 60 km/h zone, therefore this vehicle was travelling 6 km/h above the speed limit. The police report also revealed it was the bullet vehicle in a rear end crash. The start of braking time was determined to have been 1.25 seconds before impact (as per the method outlined in Elsegood *et al.*, 2020). This braking slowed the driver to 40 km/h at impact. The bottom row in Figure 2.5 shows the distance from the collision point (calculated post-download). The distance from the impact point when the vehicle started to brake was calculated to be 18.3 metres.

Figure 2.4
Crashed vehicle from example case

Time (sec)	-4.1	-3.1	-2.1	-1.1	-0.1	0 (TRG)
Vehicle Speed (MPH [km/h])	37.3 [60]	39.8 [64]	41 [66]	39.8 [64]	24.9 [40]	24.9 [40]
Brake Switch	OFF	OFF	OFF	ON	ON	ON
Accelerator Rate (V)	1.29	1.41	1.41	0.78	0.78	0.78
Engine RPM (RPM)	1,200	1,200	1,200	1,200	800	800
Distance to crash (m)	68.9	51.7	33.6	15.5	1.1	0

Figure 2.5
EDR data downloaded from crashed vehicle

The diagram in Figure 2.6 demonstrates the distances travelled by the striking vehicle during the crash (1) and in the hypothetical scenario where the driver was travelling at the speed limit (2). At point A along the road an event occurs that the driver needs to react to. At point B1 and B2 the vehicles begin to brake in response, and point C represents the impact point.

The travel speeds and distances during the crash are shown in Figure 2.6. The vehicle was originally travelling at 66 km/h. The distance from point A to point B1 was calculated to be 27.5 metres (66 km/h multiplied by the reaction time of 1.5 seconds), and the distance from point B1 to point C was calculated to be 18.3 metres. Thus, the total distance from point A to point C was 45.8 metres.

For the hypothetical scenario where the vehicle is not speeding (2), the initial speed and start–of–braking speed is set to the posted speed limit of 60 km/h. Consequently, between point A and point B2, the travel speed of the vehicle is 60 km/h. The same reaction time applies but, as the travel speed is lower, the distance from point A to point B2 is calculated to be 25 metres. The distance from point B2 to point C is consequently 20.8 metres, based on the total distance calculated previously (45.8 metres minus 25 metres). From point B2 to point C, the average deceleration from the original case between point B1 and C (0.59g), and the new impact speed is calculated to be 22 km/h.

This example shows how a modest reduction in travel speed can result in a much greater reduction in impact speed. In this case the reduction in impact speed was 18 km/h, or three times the reduction in travel speed of 6 km/h.

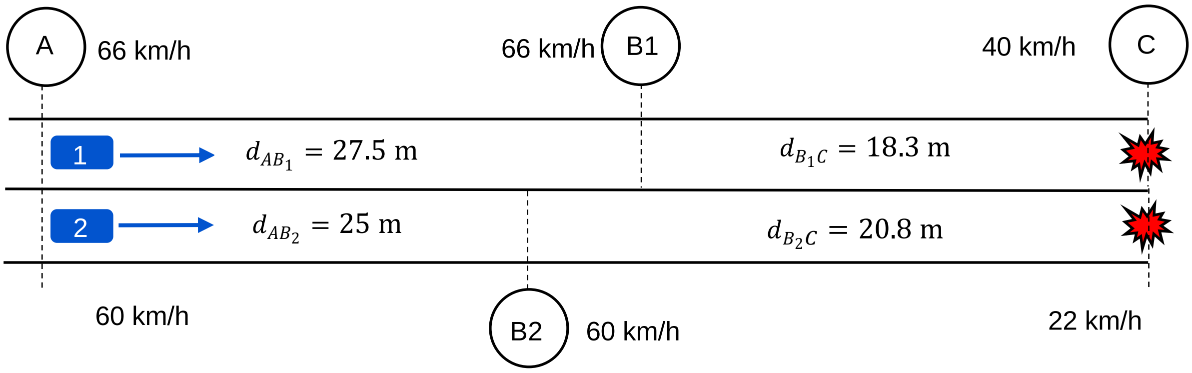

Figure 2.6
Comparison of the original example crash scenario (1) and the hypothetical scenario where speeding is eliminated (2)

The original serious injury risk of this crash with an impact speed of 40 km/h was calculated to be 0.31%. If the vehicle was travelling at speed limit and the impact speed was reduced to 22 km/h the risk reduces to 0.1%, a 68% reduction in injury risk.

3 Results

3.1 Sample characteristics

A total of 283 bullet vehicles were identified in the CASR-EDR database. Of these, 74 (26%) involved vehicles that were speeding.

Table 3.1 shows the bullet vehicles by injury severity and percentage that were speeding. Unsurprisingly, speeding was more prevalent in higher injury severity crashes. When weighting was applied a quarter of vehicles were speeding.

