THE PREVALENCE AND PROFILE OF SPEEDING IN VEHICLE CRASHES USING EVENT DATA RECORDERS

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ABSTRACT

Travelling at a speed above the speed limit is commonly known as speeding. Prior studies examining the prevalence and profile of speeding in Australia (and other countries) have used data from various sources, including speed enforcement data, speed measurement surveys, self-report studies, and naturalistic studies. Attempts have been made to determine the prevalence of speeding in crashes using police reports, but these have conflated inappropriate speed for the conditions with speeding. The objective of the present study was to use data from event data recorders (EDRs) that record pre-crash speed to determine the prevalence and profile of speeding in crashes that occur in South Australia. Data from the Centre for Automotive Safety Research's Event Data Recorder database (CASR-EDR) was used in the analysis. Separate analyses were conducted for all bullet vehicles (n=319) and for those travelling at a free, or self-selected, speed (n=160). It was found that 27% of bullet vehicles involved in the crash sample were speeding. The most common category of speeding was 1-5 km/h above the speed limit, but 6% of bullet vehicles were found to be speeding by more than 20 km/h prior to their crash. When only free speed vehicles were considered the percentage of vehicles speeding rose to 39%. Speeding was found to be more prevalent in crashes where the bullet vehicle was driven by a young driver, a driver with a provisional license, or the vehicle was black, red, or grey in colour. Speeding was also most prevalent in crashes that occurred on a weekend night, on a curve, at a mid-block location, on a local road, in regional areas, on a wet road, in low-speed zones, and in single vehicle crashes. These findings reinforce the need to reduce the prevalence of speeding through means such as education, enforcement, road design or vehicle technology. Young drivers should be a particular focus of efforts to reduce speeding. The findings can also provide some guidance on where enforcement activities should be further focussed.

INTRODUCTION

Speed is one important part of the Safe System approach to road safety which recognises the need for safe interactions between people, roads, vehicles and speed [1]. As the speed at which a vehicle is travelling increases so does the risk of being involved in an injury crash [2-4] and the risk of a crash resulting in serious or fatal injuries [5]. To balance this increase in risk against the need for mobility, jurisdictions set speed limits on roads that state the maximum speed at which a vehicle may legally travel on that road.

There are many factors that authorities may consider when setting speed limits. In Australia, speed limits are meant to be set based on the functional hierarchy and physical characteristics of the road, and should reflect individual and collective safety risk to road users as well as considering amenity and mobility [6-7]. However, other factors, such as local politics, may still play a role [8].

Although it is illegal, it remains relatively common for drivers to exceed the speed limit, commonly known as speeding [9]. Measurements or estimates of the prevalence and profile of speeding in Australia (and other countries) have come from a variety of sources.

Speed Enforcement and Speed Surveys

One of the main sources of data on the prevalence of speeding is from measurement of vehicle speeds at a given location or section of road, logged for either enforcement purposes or for speed measurement surveys conducted for research. Speed measurement devices may also record the vehicle registration, which allows matching to vehicle and driver details to provide a profile of the driver characteristics in addition to road characteristics recorded by the operators of the speed measurement devices.

Alavi *et al.* [10] analysed a sample of about 350,000 speed measurements from mobile speed enforcement cameras in Victoria. They excluded data recorded when traffic flow was particularly low or high for a given location, which may have excluded peak or late-night / early-morning periods. They found that 9.5% of drivers

captured in their sample exceeded the speed limit, and most speeders (95%) were speeding by 1 to 10 km/h over the posted speed limit. They also found that drivers in rural areas were 1.85 times more likely to speed at any specific time of the year compared to metropolitan areas (11% compared to 6% for metropolitan drivers). When considering speed zone, they found that the highest level of speeding occurred in 40 km/h speed zones, where 47% of drivers in metropolitan areas exceeded the speed limit, followed by 50 km/h (23% regional, 21% metropolitan) and 60 km/h speed zones (12% regional, 10% metropolitan). The lowest speeding rates in metropolitan areas were 80 km/h speed zones (3%) whereas the lowest speeding rates in regional areas were 90 km/h speed zones (5%).

In South Australia, annual speed surveys are conducted at more than 100 sites using pneumatic tubes to measure speed and headway. These speed surveys were conducted at sites with speed zones ranging from 50 to 110 km/h and found that speeding varied according to location (metropolitan or rural) and speed zone [9]. In 2018, speeding was most prevalent on metropolitan 50 km/h collector roads (37%), rural 100 km/h roads (35%), rural 50 km/h roads (26%) and rural 80 km/h roads (24%), for any driver exceeding the speed limit by any amount. Rural 100 km/h and Adelaide 50 km/h roads also had the highest percentage of drivers exceeding the speed limit by 10 km/h or more, 7% and 5% respectively. These speed surveys also considered speeding for free-speed vehicles. Free-speed vehicles were defined as those having a headway gap of at least four seconds. The prevalence of speeding of free-speed vehicles were only marginally different from that of all vehicles on most roads, except 60 km/h metropolitan arterial roads (12% increased to 18%) and 80 km/h rural roads (24% increased to 29%).

