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Title: Risk factors for fatal crashes in rural Australia.

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Abstract:

This paper presents findings from the Rural and Remote Road Safety Study, conducted in Queensland, Australia, from March 2004 till June 2007, and compares fatal crashes and non-fatal but serious crashes in respect of their environmental, vehicle and operator factors. During the study period there were 613 non-fatal crashes resulting in 684 hospitalised casualties and 119 fatal crashes resulting in 130 fatalities. Additional information from police sources was available on 103 fatal and 309 non-fatal serious crashes. Over three quarters of both fatal and hospitalised casualties were male and the median age in both groups was 34 years. Fatal crashes were more likely to involve speed, alcohol and violations of road rules and fatal crash victims were 2½ times more likely to be unrestrained inside the vehicle than non-fatal casualties, consistent with current international evidence. After controlling for human factors, vehicle and road conditions made a minimal contribution to the seriousness of the crash outcome. Targeted interventions to prevent fatalities on rural and remote roads should focus on reducing speed and drink driving and promoting seatbelt wearing.

Keywords: rural traffic crashes, speeding , fatalities, drink driving, causal factors

1. Introduction

Recent years have seen an increasing recognition of the need to address the higher crash fatality rates in rural regions if the overall road toll is to be significantly reduced. Each year, more than 1,500 people die and over 45,000 people are seriously injured in road crashes in Australia, with rural areas being disproportionally represented (Berry and Harrison, 2007; Henley et al., 2007). Earlier (1992) Australian figures also indicate that the majority (58.8%) of fatal crashes occur in the countryside, in this case defined as outside city centres of 100,000 people or more (Federal Office of Road Safety, 1996). An Australian analysis based on fatality and hospital admission rates and using another system of classification indicated that rates increase with increasing remoteness from metropolitan areas (Australian Institute of Health and Welfare (AIHW, 1998). For example, national fatality rates for motor vehicle crashes 1992 -1996 ranged from 13.0 per 100,000 for males in Capital Cities to 18.5 in small Rural Centres and 31.4 in Remote Centres (AIHW, 1998). More recently two Australian papers found that hospitalisation rates for injury among vehicle occupants in New South Wales were approximate twice as high in rural as in urban areas in persons under 20 years of age (Du et al 2007) and in all New South Wales residents (Mitchell & Chong 2010).

In the United States a recent NHTSA (National Highway Traffic Safety Administration) statistical report on differences between urban and rural crash rates found that “although 23% of the US population lived in rural areas in 2006, rural fatal crashes accounted for 56 percent of all traffic fatalities in 2006” (NHTSA, 2007). The definition of rural used here refers by exclusion to areas outside urban areas of densely settled territory that contain 50,000 persons or connected discontiguous areas with qualifying densities (U.S. Census Bureau, 2008). A slightly earlier study comparing occupant fatalities as a proportion of all crashes, including property only crashes, in urban versus rural counties in Utah found no difference between urban and rural crashes after controlling for factors such as alcohol involvement, speeding, safety belt wearing and various road characteristics which were themselves predictive of occupant fatality (Donalson et al 2006). Several studies from North America and Europe have found an inverse relation between population density and vehicle fatalities and injury, but have not explored the relationship in depth (Clark & Cushing 2004, Kmet & Macarthur 2006, Eksler, Lassarre and Thomas 2008). However a Swedish study has found that the difference could be largely explained by a more serious level of injuries in less densely populated regions (Gedeborg et al 2010). This is consistent with the U.S. finding that differences in fatal crash incidence between urban and rural regions was mainly due to a higher injury fatality rate in the latter (Zwerling et al 2005 Apart from differences in the reporting periods the direct comparability of these figures is limited by the lack of consistency in definitions of rurality.

