Dead Tired: Fatigue Related Crashes on National Route 39

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Fatigue related crashes represent a significant social and economic cost to the community, as it is one of the primary contributing factors of road crashes. However the examination of fatigue crashes is often problematic as there is no universal definition of fatigue and it is difficult to objectively measure the degree of driver fatigue following a crash. Therefore the Australia Transport Safety Bureau (ATSB) has constructed an operational definition of a fatigue related crash. The definition is based on a set of well research selection criterion and uses crash characteristics routinely collected by different traffic authorities. The objective of this study is to test the ATSB operational definition of fatigue and to monitor the trends of fatigue related crashes on National Route 39, which is a major transport corridor between Brisbane and Melbourne. This study found that, there was a small increase in the number of fatigue related crashes from 12% in 1995 to 14% in 1999. The ATSB definition was found to be both practical and possesses face validity. Therefore the definition could be used to study and monitor fatigue related crashes in other contexts or on other specific routes.

Key Words: Fatigue, National Route 39, operational definition

Introduction

National Route 39 (NR39) is a major heavy vehicle transport route linking Victoria and Queensland via western New South Wales. It includes the Hume and Goulburn Valley Highway in Victoria and the Newell Highway in New South Wales and links with various routes to Brisbane from Goondiwindi. It is primarily a single carriageway through rural and relatively remote areas. Fatigue is thought to play a major role in road trauma on this route because a large proportion of the drivers are on long trips (for example, interstate motorists and truck drivers).

Although fatigue is often ranked with speeding and alcohol as being a major factor causing road crashes, its contribution to individual crashes is hard to measure. Queensland, New South Wales and Victoria estimate the proportion of fatigue related crashes using different procedures. To monitor driver fatigue crashes across these three jurisdictions, a common methodology for defining a fatigue crash was developed by the Australian Transport Safety Bureau (ATSB). This operational definition of fatigue was developed following a comprehensive review of research and was tailored for use with existing crash data.

This report investigates the rate of fatigue related crashes, identified using this definition of fatigue, on the route from Melbourne to Brisbane which includes NR39. In particular, the report investigates whether the prevalence of fatigue related crashes have changed over time.

The role of fatigue in road crashes

The role of fatigue in road crashes is difficult to measure due to the absence of a single universally accepted definition or an objective test for the level of fatigue or sleepiness of drivers involved in crashes (Connor et al (1). Nor is there a definitive criterion for establishing the level of fatigue that leads to crashes.

Crash outcomes and crash data collection methods also complicate the identification of fatigue related crashes. In fatal crashes there may be no surviving witnesses to give an account of the crash, or the surviving driver may be influenced by the legal consequences of the crash. The crash itself is sufficient to alter arousal levels and may eliminate any evidence of impairment from sleepiness. On top of this, crash investigations do not routinely collect information on length of time driving, details of rest breaks or previous work and rest schedules of the drivers involved.

The current knowledge of fatigue related crashes is based on subjective evidence or surrogate measures of fatigue. A level of confidence in the results comes from the number of different studies that have reached similar conclusions on what defines a fatigue related crash (Expert Panel on Driver Fatigue and Sleepiness (2).

In the United Kingdom, fatigue related crashes have been identified using the following criteria:

?? the vehicle has run off the road and/or collided with another vehicle or object;
?? there is an absence of skid marks or braking;
?? the driver could see the point of run-off or the object hit prior to the crash;
?? other causes are eliminated eg mechanical defect, speeding, excess alcohol, bad weather; and
?? witnesses may report lane drifting prior to the crash (Horne and Reyner (3).

Similarly in the United States, the Expert Panel on Driver Fatigue and Sleepiness (2) characterises a fatigue related crash as:

?? occurring late at night/in the early afternoon or midafternoon;
?? likely to be of higher severity;
?? involves a single vehicle leaving the roadway;
?? occurring on a high speed road;
?? driver does not attempt to avoid the crash; and
?? the driver is alone in the vehicle.

The ATSB definition of a fatigue related crash employs similar criteria to those used in the United States and United Kingdom.

ATSB operational definition of fatigue

The ATSB definition of a fatigue related crash implemented in this report includes single vehicle crashes occurring during "critical times" (midnight-0600 or 1400-1600) and head on collisions, not overtaking. Crashes occurring on roads with speed limits under 80 km/h and crashes involving pedestrians or unlicensed drivers or drivers with high levels of alcohol are excluded.

