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Factors associated with old car crashes

SJ Raftery, RWG Anderson

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AUTHORS

SJ Raftery, RWG Anderson

PERFORMING ORGANISATION

Centre for Automotive Safety Research
The University of Adelaide
South Australia 5005
AUSTRALIA

SPONSORED BY

Department of Planning, Transport and Infrastructure
GPO Box 1533
Adelaide SA 5001
AUSTRALIA

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ABSTRACT

A recent examination of the crashworthiness of vehicles in South Australia revealed that the preponderance of fatal or injury crashes in South Australia were observed to involve young drivers in old cars. It has been proposed that the tendency for younger drivers to drive older vehicles is simply due to the financial costs of buying a car, as such it is likely that the prohibitive costs of buying a new vehicle are likely an issue for other low-income groups. Evidence further indicates that drivers from low SES backgounds also have an increased crash risk. The aim of the present study is to obtain a better understanding of crashes involving old cars and to identify drivers for whom these crashes are an issue. Using TARS data from 19,648 serious injury or fatal crashes occurring during the period 2001-2009 this study found some evidence that young drivers and drivers from low or middle socio-economic backgrounds are more likely to be involved in a crash involving an older vehicle. There is some evidence that older vehicles carry inherent crash risks. The implications of these findings with regard to vehicle safety technologies are discussed.

KEYWORDS

Vehicle age, crash risk, young drivers, socio economic status

Summary

A recent examination of the crashworthiness of vehicles in South Australia revealed that the preponderance of fatal or injury crashes in South Australia were observed to involve young drivers in cars that are older than vehicles crashed by the rest of the droving population (Anderson, Doecke, & Searson, 2009). That study also found that the modal vehicle age amongst teenage drivers involved in crashes was around 13 years, compared to 2 years for drivers aged over 30 years. Young drivers have long been recognised as having an increased risk of crashing, it would appear, therefore, that drivers with the highest risk of crashing are driving and crashing vehicles that are the least crashworthy.

It has been proposed that the tendency for younger drivers to drive (and hence crash) older vehicles is simply due to the financial costs of buying a car. The market value of a vehicle tends to decrease with age such that the older a car is the more affordable it is for young drivers with a limited income (Watson & Newstead, 2009; Whelan, Scully, & Newstead, 2009). The prohibitive costs of buying a new vehicle, therefore, are likely an issue for other low-income groups. There is a growing body of literature indicating that drivers from backgrounds of low socio-economic status (SES) also have an increased risk of crashing which is associated with the characteristics of the driving environment (e.g., high speed limits, road condition, longer journeys, etc.) and driving less crashworthy and crash avoidant (e.g., lacking stability control) vehicles. There is some indication that driver characteristics (e.g., propensity for risk taking) may also increase the risk of crashing for drivers of low SES.

The evidence indicates that different groups of drivers have different patterns of crash, and that certain primary and secondary vehicle safety features are associated with this differential crash risk. In light of this it would appear that, for some drivers, the age of the vehicles in which they crash is an issue of some importance. In particular, it would appear that young drivers and drivers from low SES areas who have an increased risk of crashing have access to vehicles that are the least crashworthy. The aim of the present report is to gain a better understanding of the old-car crash problem through an investigation of various factors associated with the age of a vehicle and how these factors are further associated with old car crashes. This report focused on vehicle age as it relates to crash remoteness and driver age, sex, and SES.

Criteria for including a crash in the study were crashes involving drivers aged a minimum of 16 years, crashes involving only cars, and crashes on roads with a speed limit of at least 50 km/h. This produced information for 29,813 injured drivers (53% male) from a total of 19,648 crashes. The mean age of injured drivers was 36.9 years (SD = 17.9, range: 16-99) and the mean age of crashed vehicles was 11.7 years (SD = 7.4, range: 0-92). The majority of crashes occurred within the Adelaide metropolitan area (71%). The severity of crashes was recorded as Treated at hospital in 78%, Admitted to hospital for 20%, and Fatal for 2% of drivers.

Investigation of factors associated with old-car crashes revealed that young drivers, older drivers, and drivers from low and middle socio-economic backgrounds are more likely to be involved in old-car crashes. Further analysis of old-car crashes involving young drivers revealed that young drivers from low and middle socio-economic backgrounds crashed older cars than their counterparts from high socio-economic backgrounds, but that there was no difference between the ages of vehicles amongst drivers from low and middle SES strata. Evidence also indicated that old-car crashes were more likely to be a single vehicle crash.

While the findings of the present study are largely descriptive in nature, they are clear in that there are differences in vehicle age for drivers based on age and SES. This study has demonstrated that drivers with the greatest risk of crashing appear to do so in cars that are both less crash-avoidant and crashworthy than other groups. The crashes of young drivers and drivers from low-middle socio-economic backgrounds may, in part, be due to an absence of safety technologies in their older vehicles, however other factors associated with these groups (e.g., experience, risk-taking behaviour, driving environments, etc.) may also play a role. Existing and emerging technologies may mitigate the crash risk of these groups to some extent, however given the mean age of vehicles in the present study, and assuming that these technologies were available in all new vehicles at this point in time, it would be over 11 years before these technologies became available in half of the vehicles available to those drivers who may have the most to benefit.

Contents

1 Introduction

In a recent examination of the crashworthiness of vehicles in South Australia an interesting phenomenon was noted where a preponderance of fatal or injury crashes in South Australia were observed to involve young drivers in old cars (Anderson, Doecke, & Searson, 2009). In an analysis of driver and vehicle age for crashes in the period 2003-2007 Anderson, Doecke, and Searson (2009) found that the modal vehicle age amongst teenage drivers involved in crashes is around 13 years, compared to 2 years for drivers aged over 30 years. Disaggregation of 2001-2009 crash data by vehicle age and driver age (see Figure 1.1) shows that the highest concentration of crashes for this period involved young drivers in vehicles that are 10-20 years old. Examination of the average age of crashed vehicles for the same period (see Figure 1.2) shows that the average age of vehicles was 9 years or greater across all age groups. Figure 1.2 also shows a U-shaped curve demonstrating higher average vehicle age for drivers aged 16-25 and those over the age of 60 compared to drivers aged 30-60 years. Young drivers have long been recognised as having an increased risk of crashing (see *inter alia* Chen et al, 2010; Ivers et al., 2006; Williams, 2003; Wundersitz, 2012). As such, these findings appear to indicate that drivers with the highest risk of crashing are driving and crashing vehicles that are the least crashworthy.