To date the particular challenges of rural and remote region crashes appear to have been understudied. The strongest findings are related to behavioural factors identified as associated with such crashes including excessive speed (Hasson, 1999), high levels of alcohol consumption (Pettitt et al., 1994), failure to wear seat belts or other protective gear (Sahai et al., 1998). Driver fatigue has been identified in some studies as a causal factor in rural crashes through its association with distance travelled. The phenomenon of driver fatigue is again fraught with definitional difficulties (Queensland Parliamentary Travelsafe Committee 2005). Estimates of the proportions of crashes attributable to fatigue generally range between 10 to 40 per cent with fatal crashes at the higher end (Fletcher et al., 2005).

It may be self evident that excessive speed is the major contributor to rural crashes and particularly to the severity of crashes but it may be only one of a number of contributing factors. The combination of speed, alcohol and failure to wear seat belts or other restraints seems to be highly associated with the severity of crashes.. In Australia the disproportionately high risk of fatality and injury due to the behavioural risk factors of persons living in rural and remote areas were clearly illustrated by data that showed that in 2001, the relative risk of dying as a result of a road crash in rural as compared with urban areas was 13.5 times higher for fatigue related crashes; 6.4 times higher for single vehicle crashes; 5.2 times higher for crashes where the victim was not wearing a seatbelt; 4.7 times higher for speed-related crashes and 4.3 times higher for alcohol-related crashes (Tziotis et al., 2005). This is consistent with the recent NHTSA (2008) analysis of fatalities which found that "of speeding drivers in rural areas 47 percent were drinking and rural drivers made up 62 percent of total drivers found to have been drinking, speeding and unrestrained." Furthermore "In both rural and urban areas sober drivers (BAC.00) were found speeding 14 percent or more of the time, but drivers with a BAC of .08g/dL or higher were found speeding 41 per cent of the time or more". (p.3)

Road design and conditions and associated weather hazards have also been studied as specific contributors to crashes in rural sites. The exacerbation by one or all of these and other identified risk factors in association with inappropriate speed for the conditions may have important implications for crash severity. An analysis of rural crashes in the UK (TRL 2002) indicated that single vehicle crashes were particularly strongly affected by the density of sharp road bends with a "34% increase in accident frequency per additional sharp bend per kilometre".(p.1)

There is a need for relevant and targeted interventions and people living in rural and remote communities may not be reached readily or appropriately by media safety messages or vehicle and road design countermeasures that have been developed for and found to be successful in urban regions. The design of such interventions needs to be informed by a better understanding of contributors to rural crashes and in particular those of the most severe type. One possible source of this understanding is an examination of the predictors of seriousness, in terms of fatality or serious injury, of rural crashes. This paper draws on the findings from a major program of research undertaken of all serious and fatal crashes in rural and remote North Queensland, Australia, conducted over a five year period (Sheehan et al., 2008). Rurality was defined by the exclusion of crashes occurring in the urban areas of the two major cities in the region. The paper examines the relative contribution of behavioural, vehicular and road environment factors to the severity of serious rural crashes that is, crashes which led to a fatality or a serious injury, the latter defined as hospitalisation for at least 24hrs.

2. Methods

2.1 Data sources

All crashes in the rural portions of the three northernmost Queensland Statistical Divisions that resulted in a serious injury and/or fatality in the period from 1st March 2004 to 30th June 2007 were eligible for inclusion provided that the vehicle crash resulted in at least one road user older than 15 years being killed or admitted to hospital for at least 24 hours. Crashes occurring in the urban areas of the two major cities in the region were not eligible for inclusion. Fatal crashes in which only children aged under 16 years were killed without an older person being admitted to hospital were excluded from the study. Data were abstracted from the patient charts of all participants who reached hospital. In the case of fatal crashes, data were collected from coroner's reports, when available, and from a road crash database maintained by Queensland Transport. Ethics approval was granted by the appropriate hospital and university ethics committees. A detailed description of the study and study region is available online (Sheehan et al., 2008).