Williams, Kyrychenko, & Retting [11] undertook speed surveys on roads in Northern Virginia (USA) with speed limits ranging from 40 mph to 55 mph (64 to 89 km/h). They recorded the speeds of "free-flowing" vehicles using a photoradar camera system and examined licensing details of the speeding drivers in their sample to gain further insight. Williams *et al.* [11] found that 28%, 29% and 15% of drivers in their sample exceeded the posted speed limit by 0-4, 5-9, and 10-14 mph respectively, while 5% of drivers exceeded the speed limit by more than 15 mph. However, Williams *et al.* [11] defined 'speeding' as travelling 15 mph (25 km/h) over the speed limit and at least 5 mph faster than 3 of the 4 vehicles around them, therefore only 3% of their sample met their operational definition of speeding. Their results indicated that their speeding drivers were younger and more likely to drive newer vehicles (and SUVs) and it was suggested that they were more likely to be male than female. Furthermore, their speeders had more traffic violations and on average had more crashes per year than their comparison group.

Self-Report Studies

Stephens *et al.* [12] conducted a community attitude survey on an age and sex representative sample of Australian drivers (excluding South Australia) to profile some aspects of speed behaviours. They found that males were more likely to speed by any amount compared to females, and speeding was least prevalent in low-speed zones (40 km/h) with prevalence increasing as speed limit increased. Most speeding was 1-5 km/h over the speed limit, with a higher proportion of 16–25 year olds reported driving 11 km/h or more over the speed limit.

Naturalistic Studies

Naturalistic studies can also reveal the characteristics of speeding drivers. Perez et al., [13], using objective data from the SHRP2 naturalistic driving study (conducted in various states of the US), found that male drivers were more likely to speed than females (Odds Ratio [OR] 1.1) and younger drivers were more likely to speed (OR 1.5) compared to older drivers (80+ years-old reference group). Speeding decreased across increasing age groups. Perez et al., [13] also found that the odds of speeding were larger at lower speed limits and speeding decreased with increasing speed limit; in 10-20 mph speed zones (16-32 km/h) the OR of speeding was 9.5 times than that in 60 mph (96 km/h) reference speed limit group.

Ellison & Greaves [14] used GPS data and follow-up survey data to evaluate prevalence and characteristics of speeding behaviours for drivers undertaking normal driving in the Australian state of New South Wales. They found that 20% of moving distance travelled was spent over the speed limit (by 1 km/h or more) and there was a small but significant number who frequently exceeded the speed limit by 10 km/h or more. They also found that males were more likely than females to speed in each age group (except in the 46-65 age group, where females sped more), and little difference was observed in the prevalence of speeding in the different age groups. Ellison & Greaves [14] also found that speeding was more prevalent on weekends (and at night) than weekdays, but weekday speeding was most prevalent in the mornings. Speeding was highest when the driver was the only occupant and decreased slightly as occupancy increased (to 3 occupants) but then increased again with more

occupants. Speeding was found to be highest by purpose of the trip for those traveling on vacation and commuting to work and lowest for education/childcare trips.

Crash Studies

Determining the prevalence and profile of speeding in crashes is more complex as the only way to ascertain objective speed in crashes was, historically, through crash reconstructions. Crash reconstructions require specialist knowledge, are labour intensive, and are not typically conducted by police in Australia except for the most serious of crashes. Even crash reconstructions are limited in their ability to identify speeding due to uncertainties around identifying when the vehicle began to brake.

While routine police crash reports usually cannot objectively state whether speeding was a contributing factor in a particular crash, there have been attempts to try to identify speeding based on information in a police report. The Centre for Road Safety, Transport for NSW provide criteria whereby speed as a factor in crashes can be derived that is also used in other Australian jurisdictions [15]. This method identifies both inappropriate speed for the conditions and speeding but has been shown to lack both sensitivity and specificity if used to identify only speeding [16]. A similar issue exists in the US where speed related crashes are identified by police but inappropriate speed for the conditions and speeding are often conflated [17].

Aim of the Present Study

The increasing prevalence of vehicles with event data recorders (EDRs) in the fleet enables a new method of examining speeding in crashes. Studies have found that EDR speed data are accurate, with speed generally slightly underreported by around 1 km/h [18]. Doecke, Kloeden, & Paine [19] used EDR speed data to examine the prevalence of speeding in crashes in the US, concluding that speeding in crashes is far more prevalent than indicated by police reports. Doecke *et al.* [19] suggested that routine collection and use of EDR data would better represent the extent of speeding in crashes. The aim of the current study was to determine the prevalence and profile of speeding in South Australian crashes using EDR data.

METHOD

Data from the Centre for Automotive Safety Research's Event Data Recorder database (CASR-EDR) was used to examine the prevalence and profile of speeding in South Australia. The CASR-EDR database contains the largest set of EDR data from crashed vehicles in Australia. It includes vehicles that were legally too damaged to be repaired, or were deemed uneconomical to repair by an insurer. Data collection began in 2017 and is ongoing. It also contains data matched from several sources, such as police reports and a licensing and registration database. This means that it not only contains highly accurate speed data from crashed vehicles, but also contains a range of information that can be used to profile the characteristics of drivers, vehicles, and locations of crashes involving speeding. The CASR-EDR database had 639 records of EDR data collected between 2017 and 2021 that have been matched to police reports and other data sources.