Fatigue related crashes generally include single vehicle crashes in which the vehicle has drifted off the road or a head on collision in which the vehicle has drifted onto the wrong side of the road but was not overtaking (Haworth and Rechnitzer (4); Pack et al (5). Haworth and Rechnitzer (4) found that close to 75% of fatigue crashes involved a single vehicle drifting off the road. Head on (not overtaking) crashes accounted for 22% of fatigue related crashes (Haworth and Rechnitzer (4).

The selection of the two critical times reflects the influence of circadian rhythms on levels of fatigue and crash risk. Crash risk is highest in the early hours of the morning with a secondary peak in risk in the early afternoon, corresponding with the 'post-lunch dip' (Folkard (6); Hartley et al (7); House of Representatives Standing Committee on Communication, Transport and the Arts (8); Pack et al (5).

By including only those crashes that occur where the speed limit is 80km/h or greater, crashes on rural highways are included. This is important because research has found that fatigue related crashes are more common on rural highways than on urban and rural roads (Haworth and Rechnitzer (4). One reason for this is that average trip lengths are likely to be longer on these roads and inattention and drowsiness are brought on by the constant speeds and monotony in the task and surroundings (Haworth and Rechnitzer (4); Expert Panel on Driver Fatigue and Sleepiness (2); Pack et al (5).

All crashes with high levels of alcohol involved (0.05 or above) are excluded from the fatigue crash definition as high levels of alcohol disrupt a driver's perceptual-motor coordination increasing the risk of being involved in any crash (Haworth and Rechnitzer (4). Research has also shown that low levels of alcohol increase the risk of being involved in fatigue related crash. Low levels of alcohol depress the central nervous system and make a driver more likely to fall asleep at the wheel (Haworth and Rechnitzer (4); Expert Panel on Driver Fatigue and Sleepiness (2).

Crashes involving pedestrians are also excluded from the fatigue definition because of the nature of most fatigue crashes. Most fatigue related crashes occur on rural highways, whereas most pedestrian crashes occur in urban, residential areas. In 1992, only 15% of pedestrian crashes occurred in rural areas (Federal Office of Road Safety (9).

Crashes involving unlicensed drivers have been excluded from the fatigue definition, as unlicensed drivers are known to be associated with a number of high-risk behaviours, such as speeding, alcohol and not wearing a seatbelt (Federal Office of Road Safety (10). Therefore, while fatigue may or may not be a factor, it will generally be a secondary factor in the crash.

Method

Data Source

The three separate road authorities (VicRoads, RTA and Queensland Transport) provided data on all road crashes occurring on any sections of the Melbourne to Brisbane route that includes NR39 for which they are responsible, for the period 1995 – 1999.

Implementation of the ATSB fatigue related crash definition
Crashes were identified as fatigue related based on a successive selection process. The steps are listed below:

First,
?? exclude all crashes involving alcohol
?? exclude all crashes involving any unlicensed drivers or unlicensed motorcycle riders
?? exclude pedestrian crashes
?? exclude crashes where the speed limit is less than 80km/h.
Then,
?? include all head-on crashes
?? include all single vehicle crashes from 00:00am to 5:59am and from 2:00pm to 3:59pm.

Results
Prevalence of fatigue related crashes
The selection process resulted in a total of 383 crashes satisfying the fatigue definition, 78 from Victoria, 139 from NSW and 166 from Queensland. These crashes represent 13% of all crashes on this route. The percentage of fatigue related crashes vary markedly by region (Table 1). It is 21% on the Newell (NSW), 13% on the Queensland sections and 7% on the Victorian sections. Within Victoria, it is only 5% out of 832 crashes on the Hume Highway section and 12% out of 293 crashes on the Goulburn Valley Highway.

Table 1: Fatigue related (FR) and total crashes on National Route 39 by State and crash injury severity 1995 – 1999

Severity	Vic (GVH+Hume Hwy)			NSW (Newell Hwy)			Queensland (A+B+C)			Total Melbourne-Brisbane		
Crash year	FR	%FR	Total	FR	%FR	Total	FR	%FR	Total	FR	%FR	Total
Total												
1995	14	7%	201	22	17%	132	29	15%	200	65	12%	533
1996	16	6%	252	22	18%	120	34	16%	207	72	12%	579
1997	15	7%	228	24	18%	135	40	18%	221	79	14%	584
1998	15	7%	208	35	24%	146	29	14%	209	79	14%	563
1999	18	8%	236	36	27%	135	34	13%	262	88	14%	633
1995-99	78	7%	1125	139	21%	668	166	15%	1099	383	13%	2892
Fatal												
1995	2	40%	5	1	13%	8	6	38%	16	9	31%	29
1996	4	31%	13	3	75%	4	3	30%	10	10	37%	27
1997	0	0%	4	6	46%	13	7	44%	16	13	39%	33
1998	4	36%	11	5	46%	11	3	30%	10	12	38%	32
1999	1	17%	6	5	31%	16	3	19%	16	9	24%	38
1995-99	11	28%	39	20	39%	52	22	32%	68	53	33%	159
Non-fatal												
1995	12	6%	196	21	17%	124	23	13%	184	56	11%	504
1996	12	5%	239	19	16%	116	31	16%	197	62	11%	552
1997	15	7%	224	18	15%	122	33	16%	205	66	12%	551
1998	11	6%	197	30	22%	135	26	13%	199	67	13%	531
1999	17	7%	230	31	26%	119	31	13%	246	79	13%	595
1995-99	67	6%	1086	119	19%	616	144	14%	1031	330	12%	2733