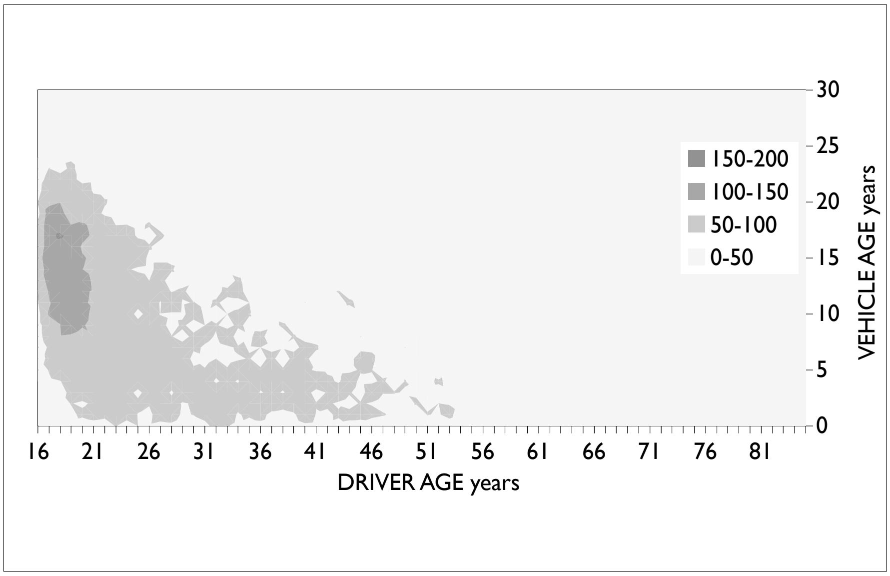

Figure 1.1
All South Australian crashes 2001-2009 disaggregated by vehicle age and driver age

It does need to be emphasised, however, that the relationship between driver age and vehicle age is weak – in other words, older vehicles are a feature of crashes involving drivers of all ages, not just young drivers. When the data are normalised the bivariate distribution of driver age and vehicle age emphasises the heterogeneity of vehicle ages for all drivers, as well as the weak decline in vehicle age with driver age up to the age of about 60 years (Figure 1.3). The distribution also reveals the relative infrequency of young driver crashes in vehicles less than 5 years old and in vehicles less than 10 years old.

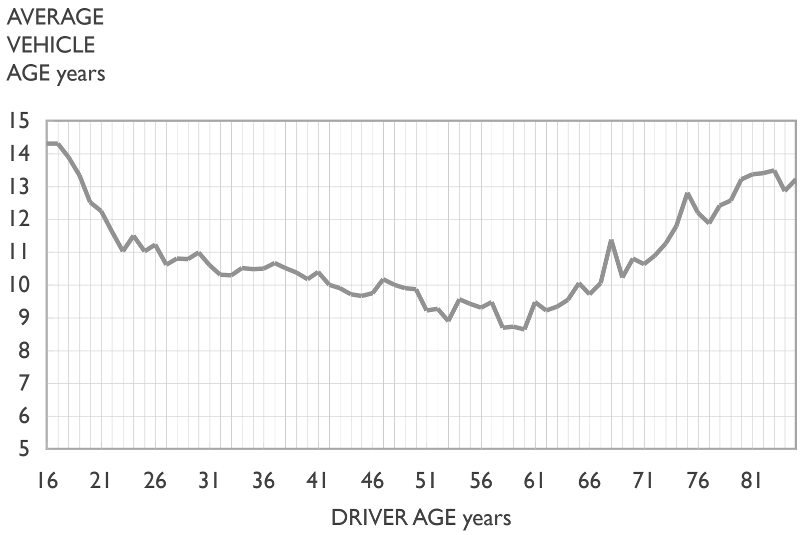

Figure 1.2
Average vehicle age by driver age for South Australian crashes 2001-2009

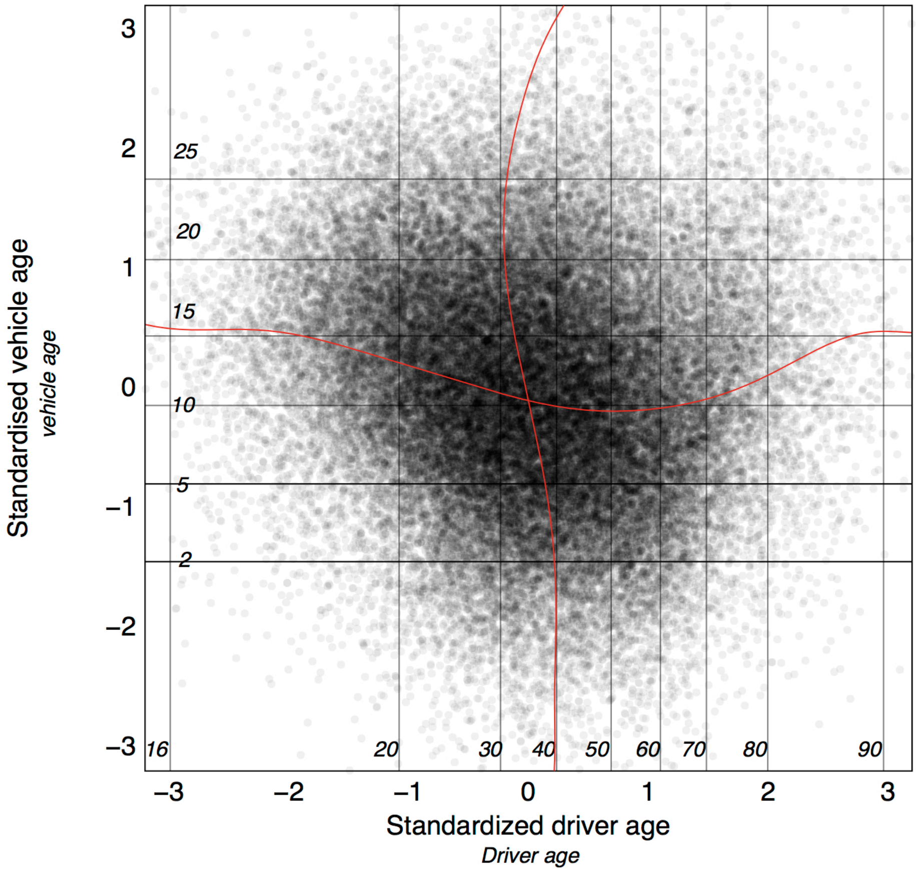

Figure 1.3
Standardised bivariate distribution of driver age and vehicle age in crashes, SA 2001-2009. Each crash is shown as a point in the point cloud. Axes labels refer to standard deviations, while the italicized labels refer to actual ages. The red lines show local regression (LOESS) lines of best fit for average vehicle age over each driver age and average driver age for each vehicle age.

