

**A longitudinal investigation of
psychosocial risk factors for speeding
offences among young motor car drivers
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Abstract

Speeding is commonly recognised as problem behaviour among young novice drivers and a major risk factor for their involvement in crashes. This study undertook a descriptive analysis of the speeding offences and demerit points incurred by a sample cohort of 1,277 young West Australian drivers over 36-months of licensing. Statistical modelling of offences and demerit points accumulated at 12, 24 and 36-months post-licensing was also undertaken to determine the effect of driver behaviour and psychosocial factors. The results show that males and drivers who are predisposed to risk taking and perceive themselves as confident and adventurous drivers and engage in other health risk behaviours have a significantly higher risk of incurring speeding offences up to 36-months post-licensing. Penalties for speeding appeared to have little impact on the risk factors for speeding or the likelihood of re-offending for some drivers. A number of recommendations were made for managing speeding behaviour among young novice drivers.

Keywords

Young driver; speeding; offence; risk

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EXECUTIVE SUMMARY

Introduction

Young Australian drivers aged 17-25 years continue to evidence double the risk of all-age drivers for fatal crash involvement, despite a 42% reduction in the fatality rate over the last 20 years. In Western Australia, drivers aged 17-24 years are similarly over-represented in serious injury crashes. They represent 13.6% of the state's licensed drivers but account for 34% and 30.5% of driver deaths and hospitalisations respectively. Investigations of crash databases in Australia and elsewhere clearly show that speeding behaviour is a major contributor to the over-represented of young drivers in serious injury crashes. Other data, including self-report, roadside observation, and traffic offence data, demonstrates that young drivers, particularly males, are more likely to speed in comparison with older aged drivers. Not so surprisingly, speeding is the single most common traffic violation committed by young drivers in the initial years of driving. Research has also demonstrated that the risk of being involved in a casualty crash significantly increases for 17-19 year olds if they have incurred a prior 'excessive' speeding offence. These findings highlight the need to develop a better understanding of the factors that contribute to young driver speeding and to use this information to reduce their risk of crashing and injury. Using data collected for the Western Australian Young Driver Cohort Study, the following research objectives addressing speeding offences among newly licensed 17-year old drivers were proposed for investigation:

1. To determine the incidence and pattern of police issued Traffic Infringement Notices for speeding and associated demerit points at 12, 24, and 36-months post-licensing.
2. To determine the extent to which driver psychosocial, behavioural, and driver training factors contribute to the risk of incurring a Traffic Infringement Notice for speeding and associated demerit points at 12, 24, and 36-months post-licensing.
3. To investigate the changes over time in identified risk factors for speeding and the effect, if any, of penalties for speeding on identified risk factors and further speeding behaviour.

4. To make recommendations, where appropriate, for the management of young driver speeding behaviour

Method

Approximately 1,277 17-year olds obtaining an A or E class motor vehicle drivers' licence under the previous, non-Graduated Driver Training and Licensing Program were recruited to the Western Australian Young Driver Cohort Study. The drivers were recruited in 1997 at the time they successfully completed their on-road driving test. On entry to the study, drivers completed an omnibus questionnaire covering pre-licence driving experience and a range of psychosocial and behavioural factors related to driving (collectively known as 'driver information'). With the assistance of the Western Australian Police Service, Traffic Infringement Notices for speeding incurred by cohort drivers within 12, 24, and 36-months months of licensing were identified and linked to the information provided by drivers at the time of licensing. The total number of speeding infringements and the total demerit points lost through speeding were calculated for each driver, along with the number of days from licensing to the driver's first speeding infringement. The data was then subjected to both univariate and multivariate analyses to address objectives 1 to 3.

Results

- A total of 2,033 Traffic Infringement Notices for speeding were incurred by 841 drivers (66% of the cohort) within 36-months of licensing. Approximately 61% of offending driver were 'repeat offenders' within this time.
- The annual incidence rate of offending drivers per 10,000 licensing days significantly increased from year one to year two and was highest for all drivers (14.4), males (18.4) and females (14.4) in the second year of driving. A non-significant decline in the annual incidence rate for all drivers, males and females was observed in year three.

- The annual incidence rate of offending drivers per 10,000 licensing days was highest for males compared with females for each year of the three years of investigation; in addition, males incurred their first speeding infringement substantially earlier in the three-year period of licensure than females (mean=434 days versus mean=507 days). A test of the equality of the survival distributions of male and female drivers confirmed the statistical significance of these gender differences in speeding offences.
- The majority of speeding infringements in each year were issued for exceeding the posted speed limit by 10-19km/hour. By 36-months post-licensing, approximately 26% of all infringement notices had been issued for ‘excessive’ speeding (ie, 20km/hour or more above the posted speed limit). Over 36-months of driving males incurred significantly more ‘excessive’ speeding infringements compared with females.
- Over the 36-months, 94% of offending drivers accumulated one or more demerit points through speeding for a total of 3,039 points. The mean number of points lost per driver was 3.61. The mean number of demerit points lost by infringing drivers was highest in year two and significantly higher for males than females in each year of driving.
- Negative Binomial Regression analysis of total infringements and demerit points accumulated at 12, 24, and 36-months produced models showing consistent and significantly higher incidence rate ratios of infringements and demerit points for *males*, and drivers with a *high disposition to risk taking behaviour* (as measured by scores on a scale of impulsivity and sensation seeking), and *high ratings on driver confidence-adventurousness* (a measure of driving style and skill). A significant protective effect was noted for the practice of *high levels of positive health-related behaviour* (as measured by scores on items assessing smoking, use of alcohol, frequency of exercise and use of sunscreen). The effects were found to be independent and significant for each cumulative year of licensure. The size of the incidence rate ratio for each significant variable was found to decline marginally and linearly with increasing years of licensure.
- One notable difference in the multivariate models of the total number of speeding infringements and demerit points was the size of the effect of *gender*. Across the two models, males evidenced a substantially higher incidence rate ratio for demerit points. This was due to males incurring significantly more infringements for ‘excessive’ speeding (ie.,

20km/hour or more above the posted speed limit) and as a consequence, a higher number of demerit points.

- Cox proportional hazards regression of the *time to first speeding infringement* at each cumulative year of licensure produced an identical model of significant variables, with comparatively similar hazard ratios to the incident rate ratios observed for total infringements and demerit points.
- By 36-months post-licensing, 61% of infringing drivers were noted to have incurred more than one speeding infringement. Logistic Regression of these ‘repeat’ offenders resulted in a model showing that the risk of a repeat speeding offence was significantly higher for *males*, and drivers who were *high in confidence-adventurousness* and *moderate to high in the disposition to risk-taking*.
- Follow-up scores for two of the identified risk factors -driver disposition to risk-taking (ie., impulsivity and sensation seeking) and driver confidence-adventurousness- were obtained at 12-months and 24-months for around 55% of the cohort. Repeated measures analysis of variance showed no significant change over time in the mean score for risk-taking and a significant increase in the mean score for driver confidence-adventurousness from recruitment to 12-months follow-up only. No statistical relationship was determined between change scores at 12-months and 24-months and demerit points accumulated within that time for either risk factor.

Discussion and Recommendations

This longitudinal cohort study of a sample of 17-year old Western Australian drivers has shown that the incidence of novice driver speeding offences increases significantly after the first year of driving with a peak at 24-months and a decline thereafter. The data suggests that the vast majority of offences are for speeding between 10 and 19km/hour above the post speed limit, with ‘excessive’ speeding offences being highest in frequency in the first year and then declining in frequency thereafter. The unadjusted rates of the incidence of speeding drivers showed that males are more likely than females to incur one or more speeding infringement. Consistent with this,

males were more likely to be repeat speeding offenders and to incur their first speeding infringement far earlier in their licensure than females.

Multivariate analysis of the speeding offence data showed that information provided by the cohort sample at the time of obtaining their motor vehicle drivers' licence can be used to predict speeding offence behaviour up to 36-months post-licensing. Four variables were found to be significantly and consistently predictive of all three measures of speeding -the total number of speeding offences incurred; the time to first offence, and the total number of speed related demerit points lost- at 12, 24, and 36-months post-licensing. Male gender, a high disposition for risk taking, high self-rated confidence and adventurousness as a driver, and the low level of practice of other health-related behaviours presented as significant risk factors for speeding offences. The effect of gender was strongest for the modelling of demerit points due to the increased likelihood of males to engage in higher-level speeding offences that incur higher demerit point penalties. Three of the four variables were also found to distinguish single offenders from repeat offenders. There was no evidence to suggest that the penalties for speeding were likely to influence two of the identified risk factors for speeding (self-rated driving style and driver disposition for risk taking) or the likelihood of a repeat offence by certain drivers.

The combination of a longitudinal design and the application of multivariate analytical techniques to objective speeding offence data have addressed many of the shortcomings of previous investigations of the psychosocial risk factors for speeding by young drivers. In particular, the findings reported here have clarified the 'causal' role of previously identified risk factors while adjusting for their co-variation with other known driver risk factors. This point is exemplified by the non-significant association of normative beliefs for speeding and attitudes toward speeding, which have been previously identified as significant independent contributors to speeding behaviour.

Various limitations to the study were discussed, including study design, sampling, and selection bias; the selective operationalisation of speeding; the inability to adjust for driving exposure, and the measurement of driver psychosocial constructs.

A number of recommendations for managing speeding among young novice Western Australian drivers were offered for discussion. These include developing a more strategic focus throughout driver training of the impact of risk taking and driver confidence on driving outcomes; greater emphasis on speeding as a health-related behaviour; adopting a more restrictive demerit point program within the probationary licensing period; restructuring speeding penalties within the probationary licensing period; the development of a speeding recidivist program for new and more experienced drivers, and the adoption of time of day of driving and passenger restrictions for novice drivers to curb the potential influence of situational factors (eg, nighttime and peer-aged passengers) on driver speeding

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Our thanks are also extended to the Western Australian Police service for the provision of speeding offence data and for their assistance with interpreting the offence data file. We would also like to acknowledge Mr Matthew Legge, Injury Research Centre, UWA, for his assistance with preparing the offence data for analysis, and Associate Professor Andy Lee, School of Public Health, Curtin University of Technology, for his advice on the statistical methods employed in this study.

1. INTRODUCTION

1.1 Young driver crash involvement

It is widely recognized across all highly motorized Western countries, including Australia, that young motor vehicle drivers have a much higher risk of involvement in crashes that result in either death or hospitalization compared with older, more experienced drivers. In Australia, driver population fatality rates for the period 1980 to 2001 (see Figure 1.1) show that young drivers have maintained a consistently higher rate of fatal injury over this time compared with older-age drivers and all-age drivers. In 2001, drivers aged 17-25 years were more than twice as likely as drivers aged 40-59 years to be killed in a motor vehicle crash (8.7 deaths per 100,000 population versus 3.8 deaths per 100,000 population) (Australian Transport Safety Bureau, 2002). Despite a 42% reduction in the fatal injury rate for young Australian drivers over the period, the fatality rate-ratio of this age group of drivers to all-age drivers has declined only marginally from 2.45 in 1980 to 2.17 in 2001.

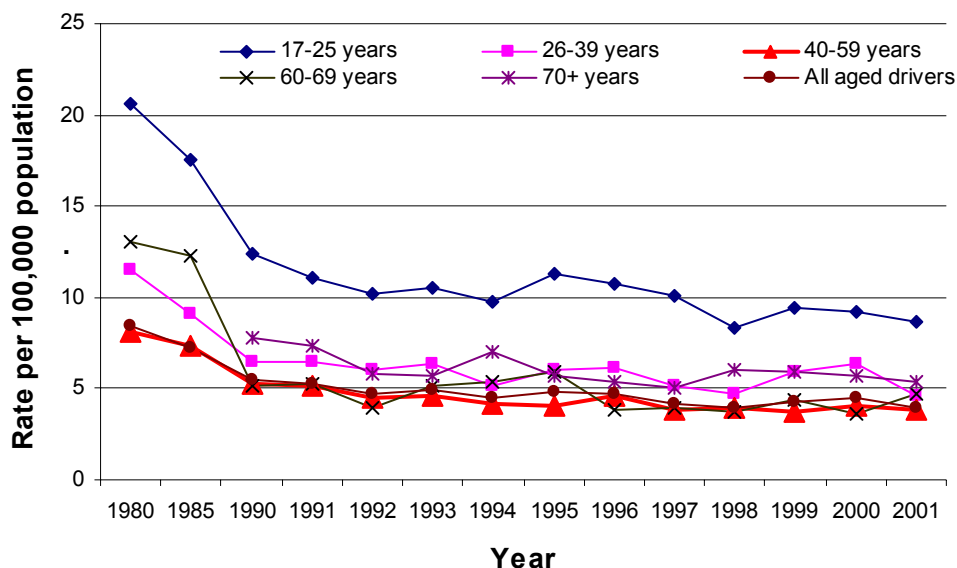


Figure 1.1: Population fatality rates for drivers by age groups; Australia, 1980-2001 (Source: Australian Transport Safety Bureau, 2002)

As in all other states and territories across Australia, Western Australian young drivers evidence a comparatively high risk of serious injury (death and

hospitalization). Analysis of police recorded crashes contained in the Western Australian Road Injury Database for the period 1987 to 1999 shows that drivers aged 17-19 and 20-24 years have a substantially higher rate of serious injury per 100,000 licensed drivers compared with drivers 25 years and older (see Figure 1.2). For example, in 1999 the serious injury rate for drivers aged 17-19 years was approximately 4.3 times that of drivers aged 25 years and older (355.07 versus 81.96 per 10,000 licensed drivers) (Legge, 2001). With respect to first year drivers, Palamara, Legge & Stevenson (2003) found that Western Australian drivers aged 17 years and in their first year of licensing are approximately 3.6 times and 2.6 times more likely to crash over a 12-month period compared with drivers respectively licensed for 10 years and 5 years.

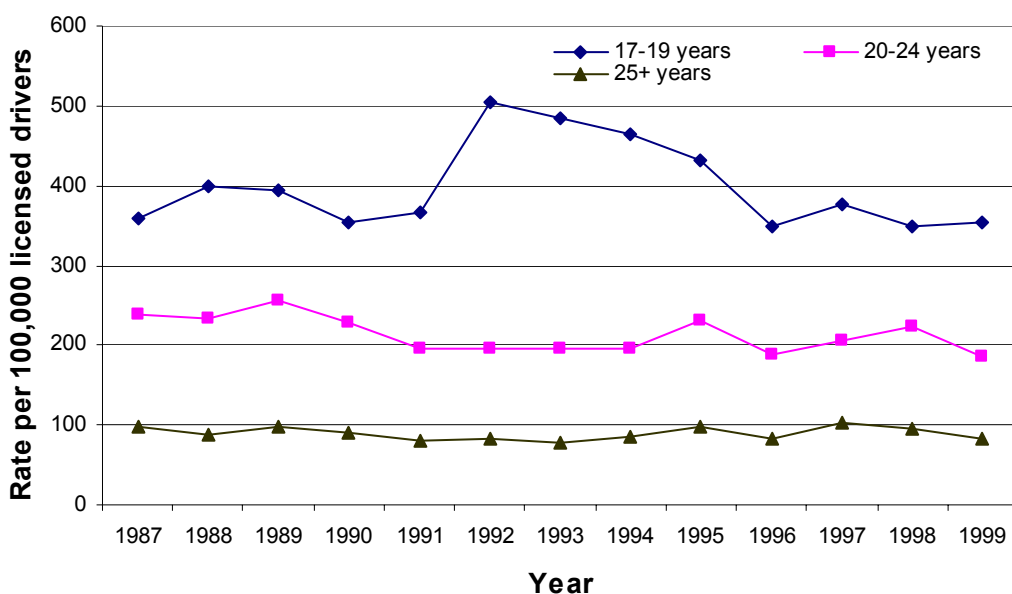


Figure 1.2: Licensed driver serious injury rates for drivers aged 17-19, 20-24, and 25+ years; Western Australia, 1987-1999 (Source: Legge, 2001)

The most recent road injury data for Western Australia continues to demonstrate the over-representation of young drivers in police recorded crashes resulting in death and hospitalisation. Drivers aged 17-24 years accounted for 34% of all driver fatalities and 30.5% of all drivers hospitalised in 2000, despite representing only 13.6% of

licensed motor car drivers in the state (Legge, Kirov & Cercarelli, 2001). Based on these percentages, the estimated risk ratio of death and hospitalisation for young drivers is 2.5 and 2.24 respectively. It should be noted however, that the rate of injury resulting in hospitalisation may be underestimated because of the known under-reporting in police recorded crashes of crashes resulting in hospital treatment (Rosman and Knuiman, 1994).

