

Behavioural factors as predictors of motor vehicle crashes: differentials between young urban and rural drivers

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In Western Australia, as for Australia as a whole, motor vehicle-related injury remained the leading cause of death in the 17-to-24-year age group throughout the period 1988-96.¹ In fact, one-third of all Western Australian drivers fatally injured (32.1%), hospitalised (36.8%) and seeking medical treatment (33%) are in the age group 17 to 24.¹ The cost of injuries to these drivers has been estimated at \$171 million annually, or \$39,600 per casualty.²

Rural drivers aged 17 to 24 years comprise 24% of licensed drivers in Western Australia,³ yet approximately 52% of all driver fatalities in the 17-to-24 age group occur in rural locations.⁴ Clearly, not all driver fatalities in rural locations involve young drivers from rural areas. However, a recent investigation of driver fatalities in the State for the period 1987-97 suggests that 72% occur in the driver's Local Government Area (LGA).⁵ Consequently, the over-representation of young rural drivers in the road fatality statistics reflects an increased risk for involvement in a fatal crash compared with young urban drivers.

Young drivers are involved in specific patterns of crashes, partly because of the nature and forms of travel undertaken and partly because of individual and other social factors.⁶ A number of studies have investigated the role that driver and behavioural factors play in motor vehicle crashes especially with respect to risk perceptions and judgement of driving abilities. However, research that has been undertaken tends to come from cross-sectional surveys, which makes it difficult to infer the direction of the

causal relationship.^{7,8} Furthermore, no research has considered whether there are differences in risk perceptions and judgement of driving abilities between young urban and rural licensed drivers that may contribute to differences in the risk for crash involvement.

Although there is much research comparing the environmental factors associated with rural crashes, there is a paucity of research that investigates the driver and behavioural factors that may predispose young rural drivers to crash. The focus of this paper, therefore, is to describe whether these factors predispose young rural drivers to crash and to compare these factors with young urban drivers.

Methods

Cohort definition

A sample of probationary drivers aged 17 to 18 years was recruited from three driver licensing centres in the Perth metropolitan area and four rural licensing centres between January 1997 and July 1998. To aid rural recruitment, the central Licensing Division posted baseline questionnaires to all newly licensed 17-year-old drivers. Drivers in Western Australia are eligible for a probationary licence at 17 years of age once a driving test has been undertaken and passed; this status of licence is held for 12 months whereupon a full driver's licence is obtained. To be eligible to participate in the study, drivers, at the time of recruitment, had to have successfully obtained a probationary driver's licence as well as have no record, as the driver, in a vehicle crash. Also, all drivers had to be residing in Western Australia at the time of recruitment.

A total of 3,350 drivers were approached

Abstract

Objective: To describe the driver and behavioural factors that predispose young drivers to crash in the first 12 months of driving and to compare whether these factors differ between young urban and rural drivers.

Methods: A cohort comprising 1796 newly licensed urban and rural drivers from Western Australia was recruited and followed over the first 12 months of driving. Using Cox proportional hazard analysis, driver and behavioural factors were assessed to determine whether they predicted the likelihood of a crash.

Results: The incidence rate for a motor vehicle crash was marginally higher for urban drivers compared with rural drivers (Urban: IR=4.2/10,000 driving days; Rural: IR=3.7/10,000 driving days). There was no significant difference in the time to crash between urban and rural drivers. Two factors, namely the frequency of driving before obtaining a learner-driver permit and the driver's level of risk taking, were significantly associated with a motor vehicle crash in the first year of driving.

Conclusion: Irrespective of whether the driver is licensed in a rural or urban area, high risk-taking drivers are at an elevated risk of a motor vehicle crash in the first 12 months of driving.

Implications: Aspects of Graduated Driver Training and Licensing Programs (GDTLP) could be effective in targeting this at-risk group.