Two variables in the CASR-EDR database were used to identify speeding, the travel speed of the vehicle and the speed limit. The travel speed of the vehicle in the CASR-EDR database is defined as the highest speed shown in the 2.5 to 5 seconds of pre-crash data recorded on the EDR. The speed limit is sourced from the matched police report. By comparing the travel speed from the EDR to the speed limit, speeding in crashes was identified.

The CASR-EDR database has been found to be representative of police reported crashes in South Australia in terms of area, speed limit, and crash type [20]. Crash severity in the CASR-EDR database is skewed toward higher severity crashes, most likely due to EDR devices not recording data from very minor crashes. It should also be noted that the sample is limited to vehicles supported by the Bosch CDR tool in Australia. This limits the sample to vehicles manufactured after about 2004. It also results in the makes of vehicle that have been supported by the Bosch CDR tool for the entire duration of the CASR-EDR database's data collection (e.g. Toyotas, Holdens, Jeeps) being over-represented in the sample, the makes that have been supported for some of the duration of data collection (e.g. Mitsubishi, Subaru, BMW) being under-represented, and some makes not being represented at all (e.g. Hyundai, KIA).

Crashes in the CASR-EDR database that occurred between 2017 and 2021 were included in the analysis if they contained speed data from a bullet vehicle. A bullet vehicle is defined in the CASR-EDR database using the movements of the vehicles as described in the police report. Bullet vehicles were vehicles that generally had

right of way (if travelling through an intersection). For crashes where a vehicle was performing a turning manoeuvre across traffic, the bullet vehicle was the through vehicle. In rear-end crashes, the rear-most vehicle was the bullet vehicle. For single vehicle crashes, the crashed vehicle was always classified as the bullet vehicle. In head-on crashes and side-swipe crashes, both vehicles were classified as bullet vehicles. There were 319 crashes identified in the CASR-EDR database as having speed data and being from a bullet vehicle.

The prevalence and profile of speeding free-speed vehicles was also examined. Free, or self-selected, speed could not be determined in terms of a time headway from EDR data, as is done in speed surveys using pneumatic tubes (e.g. [9]). Instead, the CASR-EDR database classifies free-speed according to what is deduced from the EDR data and the police report. To be considered a free-speed vehicle, the vehicle must not have been:

- involved in a rear end crash
- performing a turning manoeuvre
- accelerating from a stationary position
- performing an illegal manoeuvre
- travelling through work zones
- operated by a driver who had a medical episode or fatigued prior to their crash

The focus of the free-speed criteria in the CASR-EDR database was to minimise false positives (misclassification as free-speed). However, it is acknowledged that this comes at the expense of false negatives (misclassification as not free-speed). There were 160 vehicles that were classified as free-speed vehicles.

Prior traffic offences committed by the drivers were also included in the analysis of free-speed vehicles. This data was sourced from a licensing and registration database of offences committed within South Australia. The offences were expressed as the number of offences per three years of licensure to attempt to account for driving exposure.

RESULTS

It was found that 27% of bullet vehicles involved in the crashes were speeding (Table 1). The most common category of speeding was 1-5 km/h above the speed limit (9% of vehicles), but 6% of bullet vehicles were found to be speeding by more than 20 km/h prior to their crash. When only free speed vehicles were considered (Table 2) the percentage of vehicles speeding rose to 39%.

Table 1 and 2 also show the prevalence and category of speeding by the characteristics of the driver, while Figures 1 and 2 provide the prevalence and category of speeding by age and sex. Tables 1 and 2 show that speeding was more prevalent among younger drivers, particularly when only free-speed vehicles were considered, but there was little difference between the sexes. However, Figures 1 and 2 reveal that there were differences by sex for 16-24 year olds and those 65 and older, although these differences were not statistically significant. Tables 1 and 2 also show the prevalence of speeding according to the driver's alcohol test result, the level of license, and the location of residence. Speeding was more prevalent among drivers who had a positive alcohol test result, especially high-level speeding, but the statistical significance of this could not be tested. Speeding was also more prevalent amongst drivers on a provisional license than amongst those on a full license. Drivers that resided in regional areas had different patterns of speeding than those from the major city. For free-speed vehicles (Table 2), speeding drivers who live in a major city tended to speed by 10 km/h or less, while those in inner regional areas tended to speed by more than 10 km/h.

Table 2 displays speeding prevalence by number of prior speeding offences per year of licensure, and by all driving offences per year of licensure. Speeding was least prevalent amongst drivers that had a speeding offence but had less than 1 per 3 years of licensure. This pattern was also evident when all driving offences were considered, but neither result was statistically significant.