1.2 Young drivers and speeding

Speeding is a well known risk factor for crashing and subsequent injury severity for all drivers (eg., Kloeden, McLean, Moore & Ponte, 1997; Patterson, Frith & Small, 2000), and in particular, young drivers (Harrison, Triggs & Pronk, 1999). Investigations of Australian population crash data bases have found that younger drivers are over-represented in injury crashes when travelling above the speed limit or at excessive speeds (Catchpole, Cairney & Macdonald, 1994; Macdonald, 1994), where the circumstances of the crash suggest that speed was likely to be involved (Harrison et al., 1999), and where speeding has been judged by attending police to be the primary contributing factor to the crash (Ryan, Kirov & Cercarelli, 1999; Palamara, Mullan & Spittle, 1997; Palamara et al., 2001). The most recent data available in Western Australia shows that speed was judged (by attending police) to be a contributing factor in 42% of fatal crashes involving drivers aged 17-24 years, compared with only 26% of fatal crashes involving drivers aged 25 years and older (Legge et al., 2001).

The data presented by Legge et al. (2001) most likely underestimates the contribution of speed to the crashes of young drivers. This is because the data does not reflect the contribution of speed to injury crashes where an illegal blood alcohol reading was

obtained. In such cases, alcohol would be noted as the primary 'causal' factor because of the hierarchical ordering and reporting of the judged cause of a crash; the involvement of speed would not be reported. Furthermore, the data reflects only those crashes attended by police because of death or injury. Consequently, there is no available information of the contribution of speed to young driver crashes that were not attended by police or even reported to police.

The over-involvement of young drivers in speed-related injury crashes suggests firstly, that young drivers may have less well developed vehicle control skills relative to older drivers in handling higher vehicle speeds, and/or, secondly, that young drivers perhaps travel more frequently than older drivers at higher speeds. Whilst there is some evidence to suggest that younger drivers have inadequate vehicle control skills with respect to speed control (eg, Mayhew & Simpson, 1995), there is also substantial evidence to show that young drivers are more likely than older drivers to drive at higher speeds, thereby increasing their risk of crash involvement. Evidence supporting the higher travel speed of young Australian drivers will be considered in the following section.

1.3 Evidence of higher travel speeds

There is consistent evidence from a variety of sources to show that compared with older drivers, younger drivers are more likely to drive at higher speeds. A series of West Australian telephone surveys of road safety risk factors has consistently found that young drivers (17-25 years) are more likely than older drivers (26+ years) to report having exceeded the speed limit by 10km/h in the preceding two-week period (Cercarelli, Hendrie, Dyke & Ryan, 1997; Cercarelli, Hendrie, Legge & Ryan, 1997; Cercarelli, Hendrie, Ryan, Legge & Kirov, 1997; Cercarelli, Hendrie, Ryan, Legge &

Kirov, 1998). Similarly, road-side observations of travel speeds in metropolitan and rural Victoria have found that drivers aged 18-34 years were more likely to exceed the speed limit and to drive excessively fast compared with older drivers aged 35+ years (Fildes, Rumbold & Leening, 1991; Harrison, Fitzgerald, Pronk & Fildes., 1998).

Official evidence of higher travel speeds among young drivers is provided by traffic offence data. Analysis of expiation notices for speeding issued in South Australia, 1995-1996, found a linear relationship between age of driver and number of notices for speeding, with younger drivers incurring substantially more notices across all levels of speeding (McCull & Sutherland, 1998). Similar findings were reported by Rosman (2000) in her analysis of Western Australian 'excessive' speeding (20km/hour or more) offences for the period 1996-1998. It was found that the incidence of offences, both single and repeat, for exceeding the posted speed limit by 20km/h or more was highest for drivers aged 17-19 years and declined with increasing driver age. Rosman (2000) also found 'excessive' speeding to be a significant risk factor for subsequent crash involvement. Drivers who were apprehended for 'excessive' speeding before the age of 20 were twice as likely to be involved in a subsequent casualty crash in the two-year follow-up period of investigation.

Whilst there are limitations with the above studies, particularly in regard to adjusting the findings for driving exposure, the research shows that younger drivers are inclined to drive at higher speeds as indicated by self-report, road-side observation, and traffic offence data. It has also been demonstrated that a history of speeding offences can increase a young driver's risk of subsequent involvement in a casualty

crash. These findings confirm that speeding is a risky behaviour among young drivers and is strongly associated with their over-involvement in crashes (Elliot 2002). In the following section the literature on the factors associated with young driver speeding, will be considered.

1.4 Factors associated with speeding

Why drivers, and in particular younger drivers, engage in risky on-road behaviours such as speeding has been the subject of considerable theoretical discussion and empirical investigation. The discourse on speeding behaviour has involved a variety of disciplines and has considered the effect of external and situational factors (eg, road type and layout, traffic volume and speed, car characteristics, time of day, levels and type of police enforcement, trip purpose) and driver characteristics (eg, age, gender, personal motivations, behavioural traits, beliefs and attitudes toward speeding) on the choice of travel speeds.

As the aim of this research was to investigate the effect of driver psychosocial and behavioural characteristics on speeding behaviour, the review of the literature will be confined to research addressing such factors and work published from 1990 onwards. Evidence pertaining to older and all age drivers will also be considered when there is limited or insufficient research specific to younger drivers.

In the following sections, the driver behavioural and psychosocial characteristics of gender; health-related lifestyle; individual differences in risk taking; driving style, and attitudes and beliefs toward speeding will be briefly reviewed as background to the research that was undertaken.

1.4.1 Gender

Gender has long been recognised as a significant risk factor for a range of injury risk behaviours (National Health and Medical Research Council, 1996). Consistent with this, there is evidence to show that compared with females, males drive at higher speeds and are more likely to incur a speeding offence, and that they are more often involved in speed related crashes.

Telephone surveys of road safety risk behaviours in Western Australia show that males are significantly more likely than females to report having exceeded the speed limit in the preceding two weeks (56% versus 39%) and to have been fined for speeding in the previous 12-months (18.5% versus 9.5%) (Cercarelli et al., 1998). However, no information was provided on the relationship between age and gender and speeding. Self-report data from South Australia also confirms that male drivers (13%) are significantly more likely than female drivers (8%) to have been fined for speeding in the previous six months (Wundersitz, Kloeden, McColl, Bladock & McLean, 2002). In that study, the association between gender and speeding was consistent for drivers aged 20-29 years and 30+ years, but not for the youngest drivers interviewed (16-19 years).

Contrary to the above findings, road-side observations of travel speeds in two Victorian studies have failed to demonstrate a relationship between driver gender and speeding. In the observational studies reported by Fildes et al (1991) and Harrison et al (1998), male drivers were not significantly more likely than female drivers to be observed travelling at higher speeds on either rural or metropolitan roads. Unfortunately, neither study considered the effect of driver age on the relationship between gender and travel speed, nor explored possible reasons (eg, sample demographics) for the absence of a relationship between driver gender and speed.

Official records of speeding offences provide more reliable evidence of the relationship between gender, speeding and age. Rosman's (2000) analysis of excessive speeding offence data for Western Australia, 1996-1998, found that police enforcement activity for this period detected fewer speeding female drivers (6.7%) than male drivers (13.5%), with male drivers aged 17-19 years having the highest rates of offence (350 offences per 1,000 licensed drivers) of all drivers for this period. The data also showed that male drivers were more likely than female drivers to be repeat offenders (2.7% versus 0.8%), with male drivers aged 17-19 years most likely to be repeat offenders. Complementary findings were reported by McColl and Sutherland (1998) in their analysis of expiation notices for speeding in South Australia, 1995-1996. In that study, males accounted for approximately 72% of all speeding notices issued during this period, with male drivers aged 17-25 years incurring the highest number of offences across all age groups. Unfortunately, neither Rosman (2000) nor McColl and Sutherland (1998) were able to adjust their findings for travel exposure.

Crash data also show that across all ages, male drivers are more likely than females to be involved in speed related crashes. A review of police reported crashes in Western Australia, 1989-1997, found that the involvement of speed was significantly greater for male drivers compared with female drivers: 16% versus 8% (Ryan et al., 1999). Diamantopoulou, Hoareau, Oxley & Cameron (2003) in their analysis of South Australian and Victorian crash data similarly found that gender was a significant predictor of crashes involving speed, with males crashing at significantly higher travel speeds than females (79.3km/hour versus 71.2km/hour). The most recent speed related crash data for Western Australia showed that male drivers

accounted for 84% of speed related crashes, and that the contribution of speed was greater for crashes involving young male drivers (46%) compared with young female drivers (31%) (Legge et al., 2001).

In summary, male drivers are more likely to report driving at higher speeds and to have been recently fined for speeding. Police traffic offence data, unadjusted for exposure, likewise shows that males, and in particular young males, are more likely to be fined for speeding and to be repeat speeding offenders. Consistent with this, male drivers of all ages are more likely to be involved in speed related crashes. With respect to young drivers, male drivers are more likely to be killed in a crash involving speed. Overall, the evidence suggests that gender is a substantial risk factor for speeding and speed related crashes.

1.4.2 Lifestyle and health-related behaviours

Risky driving behaviours such as speeding and drink-driving among younger drivers is considered to be part of a cluster of risky, health-related problem behaviours associated with the developmental stage of youth (Beirness and Simpson, 1988). Over the last decade, cross-sectional and longitudinal studies have been undertaken to investigate the association of so-called problem behaviours such as alcohol use, smoking, and illicit drug use with risky driving. While there is some evidence to suggest problem behaviours of youth may be significantly associated with risky driving behaviours, the relationship is somewhat weak and inconsistent.

Of the various problem behaviours of youth, the use of alcohol is most consistently associated with risky driving. A cross-sectional study of alcohol use and self-reported driving outcomes by Beirness and Simpson (1988) found that self-reported

frequent consumption of alcohol and problems with alcohol were significantly associated with scores on a standardised measure of deliberate risky driving (eg, speeding, drink-driving, close following). Follow-up of these drivers two years after licensing found that initial reports of alcohol use and its problems were predictive of risky driving (and crash involvement) in that period (Beirness and Simpson, 1988).

A series of longitudinal studies of the effects of school based alcohol misuse and substance abuse programs in Michigan have produced findings of a relationship between pre-license alcohol use and subsequent driving outcomes (Lang, Waller & Shope, 1996; Shope, Waller, Raghunathan & Patil, 1999). Alcohol use reported in Year 10 was found to be significantly associated with police reported serious driving offences, including speeding, for both males and females up to 8 years post-licensing (Shope et al., 1999). Alcohol use information obtained from a cohort of Year 12 students found alcohol to be significantly predictive of police reported second year driving offences, including speeding, for women but not men (Lang et al., 1996).

A search of the literature has failed to identify Australian research into the relationship between adolescent health-risk behaviours and later driving outcomes such as speeding offences. Evidence from North America suggests however, that risky health-related behaviours in adolescence are significantly associated, albeit weakly, with traffic offences such as speeding. The implication is that adverse driving outcomes are more likely to occur among those young drivers who demonstrate an early propensity for a lifestyle of risky health-related behaviours.

The relationship between health-risk behaviours and driving outcomes is thought to be partially mediated by a common underlying factor that disposes individuals to

risky behaviour (Simpson, 1996). The individual difference factor of sensation seeking, a commonly regarded trait for risk taking, has been found to be associated with a range of health-risk behaviours such as illicit drug use, tobacco consumption, use of alcohol, and risky driving (Ripa et al, 2001; Hoyle et al, 2002). In the following section the theory of sensation seeking and its relationship with risky driving will be briefly reviewed.

1.4.3 Individual differences in risk taking

Road safety researchers have long sought to identify personality antecedents of risky behaviours in order to explain individual differences in risky driving such as speeding and even crashing (Jonah, 1997). One of the most commonly investigated personality traits in road safety research is sensation seeking. According to Zuckerman (1994, page 27), sensation seeking is a normal human characteristic or disposition for the seeking of “..varied, novel, complex, and intense sensations and experiences, and the willingness to take physical, social, legal and financial risks for the sake of such experiences”. Individuals who are high sensation seekers have a strong need to maintain a heightened level of physiological arousal and consequently seek new, novel and rewarding situations and experiences to maintain this level, irrespective of the risks inherent in the situation or experience (Zuckerman, 1994). Research has consistently found that high sensation seeking individuals tend to focus on the benefits of risky behaviours and are largely undeterred by threats of, or actual punishment for inappropriate behaviour (Zuckerman, 1994). The implications of these characteristics in the road environment are eminently clear.

The relevance of sensation seeking to the young driver area is further exemplified by the developmental nature of and gender differences in the trait. Research has

demonstrated that sensation seeking “..rises between the ages of 9 and 14, peaks in late adolescence or early 20’s, and declines steadily with age thereafter”. (Zuckerman, 1994, page 122). Across all ages and particularly among the young, sensation seeking is highest for males compared with females (Zuckerman, 1994). What is interesting to note is that the characteristics of the development of sensation seeking are consistent with the developmental patterns of young driver aberrant behaviour discussed above.

Numerous cross sectional and longitudinal studies of sensation seeking and driving have been undertaken over the past decade, mostly using standardised measures of sensation seeking developed by Zuckerman (1994). This vast volume of literature was extensively reviewed by Jonah (1997) who found considerable evidence of a positive relationship between sensation seeking scores and aberrant driving behaviours such as speeding. Based on his review of over 40 studies, Jonah (1997) concluded that sensation seeking scores tend to be more strongly associated with self reported and observed risky driving behaviours than with official police records of traffic offences. This could be because traffic offences represent only detected incidences of risky behaviour, which may or may not be indicative of the driver’s usual pattern or frequency of the behaviour. Speeding was a commonly reported/cited offence associated with sensation seeking, with approximately 10-15% of the variance in risky driving accounted for by sensation seeking scores. This low to moderate explanation of the variance is to be expected however, given that the trait of sensation seeking is not situation or behaviour specific (see Whissell and Bigelow, 2003). Not so surprisingly, the relationship was found to be stronger for males than females. Furthermore, there was some evidence to suggest that the relationship declined with increasing age of the drivers studied. Jonah (1997) also

reported that driver attitudes and beliefs about the outcomes of risky driving such as speeding appeared to mediate the relationship between sensation seeking and the propensity to engage in the behaviour.