Crashworthiness refers to a vehicle's ability to protect occupants in the event of a crash, and is associated with vehicle age (Newstead, Watson, & Cameron, 2009). In an examination of the crashworthiness of used vehicles in Australia and New Zealand, Newstead, et al. (2009) observed that the crashworthiness of vehicles improves with year of manufacture such that newer vehicles offer greater protection to occupants in crashes than do older vehicles. Improvements in crashworthiness are generally the product of advances in vehicle design and manufacture, including improvements in vehicle primary and secondary safety technologies such as ESC and airbags (e.g., side and curtain airbags), features that can take some time to "trickle down" to the used car fleet (Girasek & Taylor, 2010, p.151).

It has been proposed, quite reasonably, that the tendency for younger drivers to drive older vehicles is simply due to the financial costs of buying a car. The market value of a vehicle tends to decrease with age such that the older a car is the more affordable it is for young drivers with a limited income (Watson & Newstead, 2009; Whelan, Scully, & Newstead, 2009). The prohibitive costs of buying a new vehicle, therefore, are likely an issue for other low-income groups. There is a growing body of literature indicating that drivers from low SES backgrounds also have an increased risk of crashing.

A number of Australian and international studies have examined the influence of SES on involvement in crashes. Using data obtained as part of the DRIVE study (a prospective study of young drivers from NSW; for a complete description see Ivers, et al., 2006) Chen, et al. (2010) examined the association between risk of crash related injury and SES controlling for driving exposure and place of residence (i.e., urban, regional, or rural areas). They found that the risk of a crash-related hospitalisation for low SES drivers was double that of high SES drivers, RR 1.9, 95% CI 1.24 - 3.03. Furthermore, after controlling for driving exposure, the risk of crash-related injury remained 80% higher for the low SES drivers, RR 1.8, 95% CI 1.05 - 3.06. Explanations offered by the authors for this observed disparity included that low SES drivers may be exposed to more dangerous driving environments, and also have access to older cars that offer less protection. In the case of the former, SES was correlated with remoteness such that country areas were found to have a lower SES than urban areas. As such, driving environments for low SES drivers would be more likely to include high-speed roads (e.g., rural highways). In the case of the latter, the reduced crashworthiness of older vehicles was offered as an explanation for the greater risk of crash-related injury; little consideration was given to the presence or absence of crash prevention technology in older vehicles.

In a separate study Chen, Senserrick, Martiniuk, and colleagues (2010) examined the geographical and socio-economic characteristics of the fatal crashes of young Australian drivers (aged 17-25 years) using police reported data for all passenger vehicle crashes in NSW during the period 1997 to 2007. They found that the fatality rates of young drivers increased with decreasing SES while the fatality rates of young rural drivers was 2-3 times higher than that of young urban drivers. Furthermore, while the fatality rates of low SES drivers remained stable, the fatality rates of high SES drivers demonstrated a gradual decline. Examination of other crash factors revealed that young driver fatalities involving increased speed limits, fatigue, illegal BAC, and non-use of restraints were more likely to occur in regional and remote areas. Higher speed limits, fatigue, and crashing in a vehicle older than 10 years were also identified as significant issues for low SES drivers.

A New Zealand study (Whitlock, Norton, Clark, et al., 2003) of SES and experience of crash injury produced similar findings utilising occupational and educational status as a proxy for SES. Individuals from the lowest occupational or educational statuses were, respectively, four and two times more likely to experience injury as a driver compared to their counterparts from the highest statuses. Whitlock and colleagues proposed that the increased risk of injury for these groups may be linked with a greater propensity of risky driving behaviours (e.g., drink driving, non-use of restraints) among these groups, and that low SES groups may be more likely to drive older vehicles lacking modern safety features.

Research from the United States investigating the relationship between SES and vehicle safety (Girasek & Taylor, 2010) indicates that in addition to being less crashworthy, the vehicles of individuals from low SES areas are also less crash-avoidant than vehicles of individuals from high SES areas. They found that vehicles of individuals from high SES areas were significantly more likely to have ESC and other secondary safety features (e.g., side airbags) as a standard fitment than were vehicles of individuals from low SES areas. These findings reaffirm the notion that vehicle age is not only associated with crashworthiness but also has important implications for crash prevention, and that these are important issues for drivers with a higher crash risk.

Different drivers have differential crash risks. That is, for different groups of drivers there is a different level of risk for being involved in a crash, and there is a separate risk of being involved in specific types of crashes. For example, an Australian study conducted by Chen, Ivers, Martiniuk, Bourous, Senserrick, Woodward, and colleagues (2009) found that, due to differences in the driving environments (e.g., traffic density, speed limits, etc.) urban drivers are more likely to be involved in crashes involving multiple vehicles, whereas rural drivers were more likely to be involved in single vehicle crashes. The increased risk of a single vehicle crash was linked with road infrastructure (surface, alignment, intersection, and lighting) and speed (high posted speed limits, vehicle speed, and speeding; i.e. driving too fast). Of these, the alignment of the road and speeding had the greatest influence on the outcome of single vehicle crashes in rural areas, indicating that loss of control is an important factor. Evidence from the US indicates that around 70% of single vehicle fatalities are attributable to loss of control and that single vehicle loss of control crashes were more likely to occur on rural roads (Cejun & Subramanian, 2009). Furthermore, as remoteness is correlated with SES such that country areas tend to have a lower SES than urban areas, it is also possible that country drivers are driving older vehicles lacking modern safety technologies that can reduce the risk of such crashes.