The Queensland Transport Road Crash Database contains all police reports of vehicle crashes attended by the Queensland Police Service; crashes on private property are not included in the database. Matching of study crashes to those recorded in the database was made on the basis of date, time, vehicle characteristics and location; for reasons of privacy names could not be used. Details of road conditions and behavioural and vehicular factors involved in the crash were obtained from the matched record.

2.2 Data analysis

Analysis of individual road or vehicle operator factors was by standard contingency table methods, combining factor categories as appropriate. Multivariate analysis was by means of multiple logistic regression analysis modified to produce, more appropriately for this situation, risk ratios rather than odds ratios (Lee, 1994, Spiegelman & Herzmark, 2005). The unit of analysis was a crash. For the purposes of the multivariate analysis, crashes in which the only injury was to a struck pedestrian were excluded. Where a crash involved more than one operator it was deemed to be positive for a given factor, for instance excessive speed, if any one of the operators involved in the crash was positive for that factor. Seatbelt or helmet wearing, which influences survivability of individuals once a crash has occurred, was not considered an appropriate factor for inclusion in the multivariate analysis.

In the case of the factor, alcohol involvement, three categories were created: positive, if there was recorded evidence of alcohol involvement, (for example if a blood or breath alcohol reading was noted); negative, if there was firm evidence that alcohol was not involved; and uncertain, if no definitive evidence one way or the other was present. This was to avoid the bias which might arise if police, in the absence of a definitive test, were more likely to attribute alcohol to fatal than to non-fatal crashes or, conversely, assumed no alcohol involvement if they were unable to ascertain whether a hospitalised vehicle operator had been affected by alcohol. If at least one operator in a multi-vehicle crash was positive for alcohol, the crash was so designated; if all operators tested negative for alcohol, the crash was designated negative; otherwise the crash was defined as uncertain.

3. Results

During the study period there were a total of 732 crashes resulting in 814 fatalities or admissions to hospital within the study area. Of the 732 crashes, 119 were fatal (17%) and resulted in 130 fatalities.

3.1 Demographic characteristics

Table 1 shows the age distribution by sex of persons injured or killed in road crashes in the study area. Males accounted for just over three quarters of both fatal and non-fatal totals. The mean age of those who survived was 36.9 years (median, 34 years), similar to a mean age of 37.4 years (median, 34 years) in the decedents.

Table 1. Fatal and non-fatal casualties by gender and age group

	Fatal				Non-fatal			
	Males		Females		Males		Females	
Age (years)	n	%	n	%	n	%	n	%
16 - 24	28	23.9	12	34.3	147	30.1	37	23.9
25 - 34	34	29.1	7	20.0	117	23.9	36	23.2
35 - 44	20	17.1	6	17.1	96	19.6	23	14.8
45 - 54	14	12.0	7	20.0	56	11.5	17	11.5
55 - 64	11	9.4	2	5.7	45	9.2	24	15.5
65 - 74	6	5.1	0	0.0	14	2.9	11	7.1
≥ 75	4	3.4	1	2.9	14	2.9	7	4.5
Total	**117**	**100.0**	**35**	**100.0**	**489**	**100.0**	**155**	**100.0**

Motorcycle riders and car/truck drivers were the most prominently represented road user types, each accounting for a third of all casualties. Car or truck drivers had the highest rate of fatalities at 24.9%, followed by pedestrians at 21.4% (Table 2). Only one motorcyclist of 95 known to be riding off-road died in a crash whereas of 147 motor-cyclists known to be riding on the public road 22 (15.0%) died. This information was not recorded in the case of 21 motorcyclists, none of whom incurred fatal injuries.

Table 2. Total casualties by road user type and survival

	Fatalities		Hospitalisations[a]		Total
Road user type	n	%	n	%	n
Car or Truck driver	67	24.9	202	75.1	269
Pedestrian	9	21.4	33	78.6	42
Car or Truck passenger	28	17.6	131	82.3	159
Cyclist	2	10.0	18	90.0	20
Motorcyclist	23	8.7	240	91.3	263
Motorcycle pillion	1	8.3	11	91.7	12
Quad bike rider	0	0.0	36	100.0	36
Quad bike pillion	0	0.0	3	100.0	3
Total	**130**	**16.2**	**674**	**83.8**	**804**

[a] - In 10 instances, none fatal, road user type was not recorded.