The review conducted by Jonah (1997) concluded that sensation seeking is moderately related to risky driving behaviours such as speeding. His investigation and conclusions could have been strengthened however, by using meta-analytic techniques to aggregate findings or by adopting explicit systematic review criteria to accept or reject studies for analysis. Overall, the low to moderate explanation of the variability in risky driving behaviours such as speeding by sensation seeking is consistent with the generalist nature of the trait. It has been proposed that personality traits such as sensation seeking are perhaps more strongly associated with an individual's general style of driving than any particular driving behaviour per se (Underwood, Chapman, Wright & Crundall, 1997). To this end, researchers have sought to identify the behavioural styles of drivers that contribute to risky driving and an increased likelihood of crashing.

1.4.4 Driving style and driver behaviour

There has been little agreement on the conceptualisation and measurement of driving style (Taubman-Ben-Ari, Mikulincer & Gillath, 2003). West and colleagues (West, French, Kemp & Elander, 1993; Elander, West, & French, 1993) were the first to investigate the contribution of driving style to driving outcomes such as speeding and have defined driving style as the way drivers 'habitually' drive. The assessment of driving style is based upon drivers' self-reports of behaviour. Its validity is supported by cross-sectional and longitudinal studies that have demonstrated a relationship between self-reported driving styles and observations of on-road

behaviours that are commensurate with the reported style. For example, West et al (1993) found that self-ratings of preferred driving speed were moderately correlated with observed driving speed, and that observer ratings of driver calmness correlated significantly with self-reports of driver calmness.

One line of research into self-reported driving style has required drivers to rate themselves on a series of semantic differential items (eg, good-bad; fast-slow) to characterise their usual driving. These ratings have then been subjected to factor analysis to identify driving style factors. Driving styles that have been identified include carelessness, tolerance of other road user, decisiveness, attentiveness, driving speed, calmness, planning, deviance, social resistance (West et al.,1993), sociability, confidence-skill (Adam-Guppy and Guppy, 1995), patience, and safety (Quimby, Maycock, Palmer & Buttress, 1999). For example, UK company drivers aged between 24 and 65 who rated themselves as confident-skilled, aware, and less sociable as drivers, also reported frequently exceeding the motor way speed limit (Adams-Guppy and Guppy, 1995).

The second area of research into driving style has involved the development of standardised scales to measure driver behaviour to predict aberrant driving behaviour and subsequent traffic offences and crash involvement. Taubman-Ben-Ari et al (2003) has provided a brief review of the various scales. One of the most popular scales is the Driver Behaviour Questionnaire (DBQ). The underlying theory is that aberrant driving behaviour consists of errors, lapses and violations, and that drivers can be categorised with respect to their disposition to engage in such behaviours (Reason et al., 1990). Errors and lapses in driving behaviour are defined as mistakes of execution and are associated with fairly harmless outcomes, whereas violations

represent deliberate contraventions of formal and informal road rules and have a greater potential for adverse outcomes such as crashing (Taubman-Ben-Ari et al., 2003). Of these three factors, violations account for the majority of the variance in aberrant driving (Reason et al., 1990).

A review of the DBQ found that males and young drivers are more likely to report a higher level of driving violations than females and older drivers, and that the violation sub-scale is more reliably associated with traffic offences and crash involvement than either errors or lapses (Westerman and Haigney, 2000). With respect to speeding, a study of Australian drivers aged 17-60 years found that drivers with high violation scores were more likely to report having been previously convicted for speeding than those with lower violation scores (Blockey and Hartley, 1995).

In summary, the on-road behavioural style of drivers seems to be associated with risky driving such as speeding. The strongest and most consistent evidence, however, is for the DBQ sub-scale of driving violations. In this case, drivers who demonstrate a high disposition for violating formal and informal road rules are more likely to report committing traffic offences such as speeding. The mechanism which leads to the development of a violational driving style is however, yet to be fully investigated. There is some evidence to suggest that personality traits such as sensation seeking play a part in the development. For example, Rimmo and Aberg (1999) found that sensation seeking explained approximately 27% of the variance in DBQ-violation scores in Swedish drivers aged 18-27 years. Whilst driving related attitudes and beliefs can also affect driving styles (Taubman-Ben Ari et al., 2003),

the contribution of attitudes and beliefs to risky driving in general is less than clear (Assum, 1997).

1.4.5 Attitudes and beliefs

Individual attitudes and beliefs have long been investigated for their utility to predict future behaviour (Forward, 1997). In regard to road injury, researchers have sought to identify the attitudes and beliefs of drivers that underlie aberrant behaviour for the development effective countermeasures to change driver behaviour and reduce crash risk (Elliot, 2002). This approach assumes, firstly, that it is possible to identify relevant attitudes associated with behaviour (and subject these to modification), and secondly, that attitudes are causally related to behaviour. The low correlation between expressed attitudes and observed behaviour in many studies suggests that the attitude-behaviour relationship is questionable (Forward, 1997), or at the very least, attitudes are less salient in the promotion of behaviour than is assumed. The poor performance of attitudes may also be due to methodological deficiencies of the respective studies, such as the failure to identify the most appropriate and relevant attitudes associated with the behaviour in question.

The difficulty with much of the attitudinal research in road safety is a lack of theoretical framework to guide the selection of attitudinal dimensions for investigation, which in turn would define the parameters for the prediction of driving behaviour by attitudes. The consequence of this is a body of research that lacks uniformity in its approach and consistency in its findings (Forward, 1997). On the other hand, the 'theory of reasoned action' (Fishbein and Ajzen, 1975) and its more recent version known as 'planned behaviour' (Ajzen, 1985) provides a cogent theoretical framework for the investigation of driver attitudes and their relationship

with risky behaviours. In the following paragraphs the theory and its application to the prediction of risky driving behaviour will be reviewed.

According to the theory of reasoned action, behavioural intention is the strongest predictor of volitional behaviour (ie, behaviour that is the result of a voluntary choice) (Fishbein and Ajzen, 1975). Intention to behave is in turn influenced by the relative effects of attitudes towards the behaviour and subjective norms for the behaviour. Attitudes toward the behaviour are the product of the perceived outcomes or consequences of engaging in the behaviour (behavioural beliefs) weighted by the individual's evaluation of the possible outcomes (outcome evaluation). On the other hand, subjective norms for the behaviour are the product of the individual's perception of the expectation of significant others (the individual's 'referent group') to perform the behaviour (normative belief) weighted by the individual's motivation to comply with the expectations of his/her referent group (motivation to comply) (Fishbein and Ajzen, 1975). The modification of the theory proposed by Ajzen (1985) sought to extend the application of the theory to behaviours that were not necessarily under volitional control by including a further determinant of behavioural intention known as perceived behavioural control. This refers to the "...degree to which an individual feels that performance or non-performance of the behaviour in question is under his or her volitional control" (Parker et al., 1992, page 94). Overall, there is considerable evidence in the non-road safety area to support the hypothesis that behavioural intentions are an immediate antecedent of behaviour per se and mediate the influence of attitudes and subjective norms on behaviour (Terry, Gallois & McCamish, 1996).

The theory of reasoned action/planned behaviour has been applied to a number of driving behaviours and has been shown to be significantly predictive of behavioural intentions. For example, Parker et al (1992) found that attitudes toward the behaviour and subjective norms together accounted for 21% of the variance in intention to drink and drive, 33% of the variance in intention to speed, and 24% of the variance in intention to overtake in dangerous circumstances. For drink-driving and speeding, the addition of perceived behavioural control increased the percentage of variance explained by 20% and 14.5% respectively (Parker et al, 1992). Age was reported to have a significant effect on all components of the model for the prediction of behavioural intent. Consistent with the optimism bias young drivers typically display for the outcomes of risky driving (see Job, 2001), Parker et al (1992) found that younger drivers viewed the outcomes of drink-driving and speeding less negatively than older drivers. Young drivers also perceived more approval from their salient referents for their higher intentions to drink-drive and speed. This finding supports those reported by Yagil (1998), in which the compliance with traffic laws by younger drivers was found to be influenced more by normative or personal values rather than instrumental or environmental issues such as punishment, harm or loss as a result of the behaviour.

Similar results for intention to speed were reported by Gordon and Hunt (1998). The combination of attitudes toward the behaviour, subjective norms and perceived behavioural control explained 43% of the variance in intention to speed. Perceived behavioural control alone accounted for 17% of the total variance in intention. Gordon and Hunt (1998) further reported a very strong correlation (0.83) between intention to speed and past speeding behaviour, but found a low correlation of 0.18 between intention to speed and observed travel speed. Research undertaken by

Elliot, Armitage & Baugh (2003) similarly confirms the strong relationship between past speeding behaviour and intention to speed ($r=0.81$). Elliot et al. (2003) also reported a moderately strong correlation between intention to speed and self-reported speeding behaviour three months later ($r=0.67$). Unfortunately the effect of driver age on components of the model was not considered in either study.

The theory of reasoned action/planned behaviour has been shown to be moderately predictive of intentions to engage in various risky driving behaviours. The findings also show that perceived control over driving behaviours such as speeding and drink-driving, is an important element in the understanding of intentions and therefore, actual behaviour. Especially relevant to this investigation is the finding that younger drivers perceive the outcomes of risky driving less negatively than older drivers, and perceive more support from their referents for engaging in risky driving such as speeding. Unfortunately, there is no empirical evidence to substantiate the utility of behavioural intentions to prospectively predict behaviour using more objective indices of risky driving such as police issued notices for speeding behaviour.

1.5 Summary and research objectives

The above review has shown that young novice drivers in Australia are more likely than older, experienced drivers to be involved in fatal and serious injury crashes. It was also shown that young drivers tend to drive at higher speeds, as indicated by self-report, roadside observation and traffic offence data. Given this behaviour, it has been proposed that speeding is an important qualitative dimension of the exposure of young drivers which increases their risk of crashing and injury.

It has been suggested that on-road behaviours such as speeding are part of a larger complex of problem health behaviours associated with the developmental stage of youth. The disposition for risky behaviour, such as speeding, among youth is further exacerbated by an individual difference factor for risk taking, namely sensation seeking, which is heightened among younger persons and particularly males. High sensation seekers are more likely to engage in risky driving behaviours and to a lesser extent be involved in crashes. The association between sensation seeking and driving outcomes was found to be at best moderate; its influence is perhaps stronger on the development of a habitual style of risky driving (as indicated by violation scores on the DBQ) which is in turn predictive of individual risk taking behaviours and self-reported crash involvement. Lastly, attitudes have been shown to have some involvement in risky driving. Based on the theory of reasoned action/planned behaviour, attitudes about the outcomes of risky driving behaviours and perceptions of the norms associated with these behaviours can influence drivers' intention to engage in risky driving such as drink-driving and speeding. Consistent with other research, and particularly relevant to this study, is that younger drivers are less likely to perceive the negative outcomes of risky driving than older drivers, and to perceive more support from their referents for engaging in such behaviours.

A number of methodological issues limit the veracity of the findings discussed. Firstly, the majority of research undertaken to date has employed a cross-sectional methodology to investigate the relationship between the predictor variable and the driving outcome of interest, which limits the extent to which a causal relationship can be inferred. Furthermore, there is increasing concern that the majority of investigations into the psychosocial predictors of driving outcomes have failed to address important methodological issues such as the reliability and validity of the

measures of predictor variables and the outcomes of interest (see af Wahlberg, 2003). Finally, no study has attempted to ascertain the relative effect of the above cited factors on risky driving, such as speeding, among young drivers using a prospective cohort design and objective, verifiable outcome data.

Notwithstanding the criminological aspect of speeding behaviour, there is an urgent need from a health perspective to better understand the factors associated with speeding among young drivers and to subsequently develop more effective countermeasures to reduce the incidence of speeding and speeding related injury. In keeping with this need, the aim of the present study was to investigate, prospectively, the relative effects of driver psychosocial, behavioural, and pre-licence training factors on speeding offences incurred by a cohort of 17-year old West Australian drivers who obtained their motor vehicle drivers' licence in metropolitan Perth.

The specific objectives of the study were as follows:

- To determine the incidence and pattern of police issued Traffic Infringement Notices for speeding and associated demerit points at 12, 24, and 36-months post-licensing.
- To determine the extent to which driver psychosocial, behavioural, and driver training factors contribute to the risk of incurring a Traffic Infringement Notice for speeding and associated demerit points at 12, 24, and 36-months post-licensing.
- To investigate the changes over time in identified risk factors for speeding and the effect, if any, of penalties for speeding on identified risk factors and further speeding behaviour.
- To make recommendations, where appropriate, for the management of young driver speeding behaviour

The objectives and findings presented in this report represent part of a three-year program of research, known as the Western Australian Young Driver Cohort Study (WAYDCS), into young driver behaviour and outcomes (eg, police reported crashes, road injury, speeding offences, drink-driving offences). The WAYDCS recruited drivers from both metropolitan Perth and rural Western Australia. For programmatic reasons however, it was necessary to restrict this study of speeding to the cohort of metropolitan drivers.

It should also be noted that the definition of speeding behaviour for this study refers to behaviour that results in the issue of a Traffic Infringement Notice for speeding. Infringement Notices for speeding reflect at minimum, the behaviour of the driver at the time of detection and to some extent the level of enforcement activity undertaken by police at the time (ie, the likelihood of detection). The receipt of an Infringement Notice may not accurately reflect the driver's 'usual' behaviour in terms of the level or frequency of 'undetected' speeding, but it does provide objective evidence of their behaviour as opposed to potentially unreliable self-report data which is so frequently used. Moreover, given the previously cited relationship between speeding offences and crash involvement, it would seem that elucidating the risk factors for speeding offences may offer greater scope for managing and safeguarding young drivers.

2. METHOD

2.1 Overview

A cohort of 17 year-old drivers was recruited at the time of obtaining their motor vehicle drivers' licence through the Western Australian Department of Transport metropolitan Licensing Centres. Upon recruitment, drivers completed an omnibus questionnaire covering pre-licence driving experience and a range of psychosocial and behavioural factors related to driving (collectively referred to as 'driver information'). Follow-up questionnaires were administered by post at 12 and 24 months post-licensing. Details of the Traffic Infringement Notices for speeding issued to the cohort by police within three years of licensing were obtained and linked to the questionnaire information. Multivariate analyses were subsequently conducted to determine the effect of driver information obtained at the time of licensing on the number of speeding offences and demerit points accumulated through speeding at 12, 24 and 36-months post-licensing.

2.2 Ethics approval

Ethics approval for the Western Australian Young Driver Cohort Study (which provided the data for this research) was obtained from the Human Research Ethics Committees of Curtin University of Technology (Approval Number **HR 18/95**) and The University of Western Australia (Reference Number **05/06/004/J44**).