Table 1.
Speeding prevalence by driver characteristics and speeding category for all bullet vehicles

Driver Char.	Category	Count	Total speeding		Chi squared test results		Speeding category (km/h)							
							1-5		6-10		11-20		21+	
			No.	%	χ^2	p	No.	%	No.	%	No.	%	No.	%
Age	16 - 24	75	27	36%	18.5	<0.001	9	12%	7	9%	4	5%	7	9%
	25 - 39	96	35	36%			12	13%	10	10%	6	6%	7	7%
	40 - 64	110	19	17%			7	6%	3	3%	7	6%	2	2%
	≥65	34	3	9%			2	6%	1	3%	0	0%	0	0%
Sex	Male	183	51	28%	0.3	0.570	17	9%	14	8%	11	6%	9	5%
	Female	132	33	25%			13	10%	7	5%	6	5%	7	5%
Alcohol*	Positive	7	5	71%	NA	NA	1	14%	0	0%	1	14%	3	43%
	Negative	241	65	27%			27	11%	18	7%	12	5%	8	3%
	Not tested	67	14	21%			2	3%	3	4%	4	6%	5	7%
Licence	Full	274	67	24%	7.0	0.008	25	9%	16	6%	15	5%	11	4%
	Provisional	38	17	45%			5	13%	5	13%	2	5%	5	13%
	Learners	3	0	0%			0	0%	0	0%	0	0%	0	0%
Location of residence	Major Cities	262	67	26%	1.2	0.264	25	10%	19	7%	12	5%	11	4%
	Regional	48	16	33%			5	10%	2	6%	4	8%	5	10%
	Unknown	5	1	20%	NA	NA	0	0%	0	0%	1	20%	0	0%
Total		**315**	**84**	**27%**			**30**	**9%**	**21**	**7%**	**17**	**5%**	**16**	**5%**

Note: Four drivers had unknown data for all driver characteristics.
* Positive means above the legal limit for that driver, which in most cases is a BAC of 0.05, but is 0.00 for drivers with a provisional license, and bus, truck and taxi drivers.

Table 2.
Speeding prevalence by driver characteristics and speeding category for free-speed vehicles

Driver Char.	Category	Count	Total speeding		Chi squared test results		Speeding category (km/h)							
							1-5		6-10		11-20		21+	
			No.	%	χ^2	p	No.	%	No.	%	No.	%	No.	%
Age	16 - 24	33	20	61%	15.2	0.002	6	18%	5	15%	3	9%	6	18%
	25 - 39	50	24	48%			8	16%	6	12%	5	10%	5	10%
	40 - 64	62	15	24%			6	10%	3	5%	4	6%	2	3%
	≥65	13	3	23%			2	15%	1	8%	0	0%	0	0%
Sex	Male	94	38	40%	0.1	0.712	13	14%	10	11%	8	9%	7	7%
	Female	64	24	38%			9	14%	5	8%	4	6%	6	9%
Alcohol*	Positive	6	5	83%	NA	NA	1	17%	0	0%	1	17%	3	50%
	Negative	120	44	37%			19	16%	13	11%	6	5%	6	5%
	Not tested	32	13	41%			2	6%	2	6%	5	16%	4	13%
Licence	Full	138	49	36%	6.4	0.012	19	14%	11	8%	11	8%	8	6%
	Provisional	20	13	65%			3	15%	4	20%	1	5%	5	25%
Place of residence	Major Cities	126	50	40%	0.1	0.821	20	16%	13	10%	9	7%	8	6%
	Regional	32	12	37%			2	6%	2	6%	3	9%	5	16%
Previous speeding offences	None	49	21	43%	3.5	0.171	8	16%	6	12%	2	4%	5	10%
	<1 per 3 yrs	70	22	31%			8	11%	4	6%	4	6%	6	9%
	≥1 per 3 yrs	39	19	49%			6	15%	5	13%	6	15%	2	5%
Previous driving offences	None	37	17	46%	3.3	0.196	5	14%	6	16%	2	5%	4	11%
	<1 per 3 yrs	70	20	29%			10	14%	3	4%	4	69%	3	4%
	≥1 per 3 yrs	51	25	49%			7	14%	6	12%	6	12%	6	12%
Total		**158**	**62**	**39%**			**22**	**14%**	**15**	**9%**	**12**	**8%**	**13**	**8%**

Note: Two drivers had unknown data for all driver characteristics.
* Positive means above the legal limit for that driver, which in most cases is a BAC of 0.05, but is 0.00 for drivers with a provisional license, and bus, truck and taxi drivers.

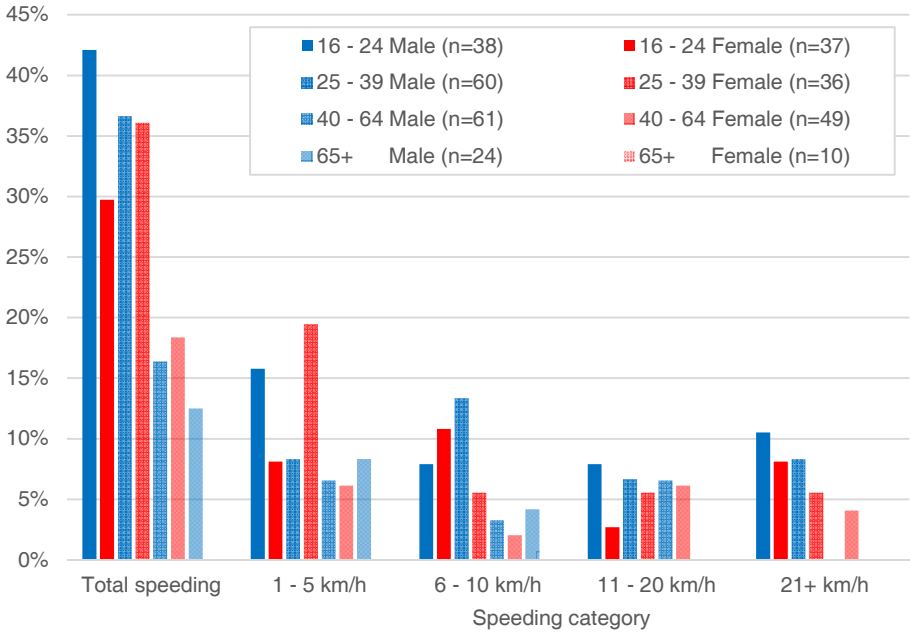

Figure 1. Speeding prevalence by age, sex, and speeding category for all bullet vehicles.