3.2 Temporal characteristics

Approximately 45% of crashes occurred over the weekend period, defined as from 6:00 p.m. Friday to midnight on Sunday night (Table 3). For individual days, the highest number of non-fatal and fatal crashes occurred on Saturday with the lowest on Wednesday. Almost 32% of crashes occurred between midday and 6pm with another 28.6% occurring between 6pm and midnight. Overall, the highest number of fatalities occurred between midday Friday and midnight Saturday. Fatal crashes occurred somewhat more frequently on weekends than was the case for non-fatal crashes ($p = 0.06$)

Table 3. Temporal characteristics of fatal and non-fatal crashes

	Fatal		Non-fatal[a]		Total	
Day of week	n	%	n	%	n	%
Weekday	55	46.2	341	56.3	396	54.6
Weekend	64	53.8	265	43.7	329	45.4
Total	**119**	**100.0**	**606**	**83.8**	**725**	**100.0**

[a] - In 7 cases there was insufficient information.

3.3 Crash Characteristics

3.3.1 Road Environment

Of the 119 fatal crashes, 118 (99.2%) occurred on public roads, compared with 476(77.6%) non-fatal crashes. Since crashes occurring off public roads are not recorded by police, these crashes are not included in analyses based on data from the Queensland Transport Crash Database. Crash Database information was matched to 103 (87.3%) of the fatal on-road crashes and 309 (64.9%) of the non-fatal on-road crashes.

The majority of fatal and non-fatal crashes happened on sealed, level and dry roads. In terms of road surface, there was little difference between fatal and non-fatal crashes in whether the surface was sealed or not, but there were relatively fewer fatal crashes on wet roads; the difference was however not significant ($p = 0.10$). However, 30% of fatal crashes occurred on curved roads with view obscured compared with 13% of non-fatal crashes. As might be anticipated in a rural environment, over 80% of crashes occurred where no road features, such as cross-roads or T-junctions, or traffic controls, such as give way signs, were noted. Over 70% of fatal crashes also occurred on open roads with the speed limit at or over 100 km/h, compared to 57% of non-fatal crashes with a correspondingly lower proportion of fatal than non-fatal crashes on roads with a speed limit of 60 km/h or less. Almost 40% of fatal crashes occurred in darkness, that is, at night with no road lighting, compared with under a quarter of non-fatal crashes. Only a small proportion of fatal or non-fatal crashes occurred in other than clear conditions, with only 7 fatal and 38 non-fatal crashes occurring while it was raining, foggy or dusty (Table 4)

Single vehicle crashes accounted for three-quarters of the total crashes and 65% of fatal crashes. Police reported road conditions as a contributing circumstance to 12% of fatal crashes and 20% of non-fatal crashes (Table 4).

Table 4. Road conditions in fatal and non-fatal crashes

		Fatal		Non-fatal		
Road condition		n	%	n	%	p values[a]
Road surface						
Sealed		89	86.4	266	86.1	
	Dry	*81*	*78.6*	*229*	*74.1*	Sealed/unsealed 0.95
	Wet	*8*	*7.8*	*37*	*12.0*	
Unsealed		14	13.6	41	13.3	
	Dry	*14*	*13.6*	*33*	*10.7*	Wet/dry 0.10
	Wet	*0*	*0.0*	*8*	*2.6*	
Unknown		0	0	2	0.6	
Sealed		89	86.4	266	86.1	
Horizontal Alignment						
Straight		54	52.4	194	62.8	Straight / obscured / open 0.003
Curved		49	47.6	115	37.2	
	View Obscured	*31*	*30.1*	*40*	*12.9*	
	View Open	*18*	*17.5*	*75*	*24.3*	
Vertical Alignment						
Level		79	76.7	210	68.0	
Grade		14	13.6	60	19.4	0.41
Crest		5	4.9	20	6.5	
Dip		5	4.9	19	6.1	
Roadway Feature						
No roadway feature		90	87.4	248	80.3	
T-junction		8	7.8	30	9.7	
Bridge/causeway		2	1.9	7	2.3	Any / none 0.14
Crossroads		2	1.9	15	4.8	
Railway crossing		1	1.0	3	1.0	
Other		0	0	6	1.9	
Traffic Control						
No control		96	93.2	287	92.9	Any / none 0.91
Give-way sign		5	4.9	14	4.5	
Other		2	1.9	8	2.6	