There are a number of emerging technologies that have been identified to reduce either the risk of crashing, the severity of injuries arising from crashes, or both. For example, studies of the effectiveness of ESC have demonstrated that this technology reduces the risk of driver injury crashes of any crash type by 8% (Scully & Newsted, 2010). The effects of ESC are more pronounced for single vehicle crashes reducing the risk of all single vehicle crashes of any severity by 27.3%, with further improvements observed for crashes where the driver is injured demonstrating reductions of around 32% (Scully & Newstead, 2010). This study also found that the benefits of ESC were more pronounced for 4WD/SUVs with a 56% reduction in risk of crashes of any severity and a 65% reduction in driver injury crashes of any severity for these vehicles. The reduction in risk increases further when considering SUV involvement in roll over crashes with reductions in all crashes and driver injury crashes of 82% and 80% respectively.

With regard to the effectiveness of side and curtain airbags, investigations indicate that the risk of driver deaths can be reduced by up to 37% for airbags offering both head and side protection, or 26% in cars with side-only airbags (McCartt & Kyrychenko, 2007). As with ESC, the greatest benefits of side/curtain airbags were observed for SUV drivers with the risk of death in side impact reduced by 52% and 36% for head and side protection and side-only protection respectively (McCartt & Kyrychenko, 2007).

Further gains in vehicle safety are to be expected with the development and fitment of advanced driver assistance systems, and while benefits in higher speed environments are at this stage theoretical (Anderson et al., 2012) the history of vehicle safety improvements suggests that such systems will continue to develop to a point where crash risk will be reduced over a large number of crash types.

It is clear that different groups of drivers have different patterns of involvement in crashes and that certain primary and secondary vehicle safety features are associated with this differential crash and injury risk. In light of the above it would appear that, for some drivers, the age of the vehicles in which they crash is an issue of some importance. In particular, it would appear that young drivers and drivers from low SES areas who have an increased risk of crashing have access to vehicles that are the least crashworthy. The aim of the present report is to gain a better understanding of the old car crash problem through an investigation of various factors associated with the age of a vehicle and how these factors are further associated with old car crashes. This report focuses on vehicle age as it relates to driver characteristics (i.e., age, sex, and SES), and crash characteristics (i.e., remoteness).

2 Method

2.1 Crash data

The data for this study were obtained from the Traffic Accident Reporting System (TARS) database maintained by the Department for Transport, Energy and Infrastructure. The TARS database contains records of crashes reported to or by the South Australian Police. These records contain information regarding the sex, age, and place of residence of people involved, the location of the crash, and the severity of injuries sustained (based on the most severe injury of all participants). TARS data for crashes during the period 2001-2009 for which the injury severity was recorded as either Treatment at hospital, Admitted to hospital, or Fatal were used for the present study.

2.1.1 Crash sample characteristics

Criteria for including a crash in the study were crashes involving drivers aged a minimum of 16 years, crashes involving only cars, and crashes on roads with a speed limit of at least 50 km/h. This produced information for 29,813 injured drivers (53% male) from a total of 19,648 crashes. The mean age of injured drivers was 36.91 years (SD = 17.88, range: 16-99) and the mean age of crashed vehicles was 11.73 years (SD = 7.36, range: 0-92). The majority of crashes occurred within the Adelaide metropolitan area (70.6%). The severity of crashes was recorded as Treated at hospital in 78.2%, Admitted to hospital for 19.7%, and Fatal for 2% of drivers.

2.1.2 Socio-Economic factors

While many of the variables required for the present study were contained within the TARS data it was necessary to devise some means of classifying socio-economic factors based on TARS data in a manner that is consistent with recognised standards. The manner in which this was achieved is outlined below.

The Statistics Socio-Economic Indexes for Areas (SEIFA) developed by the Australian Bureau of Statistics (ABS) (Pink, 2008) provides a number of indexes for ranking geographical areas according to their socio-economic characteristics. For the present report the Index of Relative Socio-Economic Advantage and Disadvantage (IRSAD) was the chosen as it considers characteristics of both advantage and disadvantage and, as such, was considered the most accurate means of classifying areas for the purpose of this study. The IRSAD is constructed using the Principal Components Analysis method to select the combination of characteristics (that are drawn from Australian census data) that best represent socio-economic advantage and disadvantage. The results of this analysis produced an index based on characteristics including, amongst others, internet availability, employment status and type, highest level of education, and annual household income (for a full list see Pink, 2008). The IRSAD score is calculated using these variables and then standardised such that scores fall on a distribution where the mean is 1000 and the majority of scores fall between 900 and 1100. These scores are then ranked individually from lowest to highest, however the ABS recommends the use of deciles when comparing IRSAD scores (Pink, 2008). Deciles contain 10% of scores such that decile 1 contains the bottom 10% of scores (representing the most disadvantaged areas), while decile 10 contains the top 10% of scores (representing the most advantaged areas).

For the purpose of the present report two IRSAD scores were used based on the postcode region in which the driver lives and the post code region in which the crash occurred. The ABS state that the use of post codes to define the socio-economic characteristics of a region is not ideal as postal areas are larger units than those that are used to calculate the IRSAD. As such they may lack a degree of sensitivity to the diversity of IRSAD scores prevalent in a single postcode region. However, it is probable that the use of post codes will be sufficient to demonstrate any association between socio-economic factors and other crash characteristics in the present study.

2.2 Procedure

In order to produce more descriptive analysis a number of variables were recoded into categorical variables. These included driver age (Young = drivers aged 16 - 24 years, Adult = drivers aged 25-59 years, and Older = drivers aged 60 or more), SES (Low = SEIFA deciles 1 & 2; Middle = SEIFA deciles 3 - 8, High = SEIFA deciles 9 & 10), Vehicle age (New = vehicles aged ≤10 years; Old = vehicles aged >10 years), Remoteness (City, Country), Speed limit (50-60 km/h, 70-90 km/h, 100-110 km/h), and Number of vehicles (One, Two or more). The frequency data for each category is presented in Table 2.1. In addition to analysis of all data three sub-samples were used, including:

- Young driver sample (N = 9,922)
- Metro driver sample: all drivers from the Adelaide metro area (N = 21,973)
- Young metro driver sample: all young drivers from the Adelaide metro area (N = 7,108).