Sources: RTA, VicRoads and Queensland Transport
Crashes include fatal, hospitalisation (serious injury) and other injury crashes, but exclude property damage crashes
GVH = Goulburn Valley Highway; A = Cunningham Highway; B = Leichhardt, Moonie & Warrego Highways; C = Gore Highway

As seen in the overall State figures, there is also variation by crash severity. One third of the 159 fatal crashes (33%) on this route are classified as fatigue related, compared with only 12% of the 2733 non-fatal injury crashes (Table 1). An intermediate severity level (crashes resulting in hospitalisation) is also available for the Victorian and Queensland data. The percentage of fatigue related crashes vary consistently by severity for these data combined (fatal 32%, hospitalisation 13%, other injury, 8%).

There is a modest overall increase from 12% in 1995 to 14% in 1999 (Table 1). However, the trend is markedly different in the different sections of the route (Figure 1). The percentage of fatigue related crashes increases dramatically after 1997 in NSW increasing from 18% to 27% by the end of 1999. The pattern for Queensland is opposite with a decrease from 18% to 13% by the end of 1999. The Victoria percentage is relatively stable and remains below 10% for the whole time period. Formal statistical tests for trend confirm these general findings. The New South Wales section is the only region with a statistically significant trend (Table 2).

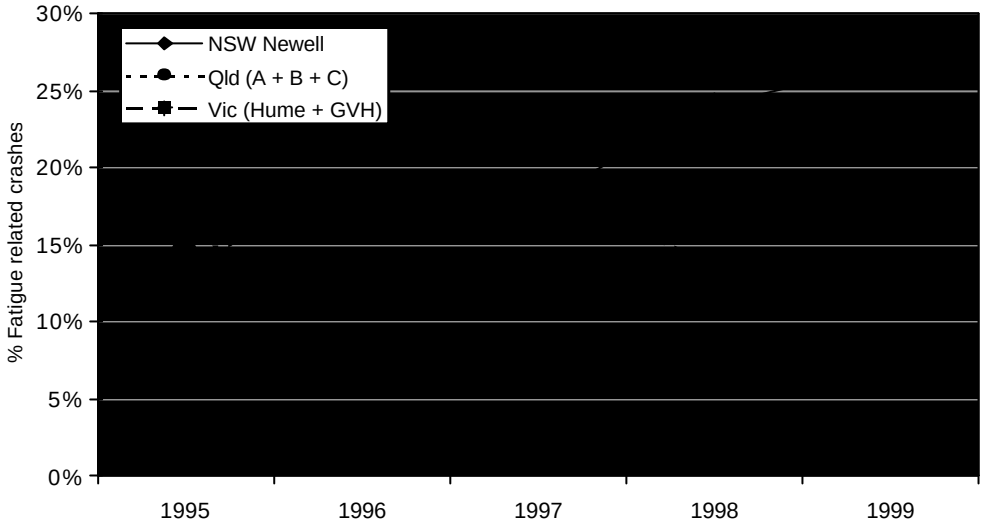

Figure 1: Percentage of fatigue related injury crashes on National Route 39 by State 1995 – 1999

Table 2: Chi-square test for trend (1 degree of freedom) in fatigue related injury crashes with calendar year by State

	Victoria (1995 - 2000)			NSW(95 - 99)	Queensland(95-99)	Total
Measure	Total	Hume	GVH	Newell	(A+B+C)	(95-99)
Total crashes	1303	963	340	668	1099	2892
Chi-square	0.38	0.93	0.03	5.36	0.68	1.23
p	p=0.5	p=0.3	p=0.9	p=0.02	p=0.4	p=0.3

Sources: RTA, VicRoads and Queensland Transport
Crashes include fatal, hospitalisation (serious injury) and other injury crashes, but exclude property damage crashes
GVH = Goulburn Valley Highway; A = Cunningham Highway; B = Leichhardt, Moonie & Warrego Highways; C = Gore Highway

Fatalities and injuries

Overall, 663 persons were injured in the 383 fatigue related crashes on the combined route in the period 1995 – 1999 (Table 3). This represents 15% of all persons injured on this route in this period. A total of 69 persons were killed in the 53 fatigue related fatal crashes on the combined route in the period 1995 – 1999. This represents 36% of fatalities on this route.