Contributory Road Conditions					
Absent	91	88.3	247	79.9	Present/absent
Present	12	11.7	62	20.1	0.08
Lighting conditions					
Daylight	55	53.4	196	63.4	Day / night unlighted / night lighted / dawn, dusk 0.036
Night	43	41.7	91	29.4	
Unlighted	*39*	*37.9*	*73*	*23.6*	
Lighted	*4*	*3.9*	*18*	*5.8*	
Dawn/dusk	4	3.9	20	6.5	
Unknown	1	1.0	2	0.7	
Atmospheric conditions					
Clear	96	93.2	271	87.7	
Raining	6	5.8	31	10.0	Clear/other
Fog	1	1.0	3	1.0	0.17
Smoke/Dust	0	0	4	1.3	

[a] - p values correspond to chi-squared tests between named groups

3.3.2 Vehicle Factors

Queensland Transport road crash database information was available for 150 units, i.e. drivers, motorcyclists, cyclists or pedestrians, involved in fatal crashes and 439 units in non-fatal crashes. For each unit other than a pedestrian, police assessed whether vehicle factors (e.g. defects in tyres, blow-outs, load shifts, faulty brakes or lights) had contributed to the crash. Only 3.4% of fatal and 2.3% of non-fatal crashes were attributed to vehicle factors.

3.4 Operator Factors

The Queensland Transport Road Crash Database recorded, for each unit in a crash, operator factors as reported by police. Such factors included licence status, alcohol involvement, speeding, fatigue, road rule violation, distraction and seatbelt or helmet wearing. Approximately 14% of fatal crash vehicle controllers were not appropriately licensed at the time of the crash compared with 7.6% of those involved in non-fatal crashes. In effect, vehicle controllers involved in fatal crashes were nearly twice as likely to be unlicensed than those involved in non-fatal crashes (p= 0.02). Provisional licence holders represented a similar proportion (approximately 10%) in both the fatal and non-fatal vehicle controller groups. Learner drivers were rarely involved, representing just 3% of all vehicle controllers (Table 5).

Alcohol was considered a contributing factor by police in nearly 30% of fatal crashes and a blood alcohol content (BAC) of greater than 0.05 (50 mg/100 ml) was recorded in 24% of operators. In the non-fatal group, only 18% of crashes were found to involve alcohol and 13% of vehicle operators had a BAC > 0.05.

Speed was considered by police to be a contributing factor for 18% of units involved in fatal crashes compared with 10% in non-fatal crashes; in the great majority of instances the police judged that the vehicles had been travelling at or below the marked speed limit, but too fast for the prevailing conditions: few operators were deemed to have been travelling over the speed limit, 6% in the case of a fatal crash, 1% in the case of a non-fatal crash. Fatigue was judged by police to be a contributing factor in 16.1% and 11.5% of fatal and non-fatal crashes respectively. Road rule violation in fatal and non-fatal crash vehicle controllers was found to be very similar at about 14% in each group, while distraction or inattention whilst driving was slightly higher in the non-fatal crash group (Table 6).