These sub-samples were utilised in order to obtain a better understanding of vehicle age with regard to young drivers and socio-economic status.

Table 2.1
Frequency data for recoded categorical variables for the complete sample and sub-samples

	Sample							
	Complete sample		Young driver		Metro driver		Young metro drivers	
	N	%	N	%	N	%	N	%
Driver age								
Young driver	9922	33.3	9922	100.0	7108	32.3	7108	100.0
Adult driver	16004	53.7	-	-	11990	54.6	-	-
Older drivers	3887	13.0	-	-	2875	13.1	-	-
Sex								
Male	15997	53.7	5481	55.2	11647	53.0	3888	54.7
Female	13816	46.3	4441	44.8	10326	47.0	3220	45.3
SES								
Low SES	5564	18.7	1814	18.3	3396	15.5	1071	15.1
Middle SES	17192	57.7	5719	57.6	11916	54.2	3773	53.1
High SES	7057	23.7	2389	24.1	6661	30.3	2264	31.9
Remoteness								
City	21038	70.6	6856	69.1	19842	90.3	6469	91.0
Country	8775	29.4	3066	30.9	2131	9.7	639	9.0
Speed limit (km/h)								
50-60	19001	63.7	6182	62.3	16177	73.6	5169	72.7
70-90	4588	15.4	1603	16.2	3556	16.2	1227	17.3
100-110	6224	20.9	2137	21.5	2240	10.2	712	10.0
Number of vehicles								
One	10984	36.8	4726	47.6	6560	29.9	2839	39.9
Two or more	18829	63.2	5196	52.4	15413	70.1	4269	60.1

3 Results

3.1 Differences in vehicle age

A number of analyses were undertaken to determine if the age of crashed vehicles differed significantly according to the characteristics of the crash involved drivers. Sex and remoteness were analysed via independent samples t-tests, and age and SES were assessed using one-way analysis of variance (ANOVA). It should be noted that actual vehicle age (a continuous variable) was used for this series of analysis.

Driver age

A one-way ANOVA was conducted in order to determine the significance of differences in the vehicle age of young, adult, and older crash involved drivers' vehicles. Significant differences in the variance in vehicle age between groups was observed, therefore the Brown-Forsythe F-ratio is reported. There was a significant effect of driver age group on the age of crashed vehicles, $F(2, 15159.59) = 269.27$, $p < .001$. Games Howell post hoc analysis revealed that younger drivers crashed vehicles that were significantly older than the vehicles of adult ($p < .001$) and older drivers ($p < .001$), and that older drivers crashed in vehicles that were significantly older than adult drivers ($p < .01$). Descriptive statistics (M and SD) are provided in Table 3.1.

Sex

An independent samples *t*-test was conducted in order to determine the significance of differences in the vehicle age of male and female crash involved drivers. The results indicate that male drivers crashed in cars that were significantly older than female drivers, $t(29775.56) = 22.42$, $p < .001$. Descriptive statistics (M and SD) are provided in Table 3.1.

SES

Differences in vehicle age according to the SES of crash involved drivers was assessed using one-way ANOVA. There was a significant effect of driver SES on the age of crashed vehicles, $F(2, 29810) = 95.64$, $p < .001$. Post hoc analysis using Tukey's Honestly Significant difference revealed that drivers from the Low SES group crashed in cars that were significantly older than drivers in the Middle ($p < .001$) and High ($p < .001$) SES groups, and that drivers from the Middle SES group crashed in vehicles that were significantly older than drivers in the High SES group ($p < .001$). Descriptive statistics (M and SD) are provided in Table 3.1.

Remoteness

A final independent samples *t*-test was conducted to determine the significance of differences in the age of vehicles crashed in the country compared to those in the city. This analysis revealed that the age of vehicles involved in crashes in the country was not significantly different to vehicles involved in crashes in the city, $t(16016.07) = 0.53$, $p = .59$. Descriptive statistics (M and SD) are provided in Table 3.1.

Crash severity

One-way ANOVA was also used to determine differences in vehicle age according to crash severity. Significant differences in the variance in vehicle age between groups was observed, therefore the Brown-Forsythe F-ratio is reported. There was a significant effect of crash severity on vehicle age, $F(2, 2311.94) = 37.5$, $p < .001$. Games Howell post hoc analysis revealed that crashes with a reported severity of Treated at hospital involved vehicles that were significantly younger than crashes with a reported severity of Admitted to hospital (p < .001) or Fatal (p < .001). No significant differences in vehicle age were observed between Admitted to hospital or Fatal crashes (p = .57).

Table 3.1
Means and standard deviations in vehicle age for driver and crash characteristics

	M	SD
Vehicle age		
Young driver	13.10	6.99
Adult driver	10.95	7.43
Older driver	11.44	7.45
Sex		
Male	12.60	7.66
Female	10.72	6.85
SES		
Low	12.54	7.31
Middle	11.85	7.30
High	10.78	7.43
Remoteness		
City	11.74	7.30
Country	11.69	7.50
Crash severity		
Treated at hospital	11.53	7.30
Admitted to hospital	12.41	7.52
Fatal	12.73	7.55

3.2 Bivariate correlations

Bivariate correlations were conducted to determine the strength and direction of relationship between driver, vehicle, and crash characteristics. Pearson's r^2 are displayed in Table 3.2. Vehicle age was significantly negatively correlated with sex, driver age, and SES. These results indicate that higher vehicle age is associated with male drivers, younger drivers, and drivers from a low SES area. This analysis also indicates that SES is negatively associated with Remoteness and positively associated with Sex and Driver age, indicating that higher SES is associated with reduced remoteness, female drivers, and older drivers.

Table 3.2
Correlation of vehicle age with driver characteristics

	Remoteness	Sex	Vehicle age	Driver age
Sex	-.041**			
Vehicle age	-.003	-.128**		
Driver age	-.013*	-.010	-.091**	
SES	-.190**	.031**	-.096**	.030**

Note: N = 29,813, * p < .05, ** p < .001

3.3 Predicting old vehicle involvement in crashes

To assess the relationship between vehicle age and driver age further a series of binary logistic regressions were conducted to identify variables that predicted involvement in each of the crash types of interest. The first regression analyses sought to identify variables that predicted the involvement of vehicles aged 11 years or more in a crash. This boundary was used to split crashes into newer vehicle crashes and older vehicle crashes. The results are presented in Table 3.3. Examination of the coefficients revealed that crashes involving older vehicles were more likely to:

- Involve young drivers or older than adult drivers
- Involve male drivers than female drivers
- Involve drivers from Low SES than drivers from Middle SES, and drivers from Middle SES more than drivers from High SES
- Involve a single vehicle than multiple vehicles
- Occur on roads with a speed limit of 50-60 km/h than on roads with a speed limit of 70-90 km/h or 100-110 km/h.
- The strongest effect was observed for Driver age (i.e., young drivers).