Table 3: Persons injured in fatigue related (FR) and total crashes on National Route 39 by severity of injury 1995 – 1999

Severity	Vic (GVH+Hume Hwy)			NSW (Newell Hwy)			Queensland (A+B+C)			Total Melbourne-Brisbane		
Crash year	FR	%FR	Total	FR	%FR	Total	FR	%FR	Total	FR	%FR	Total
Total												
1995	27	9%	295	32	15%	209	47	16%	292	106	13%	796
1996	25	7%	365	38	21%	182	61	19%	322	124	14%	869
1997	19	6%	330	53	26%	201	72	21%	341	144	17%	872
1998	31	10%	316	55	26%	214	59	17%	351	145	16%	881
1999	20	5%	366	63	32%	194	61	16%	391	144	15%	951
1995-99	122	7%	1672	241	24%	1000	300	18%	1697	663	15%	4369
Fatal												
1995	3	50%	6	1	9%	11	6	35%	17	10	29%	34
1996	6	35%	17	3	75%	4	4	29%	14	13	37%	35
1997	0	0%	4	9	53%	17	8	38%	21	17	40%	42
1998	5	42%	12	7	50%	14	6	43%	14	18	45%	40
1999	1	17%	6	6	33%	18	4	22%	18	11	26%	42
1995-99	15	33%	45	26	41%	64	28	33%	84	69	36%	193
Non-fatal												
1995	24	8%	289	31	16%	198	41	15%	275	96	13%	762
1996	19	5%	348	35	20%	178	57	19%	308	111	13%	834
1997	19	6%	326	44	24%	184	64	20%	320	127	15%	830
1998	26	9%	304	48	24%	200	53	16%	337	127	15%	841
1999	19	5%	360	57	32%	176	57	15%	373	133	15%	909
1995-99	107	7%	1627	215	23%	936	272	17%	1613	594	14%	4176

Sources: RTA, VicRoads and Queensland Transport
Crashes include fatal, hospitalisation (serious injury) and other injury crashes, but exclude property damage crashes
GVH = Goulburn Valley Highway; A = Cunningham Highway; B = Leichhardt, Moonie & Warrego Highways; C = Gore Highway

Characteristics of fatigue related crashes

Table 4 summarises the crash characteristics of the fatigue related crashes identified in the previous analysis. This allows a comparison with non-fatigue related crashes. Some of these characteristics reflect the definition that was used. For example, there are relatively high percentages of single vehicle crashes (70%) and crashes at night (49%) compared with non-fatigue related crashes (36% single vehicle and 29% at night), since these factors are used to define fatigue related crashes.

Thirty percent of fatigue related crashes involved articulated trucks. This is higher than for non-fatigue related crashes (17%). The highest involvement rate of articulated trucks was on the Goulburn Valley Highway (39%, not tabulated).

There was no marked pattern with month of the year or day of the week. Fatigue related crashes were more likely to occur on public or school holidays than other crashes in all regions except Victoria.

Table 4: Crash characteristics of fatigue related (FR) and non-fatigue related (non FR) injury crashes on National Route 39, 1995 – 2000