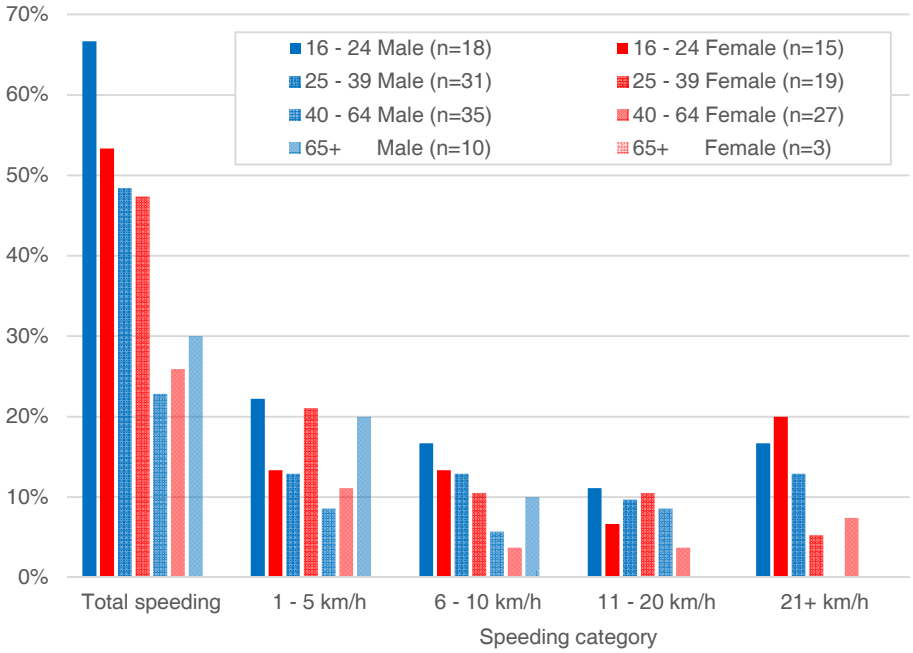

Figure 2. Speeding prevalence by age, sex, and speeding category for free-speed vehicles.

Table 3 shows the speeding prevalence of the bullet vehicles with respect to vehicle characteristics, and Table 4 shows the same data for free-speed vehicles. There was little difference in the prevalence of speeding between sedans and SUVs (including derivatives). Speeding was more prevalent amongst vehicles that were black, grey and red in colour. Speeding was also more prevalent among vehicles with a manual transmission and those with a sole occupant, but these results were not statistically significant. Newer vehicles (less than 5 years old) had lower speeding rates than older vehicles, but this was also not statistically significant.

Table 3.
Speeding prevalence by vehicle characteristics and speeding category for all bullet vehicles

Vehicle Char.	Category	Count	Total speeding		Chi squared test results		Speeding category (km/h)							
							1-5		6-10		11-20		21+	
			No.	%	χ^2	p	No.	%	No.	%	No.	%	No.	%
Body Type	Sedan type	235	64	27%	0.0	0.957	22	9%	14	6%	12	5%	16	7%
	SUV type	78	21	27%			8	10%	6	8%	5	6%	2	3%
	Van	6	1	17%	NA	NA	0	0%	1	17%	0	0%	0	0%
Transmission	Automatic	275	70	25%	2.3	0.130	26	9%	20	7%	12	4%	12	4%
	Manual	44	16	36%			4	9%	1	2%	5	11%	6	14%
Colour	Black	49	19	39%			7	14%	6	12%	3	6%	3	6%
	Grey	38	12	32%			6	16%	3	8%	2	5%	1	3%
	Red	36	12	33%	6.0	0.015	5	14%	1	3%	3	8%	3	8%
	Silver	57	13	23%			3	5%	3	5%	1	2%	6	11%
	White	99	21	21%			6	6%	6	6%	6	6%	3	3%
	Other	40	9	23%	NA	NA	3	8%	2	5%	2	5%	2	5%
Number of occupants	Sole driver	245	71	29%	2.2	0.139	24	10%	16	7%	15	6%	16	7%
	Multiple occupants	74	15	20%			6	8%	5	7%	2	3%	2	3%
Vehicle age	0 to 4 years	106	23	22%			9	8%	4	4%	7	7%	3	3%
	5 to 9 years	137	42	31%	2.5	0.292	13	9%	14	10%	7	5%	8	6%
	≥ 10 years	76	21	28%			8	11%	3	4%	3	4%	7	9%
Total		**319**	**86**	**27%**			**30**	**9%**	**21**	**7%**	**17**	**5%**	**18**	**6%**