2.3 Research design

The study represents a longitudinal cohort survey design. Drivers were non-randomly selected and surveyed at the time of obtaining their motor vehicle drivers' licence and followed up at 12 and 24 months post-licensing. This report is restricted, however, to the investigation of the relationship between data obtained at the time of licensing and police recorded speeding infringements accrued at 12, 24, and 36-months post-licensing

2.4 Driver cohort

Seventeen year-old drivers obtaining their A or E class motor vehicle drivers' licence in the Perth metropolitan area were targeted for recruitment. To be eligible for inclusion, drivers must not have previously held an A or E class drivers' licence, or previously been involved in a crash or incurred a traffic infringement or conviction as the driver. Research staff stationed at three metropolitan Perth Licensing Centres approached 3,350 newly licensed drivers to participate in the study. Fifty-six drivers declined to take a questionnaire, three did not meet the eligibility criteria, 404 drivers returned the questionnaire without completing it, and 1,610 drivers failed to respond to our telephone requests to return the questionnaire within four weeks. The final cohort of 1,277 drivers represented a response rate of 38.1%. Fifty-eight percent of the cohort was female (n=741) and 42% (n=536) male. Based on licensing data reported by Palamara et al (2001), the sample cohort represents approximately 6.6% of all 17-year old Western Australian drivers licensed in 1998 for an A or E class Motor Vehicle Drivers' Licence. With respect to gender, the sample cohort represented 8% and 5.2% respectively of 17-year old females and males licensed in 1998.

Non-responder data was collected on 606 drivers only (41.25% female; 58.75% male). Non-responders were asked how frequently they had sat for their probationary motor vehicle drivers' licence and asked to complete two items from the measure of Impulsivity and Sensation Seeking included in the research questionnaire (see Section 2.5.2). Analysis of the responses to these items showed no statistically significant differences between the participating and non-responding drivers.

2.5 Research materials

Drivers who expressed an interest in participating in the study were provided with an Information Sheet, Research Questionnaire and a reply-paid, addressed envelope to return the questionnaire.

2.5.1 Information sheet

The Information Sheet provided details of the institutions conducting the research and contact details for staff within the lead institution (UWA). Drivers were given a brief, non-technical description of the aims of the research. This was followed by a detailed description of the participation required of drivers and details of their legal and ethical rights and obligations as participants in the study. In particular, drivers were informed of their right to decline the invitation to participate and to withdraw their participation at a later date without fear of penalty or prejudice.

2.5.2 Research questionnaire

An omnibus research questionnaire was compiled to gather information on a range of behavioural and psychosocial factors to be investigated for their effect on crash involvement and speeding offences 12-months post-licensing. Prior to the recruitment of the driver cohort, the questionnaire was pilot tested on twelve 17 year-old drivers and amended where necessary. Unless otherwise specified, all items and scales were specifically constructed for the study. Internal reliability and test-retest reliability are presented, where appropriate, for scales included in the questionnaire. Internal reliability was calculated using Cronbach's Alpha (SPSS, 2001); test-retest reliability was calculated over a 12-month period. The following sections detail the content of the questionnaire in order of presentation.

Instruction sheet

The Instruction Sheet directed the driver to read and complete the Informed Consent Document and provided an overview of the questionnaire and general instructions for its completion.

Informed consent document

In accordance with Human Research Ethics requirements, drivers were provided with two copies of an Informed Consent Document for signing. One copy was to be retained by the driver and the other to be returned with the completed questionnaire. In signing the consent document, drivers acknowledged that they had read and understood the requirements and rights of their participation and the possible legal consequences of participation.

Driver demographics

In this section, drivers provided details of their date of birth, place of residence (and that of their parents if they did not live with them), marital and parental status, educational and employment status, date of licensing, Motor Vehicle Driver Licence number, and any special conditions attached to their licence (e.g., requirement to wear eye-glasses). Full contact and identification information was required so that drivers could be followed-up annually. The identifying information, along with an assigned Identification Number, was recorded in a separate, password protected database and kept separate from the database of the drivers' questionnaire responses and driving outcomes. Questionnaire response and driving outcomes could only be identified using the unique Identification Number and the driver's Motor Vehicle Driver Licence number.

Health and health-related behaviours

Drivers were required to provide information on any current illnesses, medications being taken, or disabilities that might affect their capacity for driving. With respect to health-related behaviours, drivers were asked to provide details of their cigarette smoking; their consumption of alcohol in terms of frequency, time and place; the amount of physical exercise undertaken weekly, and their use of sunscreen (sun block). The responses for the health-related behaviours were subsequently aggregated to create a 'positive health-related behaviour' score for each driver. The 12-month test-retest reliability for this aggregated measure was calculated to be 0.60 ($p < 0.01$, $n=987$).

Driving experience prior to licensing

In this section drivers completed questions on the quantity and quality of driving undertaken prior to obtaining a learner-driver permit. For example, drivers were asked to indicate the age at which they first drove or rode a motorized vehicle, how frequently they had driven a car prior to obtaining their learner-driver permit, and whether they had driven/ridden on a public road without the necessary licence or permit or without a supervising driving prior to licensing. Other questions concerned the amount and type of professional and non-professional driving instruction undertaken prior to obtaining their probationary drivers' licence.

Licensing assessment and preparedness for driving

This section required drivers to provide details of their on-road probationary licence assessment history and to complete a series of Likert-scale items assessing perceived preparedness for driving. Nine driving scenarios were used for the ratings of driver preparedness, ranging from preparation for freeway driving to driving at night in rural areas. Scores for the nine scenarios were summed to create a 'preparedness for driving' score for each driver. The internal reliability of this measure was calculated

to be 0.86. The 12-month test-retest reliability was calculated to be 0.32 ($p < 0.01$, $n=1,013$).

Expected on-road behaviours

The Driver Behaviour Questionnaire (DBQ) (Parker, Reason, Manstead & Stradling, 1995) was used to measure the cohorts' expectations of committing various on-road behaviours in the first 12 months of driving. Parker et al (1995) have identified a three-factor structure for the DBQ, consisting of driving violations, driving lapses, and driving errors. Drivers are required to indicate on a five-point scale how frequently they have committed the behaviour in the last three months of driving. The internal reliability of the three DBQ factors was found to range from moderate to high with Cronbach alpha of 0.69, 0.81, and 0.75 respectively (Parker et al 1995).

For this study, the content and administration of the DBQ required a slight modification to reflect Australian (as opposed to British) driving regulations and the prospective nature of the research. The item relating to the illegal behaviour of *overtaking on the left* was reworded to address *overtaking on the left on a single lane road*. With respect to the administration of the scale, drivers were required to estimate on a five-point Likert scale the likelihood of the behaviour occurring in the first 12 months of driving. Individual scores for items loading on the identified sub-scales of violations, lapses, and errors were summed to create individual scores for these scales. Given these changes to the scale and its administration, internal reliability for each of the sub-scales was recalculated and found to be as follows: violations 0.76; lapses 0.72; errors 0.82. The 12-month test-retest reliability was calculated to be 0.54 ($p < 0.01$, $n=995$) for violations, 0.44 ($p < 0.01$, $n=994$) for lapses, and 0.39 ($p < 0.01$, $n=999$) for errors.

Normative beliefs and attitudes toward speeding

Items addressing the normative beliefs and attitudes drivers' hold toward the eight violational behaviour of the Driver Behaviour Questionnaire were constructed using the methods detailed in Ajzen and Fishbein (1980). For this study, however, only the normative beliefs and attitudes toward the speeding violation item are relevant for the prediction of speeding infringements and demerit point losses.

Police, parents/guardian, and friends of the driver were selected as the driver's referent groups to establish the normative beliefs for each behaviour. Drivers were firstly asked to indicate on a 7-point likert scale how willing they are to drive in the manner these referents would want them to drive (willingness dimension). For the violation item related to speeding, drivers were then asked to indicate on a 7-point likert scale their perception of the referents views on the behaviour (subjective norm dimension). In accord with the scoring methods outlined by Ajzen and Fishbein (1980), the final normative belief score was calculated by multiplying the subjective norm score by the willingness score.

Attitudes toward the speeding violation item were measured using two driver ratings on a 7-point likert scale. The first rating addressed the perceived likelihood of eight possible outcomes of speeding (outcome dimension). The outcomes were categorized as deterrence related (eg, be caught by police), health related (eg, be involved in a crash), and benefit related (eg, demonstrate how skilful you are as a driver). The second rating required the driver to indicate how good or bad such an outcome would be for them (evaluative dimension). The perceived likelihood rating for each outcome was then multiplied by its respective evaluative rating. As per the scoring methods outlined by Ajzen and Fishbein (1980), these products were then summed to create the attitudinal score for speeding.

Self-rated driver style and driving skill

Thirty-five semantic differential items (eg, good-bad, safe-unsafe, skilled-unskilled) were used in the measurement of driver style and driving skill. A number of the items were selected from Adams-Guppy & Guppy (1995), though most items were selected from a larger pool of items used in pilot testing. For each word-pair item, drivers were required to rate themselves along a seven-point scale. Data reduction techniques using principal axis factor analysis with oblique rotation (SPSS, 2001) were undertaken on the responses of the $n=1,277$ drivers for the 35 items. This resulted in four factors explaining 39% of the variance. The factors were labeled *confidence-adventurousness*, *skill*, *demeanor* and *alertness*. Driver scores for each of the four factors were derived by summing the raw values of the items that loaded on each factor. The internal reliability of the four factors was 0.72, 0.85, 0.77, and 0.83, respectively. The 12-month test-retest reliability was calculated to be 0.55 ($p < 0.01$, $n=997$) for confidence-adventurousness, 0.39 ($p < 0.01$, $n=997$) for alertness, 0.45 ($p < 0.01$, $n=999$) for skill, and 0.53 ($p < 0.01$, $n=1,002$) for demeanor.

Impulsivity and Sensation Seeking

Driver disposition to risk-taking was measured using the Impulsivity and Sensation Seeking scale (ImpSS) (Zuckerman, 1994). This 19-item true-false scale is a subscale of the Zuckerman-Kuhlman Personality Questionnaire and is considered to be a general measure of sensation seeking. Zuckerman (1994) reports internal reliability coefficients for the scale ranging between .77 and .82. The scale is moderately correlated (.66) with the longer Sensation Seeking Scale: Versions V (Zuckerman, 1994). The 12-month test-retest reliability was calculated to be 0.68 ($p < 0.01$, $n=912$).

Socioeconomic status

A measure of driver socioeconomic status was based on the index of social disadvantage for Australian post-codes using 1996 census data (Australian Bureau of Statistics, 1998).

2.6 Procedures

Details of the procedures used to recruit the drivers, to obtain and link their Traffic Infringement Notices for speeding, and to analyse the data are presented in the following sections.

2.6.1 Driver recruitment procedures

Between January and July 1997, research assistants were assigned to the Department of Transport Licensing Centres at Warwick, Fremantle and Welshpool to recruit newly licensed 17 year-old drivers to the study. Eligible drivers were identified from the daily schedule of on-road assessments to be conducted by licensing assessors of the Department of Transport. At the conclusion of a successful on-road assessment, the attending research assistant approached eligible drivers and described the nature of the study and invited the driver to participate. If the driver expressed interest in participating, they were provided with an Information Sheet, Research Questionnaire and reply-paid addressed envelope and instructed on the completion and return of the questionnaire. The driver's name, MDL number and contact telephone number were then recorded. If the driver chose not to participate they were invited to complete the non-responder questionnaire there and then.

Drivers who agreed to participate but failed to return a completed questionnaire within two weeks were contacted by telephone. If the driver chose not to complete the questionnaire they were invited to complete the non-responder questionnaire by telephone. If the driver confirmed their commitment to participate but failed to

return the questionnaire within another 2 weeks, the procedure was repeated once more.

All drivers who completed the questionnaire at the time of licensing were mailed a follow-up questionnaire at 12 months post-licensing. Similarly, drivers who completed the questionnaire at 12 months were mailed a final follow-up questionnaire at 24 months post-licensing.

2.6.2 Identification and linkage of Traffic Infringement Notices for speeding

Details of the Traffic Infringement Notices for speeding incurred by the cohort within 36 months of licensing were retrieved from the Traffic Conviction and Traffic Infringement database maintained by the Western Australian Police Service. The records were identified and linked to the driver's questionnaire data via the driver's unique Motor Vehicle Driver Licence number. Speeding infringements incurred whilst driving a commercial vehicle and those not finalised (ie, demerit points not yet allocated or monetary penalties unpaid) prior to the completion of 36-months of licensing were excluded from the linkage and analysis. Since only a few infringements met the above criteria, their exclusion is unlikely to have affected the analysis.

2.6.3 Data analysis

The raw speeding infringement data was organised to provide the following outcome measures for each driver of the cohort

- Binary classification of drivers as having incurred (event=1) or not incurred (no event=0) a Traffic Infringement Notice for speeding at the completion of 12, 24, and 36 months of driving
- Total number of speeding infringements accumulated at the completion of 12, 24 and 36-months of driving

- Number of days from the date of licensing to first speeding infringement ('time to first speeding infringement') within 12, 24 and 36-months of driving. Drivers who did not incur a speeding infringement within this time were 'censored' and allocated the total number of days for the period of investigation, ie, 365, 730, 1095.
- Total number of demerit points accumulated through speeding at the completion of 12, 24, and 36-months of driving.

A description of the outcomes measures and other data collected was undertaken. Univariate statistics were computed and variations in proportions were assessed using the Pearson chi-square test, with continuity correction where necessary. Comparison of the means for continuous variables was undertaken using one-way and repeated measures Analysis of Variance and where appropriate, independent t-tests. The incidence rate of infringing drivers for each of the three years of driving was calculated using exposure time (licensing days) from date of licensing to the date of first speeding infringement within 12 months, and exposure time from the annual anniversary of licensing to the date of first speeding infringement within 24 and 36 months, or censorship (ie, no event).

Inspection of the frequency distribution of speeding infringements and demerit points accumulated at 12, 24, and 36-months post-licensing showed considerable heterogeneity. Consequently, Negative Binomial Regression (STATA, 2003) was used to investigate the effects of categorical driver information on speeding infringements and demerit points accumulated at each of the above time periods. The effects of driver information on the time to first speeding infringement within 12, 24, and 36 months of licensing were evaluated using Cox's proportional hazards regression analysis (SPSS, 2001). All p-values were two sided and were considered significant at 0.05. Ninety-five percent confidence intervals for the hazard (Cox

regression) and incident rate ratios (Negative Binomial regression) were calculated using the standard errors from the analyses. Drivers with missing data on the independent variables included in the multivariate analyses were excluded (further details of this process is provided in Chapter 3).

3. RESULTS

3.1 Descriptives

3.1.1 Speeding infringements

The distribution of speeding infringements accumulated at 12, 24, and 36 months post-licensing is presented in Figure 3.1. At 12-months post-licensing, 27% of the cohort (n=342 drivers) had incurred a total of 469 speeding infringements at an average of 1.37 infringements per infringing driver with a range of 6.