Table 5. Licence status in fatal and non-fatal crashes

	Fatal		Non-fatal		
Licence status	n	%	n	%	p values
Licensed	108	83.7	343	91.0	
Open	*91*	*65.0*	*291*	*77.2*	
Provisional	*15*	*11.6*	*39*	*10.3*	
Learner	*2*	*1.6*	*13*	*3.4*	
Unlicensed	21	16.3	34	9.0	Licensed / unlicensed 0.34
Cancelled/Disqualified	*5*	*3.9*	*13*	*3.4*	
Never Held Licence	*5*	*3.9*	*8*	*2.1*	
Other	*11*	*8.5*	*13*	*3.4*	
Australian operators	129	100.0	377	100.0	
Not licensed in Aust	2	1.3	14	3.2	
Unknown/ not applicable	19	12.7	48	10.9	

Table 6. Operator factors in fatal and non-fatal crashes.

Operator factor	Fatal n	Fatal %	Non-fatal n	Non-fatal %	p values[a]
Alcohol					
Attributed	46	30.7	60	13.7	< 0.001
Not attributed	104	69.3	379	86.3	
BAC > 0.05					
Attributed	36	24.0	41	9.3	< 0.001
Not Attributed	114	76.0	398	90.7	
Speeding related					
Attributed	28	18.7	29	6.6	< 0.001
Not Attributed	122	81.3	410	93.4	
Travelling over speed limit					
Attributed	10	6.7	4	0.9	< 0.001
Not Attributed	140	93.3	435	99.1	
Fatigue					
Attributed	24	16.0	51	11.6	0.21
Not Attributed	126	84.0	388	88.4	
Distraction/Inattention					
Attributed	30	20.0	112	25.5	0.21
Not Attributed	120	80.0	327	74.5	
Road Rule violation					
Attributed	22	14.7	59	13.4	0.81
Not Attributed	128	85.3	380	86.6	

[a] - p values correspond to chi-squared tests between named groups

Drivers involved in a fatal crash were substantially more likely to be unrestrained by seatbelts than those in non-fatal crashes, 41.1% and14.5%, respectively of those for whom seatbelt wearing was known ($p < 0.001$). A slightly higher proportion of helmet non-use was noted amongst fatally injured motorcyclists, but this difference was not statistically significant (Table 7).

Table 7. *Police-reported casualties by injury severity and protective equipment use*

	Fatality		Hospitalisation	
Protective equipment	n	%	n	%
Seatbelt				
Worn	40	47.1	159	66.0
Not worn	28	32.9	27	11.2
Unknown	17	20.0	55	22.8
Total	**85**	**100.0**	**241**	**100.0**
Helmet				
Worn	17	73.9	78	87.6
Not worn	2	8.7	6	6.8
Unknown	4	17.4	5	5.6
Total	**23**	**100.0**	**89**	**100.0**

3.5 Multivariate analysis

All factors were entered into multiple logistic models and those showing little evidence of association with the outcome were sequentially discarded; the factors remaining are shown in Table 8. Both speed-related factors, speed limit and speeding, i.e. travelling too fast for the circumstances, are powerful predictors of a fatal crash outcome, as, to lesser extent, are alcohol involvement and road rule violation. These are all behavioural factors. There is a suggestion that fatigue, as attributed by police, and one road condition, the presence of a curve in the road, had contributed to a fatal outcome, but the associated risk ratios do not reach statistical significance.

Table 8. Risk ratios, with 95% confidence intervals (95% C.I.), for a fatal outcome in serious crashes in North Queensland, derived by modified multiple logistic analysis

Factor	Risk ratio	95% CI	p
Alcohol involvement definite	1.71	1.15 – 2.54	0.01
Alcohol involvement uncertain	0.65	0.41 – 1.03	0.07
Speeding	2.39	1.61 – 3.55	0.001
Speed limit 70 – 90 km/h	2.00	0.90 – 4.44	0.09
Speed limit 100 - 110 km/h	3.53	1.73 – 7.22	0.001
Road rule violation	1.74	1.10 – 2.74	0.02
Curve – view open	1.31	0.91 – 1.87	0.14
Curve – view obscured	1.30	0.87 – 1.96	0.20
Fatigue attributed	1.57	0.93 – 2.65	0.09