Table 4.
Speeding prevalence by vehicle characteristics and speeding category for free-speed vehicles

Vehicle Char.	Category	Count	Total speeding		Chi squared test results		Speeding category (km/h)							
							1-5		6-10		11-20		21+	
			No.	%	χ^2	p	No.	%	No.	%	No.	%	No.	%
Body Type	Sedan type	119	48	40%	0.0	0.939	17	14%	10	8%	9	8%	12	10%
	SUV type	39	16	41%			5	13%	5	13%	3	8%	3	8%
	Vans	2	0	0%	NA	NA	0	0%	0	0%	0	0%	0	0%
Transmission	Automatic	131	51	39%	0.3	0.558	19	15%	14	11%	9	7%	9	7%
	Manual	29	13	45%			3	10%	1	3%	3	10%	6	21%
Colour	Black	24	12	50%			6	25%	3	13%	0	0%	3	13%
	Grey	17	9	53%			4	24%	2	12%	2	12%	1	6%
	Red	24	10	42%	2.3	0.133	4	17%	1	4%	3	13%	2	8%
	Silver	31	10	32%			2	6%	3	10%	1	3%	4	13%
	White	43	16	37%			4	9%	5	12%	4	9%	3	7%
	Other	21	7	33%	NA	NA	2	10%	1	5%	2	10%	2	10%
Number of occupants	Sole driver	116	51	44%	2.8	0.096	18	16%	10	9%	11	9%	12	10%
	Multiple	44	13	30%			4	9%	5	11%	1	2%	3	7%
Vehicle age	0 to 4 years	50	16	32%			6	12%	2	4%	5	10%	3	6%
	5 to 9 years	72	31	43%	2.0	0.373	9	13%	10	14%	5	7%	7	10%
	≥ 10 years	38	17	45%			7	18%	3	8%	2	5%	5	13%
Total		**160**	**64**	**40%**			**22**	**14%**	**15**	**9%**	**12**	**8%**	**15**	**9%**

The prevalence of speeding according to characteristics of the crashes are shown in Tables 5 and 6 for all bullet vehicles and free-speed vehicles, respectively. Speeding was more prevalent in crashes that occurred at night and on the weekend, in regional areas, on curves, at midblock locations, and on a wet road. Speeding was most prevalent on local roads and least prevalent on arterial roads. In terms of speed limit, speeding was most prevalent on roads with a speed limit of 50 km/h or less and least prevalent on roads with speed limits of 60 km/h. Speeding was also far more prevalent in single vehicle and side swipe crashes than any other crash type.

Table 5.
Speeding rates according to crash characteristics and speeding category for all bullet vehicles

Crash Char.	Category	Count	Total speeding		Chi squared test results		Speeding category (km/h)							
							1-5		6-10		11-20		21+	
			No.	%	χ^2	p	No.	%	No.	%	No.	%	No.	%
Time and day	Weekday day	213	47	22%	13.2	0.004	20	9%	13	6%	7	3%	7	3%
	Weekend day	22	8	36%			2	9%	1	5%	2	9%	3	14%
	Weekday night	58	17	29%			6	10%	6	10%	4	7%	1	2%
	Weekend night	26	14	54%			2	8%	1	4%	4	15%	7	27%
Area	Major Cities	265	65	25%	4.7	0.030	24	9%	17	6%	12	5%	12	5%
	Regional	54	21	39%			6	11%	4	7%	5	9%	6	11%
Road curvature	Curved	33	17	52%	11.3	0.001	5	15%	4	12%	4	12%	4	12%
	Straight	286	69	24%			25	9%	17	6%	13	5%	14	5%
Intersection	Mid-block	200	66	33%	10.6	0.031	22	11%	15	8%	15	8%	14	7%
	Cross Road	47	9	19%			3	6%	2	4%	2	4%	2	4%
	T-Junction	55	8	15%			4	7%	3	5%	0	0%	1	2%
	Roundabout	9	1	11%			0	0%	0	0%	0	0%	1	11%
	Other	8	2	25%			1	13%	1	13%	0	0%	0	0%
Road class	Freeway	23	8	35%	14.9	0.002	4	17%	1	4%	2	9%	1	4%
	Arterial	159	30	19%			11	7%	8	5%	7	4%	4	3%
	Collector	89	26	29%			10	11%	8	9%	5	6%	3	3%
	Local	48	22	46%			5	10%	4	8%	3	6%	10	21%
Speed zone (km/h)	≤ 50	75	33	44%	16.3	0.001	8	11%	8	11%	6	8%	11	15%
	60	163	31	19%			11	7%	9	6%	5	3%	6	4%
	70 - 90	48	13	27%			8	17%	2	4%	3	6%	0	0%
	100 - 110	33	9	27%			3	9%	2	6%	3	9%	1	3%
Crash type	Head on	12	3	25%	23.3	<0.001	2	17%	0	0%	1	8%	0	0%
	Rear end	90	19	21%			8	9%	6	7%	4	4%	1	1%
	R. turn/angle	96	15	16%			8	8%	5	5%	2	2%	0	0%
	Side swipe	16	6	38%			3	19%	2	13%	1	6%	0	0%
	Single vehicle	86	39	45%			9	10%	6	7%	8	9%	16	19%
	Other	19	4	21%	NA	NA	0	0%	2	11%	1	5%	1	5%
Road conditions	Dry	277	23	25%	3.0	0.084	23	8%	21	8%	14	5%	12	4%
	Wet	42	7	38%			7	17%	0	0%	3	7%	6	14%
Total		**319**	**30**	**27%**			**30**	**9%**	**21**	**7%**	**17**	**5%**	**18**	**6%**

Day is defined as 6:00 to 19:59, Night is defined as 20:00 to 5:59.
Area is defined according to the Australian Statistical Geography Standard Remoteness Structure. Regional includes the categories; inner regional, outer regional, remote, and very remote.