Table 3.3
Coefficients of variables predicting older vehicle involvement in crashes

	B	SE B	Exp (B)	Exp (B) 95% C.I.
Driver age				
Adult	Reference			
Young	0.56**	0.03	1.75	1.66 - 1.85
Older	0.10*	0.04	1.10	1.02 - 1.18
Sex				
Male	Reference			
Female	-0.38**	0.02	0.68	0.65 - 0.71
SES				
Middle	Reference			
Low	0.18**	0.03	1.20	1.13 - 1.28
High	-0.34**	0.03	0.71	0.67 - 0.76
Remoteness				
City	Reference			
Country	-0.03	0.03	0.97	0.91 - 1.04
No. of vehicles				
Multiple vehicles	Reference			
Single vehicle	0.24**	0.03	1.27	1.20 - 1.34
Speed limit (km/h)				
50-60	Reference			
70-90	-0.16**	0.03	0.85	0.80 - 0.91
100-110	-0.35**	0.04	0.70	0.65 - 0.76
Constant	0.18**	0.03	1.20	

Note: * p < 01, ** p < .001

Predicting old car crashes involving young drivers

In order to determine factors predicting crashes involving young drivers in older vehicles the regression was run again restricting the sample to drivers aged 16-24. Due to this restriction the driver age category was excluded from this analysis, all other variables were kept. Results of the analysis are provided in Table 3.4. Examination of the coefficients revealed that young drivers crashing in old vehicles were more likely to:

- Involve male drivers than female drivers
- Involve drivers from Middle SES than drivers from High SES (no difference was observed between Middle and Low SES groups)
- Involve one vehicle than multiple vehicles
- Occur on roads with a speed limit of 50-60 km/h than on roads with speed limits of 70-90 km/h or 100-110 km/h
- The strongest effect was observed for sex (i.e., male drivers) and speed limit (i.e., 50-60 km/h roads).

Table 3.4
Coefficients of variables predicting older vehicle crashes involving young drivers

	B	SE B	Exp (B)	Exp (B) 95% C.I.
Sex				
Male	Reference			
Female	-0.36**	0.04	0.69	0.64 - 0.75
SES				
Middle	Reference			
Low	0.05	0.05	1.05	0.94 - 1.18
High	-0.19**	0.05	0.83	0.75 - 0.91
Remoteness				
City	Reference			
Country	0.03	0.06	1.03	0.92 - 1.16
No. of vehicles				
Multiple vehicles	Reference			
Single vehicle	0.09*	0.5	1.10	1.00 - 1.20
Speed limit				
50-60	Reference			
70-90	-0.22*	0.06	0.80	0.72 - 0.90
100-110	-0.36**	0.07	0.69	0.61 - 0.79
Constant	0.49**	0.04	1.64	

Note: * p < 05, ** p < .001

Predicting old vehicle crashes of drivers from the Adelaide metropolitan area

Further regression analysis was undertaken in order to identify variables predicting old vehicle crashes in the Adelaide metropolitan area. The purpose of this analysis was to control for any confounding between SES and remoteness and produce a clearer insight into the relationship of SES with vehicle age. The results of this analysis are reported in Table 3.5. Examination of the coefficients revealed that old vehicle crashes were more likely to:

- Involve young drivers and older drivers than adult drivers
- Involve male drivers than female
- Involve drivers from Low SES than drivers from Middle SES, and drivers from Middle SES more than drivers from High SES
- Occur in the city than country
- Involve a single vehicle rather than multiple vehicles
- Occur on roads with a speed limit of 50-60 km/h than on roads with speed limits of 70-90 km/h or 100-110 km/h
- The strongest effect was observed for driver age (i.e. young drivers).

Table 3.5
Coefficients of variables predicting older vehicle crashes of drivers from the Adelaide metropolitan area

	B	SE B	Exp (B)	Exp (B) 95% C.I.
Driver age				
Adult	Reference			
Young	0.59**	0.03	1.81	1.70 - 1.92
Older	0.17**	0.04	1.18	1.09 - 1.28
Sex				
Male	Reference			
Female	-0.36**	0.03	0.69	0.66 - 0.73
SES				
Middle	Reference			
Low	0.27**	0.04	1.31	1.21 - 1.42
High	-0.32**	0.03	0.72	0.68 - 0.77
Remoteness				
City	Reference			
Country	-0.23**	0.06	0.79	0.70 - 0.90
No. of vehicles				
Multiple vehicle	Reference			
Single vehicle	0.29**	0.03	1.33	1.25 - 1.42
Speed limit				
50-60	Reference			
70-90	-0.12*	0.04	0.90	0.83 - 0.97
100-110	-0.24**	0.06	0.78	0.69 - 0.88
Constant	0.24**	0.03	1.28	

Note: * $p < 01$, ** $p < .001$

A further regression was conducted further limiting the analysis to young drivers from the Adelaide metropolitan area. The results of this analysis are provided in Table 3.6. Examination of the coefficients revealed that old car crashes involving young drivers were more likely to:

- Involve male drivers than female drivers
- Involve drivers from Middle SES the drivers from High SES (no difference observed between Middle and Low SES drivers)
- Involve a single vehicle than multiple vehicle
- A significant effect was not observed for speed limit or remoteness
- The strongest effect was observed for sex (i.e., male drivers).