4. Discussion

We found that fatal casualties were reasonably comparable to non-fatal casualties in terms of age-sex profile. The male predominance in both the fatal and non-fatal casualty groups can be partly accounted for by increased risk exposure in terms of road use. It may also be partly attributed to certain at-risk behaviours being more common among male vehicle operators. The similarity in age distributions in the two severity groups suggests that inexperience does not play a major role in severity once a crash has occurred. In concordance with this, of the 70 coroner's reports available, only 15% indicated that fatal crashes were due to driver inexperience. The factors making the major contribution were shown to be travel speed, often at or below the posted speed limit but without regard to the road environmental conditions, failure to obey road rules and alcohol use. The latter factor had a strong influence on severity even after allowing for its indirect effects on speeding or road rule violation. Driver fatigue, as attributed by investigating police, was of marginal significance. There was some suggestion that crashes on curves had more serious consequences than crashes on straight road segments. In this study as in many others, failure to wear a seatbelt was a strong risk factor for traffic fatality. Thus the known risk factors for a serious crash are also risk factors for a fatal outcome given that a serious crash has occurred.

These results are consistent with a study from the U.S.A. which examined risk factors for occupant fatality in all types of crashes, including minor. Although the methodology and denominator were somewhat different, the set of significant risk factors found in that study are similar to those found by us (Donaldson et al 2006). We are unaware of other studies which have used crash fatalities as an outcome.

That alcohol use remains a strong risk factor for a fatal outcome, even after allowing for its potential effects on excessive travelling speed and improper driving behaviour, needs elucidation. There is evidence that persons with an elevated blood alcohol are at increased risk of injury and death in the event of a traffic crash or other traumatic event than persons with zero or low blood alcohol (Waller, 1985; Tien et al., 2006), but it is unclear whether this effect is large enough to explain the size of the relative risk found in this study. Another possible pathway is the relationship of alcohol use and seatbelt wearing (Steptoe et al., 2002; Graham, 1993). We analysed a subset of 126 drivers in single-vehicle crashes, 40 fatal, for whom alcohol and seatbelt use were known. Controlling for seatbelt wearing reduced the alcohol-related relative risk of dying in the crash from 2.0 to 1.3. However there was a suggestion in these rather limited data that the situation may be more complex: among the drivers not wearing seatbelts, alcohol use had no effect (RR = 1.1), whereas among those wearing seatbelts the relative risk for a fatal outcome in the presence of alcohol was 2.4. The difference was however not statistically significant. Further control for speeding or road rule violation among the drivers wearing seatbelts did not materially alter the size of this relative risk, leaving the exact mechanism of operation of alcohol on crash severity unexplained.

Road conditions, often blamed by the media for traffic fatalities in rural and remote regions, did not appear to be a factor: on a univariate basis, adverse road conditions were noted more often in the case of non-fatal than of fatal crashes, possibly due to their influence on travelling speed. There is a suggestion that crashes at curves in the road may lead to a more serious outcome, but the evidence for this is weak. Other factors which might be expected to play a role in crash severity, such as unlicensed driving, atmospheric conditions or vehicle defects did not prove to be independent influences on crash severity, nor did the day of week or number of vehicles involved. Speeding and alcohol involvement are significantly over-represented in both fatal and non-fatal crashes at the weekend compared to weekdays, which may explain the excess of fatal crashes over the former period, as well as the lack of an independent contribution of day of week to seriousness after allowing for these two factors..

Much of rural Australia, especially away from the coastal strip, is, like our study area, sparsely populated with large distances between settlements and a thinly spread police presence. In consequences, travel speeds tend to be high even on minor or unsurfaced roads. In a comprehensive survey of the relevant literature, Elvik and colleagues (2004) have established that a relative reduction in average speeds leads to a far larger relative increase in road safety, encapsulated by a power law. This relationship seems to hold over a wide range of speeds which include those typical in rural regions. Conversely, even a small increase in average speeds will have a large influence on the lethality of a traffic crash.