Table 3.1
Speeding by injury severity

Injury severity	Not speeding	Speeding	Total	% Speeding	Weighted % Speeding
Property damage only	112	30	142	21%	21%
Treated by doctor	5	2	7	29%	33%
Treated at hospital	74	28	102	27%	28%
Admitted to hospital	10	5	15	33%	37%
Fatal	8	8	16	50%	58%
Unknown	0	1	1	100%	100%
Total	209	74	283	26%	25%

The percentage of vehicles speeding in different broad crash types is shown in Table 3.2. Vehicle involved in single vehicle crashes were much more likely to be speeding than in any other broad crash type.

Table 3.2
Speeding by broad crash type

Crash type	Not speeding	Speeding	Total	% Speeding	Weighted % Speeding
Intersection*	82	15	97	15%	14%
Single vehicle	49	38	87	44%	41%
Rear end	62	17	79	22%	22%
Head on	16	4	20	20%	23%
Total	208	74	283	26%	25%

*Includes U-turn in front crashes

The percentage of vehicles speeding, by speeding level is shown in Table 3.3. The unweighted number of crashes at each speeding level is also shown. The majority of the vehicles that were speeding were speeding by 10 km/h or less. Only 3% of the total sample were speeding by more than 45 km/h. Note that the speeding levels were chosen to match the speeding offence level in South Australia, but other states have different offence levels.

Table 3.3
Speeding by speeding level (weighted)

Speeding level (km/h)	Number (unweighted)	Percentage of total sample	Percentage of speeding
1 to 10	40	14.5%	57.5%
11 to 20	13	3.7%	14.8%
21 to 30	5	1.9%	7.5%
31 to 45	7	2.0%	7.9%
45+	9	3.1%	12.2%
Total	74	25.2%	100.0%

Figure 3.1 provides the percentage of speeding, by speeding level, in smaller increments than Table 3.3. This shows that vehicles travelling up to 5 km/h over the speed limit account for more than a third of all speeding vehicles. None of the 5 km/h increment speeding levels above 10 km/h over the speed limit represent more than 8% of the speeding bullet vehicles involved in a crash.

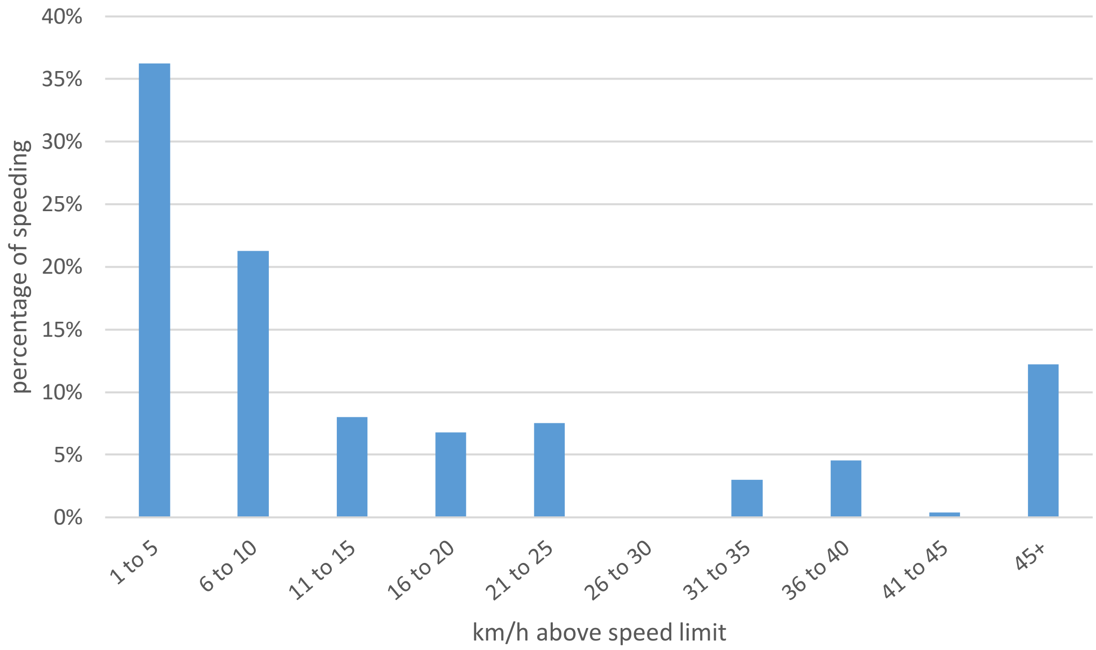

Figure 3.1
Weighted percentage of bullet vehicles that were speeding, by level above speed limit

3.2 Reductions in impact speed

The benefit of eliminating speeding is a travel speed reduction, which translates into a reduction in impact speed. In cases where the driver braked before a crash the impact speed reduction is higher than the travel speed reduction. Table 3.4 shows the median reductions in travel and impact speed for the 74 crashes where the bullet vehicle was speeding, categorised by injury severity. The largest reduction in travel speed apart from the single case with unknown injury severity is found in fatal crashes. For these crashes the 15 km/h decrease in median travel speed more than doubles to a 38 km/h decrease in impact speed.