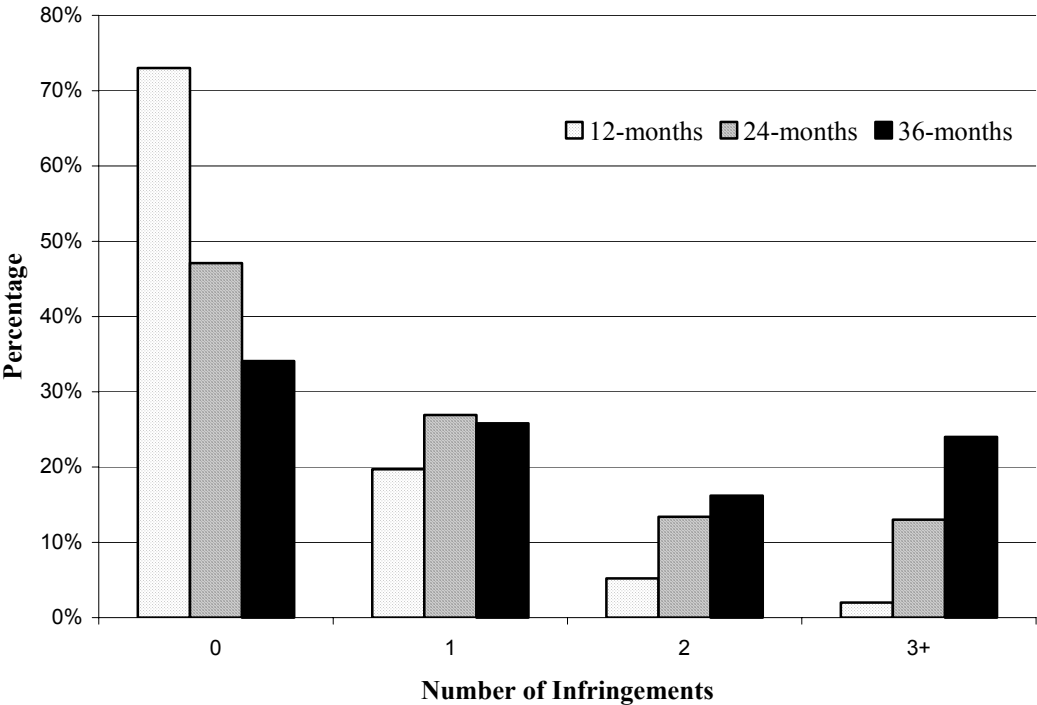


Figure 3.1: Distribution of speeding infringements accumulated at 12, 24, and 36-months post-licensing

At 24-months post-licensing, the number of infringing drivers had increased to 53% of the cohort (n=675), with a 2.8 times increase in the number of infringements (n=1318) and a range of 11. By 36-months post-licensing 66% of the cohort (n=841) had incurred a total of 2,033 speeding infringements with a range of 16. A description and multivariate analysis of repeat speeding infringements will be presented in Section 3.3.

The annual incidence rate of infringing drivers by year of driving and gender is presented in Table 3.1. The rate for all drivers per 10,000 licensing days was significantly lower in the first year of driving compared with years two and three, with the highest rate for all drivers recorded in year two (14.4 infringing drivers per 10,000 driving days). With respect to gender, the rate was significantly higher among males compared with females in each of the three years of driving.

Table 3.1: Incidence rate of infringing drivers per 10,000 licensing days; by year of driving and gender

Year of Driving	Number of Infringing Drivers	Rate/10,000 licensing days	95% Confidence Interval
Year One			
Males	174	10.7	9.1-12.3
Females	168	6.8	5.8-7.9
All drivers	342	8.4	7.5-9.2
Year Two			
Males	263	18.4	16.2-20.7
Females	260	11.7	10.3-13.2
All drivers	523	14.4	13.1-15.6
Year Three			
Males	221	15.0	13.1-17.0
Females	251	11.4	10.0-12.8
All drivers	472	12.8	11.7-14.0

The non-adjusted Kaplan-Meier hazard curve for a first speeding offence at 36-months (1095 days) post-licensing by gender is presented in Figure 3.2. The Figure highlights the higher (unadjusted) rate of offending among males from the outset of driving and the propensity of males to offend earlier in their licensure compared with females (mean=434 days versus mean=507 days). A test of the equality of the survival distributions of male and female drivers confirmed the statistical significance of these gender differences in speeding offences at 36-months post-licensing (Log Rank Test=31.95, df=1, p<0.001).

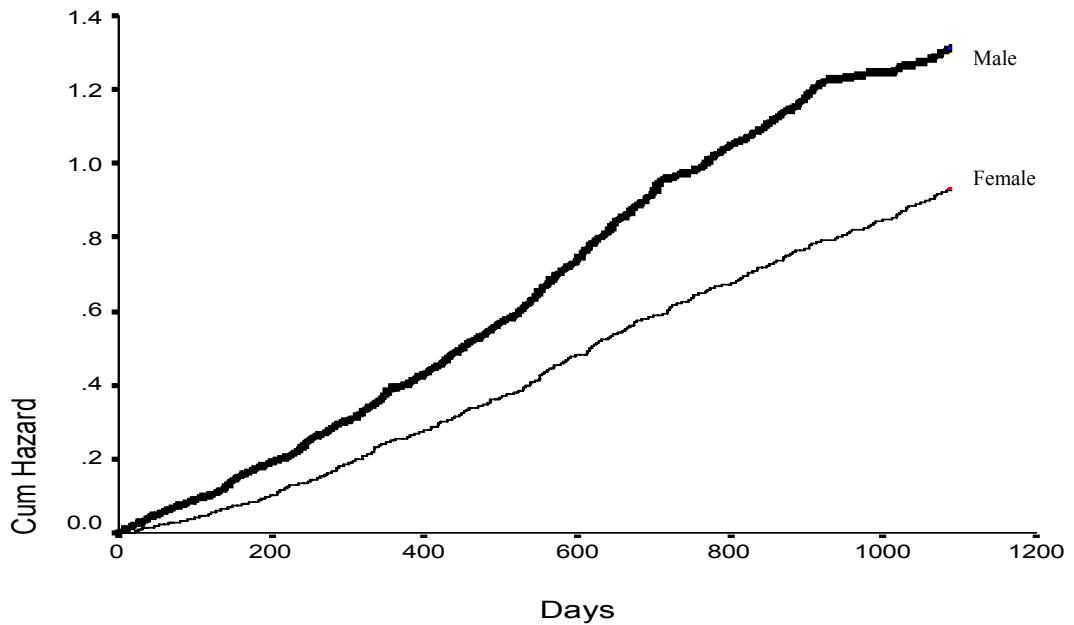


Figure 3.2: Hazard curve for male and female drivers first speeding infringement, 36-months post-licensing

As shown in Table 3.2, the majority of speeding infringements in each year were issued for exceeding the posted speed limit by 10-19km/hour. Approximately 49% of first year infringements were issued for exceeding the posted speed limit by 10-19km/h. The proportion increased by 16.4% in the second year of driving to just under 66%, and by a further 2.6% in the third year of driving to 68.3%. In contrast, infringements for exceeding the posted speed limit by 30-40km/hour and 20-29km/hour declined by 50% from first year to second year, with smaller reductions again in the third year.

Analysis of the relationship between gender and category of infringement showed that compared with females, males incurred a significantly higher proportion of speeding infringements for exceeding 19km/h in each of the three years of driving (first year $\chi^2=29.68$, $df=4$, $p < 0.001$; second year $\chi^2=19.85$, $df=4$, $p < 0.001$; third year $\chi^2=24.65$, $df=4$, $p < 0.001$).

Table 3.2: Distribution of speeding infringements by category and year of driving

Category of Speeding Infringement		Year of Driving		
		Year One	Year Two	Year Three
Up to 9km/hour	n	43	100	85
	%	9.2	11.8	11.9
10-19km/hour	n	231	558	488
	%	49.3	65.7	68.3
20-29km/hour	n	148	140	107
	%	31.6	16.5	15.0
30-40km/hour	n	42	38	27
	%	9.0	4.5	3.8
> 40km/hour	n	5	13	8
	%	1.1	1.5	1.1
All Categories	n	469	849	715
	%	100	100	100

3.1.2 Demerit points

Speeding offences up to 9km/hour above the posted speed limit in Western Australia do not incur a demerit point penalty. Exceeding the speed limit by more than 9km/hour incurs between 1 and 6 demerit points, depending on the level of offence. The distribution of speeding related demerit points accumulated at 12, 24, and 36-months post-licensing is presented in Figure 3.3.

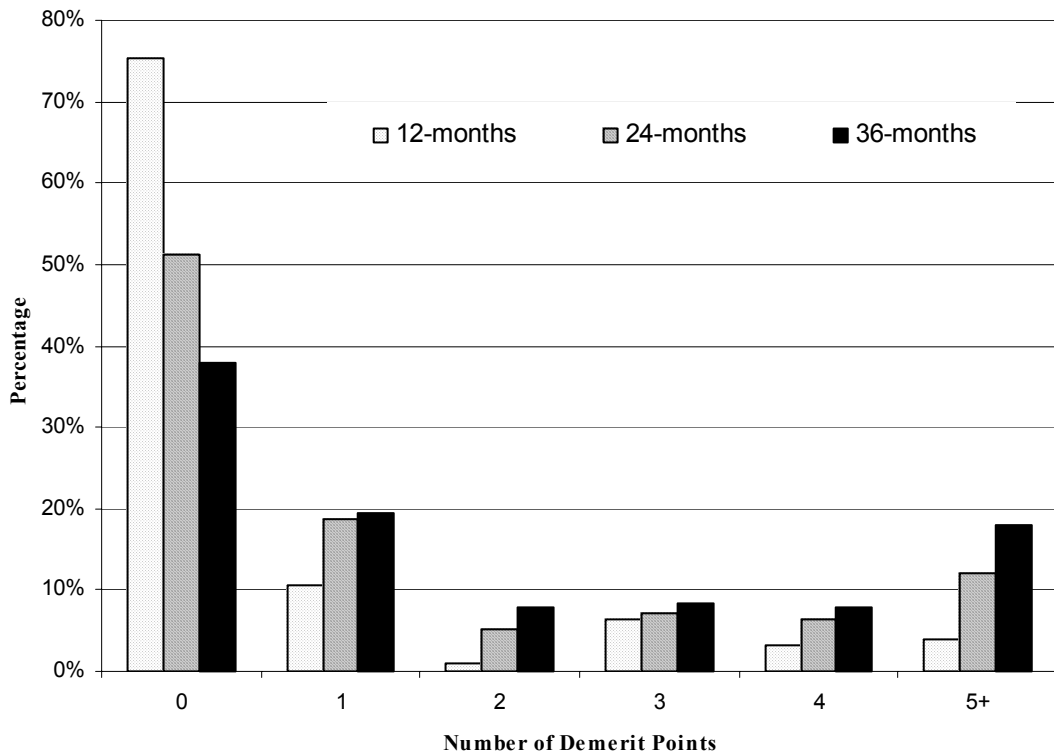


Figure 3.3: Distribution of demerit points accumulated at 12, 24, and 36-months post-licensing

Of the 841 drivers who incurred an infringement notice for speeding within 36-months of driving, 792 (94%) drivers accumulated one or more demerit points for a total of 3,039 points at an average of 3.61 points per driver (SD=3.51). By 36-months, 18% of the entire cohort of drivers had incurred five or more demerit points up to a maximum of 38 points. The mean number of demerit points lost by infringing drivers was highest in year two and significantly higher for males than females in each year of driving (see Table 3.3).

Table 3.3: Mean and Standard Deviation for demerit points lost by infringing drivers; by gender and year of driving

Drivers	Year					
	Year One		Year Two		Year Three	
	Mean	Std.D	Mean	Std.D	Mean	Std.D
Males	1.40 ^a	2.36	1.79 ^b	2.25	1.32 ^c	2.04
Females	0.71 ^a	1.36	1.12 ^b	1.76	1.00 ^c	1.48
All	1.03	1.92	1.43	2.01	1.15	1.78

^a t= -5.06, df=601.37, p <0.001; ^bt= -4.79, df=720.41, p<0.001 ; ^c t= -2.60, df=684.30, p<0.01

3.2 Risk factors for accumulated Traffic Infringement Notices for speeding and demerit points

The effect of driver psychosocial and behavioural factors (“driving information”) on accumulated speeding infringement notices and demerit points was modelled using selected driver information collected at the time of *first licensing* (baseline). See Table 3.4 for a list of independent variables included in the analysis. Driver information collected at follow-up (12 and 24-months post-licensing), which included driving exposure, was not included in the analyses undertaken. Approximately 20% of the cohort was lost to follow-up at each of these time-points. Limiting the analyses to drivers who had completed the questionnaire at all three time periods would have led to a substantial reduction in statistical power.

It was necessary nonetheless to restrict the baseline dataset to drivers with complete data for the independent variables to be modelled. Two hundred and thirty-three drivers (18%; n=112 males; n=121 females) of the original cohort were deleted because of missing data. As a percentage of the original cohort, proportionally more males (21%) than females (16%) were deleted ($\chi^2=4.81$, $df=1$, $p=0.03$). A comparison of the deleted (n=233) and retained driver (n=1,044) groups with respect to infringement notices showed that proportionally more of the deleted drivers had incurred one or more speeding infringements over the 36-month period (74% versus 66%) ($\chi^2=8.03$, $df=1$, $p=0.005$).

Table 3.4: Independent variables included in the modelling of speeding infringements and demerit points at 12, 24, and 36-months post-licensing

Categorical Variables	Levels
Gender	Female Male
Positive health related behaviour	Low Moderate High
Age at first driving/riding	15 years and younger 16 years 17 years
Frequency of driving prior to holding a learner-driver permit	Never Yearly Monthly Weekly to Daily
Driving on a public road without the necessary permit prior to holding a learner-driver permit	Never Once Two to five times Six or more times
Driving without supervision when holding a learner-driver permit	Never Once Two to five times Six or more times
Number of vehicles driven or ridden prior to probationary licensing	One Two Three or more
Number of locations in which a vehicle had been driven/ridden prior to probationary licensing	One Two Three Four or more
Frequency of non-professional driving instruction prior to probationary licensing	No instruction Less than weekly sessions One to three sessions per week Four or more sessions per week
Number of probationary licence examinations undertaken	One Two Three or more
Preparedness for driving	Low Moderate High
Driver Behaviour Questionnaire: Violations	Low Moderate High
Driver Behaviour Questionnaire: Errors	Low Moderate High
Driver Behaviour Questionnaire: Lapses	Low Moderate High
Driver confidence-adventurousness	Low to Moderate High
Driver demeanour	Low Moderate High
Driver alertness	Low Moderate High
Driving skill	Low Moderate High
Impulsivity and sensation seeking	Low Moderate High
Driver attitudes toward speeding	Low Moderate High
Driver normative beliefs for speeding	Low Moderate High

3.2.1 Speeding infringements

Multivariate analysis was conducted on the total number of infringements incurred by drivers at 12, 24, and 36-months post-licensing, and on the time (in days) from the date of licensing to the first speeding infringement within these time periods. As the speeding infringement data was found to be over-dispersed for each cumulative period of licensing, Negative Binomial Regression was used in preference to Poisson Regression. Time to first infringement was modelled using Cox proportional hazards regression. A backward, stepwise procedure was used for both analytical techniques, with the least significant variable being manually removed prior to the next permutation.

The Negative Binomial Regression models for speeding infringements accumulated at 12, 24, and 36-months post-licensing are presented in Tables 3.5-3.7. For each model the computed Alpha statistic was found to be statistically significant and therefore justifies the use of Negative Binomial Regression. All models were adjusted for the socio-economic status of the driver and assessed for interaction effects. For each of the three cumulative periods of driving, four driver psychosocial and behavioural factors -gender, impulsivity and sensation seeking, confidence-adventurousness, and positive health-related behaviours- were found to be significantly and independently associated with speeding infringements.

At 12-months post-licensing, the infringement rate for males was 48% greater than that for females (IRR=1.48, 95% CI=1.15-1.82). The rate declined by approximately 10% at both 24-months (IRR=1.38, 95% CI=1.17-1.62) and at 36-months (IRR=1.29, 95% CI=1.12-1.48).