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at the Perth metropolitan licensing centres to participate in the study. At the time of recruitment, each driver was asked to complete a questionnaire. Fifty-six drivers declined to take a questionnaire, while the remainder of the drivers either did not meet the eligibility criteria ($n=3$), returned the questionnaire without completing it ($n=404$) or failed to respond to our requests to return the questionnaire ($n=1607$). The Licensing Division posted 3,763 questionnaires to drivers licensed through rural centres and 450 completed questionnaires were received. The remaining drivers ($n=67$) were recruited directly from the rural licensing centres. In total, the cohort comprised 1,796 young drivers made up of 1,277 metropolitan licensed drivers and 517 rural licensed drivers.

Preliminary analyses of data gathered from those who chose not to participate in the study (but who completed a brief telephone interview; $n=577$) indicates no significant differences between the cohort responders and non-responders on key risk factors (impulsivity, sensation seeking and the frequency of sitting the driver licensing test).

Follow-up of participants was undertaken at 12 months by administering a questionnaire and linking the cohort research records to police accident records using the motor vehicle driver's licence number (MDL).

Instrument

The questionnaire administered at baseline was developed following an extensive review of the literature and a critique of instruments used in similar studies.⁹ The questionnaire was pilot tested on a sample ($n=20$) of the target audience and modified prior to administration. The questionnaire comprised nine sections: demographic details; driving experience prior to licensing; the practical driving test and preparedness for driving; driver expectations of on-road behaviour in the first 12 months of driving; how others think you should drive; perceived outcomes of certain on-road behaviours; reaction to the expected outcomes; self-perceptions of driving style and skill; and impulsivity and sensation seeking. The questionnaire took approximately 40 minutes for the young driver to complete.

The choice of items and scales for the questionnaire was directed by the theoretical framework of the study, namely, the Theory of Reasoned Action and Planned Behaviour.^{10,11} Specific driver and behaviour-related questions were derived from standardised questionnaires. Risk-taking by the driver was measured using the reliable (Cronbach's $\alpha=0.82$) Impulsive Sensation Seeking Scale,¹² while the Driver Behaviour Questionnaire (DBQ)⁹ was used to estimate the drivers' expectations of their on-road behaviour in the first 12 months of driving. A factor analysis on the DBQ confirmed three factors, namely errors, lapses and violations, that explained 37% of the variance. The internal reliability of the DBQ factors ranged from moderate to high with Cronbach alpha of 0.69, 0.81 and 0.75, respectively. Questions relating to the drivers' perceived driving style and skill were adapted from research by Adams-Guppy and Guppy.¹³ A factor analysis on these questions identified four factors (confidence-adventurousness, skill, demeanour and

alertness). The internal reliability of the driving style and skill factors were 0.72, 0.85, 0.77, and 0.83, respectively. Seven scores were derived by summing the raw values of the responses provided by participants in the items that comprised each factor (three factors from the DBQ and four factors from driving style and skills questions) identified from the factor analysis. These scores were used for the multivariate analyses.

Endpoints

The survival time for this study was calculated from the date of recruitment (i.e. first licensing date) through to the date of first motor vehicle crash, loss to follow-up, or censoring. Motor vehicle crashes were identified by linking the data obtained for this study with police crash reports obtained from the Traffic Accident System of the Main Roads Department of Western Australia.

Analysis

A description of the demographic characteristics of the cohort and their putative risk factors was undertaken using SPSS software.¹⁴ Data reduction techniques using principle axis factor analysis with oblique rotation were undertaken on the 35-item driving style and skill scale. Comparison of the means for continuous variables was undertaken using independent t-tests. Incidence rates were calculated using the exposure time from the date of recruitment to the study to the date of first crash or censorship. Only the first motor vehicle crash per participant was included in the numerator and censoring occurred at 12 months post licensing. Survival curves were calculated and significance was determined by the log-rank test. The effects of driver (sex, lifestyle behaviours, pre-licence driver training and experience, driver behaviour, and driver style and skill), behavioural differences (impulsivity and sensation seeking) and differences between urban and rural licensed drivers on motor vehicle crashes were evaluated using Cox proportional hazards analysis. All p values were two-sided and were considered significant at 0.05 and 95% confidence intervals were calculated using the standard errors from the analysis.