Table 3.4
Median speed reductions (km/h) if the speeding bullet vehicles had been travelling at the speed limit, by injury severity

Injury severity	Number	Median travel speed reduction	Median impact speed reduction
Property damage only	30	6.5	19.0
Treated by doctor	2	1.5	4.9
Treated at hospital	28	10.5	13.5
Admitted to hospital	5	8.0	12.6
Fatal	8	15.0	38.0
Unknown	1	35.0	35.0
Total	74	9.0	16.5

In cases where the impact speed is reduced to 0 km/h the crash would have been avoided, with the possible exception of head on crashes. It is also likely that in crashes where the impact speed is calculated to be less than 5 km/h the crash would have either been avoided, due to the other vehicle having moved clear of the path of the bullet vehicle, or the impact would be negligible. The number of crashes that meet these criteria and the weighted percentage of crashes they represent are shown in Table 3.5, categorised by injury severity. It was found that 6.2% of crashes would have been completely avoided if speeding were eliminated, rising to 7.7% if an impact speed of less than 5 km/h is considered avoided. A quarter of fatal crashes in the sample would have been completely avoided if the speeding was eliminated.

Table 3.5
Crashes avoided if speeding eliminated, by injury severity

Injury severity	New impact speed			
	0 km/h		<5 km/h	
	No.	Weighted %	No.	Weighted %
Property damage only	9	6.4%	10	7.8%
Treated by doctor	1	16.7%	1	16.7%
Treated at hospital	5	5.0%	7	7.0%
Admitted to hospital	1	7.4%	1	7.4%
Fatal	3	25.0%	3	25.0%
Unknown	0	0.0%	0	0.0%
Total	18	6.2%	22	7.7%

3.3 Contribution of speeding to fatal and serious (FSI) road trauma

The contribution of speeding to FSI crashes is shown in Table 3.6 by speeding level. In total speeding contributed to 18.1% of serious and fatal road trauma. To state this another way, if speeding was eliminated there would be an expected reduction in FSI road crashes of 18.1%. While much of this contribution is attributable to vehicles speeding by more than 30 km/h, a quarter is due to speeding by 10 km/h or less.

Table 3.6
Contribution of speeding to FSI road trauma

Speeding level (km/h)	Contribution to total	Contribution to speeding sub-total
1 to 10	4.4%	24.6%
11 to 20	2.1%	11.4%
21 to 30	1.7%	9.2%
31 to 45	5.2%	29.0%
45+	4.7%	25.8%
Total	18.1%	100.0%

Figure 3.2 shows the contribution of speeding to serious and FSI crashes by speeding level in smaller increments than Table 3.6. This shows that the 5 km/h increment with the highest contribution to FSI crashes is 1 to 5 km/h over the speed limit, with only the group that includes all speeds 45 km/h above the speed limit and greater having a higher contribution.