A linear association with speeding infringements was evident for impulsivity and sensation seeking at 12, 24 and 36-months post-licensing. At 12-months post-licensing, drivers who were highly disposed to risk-taking had an infringement rate two and half times greater than drivers with a low disposition (IRR=2.52, 95% CI=1.67-3.80). With each additional year of driving, the effect of high impulsivity and sensation seeking on the incidence rate ratio of infringing declined somewhat, though remained around double the rate of drivers with a low disposition at 24-months (IRR=2.11, 95% CI=1.63-2.72) and 36-months (IRR=1.90, 95% CI=1.52-2.36).

Table 3.5: Predictors of total speeding infringements accumulated at 12-months post-licensing^a

Variable	Incidence Rate Ratio	95% Confidence Interval	P-value
Gender			
Female ^b	1.00	-	
Male	1.48	1.15-1.82	<0.01
Impulsivity and Sensation Seeking			
Low ^b	1.00	-	
Moderate	1.65	1.14-2.40	<0.01
High	2.52	1.67-3.80	<0.01
Confidence-Adventurousness			
Low-Moderate ^b	1.00	-	
High	1.82	1.37-2.43	<0.01
Positive Health-Behaviour			
Low ^b	1.00	-	
Moderate	0.69	0.50-0.94	0.02
High	0.61	0.39-0.96	0.03

Log Likelihood= -734.42, $\chi^2=77.08$, df=9, p<0.01, Alpha=0.617; p<0.01

^aModel adjusted for socioeconomic status of driver; ^b Baseline level

In the first 12-months of driving, drivers who rated their driving style as highly confident-adventurous were found to have a speeding infringement rate that was 82% higher than drivers who rated their driving style as low to moderate in confidence-adventurousness (IRR=1.82, 95% CI=1.37-2.43). By 24-months, the excess rate for these drivers had reduced to 45% (IRR=1.45, 95% CI=1.18-1.78) with no further appreciable reduction in the rate at 36-months (IRR=1.44, 95% CI=1.21-1.73).

The fourth variable -positive health-related behaviour- was found to have a linear, protective, association with speeding infringements. In the first 12-months of driving, drivers who reported high levels of positive health-related behaviour were found to have a speeding infringement rate that was 39% *lower* than that of drivers who reported low levels of positive health-related behaviour (IRR=0.61, 95% CI=0.39-0.96). The effect of this variable remained relatively stable with each additional year of driving. Compared with drivers who reported low positive health-related behaviours at the time of licensing, drivers recording high positive health-related behaviour evidenced a 35% lower rate of infringements at 24-months (IRR=0.65, 95% CI=0.48-0.88) and a 27% lower rate at 36-months (IRR=0.73, 95% CI=0.57-0.95).

Table 3.6: Predictors of total speeding infringements accumulated at 24-months post-licensing^a

Variable	Incidence Rate Ratio	95% Confidence Interval	P-value
Gender			
Female ^b	1.00	-	
Male	1.38	1.17-1.62	<0.01
Impulsivity and Sensation Seeking			
Low ^b	1.00	-	
Moderate	1.43	1.15-1.79	<0.01
High	2.11	1.63-2.72	0.00
Confidence-Adventurousness			
Low-Moderate ^b	1.00	-	
High	1.45	1.18-1.78	<0.01
Positive Health-Behaviour			
Low ^b	1.00	-	
Moderate	0.74	0.59-0.92	<0.01
High	0.65	0.48-0.88	<0.01

Log Likelihood= -1387.38, $\chi^2=96.32$, df=9, p<0.01, Alpha=0.610; p<0.01

^aModel adjusted for socioeconomic status of driver; ^b Baseline level

Table 3.7: Predictors of total speeding infringements accumulated at 36-months post-licensing^a

Variable	Incidence Rate Ratio	95% Confidence Interval	P-value
Gender			
Female ^b	1.00	-	
Male	1.29	1.12-1.48	<0.01
Impulsivity and Sensation Seeking			
Low ^b	1.00	-	
Moderate	1.42	1.18-1.71	<0.01
High	1.90	1.52-2.36	<0.01
Confidence-Adventurousness			
Low-Moderate ^b	1.00	-	
High	1.44	1.21-1.73	<0.01
Positive Health-Behaviour			
Low ^b	1.00	-	
Moderate	0.74	0.61-0.89	<0.01
High	0.73	0.57-0.95	<0.01

Log Likelihood= -1712.57, $\chi^2=101.29$, df=9, p<0.01, Alpha=0.547; p<0.01

^aModel adjusted for socioeconomic status of driver; ^b Baseline level

Cox proportional hazards regression models of the time to first speeding infringement within 12, 24, and 36-months of licensing are presented in Tables 3.8-3.10). All models were similarly adjusted for the socio-economic status of the driver and assessed for interaction effects. As for the predictors of accumulated speeding infringements, gender, impulsivity and sensation seeking, confidence-adventurousness, and positive health-related behaviours were found to be significant predictors of first infringements at each of the three time periods.

The hazard ratios of the Cox models for each time period approximate the incidence rate ratios of the models for accumulated infringements. For example, drivers who rated high in impulsivity and sensation seeking at the time of licensing were 2.59 times (HR=2.59, 95% CI=1.67-4.01) more likely than low impulsivity and sensation seeking drivers to incur a first speeding infringement within 12-months.

Table 3.8: Predictors of time to first speeding infringement within 12-months post-licensing^a

Variable	Hazard Ratio	95% Confidence Interval	Wald Test [df] (P)
Gender			8.19 [1] (<0.01)
Female ^b	1.00	-	
Male	1.44	1.12-1.86	
Impulsivity and Sensation Seeking			18.25 [2] (<0.01)
Low ^b	1.00	-	
Moderate	1.89	1.27-2.82	
High	2.59	1.67-4.01	
Confidence-Adventurousness			20.04 [1] (<0.01)
Low-Moderate ^b	1.00	-	
High	1.93	1.49-2.58	
Positive Health-Behaviour			15.66 [2] (<0.01)
Low ^b	1.00	-	
Moderate	0.57	0.42-0.77	
High	0.45	0.28-0.72	

Log Likelihood= -1703.41, $\chi^2=93.51$, df=9, p<0.01

^aModel adjusted for socioeconomic status of driver; ^b Baseline level

As for the estimates of the predictors of accumulated infringements, the estimates of the proportional hazards regression models varied over time, particularly from 12-months to 24-months. Reductions in effect were noted for all variables at 24-months, particularly for confidence-adventurousness and impulsivity and sensation seeking. The risk estimates remained relatively stable at 36-months, with the exception of high confidence-adventurousness which was associated with a 32% increased risk of infringement from 24-months to 36-months.

As with the models of accumulated infringements, impulsivity and sensation seeking evidenced the strongest relationship over the 36-month period. Drivers rated high in impulsivity and sensation seeking at the time of licensing maintained nearly double the risk of drivers low in impulsivity and sensation seeking of incurring a first speeding infringement (HR=1.90, 95% CI=1.47-2.44) within 36-months of licensing.

Table 3.9: Predictors of time to first speeding infringement within 24-months post-licensing^a

Variable	Hazard Ratio	95% Confidence Interval	Wald Test [df] (P)
Gender			7.56 [1] (<0.01)
Female ^b	1.00	-	
Male	1.27	1.07-1.52	
Impulsivity and Sensation Seeking			17.89 [2] (<0.01)
Low ^b	1.00	-	
Moderate	1.52	1.19-1.95	
High	1.83	1.38-2.44	
Confidence-Adventurousness			6.63 [1] (<0.01)
Low-Moderate ^b	1.00	-	
High	1.32	1.07-1.65	
Positive Health-Behaviour			9.04 [2] (<0.01)
Low ^b	1.00	-	
Moderate	0.74	0.59-0.93	
High	0.63	0.46-0.87	

Log Likelihood= -3585.13, $\chi^2=61.45$, df=9, p <0.01

^aModel adjusted for socioeconomic status of driver; ^b Baseline level

Table 3.10: Predictors of time to first speeding infringement within 36-months post-licensing^a

Variable	Hazard Ratio	95% Confidence Interval	Wald Test [df] (P)
Gender			10.66 [1] (<0.01)
Female ^b	1.00	-	
Male	1.29	1.11-1.52	
Impulsivity and Sensation Seeking			26.85 [2] (<0.01)
Low ^b	1.00	-	
Moderate	1.58	1.28-1.96	
High	1.90	1.47-2.44	
Confidence-Adventurousness			23.50 [1] (<0.01)
Low-Moderate ^b	1.00	-	
High	1.64	1.34-2.00	
Positive Health-Behaviour			20.36 [2] (<0.01)
Low ^b	1.00	-	
Moderate	0.63	0.51-0.78	
High	0.57	0.43-0.77	

Log Likelihood= -4312.00, $\chi^2=116.34$, df=9, p <0.01

^aModel adjusted for socioeconomic status of driver; ^b Baseline level

3.2.2 Demerit points

As with the speeding infringement data, the accumulated demerit point data was found to be over-dispersed for each cumulative year of driving. Consequently, Negative Binomial Regression was again used in preference to Poisson Regression.

The significant Alpha statistic for each model confirmed the appropriateness of this analysis. A backward, stepwise procedure was once again used, with the least significant variable being manually removed prior to the next permutation.

Negative Binomial Regression models for demerit points accumulated at 12, 24, and 36-months post-licensing are presented in Tables 3.11-3.13. All models were adjusted for the socio-economic status of the driver and assessed for interaction effects. The four driver psychosocial and behavioural factors associated with accumulated speeding infringements and time to first infringement were likewise found to be significantly associated with demerit points accumulated at all three time periods. With the exception of gender, the risk ratios of the predictor variables approximated those for accumulated infringements and time to infringement at 12, 24, and 36-months post-licensing. The effect of gender was substantially stronger for demerit points across all three time periods, and similarly showed a linear decline from 12-months to 36-months. For example, at 12-months, males were 2.25 times more likely than females to incur a demerit point (IRR=2.25, 95% CI=1.63-3.12). By 36-months the excess risk had reduced to 69% (IRR=1.69, 95% CI=1.42-2.00) but was still 40% higher than the estimated risk of an infringement for same time period.

Table 3.11: Predictors of total demerit points accumulated at 12-months post-licensing^a

Variable	Incidence Rate Ratio	95% Confidence Interval	P-value
Gender			
Female ^b	1.00	-	
Male	2.25	1.63-3.12	<0.01
Impulsivity and Sensation Seeking			
Low ^b	1.00	-	
Moderate	1.73	1.12-2.69	<0.01
High	2.80	1.67-4.70	<0.01
Confidence-Adventurousness			
Low-Moderate ^b	1.00	-	
High	2.00	1.32-3.03	<0.01
Positive Health-Behaviour			
Low ^b	1.00	-	
Moderate	0.62	0.40-0.97	0.03
High	0.50	0.27-0.93	0.03

Log Likelihood= -928.08, $\chi^2=70.61$, df=9, p <0.01, Alpha=4.44; p <0.01

^aModel adjusted for socioeconomic status of driver; ^b Baseline level

Table 3.12: Predictors of total demerit points accumulated at 24-months post-licensing^a

Variable	Incidence Rate Ratio	95% Confidence Interval	P-value
Gender			
Female ^b	1.00	-	
Male	1.89	1.51-2.25	<0.01
Impulsivity and Sensation Seeking			
Low ^b	1.00	-	
Moderate	1.47	1.13-1.92	<0.01
High	2.07	1.50-2.85	<0.01
Confidence-Adventurousness			
Low-Moderate ^b	1.00	-	
High	1.64	1.26-2.14	<0.01
Positive Health-Behaviour			
Low ^b	1.00	-	
Moderate	0.69	0.52-0.91	<0.01
High	0.64	0.43-0.93	0.02

Log Likelihood= -1646.88, $\chi^2=98.29$, df=9, p <0.01, Alpha=1.83; p <0.01

^aModel adjusted for socioeconomic status of driver; ^b Baseline level

Table 3.13: Predictors of total demerit points accumulated at 36-months post-licensing^a

Variable	Incidence Rate Ratio	95% Confidence Interval	P-value
Gender			
Female ^b	1.00	-	
Male	1.69	1.42-2.00	<0.01
Impulsivity and Sensation Seeking			
Low ^b	1.00	-	
Moderate	1.49	1.19-1.85	<0.01
High	1.85	1.42-2.43	<0.01
Confidence-Adventurousness			
Low-Moderate ^b	1.00	-	
High	1.60	1.27-2.01	<0.01
Positive Health-Behaviour			
Low ^b	1.00	-	
Moderate	0.68	0.53-0.86	<0.01
High	0.70	0.51-0.96	0.02

Log Likelihood= -1996.54, $\chi^2=109.48$, df=9, p <0.01, Alpha=1.35; p <0.01

^aModel adjusted for socioeconomic status of driver; ^bBaseline level

3.3 Repeat speeding offenders

Repeat speeding offenders were defined as drivers who incurred more than one infringement during the three-year period of investigation. At 12-months post-licensing 26.4% of infringing drivers were ‘repeat offenders’. By 24-months and 36-months post-licensing, the proportion of ‘repeat offenders’ had increased respectively to 49% and 61% of infringing drivers (see Table 3.14).

Table 3.14: Frequency distribution of single and repeat speeding offenders at 12, 24, and 36-months post-licensing

Offender Type		Period		
		12-months	24-months	36-months
Single offender	n	252	344	330
	%	73.6	51	39.0
Repeat offender	n	90	331	511
	%	26.4	49.0	61.0
All offenders	n	342	675	841
	%	100	100	100

The likelihood of re-offending within 36-months of driving was modelled through Logistic Regression using the baseline driver information predictor variables used in

the previous analyses of infringements and demerit points. Once again, the findings were adjusted for the socio-economic status of the driver. Three variables, gender, confidence-adventurousness and impulsivity and sensation seeking, were found to be significantly associated with repeat speeding offences (see Table 3.15). Compared with female offenders, male offenders were 44% more likely to re-offend within 36-months of driving (OR=1.44, 95% CI=1.06-1.96). Offending drivers who were high in confidence-adventurousness were found to be 86% more likely to re-offend within 36 months of driving compared with offending drivers who were rated as low to moderate in confidence-adventurousness (OR=1.86, 95% CI=1.22-2.82). Lastly, impulsivity and sensation seeking recoded to two levels (low and moderate to high) was found to be significantly predictive of repeat speeding, with drivers rated moderate to high being 54% more likely to re-offend compared with drivers rated low. No interaction of the main effects was found. These results further highlight the increased risk of speeding associated with gender, driver confidence-adventurousness, and impulsivity and sensation seeking.