Results

Female drivers comprised 60% of the cohort with significantly more females compared with male drivers recruited from rural areas (64% vs. 26%; $\chi^2=5.86$, $df=1$, $p=0.017$). The majority of the cohort participants were students (urban drivers 80%, rural drivers 70%). The mean age at first driving was significantly lower for rural drivers (mean=12.2 years) compared with urban drivers (mean=14.7 years, $t=14.0$, $df=778.6$, $p=0.000$). Rural drivers also spent less time on their 'L-plates' (mean=three months) compared with urban drivers (mean=four months; $t=4.93$, $df=1462$, $p=0.000$) and fewer young rural drivers obtained professional driving instruction prior to licensing compared with urban drivers (79% versus 98%; $\chi^2=196.2$, $df=1$, $p=0.000$). Among the cohort participants who obtained professional driver training, urban drivers obtained significantly more driving lessons (mean=11; $SD=5.45$) compared with rural drivers (mean=5, $SD=3.6$; $t=22.5$, $df=1047.9$, $p=0.000$).

A total of 181 urban drivers and 67 rural drivers (14% of the cohort) were involved in crashes that were reported to the police during the first 12 months of driving. One hundred and seventy-two urban drivers (95%) and 59 (88%) rural drivers were involved in one crash only during the follow-up period. The majority of crashes occurred during the day (urban crashes 69%, rural crashes 76%) and between 9am and 4pm (urban crashes 42%, rural crashes 49%). The speed zone in which the crashes occurred was significantly different between urban and rural crashes, with more rural crashes occurring in 110 kilometre speed zones (rural=16%, urban=1%; $\chi^2=31.4$, $df=3$, $p=0.000$). Ninety per cent of rural drivers crashed in local government areas (LGAs) outside of the Perth statistical region and the majority (95%) of urban drivers crashed within the Perth statistical region. Twenty-one per cent of both the urban (n=38) and rural (n=14) crashes resulted in hospital or medical treatment, with the majority of crashes (urban 76%, n=139, rural 70%, n=47) not resulting in injury but exceeding \$1000 in property damage.

Although the incidence rate for a motor vehicle crash was marginally higher for urban drivers compared with rural drivers (see Table 1), there was no significant difference in the time to crash between urban and rural drivers (Log Rank Test=0.56, $df=1$, $p=0.455$). The incidence of motor vehicle crash was particularly high for rural drivers who reported they were high risk-takers. Crash incidence rates were also elevated for urban drivers who reported they were highly skilled drivers. In fact, the rate ratio for motor vehicle crash between urban and rural drivers who reported high levels of driving skill was 2.

Survival curves are plotted for the levels of risk-taking by urban and rural drivers (see Figures 1 and 2). A significant difference was apparent between high risk-taking and low to moderate risk-taking drivers and their time to first crash (Log Rank

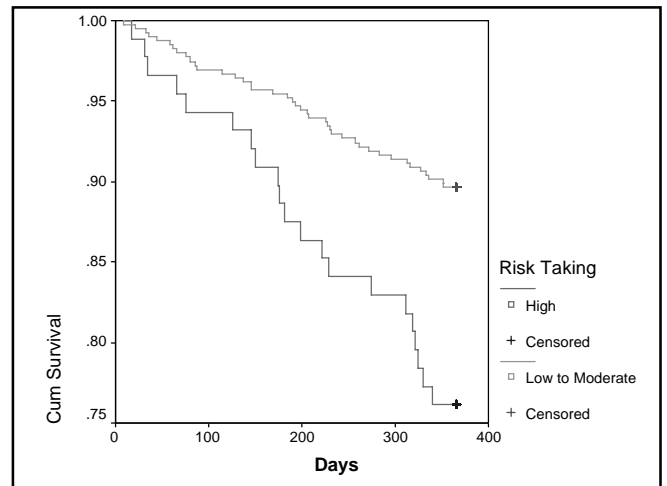


Figure 1: Survival curve for rural drivers and levels of risk-taking.