Table 3.6
Coefficients of variables predicting older vehicle crashes of young drivers from the Adelaide metropolitan area

	B	SE B	Exp (B)	Exp (B) 95% C.I.
Sex				
Male	Reference			
Female	-0.33**	0.05	0.72	0.65 - 0.79
SES				
Middle	Reference			
Low	0.10	0.07	1.10	0.95 - 1.27
High	-0.19**	0.05	0.83	0.74 - 0.92
Remoteness				
City	Reference			
Country	-0.08	0.11	0.92	0.74 - 1.14
No. of vehicles				
Multiple vehicle	Reference			
Single vehicle	0.15*	0.05	1.16	1.05 - 1.29
Speed limit				
50-60	Reference			
70-90	-0.18*	0.07	0.83	0.73 - 0.94
100-110	-0.26*	0.10	0.77	0.62 - 0.94
Constant	0.55**	0.06	1.74	

Note: * *p* < 05, ** *p* < .001

Predicting crashes involving two vehicles

A final binary logistic regression was undertaken in order to identify variables predicting crashes involving two vehicles. As two vehicle crashes dilute responsibility, any factor predictive of two vehicle crashes rather than single vehicle crashes, may indicate lower crash risk (when the analysis is appropriately controlled). The analysis was restricted to drivers from the Adelaide metro area in order to reduce the effect of remoteness of residence on SES. Variables included in the regression were driver age, driver sex, vehicle age, SES, remoteness of crash, and speed limit. The results of the analysis are reported in Table 3.7. Examination of the coefficients indicate that two vehicle crashes were more likely to:

- Involve adult drivers than younger drivers
- Involve older drivers than adult drivers
- Involve female drivers than male drivers
- Involve Drivers from Middle SES than High SES
- Involve new vehicles rather than older vehicles.

Interestingly there were no differences observed in terms of the likelihood of being involved in a crash in an older vehicle for drivers from middle and low socio-economic backgrounds.

The influence of factors used to control for location were as expected. Two vehicle crashes were more likely to:

- Occur in the city than the country
- Occur on roads with a speed limit of 50-60 km/h than roads with speed limits of 70-90 and 100-110 km/h.

Table 3.7
Coefficients of variables predicting two vehicle crashes

	B	SE B	Exp (B)	Exp (B) 95% C.I.
Driver age				
Adult	Reference			
Young	-0.67**	0.03	0.51	0.48 - 0.54
Older	0.34**	0.04	1.40	1.28 - 1.53
Sex				
Male	Reference			
Female	0.65**	0.03	1.92	1.81 - 2.03
Vehicle age				
Old	Reference			
New	0.21**	0.03	1.24	1.17 - 1.31
SES				
Middle	Reference			
Low	0.00	0.04	1.00	0.93 - 1.08
High	-0.11*	0.03	0.90	0.84 - 0.96
Remoteness				
City	Reference			
Country	-0.89**	0.04	0.41	0.38 - 0.44
Speed limit				
50-60	Reference			
70-90	-0.19**	0.04	0.82	0.76 - 0.89
100-110	-1.28**	0.04	0.28	0.26 - 0.30
Constant	0.79	0.03	2.20	

Note: * *p* < 01, ** *p* < .001

4 Discussion

The aim of this report was to gain a better understanding of the old car crash problem through an investigation of the association of driver age, sex, and SES and the remoteness of a crash with old car crashes. The interpretation of these findings requires some caution as there is a confluence of factors that contribute to the occurrence of a crash and its outcomes. For example, the characteristics of the location in which a crash occurs such as speed limit, road geometry, traffic patterns, and general driving conditions will affect the type, number, and severity of crashes. As the majority of crashes in the present study occurred within the Adelaide metropolitan area (see Table 2.1) we might expect to see more crashes involving multiple vehicles and occurring on urban roads (i.e., speed limits of 50-60 km/h), which is indeed the case.

Comparisons of the age of vehicles according to driver age, sex, and SES revealed significant differences such that males, young drivers, and drivers from Low SES were found to crash in vehicles that were older than their counterparts. Additionally, there is evidence to suggest that the old car crash problem is also an issue for older drivers and drivers from Middle SES. Having said this, the mean vehicle age for female drivers, adult drivers, and drivers from High SES was around 10 years indicating that while the vehicles of drivers from these groups were found to be younger, this would appear to be marginally so. This further indicates that while the South Australian vehicle fleet in general is quite old, there are some groups who appear to be involved in crashes in vehicles that are older still.

Comparisons of vehicle age based on crash severity revealed that the age of vehicles involved in crashes at the lowest severity (i.e., Treated at hospital) was significantly lower than that of vehicles in crashes at higher severities (i.e., Admitted to hospital and Fatal) and may indicate a decline in vehicle crashworthiness with age, most probably related to the design of older vehicles. Taken in conjunction with the findings discussed above there is an implication that young drivers, a group which is known to have an increased risk of crashing over other groups, appear to be crashing in vehicles that are less effective at protecting occupants from injury, exacerbating the severity of those crashes.

A number of regression analyses were undertaken in order to determine further the extent to which a range of factors were associated with old vehicle crashes. The results of these analyses were generally along the same lines as the between groups analysis discussed above. Of note, however, is the finding that single vehicle crashes were more likely to involve older vehicles than were multi-vehicle crashes. This might indicate an absence of crash-avoidant technologies such as electronic stability control (ESC). As the results also indicate that young drivers, and to a certain extent older drivers, were more likely to crash in older vehicles it is possible that some characteristic of these groups might better explain the involvement of older vehicles in a single vehicle crash. For example, young drivers are recognised as having an increased risk of crashing compared to older drivers (Evans, 1991). Factors such as inexperience (OECD, 2006; McCartt, Mayhew, Braitman, Ferguson, & Simpson, 2009), driving at night (Williams, 2003), the presence of peer age passengers (Williams, 2003), and the adolescent propensity for risk taking in general (Fergusson, Swain-Campbell, & Horwood, 2003; Turner & McClure, 2002) are known to increase young drivers' risk of crashing in general, and may also contribute to an increased risk of single vehicle crashes. For older drivers factors such as medical conditions (Lindsay & Ryan, 2011) and declining cognitive and physical functioning (Baldock, Berndt, & Mathias, 2008; Marmeleira, Godinho, & Vogelaere, 2009) may lead to single vehicle crashes.