Table 3.15: Predictors of repeat speeding offenders at 36-months post-licensing^a

Variable	Odds Ratio	95% Confidence Interval	Wald Test [df] (P)
Gender			5.69 [1] (0.017)
Females ^b	1.00	-	
Males	1.44	1.06-1.96	
Confidence- Adventurousness			8.57 [1] (<0.01)
Low-Moderate ^b	1.00	-	
High	1.86	1.22-2.82	
Impulsivity and Sensation Seeking			4.80 [1] (0.028)
Low	1.00	-	
Moderate-High	1.54	1.04-2.27	

Log Likelihood=-987.13, $\chi^2=24.60$, df=6, p<0.001

^aModel adjusted for socioeconomic status of driver; ^b Baseline level

3.4 The effect of demerit point penalties on identified risk factors for speeding

To investigate the effect of demerit point penalties on selected risk factors, drivers of the cohort who completed all three measures (ie, baseline, 12 and 24 months) of impulsivity and sensation seeking and confidence and adventurousness were first identified. Fifty-one percent (n=648) of the cohort completed all three measures of impulsivity and sensation seeking, while 56.7% (n=725) completed all three measures of confidence and adventurousness. Repeated measures analysis of variance found no statistically significant difference over time in the mean scores for impulsivity and sensation seeking but a statistically significant difference over time in the mean score for confidence-adventurousness (see Table 3.16). Post-hoc comparison of the mean scores with Bonferroni adjustment ($p=0.05/3$ comparisons=0.016) showed that the mean confidence-adventurousness score significantly increased from baseline to 12-months but did not change from 12-months to 24-months.

Table 3.16: Repeated measures analysis of variance table for impulsivity and sensation seeking and confidence-adventurousness

Variable	Mean	df	F	P-value
Impulsivity and Sensation Seeking		1.96	1.42	0.242
Baseline	6.87			
12-months	7.02			
24-months	6.80			
Confidence-Adventurousness		1.92	111.22	<0.01
Baseline	21.80			
12-months	23.73			
24-months	23.58			

baseline vs 12-months= $t=-12.92$, $df=724$, $p<0.001$; 12-months vs 24-months= $t=1.14$, $df=724$, $p=0.251$

Changes in individual scores from baseline to 12-months (labelled as ‘12-month change scores’) and from 12-months to 24-months (labelled as ‘24-month change scores’) for both risk factors were calculated by subtracting subsequent year scores from previous year scores (ie, 12-months score minus baseline score). These scores were then correlated with the demerit points respectively accumulated at 12 and 24

months. As shown in Table 3.17, the correlations between change scores and demerit points accumulated at each of the time periods were close to zero and were not statistically significant. This indicates that change scores are unrelated to accumulated demerit points.

Table 3.17: Bivariate correlations between demerit points accumulated and change scores for Confidence-Adventurousness and Impulsivity and Sensation Seeking; by period of licensure

Demerit points at period of licensure	Confidence-Adventurousness change score		Impulsivity and Sensation Seeking change score	
	12-months	24-months	12-months	24-months
365 days	.018	-	-.040	-
730 days	-	-.030	-	-.050

4. DISCUSSION

This section will commence with a discussion of the results in relation to the objectives of the study. This will be followed by a more general discussion of the findings and the limitations of the study. Lastly, a brief discussion of the recommendations for managing young driver speeding will be presented.

4.1 Study objectives

To determine the incidence and pattern of police issued Traffic Infringement Notices for speeding and associated demerit points at 12, 24, and 36-months post-licensing.

Traffic Infringement Notices

The proportion of first time offending drivers was roughly 25% in each of the first two years of driving. In year three, only 13% of the cohort became first time offending drivers. The 841 offending drivers (66% of the cohort) incurred an average of 2.4 Traffic Infringement Notices for speeding each. These figures confirm previous research highlighting a relatively high level of speeding offences among young drivers in the initial years of licensure (see Forsyth, Maycock & Sexton., 1995; Rosman, 2000; Palamara et al., 2001; Stradling et al., 2003). The extent to which speeding constituted the majority of traffic offences committed by the cohort over the investigative period can not be determined due to difficulty in extracting and interpreting aspects of the traffic infringement and conviction data supplied for analysis. There is some evidence however, to suggest that for first year drivers, the majority of traffic offences are likely to be speeding related. Palamara et al (2001) reported that 58% of Traffic Infringement Notices issued to the 1998 population cohort of 17-year old Western Australian drivers in their first 12 months of licensing were for speeding. In the UK, approximately 45% of all fixed penalty notices reportedly issued to a sample of first year drivers were for speeding (Forsyth et al., 1995).

The annual incidence rate of offending drivers (per 10,000 licensing days) was found to increase significantly from 8.4 offending drivers in year one to 14.4 in year two. A non-significant decline in the rate was observed in year three (12.8). Research evidence suggests that unlike crash rates which steadily decline with increasing years of licensure, the rates for traffic offences are observed to increase somewhat for younger drivers (Waller et al., 2001). A number of factors most likely to contribute to this increase, including an increase in driving exposure and the realisation that comes with increased time on the road that aberrant driving behaviour does not always result in adverse outcomes.

With respect to the latter issue, there is good reason to believe that a driver's style and on-road behaviour is progressively 'shaped' by the experience of rewards and punishment that follow (Engstrom, Gregersen, Hernetkoski & Nyberg, 2003). For example, the most likely result if a driver speeds is that they will not be detected by police, nor will they crash, and they will most likely get to their destination faster (Engstrom et al., 2003). This is likely to lead to further speeding behaviour and the development of a commensurate cognitive schema for speeding. There is some evidence in this study to support this contention. A significant change was noted in the intentions of drivers to speed and their perceptions of the likely outcomes of speeding in the first 24-months of driving. The proportion of drivers who expected to drive above the posted speed limit in the coming year increased significantly from 31% at the time of licensing to 58% at 24-months post-licensing. Similarly, a significant increase was noted in the proportion of drivers who believed that it was unlikely to very unlikely that they would be caught for speeding (35% to 52%) or that they would crash as a result of speeding (32% to 46%).

Consistent with the findings of Rosman (2000) and McColl and Sutherland (1998), young males were significantly more likely than females to incur speeding infringements. Across each of the three years of driving, the unadjusted rate of offending was highest among males, with the divergence in the rate evident from the commencement of licensure and increasing substantially over the three-year period. Not only were males more likely to offend and to be repeat offenders, but they also committed their first speeding offence substantially earlier than females in the three-year period. The relationship between gender and offending will be discussed in greater detail under the next objective.

The most common speeding offence in each of the three years of investigation was speeding 10-19km/hour above the posted limit (62.8% of offences over the three year period), followed by speeding up to 9km/hour above the posted limit (11.2% of offences over the three year period). 'Excessive' speeding -being 20km/hour or more above the post limit- accounted for approximately 26% of offences over the three year period. The high level of 'excessive' speeding among the cohort supports the findings reported by Rosman (2000) of an age difference in the incidence of such offences. In that study, drivers aged 17-19 years, who are of a comparable age to this cohort, were issued with a greater number of infringement notices for 'excessive' speeding compared with older age drivers. Likewise, the finding in this study of a significant gender difference in 'excessive' speeding (ie., exceeding 19km/hour above the posted speed limit) is consistent with Rosman's (2000) finding that young males (17-19 years) have the highest rates of 'excessive' speeding of all drivers, irrespective gender.

The incidence and level of speeding among the cohort is particularly troubling. The relative risk for involvement in a casualty crash is known to double with each 5km/hour above the post-speed limit (in a speed zone of 60km/hour), which is equivalent to the risk of crashing associated with a BAC of 0.05gm% (Kloeden et al., 1997). Moreover, Rosman's (2000) finding that incurring an 'excessive' speeding offence significantly increases the risk of being involved in a casualty crash within two years for young drivers further emphasises the need to lower the incidence of 'excessive' speeding for this age group. One positive finding in this study is that the proportion of infringements incurred for 'excessive' speeding decreased from 42% of all infringements in year one to 20% of all infringements in year three. The relatively high penalties for 'excessive' speeding offences (eg, \$150 and 3 demerit points for 20-29km/hour, \$250 and 5 demerit points for 30-40km/hour; \$350 and 7 demerit points for >40km/hour) may have contributed to this decline, but it would also seem that the current penalties were ineffective in reducing lower-levels of speeding over all from year one. Crash risk for young novice drivers may decrease over time and with experience, but offence behaviour, as indicated by speeding behaviour in this study, seemingly increases over the early years of licensure.

Demerit Points

The relatively low incidence of speeding at 9km/hour above the posted speed limit, which does not incur a demerit point penalty, meant that the vast majority of offending drivers (94%) incurred one or more demerit points. Consistent with the pattern of offences over the period of investigation, the greater proportion of demerit points (40%) were lost in the second year of driving.

Considerable variation was noted in the number of points lost in the 36-month period, ranging from one to 39 points. Offending drivers averaged a loss of 3.6

points, with males losing significantly more points than females overall (mean=3.30 points versus 2.38 points) and for each year of investigation. This gender difference is due to males being fined for a significantly greater number of ‘excessive’ speeding offences, which, as discussed, attract a higher demerit point penalty.

Under the current WA regulation of licence *suspension* for the loss of 12 demerit points within a 36-month period, approximately 2% (n=27) of the cohort qualified for suspension from speeding related demerit points alone. Not so surprisingly, 77% (n=21) of qualifying drivers were male. Three of these drivers (0.3% of the cohort) actually qualified for licence *cancellation* in their first year of licensing based on their speeding related demerit points alone. In contrast, a recent population-based study in Western Australia found that 0.7% of the 1998 cohort of first year drivers were eligible for licence *cancellation* for incurring 12 or more demerit points from all codes of traffic infringements (Palamara et al., 2001).

To determine the extent to which driver psychosocial, behavioural, and driver training factors contribute to the risk of incurring a Traffic Infringement Notice for speeding and associated demerit points at 12, 24, and 36-months post-licensing.

Traffic Infringement Notices

Four independent variables measured at the time of first licensing were found to be significantly and independently associated with the number of speeding infringements incurred and the time to first infringement within 12-months of licensing. The same four variables were subsequently found to be significantly and independently associated with the number of infringements accumulated at 24-months and 36-months and the time to first infringement within these periods. Overall, the risk estimates were highest at 12-months post-licensing, with a slight linear decline in the size of the incidence rate ratios thereafter. As the risk estimates

for the number of infringements and time to first infringement were of a similar magnitude at each period of analysis, the discussion will focus on the results obtained for the total number of infringements.

Of the four significant variables, the highest incidence rate ratio for infringements was calculated for Impulsivity and Sensation Seeking. This variable, which is a broad measure of an individual's preparedness for risk taking behaviour (Zuckerman, 1994), was found to be linearly associated with speeding infringements at 12, 24, and 36-months post-licensing. At 12-months, drivers high and moderate in Impulsivity and Sensation Seeking incurred infringements at 2.5 and 1.65 times the rate respectively of drivers low in Impulsivity and Sensation Seeking. By 36-months, the incidence rate ratio for these drivers remained relatively high at 1.90 (high) and 1.58 (moderate), which suggests that three years on from initial licensing the disposition to risk-taking remained a relatively strong predictor of cumulative speeding offences. Sensation seeking theory would explain the above findings in terms of the disposition of high sensation seekers to willingly and repeatedly engage in high risk behaviours to attain some preferred level of physiological and emotional arousal (Zuckerman, 1994). Furthermore, their cognitive style of minimising the risks associated with risky behaviour is likely to have contributed to their speeding behaviour.

Previous research into the relationship between Impulsivity and Sensation Seeking and speeding, which has been predominantly cross-sectional and correlational, has demonstrated a relationship with self-reported speeding behaviour and to a lesser extent police reports of speeding (Jonah, 1997). This study has provided even stronger evidence of a causal relationship because of the prospective methodology

employed and the use of objective police data on speeding offences. The study also provides good evidence of the longevity of the effect of the disposition to risk-taking on young driver speeding.

Driver Confidence-Adventurousness was the next most significant predictor of speeding infringements at each of the three time periods. This variable was collapsed to two levels (low to moderate and high) to provide a better fit of the data. At 12-months post-licensing, drivers who rated themselves as high in Confidence-Adventurousness were found to have a speeding infringement rate that was 82% greater than that of drivers rated low to moderate. By 24-months and 36-months post-licensing, the rate was approximately 45% that of drivers low to moderate in Confidence-Adventurousness.

Drivers who were categorised as high in Confidence-Adventurousness rated their driving as more relaxed, confident, adventurous, exciting, and daring. The higher rate of speeding among this group is seemingly consistent with their self-rated driving style and skill. Despite the uniqueness of the Confidence-Adventurousness factor to this study, the findings reported here are consistent with previous research documenting a relationship between self-ratings of driving style and actual driving behaviour such as speeding (Adams-Guppy and Guppy, 1995; Quimby et al., 1999). Moreover, the study perhaps provides the strongest evidence to date of the independent causal effect of driver self-ratings of style and skill on objectively measured, future driving behaviour. As with Impulsivity and Sensation Seeking, the longevity of the effect of driver self-ratings of style and skill on driver behaviour has been clearly demonstrated.

The third significant predictor of speeding infringements was the meta-health behaviour variable labelled 'positive health-related behaviour'. This variable was constructed from the drivers' scores on items of smoking, alcohol consumption, exercise, and use of sunscreen. Speeding can be construed as a health-related behaviour because of its association with crashing and injury. It was therefore presumed that a meta-variable comprised of various health-behaviours would be a better indicator of a driver's disposition to healthy behavioural practices than any one health-related behaviour per se.

As expected, a significant linear *protective effect* was obtained for this variable. At 12-months post-licensing, drivers who scored high on the practice of positive health-related behaviour evidenced a speeding infringement rate *39% lower* than drivers reporting regular use of cigarettes and alcohol and infrequent exercise and use of sunscreen (ie., low positive health-related behaviour). At 24 and 36-months post-licensing, the variable had maintained its statistical significance though showed a slight linear decline with time in its protectiveness. This finding supports the contention that speeding behaviour is part of a broader pattern of the practice of individual health-related behaviours among the young. The results are also supportive of previous research documenting a relationship between health risk behaviours such as alcohol and drug use and risky driving including speeding (Beirness and Simpson, 1988; Lang et al., 1996; Shope et al., 1999).

The final variable associated with speeding infringements was driver gender. Across all three time periods males were found to have a significantly higher rate of infringing compared with females. The difference in rates between males and females was highest at 12-months post-licensing (48% higher rate) and showed a

slight linear decline with time by 36-months post-licensing, whereupon the excess rate had declined to 29%. The higher rate of infringements for males is consistent with numerous reports documenting comparatively higher levels of speeding behaviour among young males (eg., Rosman, 2000; McColl and Sutherland, 1998).

It has been suggested that the relationship between gender and adverse driving outcomes such as crashing and speeding is due to the increased propensity of males for risk taking and their higher self-ratings of driver confidence (National Health and Medical Research Council, 1996). Consistent with this, males have been found to score significantly higher than females on measures of Impulsivity and Sensation Seeking (Zuckerman, 1995; Palamara, 2000) and Confidence-Adventurousness (Palamara, 2000). However, the findings reported here of a independent and significant effect for male gender, which has been adjusted for risk taking and self-ratings of driver confidence, suggests that there may be other factors associated with gender that contribute to the higher incidence of speeding among males.

Driving exposure is one of the factors that may help explain the higher incidence of speeding among males. Put simply, males may be detected more often for speeding because they spend more time driving and consequently have more opportunity to speed. No measure of exposure was used in this study to adjust the effects of the potential risk factors (see section 4.3). It is worth noting however, that based on exposure data collected at 12-months post-licensing for a reduced number of cohort drivers, no statistically significant relationship was found between gender and driving exposure ($\chi^2 = 5.47$, $df=2$, $p=0.065$). This suggests that driving exposure is unlikely to explain the higher rate of speeding offences observed for males in this study.