Table 6.
Speeding rates according to crash characteristics and speeding category for free-speed bullet vehicles

Crash Char.	Category	Count	Total speeding		Chi squared test results		Speeding category (km/h)							
							1-5		6-10		11-20		21+	
			No.	%	χ^2	p	No.	%	No.	%	No.	%	No.	%
Time and day	Weekday day	100	32	32%	11.6	0.009	14	14%	9	9%	4	4%	5	5%
	Weekend day	14	7	50%			2	14%	0	0%	1	7%	4	29%
	Weekday night	30	13	43%			4	13%	5	17%	3	10%	1	3%
	Weekend night	16	12	75%			2	13%	1	6%	4	25%	5	31%
Area	Major Cities	124	46	37%	1.9	0.164	17	14%	12	10%	8	6%	9	7%
	Regional	36	18	50%			5	14%	3	8%	4	11%	6	17%
Road curvature	Curved	21	15	71%	9.9	0.002	4	19%	3	14%	4	19%	4	19%
	Straight	139	49	35%			18	13%	12	9%	8	6%	11	8%
Intersection	Mid-block	80	46	58%	19.6	<0.001	14	18%	10	13%	10	13%	12	15%
	Cross Road	32	8	25%			3	9%	2	6%	2	6%	1	3%
	T-Junction	43	9	21%			4	9%	3	7%	0	0%	2	5%
	Roundabout	1	0	0%	NA	NA	0	0%	0	0%	0	0%	0	0%
	Other	4	1	25%	NA	NA	1	25%	0	0%	0	0%	0	0%
Road class	Freeway	16	7	44%	10.7	0.014	3	19%	1	6%	2	13%	1	6%
	Arterial	65	17	26%			7	11%	6	9%	2	3%	2	3%
	Collector	45	20	44%			8	18%	4	9%	5	11%	3	7%
	Local	34	20	59%			4	12%	4	12%	3	9%	9	26%
Speed zone (km/h)	≤ 50	39	24	62%	10.5	0.015	5	13%	7	18%	3	8%	9	23%
	60	75	23	31%			10	13%	5	7%	3	4%	5	7%
	70 - 90	23	8	35%			4	17%	1	4%	3	13%	0	0%
	100 - 110	23	9	39%			3	13%	2	9%	3	13%	1	4%
Crash type	Head on	10	3	30%	26.0	<0.001	2	20%	0	0%	1	10%	0	0%
	R. turn / angle	72	16	22%			8	11%	5	7%	2	3%	1	1%
	Side swipe	9	6	67%			3	33%	2	22%	1	11%	0	0%
	Single vehicle	54	35	65%			9	17%	6	11%	7	13%	13	24%
	Other	15	4	27%	NA	NA	0	0%	2	13%	1	7%	1	7%
Road surface conditions	Dry	139	50	36%	7.2	0.007	16	12%	15	11%	9	6%	10	7%
	Wet	21	14	67%			6	29%	0	0%	3	14%	5	24%
Total		**160**	**64**	**40%**			**22**	**14%**	**15**	**9%**	**12**	**8%**	**15**	**9%**

Day is defined as 6:00 to 19:59, Night is defined as 20:00 to 5:59.
Area is defined according to the Australian Statistical Geography Standard Remoteness Structure. Regional includes the categories; inner regional, outer regional, remote, and very remote.

DISCUSSION

This study used EDR data matched to police reports and a licensing database to examine the prevalence of speeding in crashes in South Australia. It also produced a profile of the driver, vehicle and crash characteristics of crashes where the bullet vehicles and free-speed vehicles were speeding. Speeding was also broken down into different categories of speeding to provide further detail related to the prevalence and profile of speeding in South Australia.

When interpreting the results, it is important to bear in mind that they do not necessarily reflect the prevalence of speeding under normal traffic conditions. For a vehicle to be included in the sample it had to have been involved in a crash. The prevalence of vehicles speeding in a crash with a certain characteristic is a function of the prevalence of vehicles speeding with that characteristic, and the relationship between speed and crash risk for that characteristic. For example, the crash risk of driving on a wet road or around a curve may be more

sensitive to driving above the speed limit than driving on a dry or straight road. It should not be concluded that speeding is more prevalent on curves or wet conditions based on the results.

Limitations

Several limitations with police report and traffic offence data should be noted. Data from police reports should not be assumed to be 100% reliable. Kloeden, Linke and Ponte [21] found that South Australian police reports on injury crashes attended by police were at least 92% for the variables used in the present analysis, but this may be reduced for non-injury crashes that police do not necessarily attend. The traffic offence database only contains offences committed within South Australia, and may therefore not reflect the overall driving history for drivers who have spent a considerable amount of their time driving in other states.