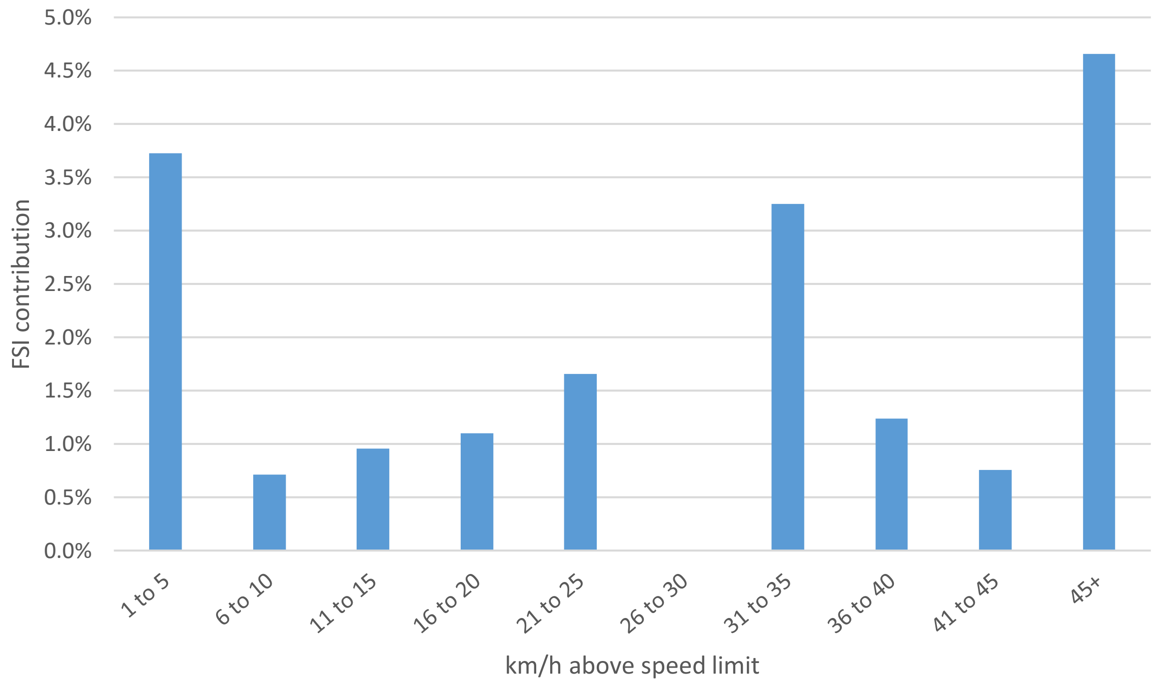

Figure 3.2
FSI contribution by level above speed limit

4 Discussion

The results show that if speeding was eliminated, fatal and serious injury crashes would be reduced by 18%. This can also be interpreted as speeding contributing to 18% of FSIs. Nationally this represents 216 fatalities and 7,132 serious injuries per year, at current levels. This is a similar reduction to the estimate produced by Kloeden *et al.*, (2002) with respect to injury crashes and eliminating speeding on metropolitan roads.

The results also show that a quarter of this reduction is attributable to low level speeding, with most of this quarter coming from the first 5 km/h over the speed limit.

Comparison with previous studies

The results of the present study are consistent with those of Doecke *et al.* (2011) over the range of speeds above the speed limit that were considered. Doecke *et al.,* (2011) only considered speeds up to 20 km/h above the speed limit. Within this range, the results of both studies show that speeding by up to 5 km/h contributes much more to road trauma than those travelling 6 to 20 km/h above the limit, be it injury crashes as considered in Doecke *et al.* (2011), or the serious and fatal crashes in the present study. This is despite Doecke *et al.* (2011) only considering a uniform speed reduction e.g. 1 km/h, rather than a reduction in speed to the speed limit.

The results differ to those of Alavi *et al.* (2014) who estimated that speeding by less than 10 km/h contributed to 79% of speeding related casualty crashes. It seems likely that this difference may be largely due to Alavi *et al*'s decision to cap the relative risk curve they used at high speeds. However, as Alavi *et al* do not present results with and without this capping, hence the exact effect on their results is unclear. There are also many methodological differences between the two studies that may have contributed to the different results.

Limitations

This study did not consider factors other than change in impact speed that may reduce the risk of a crash resulting in an FSI, or reduce the likelihood of the crash occurring. In a two-vehicle crash at an intersection a reduction in impact speed may also change the impact configuration. This may reduce the risk further by moving the impact away from the occupant compartment and lowering the change in velocity experienced by both vehicles. Small reductions in impact speed may, in certain circumstances, move the impact to the occupant compartment and increase the risk of injury, but these instances are likely to be less common. There may also be some instances where the struck vehicle is able to clear the path of the bullet vehicle due to a reduction in travel speed.

Another limitation of the study is that the sample contains an overrepresentation of crashes that resulted in hospital treatment, and an underrepresentation of crashes that resulted in property damage only (Elsegood, Doecke & Ponte, 2021) which was not accounted for with weighting. While the magnitude of the over/under-representation is not large, there was a difference in weighted percentage speeding between property damage only crashes and hospital treated crashes. This would have resulted in a small over-representation of speeding in the sample.

On balance, it seems likely that any effects of the former limitation would outweigh the latter. The result could therefore be considered conservative, though this cannot be confirmed.

Some caution should also be exercised due to the low number of cases at higher speeds. Low numbers in a given category can make that result vulnerable to random error.

Finally, this study uses data from South Australia. The extent to which it can be generalised to other jurisdictions depends on the distribution of speeding in crashes in a given jurisdiction compared to South Australia.

5 Conclusion

Speeding contributes to 18% of fatal and serious road trauma. That is, if speeding were eliminated, fatal and serious injury crashes are estimated to be reduced by 18%. At current national FSI levels, this represents 216 fewer fatalities and 7,132 fewer serious injuries per year. Low level speeding, speeding by less than 10 km/h, accounted for a quarter of this contribution to fatal and serious injury crashes.

The results suggest that low level speeding is not benign and should remain the focus of various road safety interventions, along with all levels of speeding.

6 Future work

Given the low number of high-level speeders in the sample it would be worthwhile repeating this analysis once the sample in the CASR-EDR database has doubled to confirm that the results are not unduly influenced by random error.

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