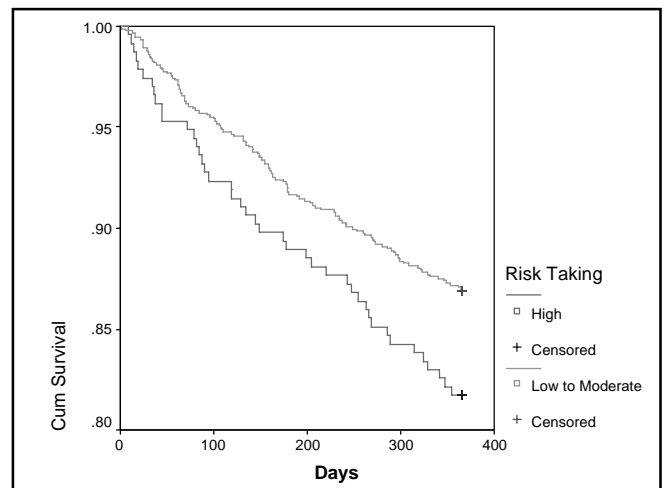


Figure 2: Survival curve for urban drivers and levels of risk-taking.

Table 1: Incidence rates of first crash for selected variables by urban versus rural licensed drivers.

Variables	Days from licence issue	Urban drivers Number of crashes	Crash incidence rate (per 10,000 driving days)	Days from licence issue	Rural drivers Number of crashes	Crash incidence rate (per 10,000 driving days)
Sex						
Males	176,545	82	4.6	63,373	21	3.3
Females	251,835	99	3.9	113,159	46	4.0
All	428,380	181	4.2	176,532	67	3.7
Risk-taking						
Low to moderate	316,399	123	3.8	137,104	41	3.0
High	76,856	43	5.5	28,502	21	7.3
Confident-adventurous driver						
Low to moderate	364,174	152	4.1	142,784	54	3.7
High	59,352	28	4.7	28,502	13	4.5
Age of first driving						
15 years & younger	168,709	73	4.3	127,442	45	3.5
16 to 17 years	255,407	104	4.0	48,360	22	4.5
Driver skill						
Low to moderate	368,176	148	4.0	148,280	59	3.9
High	54,985	32	5.8	26,792	8	2.8

Table 2: Predictors of time to first crash among young drivers^a

Variable	Hazard ratio	95% confidence interval	Wald Test [df] (P-value)
Frequency of driving before L-plates			9.43 [4] (0.05)
Never ^b	1.00	–	
Yearly	1.18	0.81-1.72	
Monthly	1.37	0.91-2.04	
Weekly	1.55	1.06-2.27	
Daily	1.96	1.19-3.22	
Risk-taking			
Low to moderate ^b	1.00	–	10.1 [1] (0.00)
High	1.61	1.20-2.16	

Notes:

(a) Model adjusted for sex and urban/rural licensed drivers.

(b) Baseline level.

Test=12.4, df=1, $p=0.000$). At the cessation of the first 12 months of driving, 24% of high risk-taking rural drivers had crashed. In contrast, only 10% of low to moderate risk-taking rural drivers had crashed. Although a similar pattern was apparent for urban drivers, the difference between the high and the low to moderate risk-taking drivers was not large; 19% of high risk-taking urban drivers had crashed while only 14% of low to moderate risk-taking rural drivers had crashed in the first 12 months.

Table 2 presents the results of the Cox proportional hazards model. Two factors, namely the frequency of self-reported driving before obtaining a learner-driver permit and the drivers' level of risk-taking, were significantly associated with a motor vehicle crash within the first 12 months of driving. These findings were irrespective of the sex of the driver or whether the driver was an urban or rural licensed driver. A linear association was evident for the frequency of driving before obtaining a learner-driver permit. Those drivers who reported daily driving prior to obtaining their L-plates were approximately at twice the risk (HR=1.96, 95% CI 1.19-3.22) of a crash compared with drivers who never drove prior to obtaining their L-plates. Risk-taking, which was derived from the Impulsive Sensation Seeking Scale,¹³ was also a significant predictor of crash involvement in the first year of driving. Drivers who were classified as high risk-takers were at 61% increased risk of crashing (HR=1.61, 95% CI 1.20-2.16) compared with drivers who reported low to moderate levels of risk-taking.