Crash characteristics	Victoria (GVH + Hume)		NSW (Newell Highway)		Queensland (A + B + C)		Total Melbourne-Brisbane	
	FR (n=92)	Non FR (n=1211)	FR (n=139)	Non FR (n=529)	FR (n=166)	Non FR (n=933)	FR (n=397)	Non FR (n=2673)
Crash type								
Single vehicle	74%	24%	71%	54%	66%	41%	70%	36%
Multiple vehicles	26%	76%	29%	46%	34%	59%	30%	64%
Articulated truck involved								
No	77%	86%	65%	80%	69%	81%	70%	83%
Yes	23%	14%	35%	20%	31%	19%	30%	17%
Month								
January	9%	6%	10%	11%	12%	7%	11%	7%
February	11%	7%	5%	8%	5%	8%	6%	8%
March	11%	9%	8%	6%	3%	7%	7%	8%
April	5%	9%	10%	7%	7%	10%	8%	9%
May	11%	10%	4%	8%	7%	9%	7%	9%
June	11%	9%	10%	9%	8%	8%	9%	9%
July	10%	10%	7%	9%	8%	10%	8%	10%
August	4%	9%	8%	6%	9%	9%	8%	9%
September	13%	10%	10%	8%	10%	10%	11%	9%
October	8%	7%	9%	7%	11%	8%	9%	8%
November	5%	8%	6%	10%	7%	8%	6%	8%
December	2%	6%	13%	11%	14%	7%	11%	7%
Day of week								
Sunday	18%	14%	16%	13%	13%	14%	15%	14%
Monday	10%	14%	14%	12%	14%	13%	13%	13%
Tuesday	10%	12%	14%	12%	7%	14%	10%	13%
Wednesday	20%	14%	14%	16%	13%	13%	15%	14%
Thursday	14%	15%	14%	16%	14%	15%	14%	15%
Friday	14%	18%	15%	15%	16%	16%	15%	17%
Saturday	14%	12%	14%	16%	22%	15%	17%	14%
School or public holiday								
No	76%	76%	68%	73%	62%	75%	68%	75%
Yes	24%	24%	32%	27%	38%	25%	32%	25%
Time of day								
Day (6am-6pm)	50%	69%	49%	72%	53%	72%	51%	71%
Night (6pm-6am)	50%	31%	51%	28%	47%	28%	49%	29%
Total	100%	100%	100%	100%	100%	100%	100%	100%

Sources: RTA, VicRoads and Queensland Transport

Crashes include fatal, hospitalisation (serious injury) and other injury crashes, but exclude property damage crashes

GVH = Goulburn Valley Highway; A = Cunningham Highway; B = Leichhardt, Moonie & Warrego Highways; C = Gore Highway

Crash period is 1995-1999 for all except Victoria for which it is 1995-2000.

Discussion

A stepwise selection of crashes likely to be related to fatigue was conducted on data from different jurisdictions to enable monitoring of fatigue on NR39 over recent years. A consistent definition across the jurisdictions was feasible despite minor differences in the coding of the crash databases in each State.

Of greatest concern is the adequacy of the selection rules underlying the ATSB definition of a fatigue related crash. This definition will inevitably overlook some crashes caused by fatigue and also include crashes that are caused by factors other than fatigue. However, there is no existing definition that is widely accepted and could be consistently implemented. Accordingly, the ATSB definition appears to be both practical and to have face validity.

There is a degree of validation of the ATSB definition since the prevalence of fatigue related crashes varies in a consistent manner by region. Fatigue related crashes are more common in the remote areas where the roads are primarily single carriageways and traffic density is lowest and many motorists are undertaking long trips, and lowest in the more populated regions. For example, the fatigue crash prevalence is 5% on the Hume Highway, 12% on the Goulburn Valley Highway, 21% on the Newell Highway and 13% on the Queensland routes from the NSW border to Brisbane.

Other positive evidence for the definition is the consistent manner that the results vary with crash severity. It is lowest for injury crashes where no one requires hospitalisation and highest for crashes resulting in fatal injury. This is consistent with patterns in State based published figures.

Additionally, the breakdown of fatigue related crashes into single vehicle crashes (70%) and head on crashes (30%) is similar to that observed in other Australian research by Haworth and Rechnitzer (1993). They reported 75% single vehicle crashes and 22% head on crashes among fatigue related crashes.

A modest, but consistent increase in the estimate of fatigue related injury crashes from 12% in 1995 to 14% in 1999 is observed overall. However, the patterns within each State differ. The most stable figures over time are observed in Victoria, but the trends in NSW and Queensland are divergent. The NSW rate increased from 17% in 1995 to 27% in 1999 with most of the increase occurring in the last two years. The Queensland rate increased initially and then decreased.

The reasons for these different patterns are unclear. There is no evidence of a consistent change in the composition of the fatigue related crashes and there is no particular section of the Newell Highway where the increase is concentrated. The increase for the Newell Highway is interesting since an increase of a similar magnitude is not observed for injury crashes in NSW in general over the same time period. However, the decrease for the Queensland section of the route does appear to mirror the slight decrease observed for Queensland as a whole from 1997 to 1999.

Conclusion

Despite the difficulties in determining the actual contribution fatigue in individual crashes, we conclude that it is feasible to identify likely fatigue related crashes through crash characteristics routinely collected in the standard crash databases, and that this is sufficient for monitoring general trends in the prevalence of fatigue related trauma. Based on this analysis, there is no evidence for an overall decrease in fatigue related crashes on the heavy vehicle truck route between Melbourne and Brisbane which includes National Route 39. In particular, the percentage of fatigue related crashes on the Newell Highway section of this route has increased in recent years.

Acknowledgment

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