There are two key findings regarding young drivers that should be discussed. First, when analysis was restricted to young drivers the effect of Low SES vs Middle SES disappeared, indicating no differences in the vehicle age of young drivers from low and middle socio-economic backgrounds. Second, when analysis of drivers from the Adelaide metropolitan area was further restricted to young drivers the effect of remoteness also disappeared. This latter finding is particularly interesting as it raises the issue of vehicle choice: the fact that when all drivers were considered, and all factors were considered, more remote crashes tended to involve newer cars, might be seen as evidence that drivers may choose to take the 'better vehicle' on a trip into areas remote from their homes. The fact that no such effect is evident amongst younger drivers might then suggest that this choice is not available to younger drivers (or possibly, that it is a choice that the young driver does not want, even where one might exist).

In order to examine the association between vehicle age and inherent riskiness, a regression predicting the involvement of two vehicles rather than one vehicle in a crash was undertaken. The basis for this analysis was that, in two-vehicle crashes, responsibility is diluted because a second party may also be responsible to a greater or lesser extent, whereas in a single vehicle crash, there is generally only one responsible driver. Hence, any factor that is predictive of two-vehicle rather than one-vehicle crashes indicates reduced riskiness. The analysis found that adult drivers who crash were almost twice as likely to be involved in a two-vehicle crash than were young drivers, while older drivers were 1.4 times more likely than adult drivers. We regard this as evidence of relatively higher riskiness of younger drivers. Female drivers were twice as likely to be involved in two-vehicle crashes, again reflecting differences in inherent riskiness. The effect of SES on two-vehicle crashes was slight with a small effect observed for drivers from Middle SES having a marginally increased risk of being in a two-vehicle crash over High SES. No effect was observed for Low SES drivers. With regard to vehicle age, two-vehicle crashes were 1.2 times more likely to involve a new vehicle than an old vehicle. This is potentially important as the result suggests that there is an inherent riskiness attributable to vehicle age such that older vehicles are inherently more likely to crash than newer vehicles. One caveat must be mentioned in relation to this, we cannot rule out that this result is free from confounding, and it remains a possibility that we have inadequately controlled for driver riskiness.

As a whole these findings point to single vehicle crashes being a concern for the safety of young drivers and drivers from Low and Middle SES, particularly as these groups are more likely to be driving older vehicles, which are significantly more likely to be involved in single vehicle crashes. This latter finding was quite robust in the sense that each of the analyses conducted in order to identify factors predicting old vehicle crashes identified single vehicle crashes, even when the sample was restricted to drivers from the Adelaide metropolitan area for whom the majority of crashes occurred within that area. Due to the nature of the driving and traffic environments associated with urban areas we might expect to observe more crashes involving multiple vehicles, as such the finding that old vehicle crashes are more likely to involve only one vehicle and occur within the Adelaide metropolitan area highlights the significance of this association.

While significant differences in vehicle age were observed between various groups, the mean age of the younger vehicles was between 10-11 years (see Table 3.1), suggesting that the age of vehicles in the present study is quite high. Indeed, Anderson, Doecke, and Searson (2009) report that the median age of the South Australian vehicle fleet exceeds the median age of passenger vehicles in Australia. As such it is difficult to discern the extent to which the presence or absence of active or passive safety technologies might be associated with crashes in the present study. However, there is some evidence that existing and emerging technologies will have safety benefits for all drivers. Electronic stability control (ESC) has been demonstrated to reduce the risk of single vehicle crashes (Scully & Newstead, 2010), and could thus be expected to improve the safety of young drivers, old drivers, and drivers from Low and Middle SES. Intelligent speed adaptation (ISA) may also reduce the risk of single vehicle crashes by limiting the speed at which they can travel (Doeke & Woolley, 2011). Other technologies that have the potential to improve safety for all drivers, and particularly those with an increased risk of being involved in multiple vehicle crashes include Autonomous Emergency Braking (AEB), adaptive cruise control, Emergency Brake Assist (EBA), and vehicle-to-vehicle communications (V2V).

AEB systems are able to detect hazards (e.g., objects or other road users) ahead of the vehicle and activate emergency braking should a collision be likely to occur. Adaptive cruise control assists the driver to maintain a safe following distance through active control of acceleration and braking systems and can be expected to reduce the incidence of rear end crashes (Anderson, Hutchinson, Linke, and Ponte, 2011). EBA systems are designed to reduce the stopping distance of a vehicle in emergency situations (Anderson et al., 2011). V2V systems allow vehicles to communicate wirelessly their position, speed, and direction to other nearby vehicles and provide advance warning of emergency braking situations (e.g., where a vehicle two or three cars ahead brakes suddenly), advise of unsafe lane change or overtaking manoeuvres, or alert the driver of vehicles that may fail to stop at an intersection, allowing drivers to take pre-emptive actions to avoid or mitigate a crash (USDOT & NHTSA, 2011). Each of these technologies has the potential to increase the safety of all drivers in high-volume traffic areas.

While the findings of the present study are largely descriptive in nature it is clear that there are significant discrepancies in vehicle age for drivers based on age and SES. This study has demonstrated that drivers with the greatest risk of crashing appear to do so in cars that are both less crash-avoidant and crashworthy than other groups. The crashes of young drivers and drivers from low-middle socio-economic backgrounds may, in part, be due to an absence of safety technologies in their older vehicles, however other factors associated with these groups (e.g., experience, risk-taking behaviour, driving environments, etc.) may also play a role. Existing and emerging technologies may mitigate the crash risk of these groups to some extent, however given the mean age of vehicles in the present study, and assuming that these technologies were available in all new vehicles at this point in time, it would be over 11 years before these technologies became available in half of the vehicles available to those drivers who may have the most to benefit.

There were some indications that young drivers are not exercising any choice about the vehicle they drive, to the same extent that choice is apparently being exercised by other drivers. The evidence for this was that other drivers from Adelaide who crashed in an area at a distance from the city tended to do so in newer cars when compared with their crashes in the city. No such difference was apparent amongst young drivers from Adelaide. While it is possible that the differences in vehicle age that are apparent might indicate two distinct sub-groups of the non-young drivers (i.e. those that own older cars and crash in the city and those that own newer cars and crash remotely), it might also indicate that non-young drivers are exercising some choice about the vehicle that is taken on a particular trip, and that young drivers do not. This might be remediable to some extent: when more than one vehicle is owned within a household, young drivers might be encouraged to take a newer, safer vehicle on trips to rural and remote areas (where serious crash risk is high), thereby increasing the proportion of rural trips in vehicle fitted with features such as ESC, hence reducing their crash risk.

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