Discussion

Although the incidence of crash in the first 12 months of driving was slightly higher for urban drivers, no significant difference was evident between urban and rural drivers and their time to first crash. An interesting finding in the study was the elevated incidence of motor vehicle crash for women drivers who were licensed in rural areas. Although not explicitly rural drivers, research undertaken in the United States found the risk of crash, per mile driven, was greater for female drivers aged 16-19 years.¹⁵ Also evident in the study was the differential in the incidence

rates between urban and rural male drivers; the incidence of motor vehicle crash in the first year of driving was 39% higher among urban drivers. This finding may be due, in part, to the fact that a sensitive measure of exposure such as kilometres travelled was not obtained from the drivers in the study.

Although there were differences in the incidence rates between urban and rural drivers in relation to levels of driver skill and risk-taking, no urban versus rural differentials were evident at the multivariate level. When both the urban and rural crashes were modelled together, the findings indicated that drivers who drove most frequently prior to obtaining their L-plates and drivers with high levels of risk-taking are at greatest risk of a crash in the first 12 months of driving. Of particular interest is the group of drivers who drove weekly or daily prior to obtaining their L-plates. Previous research has found that this sub-group has distinctive characteristics that stand out from the remainder of the cohort, namely, increased alcohol consumption, higher driving behaviour violational scores, higher levels of driver confidence-adventurousness and a lower age at first driving.¹⁶ However, it is necessary to consider that this finding may merely be a 'proxy' for the drivers' exposure to the road environment over the observational period. Since the drivers completed the questionnaire after successfully obtaining their licence, it was not possible to obtain measures of distances travelled or the time spent in the road environment during the first 12 months of driving. However, a retrospective record of their exposure has recently been obtained from a survey completed at the end of the first 12 months of driving. Unfortunately, we were not able to model this exposure variable due to the loss-to-followup encountered at 12 months. Despite this, a post-hoc univariate analysis found a strong association between the drivers' time spent in the road environment over the past 12 months and their reported frequency of driving prior to L-plates. Consequently, one could interpret the inclusion of the variable 'frequency of driving prior to L-plates' as an adjustment in the multivariate model for the driver's time spent in the road environment.

The key finding from the study is that risk-taking is a significant predictor of a motor vehicle crash in the first 12 months of

driving, irrespective of whether the driver was licensed in a rural or urban area. Many studies have reported an association between risk-taking and motor vehicle crash.¹⁷ However, this is the first study that has described a high level of risk-taking that is prevalent in both urban and rural drivers and which can be linked to the driver's probability of a motor vehicle crash.

This study has a number of limitations. The most noticeable is the under-reporting of crash outcomes. A comparison of hospital and police road injury data in Western Australia has shown that there is a large degree of under-reporting of hospital-attended motor vehicle casualties to the police, and the level of under-reporting is greatest for those less severely injured.¹⁸ In fact, Rosman and Knuiman¹⁹ suggest that police estimates for motor vehicle casualties should be inflated by approximately 20%. Consequently, it is likely that this study has under-estimated the number of hospital-attended crashes and that the underestimation would be biased towards the less severely injured. A further limitation of the study is the self-reported nature of much of the data. Although validated scales were used whenever suitable, many of the individual difference variables are based on self-report. Consequently, bias due to misclassification of exposure data is a potential threat to the validity of the study.

Based on the findings of this research, 20% of the cohort (n=323), namely urban and rural drivers who considered themselves to have high levels of risk-taking at the time of licensing, are at an elevated risk of motor vehicle crash in the first 12 months of driving. Most Australian States and Territories have introduced Graduated Driver Training and Licensing Programs (GDTLP) as a key strategy to reduce the incidence of young driver motor vehicle crashes and there is sufficient evidence to suggest that this is an effective strategy.²⁰ GDTLPs comprise a number of components such as night curfews, log books and restricted driving times where the driver can travel with their peers. To date, however, there is little evidence as to what components of the GDTLP are most effective and, in particular, what aspects of the GDTLP will be effective in targeting this at-risk group. It is timely, therefore, that evaluations of the GDTLPs across Australia are undertaken with this specific focus in mind.

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