As detailed in the method, the sample is limited to crashed vehicles that could have their EDR data downloaded using the Bosch CDR tool. This limited the sample to vehicles manufactured from about 2004 onwards, and has resulted in certain makes of vehicle being over-represented. The exclusion of older vehicles may have had an impact on the overall prevalence of speeding found in the results. Older vehicles are generally thought to be driven by younger drivers due to affordability, but a US study showed that drivers aged over 65 also drive older vehicles than the middle aged [22]. It is therefore unclear what effect this may have had on the results, as it may have excluded some young drivers, who are the most likely to be speeding in a crash, and some old drivers who are least likely to be speeding. Particular makes were over-represented and this would influence the results if speeding varied between makes. This seems unlikely as the two most common vehicle makes in the sample, Holden and Toyota, have a wide range of models to appeal to various market segments and demographics.

Comparisons to prior research

The age of drivers that were more likely to have been speeding prior to a crash in the present study is largely consistent with prior research that obtained data on speeding drivers from other sources. The naturalistic study by Perez *et al.* [13] and the study by Williams, Kyrychenko & Retting [11] based on enforcement data, and the study by Stephens *et al.* [12] based on self-reported speeding behaviours, all found that speeding was more prevalent amongst younger drivers. However, the findings of the present study with regard to sex was not consistent with prior research. The same prior studies that examined speeding outside of the context of a crash [11-13] found that speeding was more prevalent amongst males drivers, but in the present study males involved in crashes had very similar prevalence of speeding to females. While the present study did show some differences between young (16-24 year old) males and young females, and males and females aged over 65, the sample size precluded these differences from being statistically significant when disaggregated to this level.

Speeding, and especially high-level speeding, was more prevalent in crashes on roads with a low-speed limit. This is consistent with studies that measured speeding objectively, be it through enforcement data [10], speed surveys [9], or naturalistic studies [13]. However, it is inconsistent with the study by Stephens *et al.* [12] that used self-reported data. This may suggest that drivers that self-report their speeding behaviour are less aware of their speeding in low-speed zones, or that speeding in low-speed zones is less socially acceptable and therefore less likely to be self-reported. The increased speeding in crashes in low-speed zones may be a result of the perceived risk of being caught on such roads being low, as these tend to be local metropolitan roads that have less enforcement. It may also point to a lack of credibility of these speed limits in the minds of some drivers, which can be related to compliance [23].

Speeding in crashes was more common in regional areas than in the major city areas. This is consistent with Alavi *et al.* [10]. Like speeding on low-speed local roads, this may be related to a low perceived chance of being caught by enforcement activities.

A prior study looking at speeding survey data found that speeding drivers had a higher number of traffic violations [11]. The present study found that drivers involved in speeding crashes were more likely to have either no speeding or no traffic offences, or more than 1 per 3 years of licensure, but this result was not statistically significant.

Newstead & D'Elia [24] found that black, grey and red were some of the colours that had an increased risk of being involved in a crash, with blue, green and silver also being associated with higher crash risk. The current work suggests that at least some of this increased crash risk for black, red and grey vehicles is due to the fact that they are more likely to be speeding. However, it should be noted that the sample size of the present analysis only allowed for the most common colours to be examined.

Williams, Kyrychenko & Retting [11] found that newer vehicles and SUVs were more likely to be speeding, but this was not reflected in the present study. This may be due to differences between the types of drivers of such vehicles in Australia and the US.

Generalisability

The generalisability of the results may vary between the different characteristics being considered. The results related to driver characteristics are most likely applicable to many other jurisdictions and countries as they are unlikely to be cultural to South Australia. The region of the drivers' homes may be uniquely related to South Australia's geography and the perception of the risk of being caught for speeding in these different regions. With respect to crash characteristics, the results for road curvature, intersection type, and road surface condition are likely to be widely applicable. However, the way in which the area, road class, and speed zones are classified may vary between jurisdictions and countries in a manner that reduces the generalisability of these results. It is unclear how generalisable the results related to crash type are as classification may vary between regions. The degree of generalisability of the results relating to vehicle characteristics will also depend on consistency in classification.

CONCLUSIONS

It was found that 27% of bullet vehicles involved in crashes in South Australia were speeding. The most common category of speeding was 1-5 km/h above the speed limit, but 6% of bullet vehicles were found to be speeding by more than 20 km/h prior to their crash. When only free speed vehicles were considered the percentage of vehicles speeding rose to 39%. Speeding was found to be more prevalent in crashes where the bullet vehicle was driven by a young driver, a driver with a provisional license, or the vehicle was black, red, or grey in colour. Speeding was also most prevalent in crashes that occurred on a weekend night, on a curve, at a mid-block location, on a local road, in regional areas, on a wet road, in low-speed zones, and in single vehicle crashes.

These findings reinforce the need to reduce the prevalence of speeding through means such as education, enforcement, road design or vehicle technology. Young drivers should be a particular focus of efforts to reduce speeding. The findings can also provide some guidance on where enforcement activities should be further focussed.

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