Alcohol use is high in rural communities (Sheehan et al 2008). The consistency of alcohol misuse as a major contributor to road crash fatalities in virtually all studies, regardless of variations in legal BAC levels and methods of enforcement, presents a challenge. Increased enforcement is an obvious response, but low population density in rural regions would be costly with low saturation levels of methods such as Random Breath Testing. There is clearly a need to raise understanding in rural communities of the dangers of drink driving through education and information about the increased risks involved. The increased involvement of alcohol in weekend crashes that we found highlights the need to focus on liquor outlets both as the target for enforcement interventions and for promotion of alternative transport methods. Courtesy transport provided by liquor outlets as an alternative to driving and programs for dedicated volunteer non-drinking drivers to drive people home (Nielson & Watson 2009) need consideration and support, both as prevention and a community signal.

A major limitation of the study is the inability to match crashes identified in medical records with the corresponding crashes in the Queensland Transport Road Crash Database, particularly in the case of non-fatal crashes. A change in police reporting systems consequent on the introduction of new computer software partway through the study period appears to be the principal contributory factor to this; fatal crashes, which receive special attention from police, would be less affected by this problem. This implies that the unmatched crashes are unlikely to differ systematically from those matched, and hence that our findings are unlikely to be biased by this factor. Another limitation is the reliance on the judgment of attending police, who may be more prone to attribute deviant behaviour to the vehicle operator in the case of more serious crashes. We were able to counteract this form of bias where alcohol use was concerned by assigning operators to an “unknown” category if no blood alcohol level had been determined and documented. The relative sizes of the alcohol-related risk ratios suggest that this category in fact contains a high proportion of non-fatal crashes in which no operator was over the legal blood alcohol limit, and that the contribution of alcohol to crash severity has been underestimated. However for factors involving a degree of post hoc judgment, such as speeding, road rule violation or fatigue, there remains some potential for observer bias.

Serious crashes are optimally investigated by a dedicated Forensic Crash Unit whose task is to examine the circumstances of the crash and attribute causality. However, due to resourcing issues, investigation teams in regional and rural areas when our study was being conducted often comprised members of the local constabulary who may not always have the same degree of training and expertise as their metropolitan counterparts. This problem is not confined to North Queensland so whatever misclassification occurs as a result of the lesser expertise of investigating police would be similar in its effects in most rural areas of Australia.

5. Conclusion

These findings based on a study of crashes in rural and remote Australia are consistent with the data reported by the recent NHTSA study of relevant statistics in the United States. They indicate that human behaviours play a far greater role in the severity of traffic crashes than do environmental, vehicle or road factors. In terms of preventive strategies or countermeasures the key need to modify excessive speed for the particular road conditions and driving task is clear. In a public policy and community context this finding is frequently interpreted to mean that road conditions need to be modified rather than the driver’s behaviour. Such an approach has limited promise for positive outcomes as the evidence from this study indicates judgment errors and excessive drinking are also involved.

The findings suggest that there is an important role for countermeasures and policy initiatives that reduce alcohol associated driving, particularly in rural areas. Another policy recommendation that is consistent with UK findings (TRL 2002) is that there needs to be interventions that alert drivers to moderate their speed to the conditions and situations in which they are driving. The low contribution of wet weather conditions to the crashes reviewed here suggests that drivers do adjust their speed to some adverse conditions and that such an approach to the drivers could be valuable. A complementary approach would be the reduction of speed limits on roads judged to be unsafe at the default speed limit in rural areas, typically 100 kph. But all such measures are likely to be unavailing in the absence of credible enforcement efforts, targeting excessive speed, raised blood alcohol and seat belt or helmet wearing.

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