Whilst young males and females in this study may not differ in regards to the quantity of driving, their exposure may be qualitatively different in a way that is related to the risk of speeding. Just as the presence of same-aged passengers has been found to increase the risk of crashing for young drivers (eg., Preusser, Ferguson & Williams, 1998; Regan and Mitsopoulos, 2001; Williams, 2003), there is evidence, though somewhat varied, of a differential effect of passengers on the driving behaviour of young males and females. On the one hand it has been found that both young male and female drivers take greater risks, including speeding, irrespective of the gender of same-aged passengers (eg., Waylen and McKenna, 2002). In contrast, it has been reported that young males are more likely to engage in risky driving when carrying a same-aged, same-gender passenger (eg., Baxter et al., 1990). It is possible that young males do more of their driving with same-aged male passengers and that this dynamic increases their likelihood of engaging in risk driving, including speeding.

Demerit Points

The four variables identified in the modelling of the total number of speeding infringements and time to first speeding infringement were also found to be significant predictors of the total demerit point losses for speeding. The incidence rate-ratios for the predictor variables were similar in magnitude to those observed for the modelling of total infringements. Similarly, the effect of the significant variables was strongest at 12-months, with a slight linear decline in the incidence rate-ratios over time.

The one notable exception in the pattern of results for demerit points was the stronger effect of gender across all three time periods. For example, at 12-months post-licensing males incurred demerit point losses at 2.25 times the rate of female drivers (compared with a 48% higher rate for total infringements at the equivalent time). The higher rate of demerit point losses for males is due to their higher frequency of 'excessive' speeding, which in turn attracted higher demerit point losses. Consequently, the problem of gender and speeding is a more substantial one when demerit points are considered as a 'marker' of the severity of speeding. Analysis of the total number of speeding infringements in isolation of demerit points can mask the propensity of male drivers to engage in more 'excessive' speeding.

To investigate the changes over time in identified risk factors for speeding and the effect, if any, of penalties for speeding on identified risk factors and further speeding behaviour.

As mentioned, the incidence rate-ratios for each of the four variables evidenced a slight linear decline with time, with the 12 to 24-month period evidencing the greatest reduction compared with the 24 to 36-month period. Of the four significant variables, the greatest reduction in the size of the incidence rate-ratios was observed for high levels of Impulsivity and Sensation Seeking (from 2.52 to 1.90). Linkage of the cohorts' speeding infringements beyond 36-months will provide further evidence of the variability or stability of the effect of these variables over time.

Two of the four identified risk factors -Confidence-Adventurousness and Impulsivity and Sensation Seeking- were investigated for changes over time and to ascertain the extent to which such changes may be related to previously incurred demerit point losses. Since this analysis was based on a reduced number of drivers (around 54% of the cohort) who had completed all three measures, the findings are likely to reflect

some selection bias due to the substantial loss to follow-up as well as measurement error.

The mean score for Confidence-Adventurousness was found to increase significantly from baseline to 12-months. This was to be expected given that drivers were relatively inexperienced as drivers at the time of licensing and would most likely develop greater confidence and adventurousness with time spent driving and increasing familiarity with the road environment. However, no significant change in the mean score was found from 12 to 24 months. Investigation of the relationship between the change in scores from one time period to the next and demerit points accumulated in the preceding period showed correlations that were close to zero and not statistically significant. This finding suggests firstly, that driver ratings of Confidence-Adventurousness increase over the first 12-months of driving, and secondly, that any changes in Confidence-Adventurousness over time are seemingly unrelated to the number of speeding related demerit points accumulated over time. In other words, speeding demerit point penalties appeared to have no impact on changes in self-rating of Confidence-Adventurousness.

The mean Impulsivity and Sensation Seeking score did not statistically differ over time. The mean score at the time of licensing was not significantly different to that observed at either 12-months or 24-months post-licensing. The stability of the score over time is however, consistent with the developmental nature of the construct, in that scores are expected to decline in early adulthood after peaking in late adolescence (Zuckerman, 1994). As with Confidence-Adventurousness, individual change scores in Impulsivity and Sensation Seeking were not found to be associated with previously accumulated speeding related demerit points. The absence of an

observed relationship is also consistent with the theory that sensation seekers are less likely to be concerned with the adverse consequences of risky behaviour and are unlikely to be deterred by punishments for violation of formal rules governing risky behaviour (eg, traffic laws and penalties) (Zuckerman, 1994).

It must be borne in mind that the investigation of the relationship between risk factor change scores and demerit point penalties is limited to penalties resulting from speeding and do not therefore, take into account the potential impact of other traffic penalties incurred by the driver. If it assumed that most young drivers will lose the majority of their demerit points as a result of speeding, the findings do however suggest that demerit point penalties for speeding have no impact on individual differences in the disposition to risk-taking and self-rated driver confidence and adventurousness in the initial years of licensure.

Of the 841 drivers who incurred a speeding infringement in the 36-months of licensure, approximately 61% were repeat offenders. Given this sizeable proportion, there was reason to consider that repeat offenders may differ as a group from single offenders. Three of the four significant variables discussed above were found to be significantly predictive of repeat speeding offences. Of the offending drivers, males were found to have a 44% increased risk of a repeat offence. The result is in line with Rosman's (2000) finding that young males aged 17-19 years have the highest incidence of repeat speeding offences of all drivers in Western Australia. Drivers high in Confidence-Adventurousness and moderate to high in Impulsivity and Sensation Seeking were found to be 86% and 54% respectively more likely to be repeat speeding offenders. The influence of Confidence-Adventurousness on repeat offending suggests that drivers will continue to drive in a manner that is consistent

with their perceived driving style, despite being caught and penalised for a previous indiscretions. Likewise, it appears that being apprehended and punished previously for speeding is not a sufficient deterrent for beginning drivers who are predisposed to risk-taking. On the whole, these findings suggest that males and drivers who are predisposed to risk taking and regard themselves as confident and adventurous drivers are unlikely in the initial years of licensure to be deterred by previous penalties, and as a consequence, they are more likely to re-offend in the initial years of licensure.

4.2 Summary and general discussion

This longitudinal cohort study has shown that information provided by a sample of 17-year old Western Australian drivers at the time of obtaining their motor vehicle drivers' licence is predictive of their speeding offence behaviour up to 36-months post-licensing. Four variables were found to be significantly and consistently predictive of the total number of speeding offences incurred, the time to first offence, and the total number of speed related demerit points lost at 12, 24, and 36-months post-licensing. In summary, male gender, a high disposition for risk taking, high self-rated confidence and adventurousness as a driver, and the low level of practice of other health-related behaviours presented as significant risk factors for speeding offences. Three of the four variables were also found to distinguish single offenders from repeat offenders. Finally, there was no evidence to suggest that the penalties for speeding were likely to influence two of the identified risk factors for speeding (self-rated driving style and driver disposition for risk taking) or the likelihood of a repeat offence by certain drivers.

The combination of a longitudinal design and the application of multivariate analytical techniques to objective speeding offence data have addressed many of the shortcomings of previous investigations of the psychosocial risk factors for speeding by young drivers. In particular, the findings reported here have clarified the role of previously identified risk factors while adjusting for their co-variation with other known driver risk factors.

Perhaps one of the more interesting, non-significant findings in the study (at a multivariate level) was the absence of a previously reported association between normative beliefs for and attitudes toward speeding and speeding behaviour. At a univariate level, a significant relationship was computed between driver normative beliefs for speeding behaviour and speeding offences for the first year of driving ($\chi^2 = 19.12$, $df=2$, $p<0.001$), indicating that drivers who held stronger normative beliefs against speeding failed to incur a speeding infringement in the first year of driving. A significant relationship was likewise found for driver attitudes toward speeding ($\chi^2 = 11.42$, $df=2$, $p<0.01$). However, after adjusting for other psychosocial variables, neither the drivers' normative beliefs for speeding and attitudes they held toward speeding were found to be significantly associated with any of the measures of speeding (ie., total infringements, time to first infringement, and speed related demerit points) at 12-months post-licensing (the period for which the drivers' normative beliefs and attitudes were assessed for).

In other words, neither the norms for speeding held by the driver nor their attitudes toward speeding presented as a risk or protective factor for speeding offences, independent of the other significant psychosocial variables. This is not to suggest that neither construct is relevant to the process of speeding, for it should be noted

that drivers who scored high in Impulsivity and Sensation Seeking and Confidence-Adventurousness expressed significantly lower levels of normative beliefs against speeding and lower expectations of the adverse outcomes of speeding (ie, attitudes toward speeding).

The other non-significant finding at a multivariate level that is worth noting is the absence of the previously reported relationship between the DBQ driving violation sub-scale and speeding (see Block and Hartley, 1995). At a univariate level, a significant relationship was computed between driver violation subscale scores and speeding offences. Drivers who expressed a high likelihood of committing driving violations in the first year of driving were more likely to incur one or more speeding infringements within that year ($\chi^2 = 22.87$, $df=2$, $p < 0.001$). This variable was not however, found to be significantly associated with any of the measures of speeding in the first year of driving after adjusting for the other significant risk factors. One reason for this may be the 'prospective' manner in which the DBQ was employed to ascertain the drivers' expectations of engaging in violational behaviour in the first year of driving. The more common use of the DBQ is as a retrospective measure of violational behaviour.

4.3 Limitations of the study

There are a number of limitations of the study which should be considered in conjunction with the findings. These are addressed in the following paragraphs.

Study design, sampling, and selection bias

The expense and time expended in recruiting a prospective sample of newly licensed drivers, and the non-random sampling method employed, has resulted in a relatively small cohort of drivers who were predominantly female. Whilst no differences on

key variables were found between participants and selected non-responders, the possibility of a selection bias in relation to the broader target population must be considered. For these reasons, caution must be exercised in extrapolating the findings from the sample cohort to the wider population of 17 year old drivers in Western Australia.

Further to this, the restriction of the multivariate modelling of speeding infringement notices and demerit points over the period of investigation to cohort drivers with complete data on the independent variables selected for analysis increases the possibility that the findings may be somewhat biased. Firstly, comparison of the retained and deleted driver groups with respect to the occurrence of speeding infringements showed that a significantly greater proportion of deleted drivers (ie., those with missing base-line data) had incurred one or more infringements over 36-months (74% versus 66%). Secondly, the findings may have been further biased with respect to the identification of significant variables and/or the size of their effect if the retained driver group differed from the deleted driver group on key independent variables included the analysis.

Speeding offences

Speeding offence behaviour in this study was operationalised as the receipt of one or more police issued Traffic Infringement Notices for speeding in the 36-months following licensing. This operationalisation limits speeding behaviour to that which has been detected and punished. The obvious implication of this is that the actual number of cohort drivers who engaged in offence-level speeding may be greater than that reported here.

Central to the likelihood of being detected for an offence is the level of police enforcement in the areas where drivers travel, and secondly, the methods employed by drivers to avoid detection (eg., use of radar detection devices or active monitoring of media advertising and reporting of speed camera locations). No follow-up data was collected on drivers' experience of speed enforcement activities or their attempts to actively avoid detection.

Adjusting for driving exposure

Driving exposure information is crucial to the reliable estimation of the risk of on-road outcomes such as crashes and traffic offences (Cameron and Oxley, 1994; Over, 1998). In this study driving exposure data was collected for a reduced number of cohort drivers at 12-months (n=1,022) and 24-months (n=739) follow-up. However, this exposure data was not used to adjust the effects of the driver psychosocial variables because it would have led to a substantial reduction in drivers (and outcomes) available for analysis and associated statistical power. With respect to gender, univariate analysis of driving exposure by gender showed that males and females did not significantly differ in driving exposure at 12-months ($\chi^2=5.47$, $df=2$, $p=0.065$) and 24-months ($\chi^2=12.24$, $df=2$, $p=0.057$). This suggests that it is unlikely that driving exposure can account for the observed gender differences in speeding offences.

Measurement of driver psychosocial constructs

With the exception of the measure of Impulsivity and Sensation Seeking (Zuckerman, 1994), all driver psychosocial constructs were measured using scales and items specifically constructed for this study. These measures have reasonable face validity, though no work has been undertaken to establish other forms of

validity for these scales and items. With respect to the reliability of the constructed measures and items, 12-month test-retest reliabilities were found to vary somewhat across the constructs (as reported in Chapter 2).

The low to moderate test-retest coefficients for some measures and items suggest that certain driver psychosocial constructs may have been affected by experiences over the intervening period. This was not entirely unexpected, since some of the constructs, such as preparedness for driving and driving style are in theory likely to be influenced by the amount and type of driving undertaken. Depending on when the change in the driver's score on the construct occurred, ie, prior to the infringement or after, the use of the baseline measure of the construct as a predictor variable may have misrepresented the driver's 'true' position and its association with the future outcome behaviour.

4.4 Recommendations

Although the sample of drivers investigated in this study were metropolitan based drivers, the size and stability of the computed effects for speeding infringements suggests that the findings are potentially useful for the development of training and licensing initiatives in Western Australia. The following recommendations are offered for discussion.

1. The strong effects of risk-taking and confidence-adventurousness driving style on the incidence of speeding infringements suggest that the training of young drivers should consider more closely the role of driver demeanour. In particular, training should highlight through theory and practice how the disposition for risk-taking and a heightened sense of confidence and

adventurousness as a driver increases the risk of crashing and the likelihood of engaging in aberrant driving.

2. The observed protective effect of the practice of positive health-related behaviours indicates that the promotion of speeding as a health (injury) related behaviour is a strong focal point for the development of enduring, safe driving. This approach should be used in tandem with programs aimed at increasing the perception of the likelihood of detection and punishment for speeding.
3. Male gender has been clearly highlighted as a substantial risk factor for speeding behaviour. Given this, perhaps it is time to develop a more overtly gender-focussed approach to speeding countermeasure mass-media rather than the more subtle, seemingly gender-neutral stance.
4. The observation that the rate of speeding offences increased in the early period of licensure (in association with increased driver confidence and risk taking) suggests that new drivers should be subject to a more restrictive demerit point penalty program in the probationary period to heighten their perception of the risk of licence cancellation or suspension. At present, drivers can lose up to 11 demerit points within the two-year probationary period and not have their licence cancelled. It is suggested that the number of demerit points that can be lost in this time before licence cancellation should be reduced to 4 points in the first year with an increase of 2 points upon completion of 12-months of licensure, giving a total of 6 points for the

probationary period. This is similar to the program currently operating in New South Wales.

5. Just as there is a stricter penalty system for drink-driving in the probationary period, consideration should be given to adopting a similar strategy in regards to speeding offences which are the more common offence in the early years of licensure. For example, the demerit point penalty for offences committed above a certain post speed limit could be increased for the probationary period to reflect the seriousness of the offence (and the associated risk of crashing) far earlier in the driver's history. Alternatively, a speeding recidivist program that targets not only young novice drivers, but also older drivers could be developed to reduce the incidence of repeat offenders and high level speeding and the increased risk of future crash involvement. Unlike repeat drinking-driving, Western Australian road traffic regulations and penalties do not distinguish between single and repeat speeding offences and offenders.

6. Although this study was not able to address the influence of situational factors such as time of day of offence and the presence of passengers on speeding behaviour, other research findings suggest that restricting young novice drivers' from travelling at night and limiting the number and type of passengers they can carry may assist with reducing the incidence of speeding. Time of day (eg., nighttime) and passenger restrictions are an effective component of the graduated driver training and licensing systems operating across Nth America, Canada, and New Zealand (Engstrom et al., 2003).

Greater consideration should be given to adopting similar licensing restrictions for young novice drivers in Western Australia and elsewhere.

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