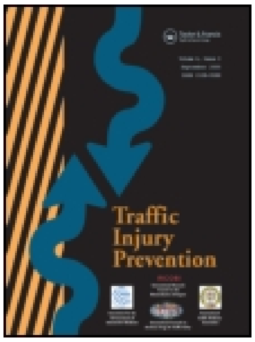

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Unlicensed Drivers and Car Crash Injury

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Objective. *Previous studies have indicated that unlicensed drivers are more likely to engage in risky driving behaviors, and are more likely than licensed drivers to be at fault and more seriously injured when involved in a crash. However, the prevalence of unlicensed drivers in the general driving population has not been measured, and the risk of an unlicensed driver being involved in an injury crash has not been quantified. We examined the association between unlicensed driving and car crash injury using data from a population-based case control study.*

Methods. *The study population was the drivers of all cars on public roads in the Auckland region. Cases were 571 vehicles involved in a crash resulting in any occupant being hospitalised or killed, from the study base, during the recruitment period. Controls were 588 vehicles selected from the driving population using a random cluster sampling method. The drivers of all vehicles completed a structured interview covering multiple potentially crash-related factors.*

Results. *Driving unlicensed was reported by 12% of case and 1% of control drivers. Unlicensed drivers were at significantly higher risk of car crash injury than those holding a valid licence (odds ratio 11.1, 95% confidence interval 4.2 to 29.7) after adjustment for age and sex. After further adjustment for education level, ethnicity, driving exposure, time of day, sleepiness score, year of vehicle manufacture, passenger carriage, seatbelt use, blood alcohol concentration, and travelling speed at time of crash, the increased risk was still present but no longer significant (OR 3.9, 95% CI 0.7–22.4).*

Conclusions. *Unlicensed drivers are a high risk group for car crash injury after taking other crash-related risk factors into account. Strategies to reduce unlicensed driving may therefore facilitate reductions in road crashes, although further work is needed in this area.*

Keywords Transportation; Motor Vehicle Injury; Unlicensed Drivers; Case-Control Study

Many countries require drivers to hold a licence to legally operate a motor vehicle, and reserve the right to suspend or disqualify this licence if road rules are not obeyed. Despite such laws, a number of people drive unlicensed, either having never obtained a licence or continuing to drive after their licence has been suspended or disqualified (Griffin & DeLaZerda, 2000; Knox et al., 2003). These unlicensed drivers are thought to be at higher risk of motor vehicle injury than their licensed counterparts, but this has been difficult to prove (Federal Office of road Safety, 1997a; Griffin & DeLaZerda, 2000; Knox et al., 2003).

Several studies of unlicensed drivers have suggested that they are more likely to engage in risky driving behaviors such as speeding, drink driving, red light running, and non-use of seatbelts, than those with a valid licence (Federal Office of Road Safety, 1997; Retting et al., 1999; Griffin & DeLaZerda 2000; Kim & Kim, 2003). It has also been suggested that unlicensed drivers may be over-represented in crash statistics (Federal Office of Road Safety, 1997; Griffin & DeLaZerda, 2000), but this has not been conclusively demonstrated because of a lack of comparative data on the prevalence of unlicensed driving in the general driving population (DeYoung et al., 1997; Knox, 2003). Studies of crashed drivers have found that compared to licensed drivers, unlicensed drivers are more likely to be at fault (Perneger & Smith, 1991; Land Transport Safety Authority, 2003) and more seriously injured (Harrison, 1997) when involved in a crash. These studies used control drivers who were involved in a crash, rather than population-based controls, so were unable to determine the excess risk of car crash injury for unlicensed drivers.

Only one previous study has estimated the driving exposure of suspended/revoked and unlicensed drivers, using a "quasi-induced" exposure estimation method (DeYoung et al.,

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1997). This study found that both groups were at higher risk of crash involvement compared to validly licensed drivers, but caution that their exposure estimates are likely to be subject to significant bias. There remains a lack of estimates of the prevalence of unlicensed driving amongst the general driving population, and because of this the excess risk of an unlicensed driver's involvement in a crash that leads to injury has not previously been quantified.

In New Zealand, a driver's licence is obtained by completing a series of applications and driving tests, and payment of a number of fees. Unlicensed drivers may have not undertaken this licensing process, or they may have had their licence suspended or disqualified for a variable period of time as a result of offences such as drink driving, speeding, or other serious infringements of the road rules (Land Transport Safety Authority, 2004). We used data from a population-based case-control study conducted in the Auckland region of New Zealand to examine the prevalence of unlicensed driving in the regional driving population, and the relationship between unlicensed driving and car crash injury.

METHODS

A complete description of the methodology of the study has been published previously (Connor et al., 2002). Recruitment took place from 1998 to 1999 in the Auckland region, which contains the largest city in New Zealand and a mixture of other urban, suburban and rural areas. The regional population is about 1.1 million people (Statistics New Zealand, 2001). The study base was defined as all light vehicles driving on non-local public roads in the region. Case vehicles were identified when any occupant of a vehicle from the study base was hospitalized or killed in a crash during the recruitment period. Case identification took place through surveillance at the four hospitals serving the Auckland region, and through the Auckland Coroner.

During the study period 615 eligible case drivers were identified and interviews were completed for 571 (93%) of these. Control selection aimed to achieve a representative sample of all driving time for the study base during the recruitment period. Control vehicles were identified during the same time interval and at approximately the same rate as cases. To select controls, a list of roads in the Auckland region was obtained and 69 roadside sites were randomly selected from this list. A day of the week, time of day, and direction of travel were randomly assigned to each site. Study staff then visited the site at the selected time and vehicles that passed the site during a defined period were randomly selected as control vehicles. The number of vehicles selected from each site was proportional to the volume of traffic at the site. These vehicles were stopped at the roadside and a suitable time for a telephone interview was arranged. During these roadside surveys 746 control cars were identified, and of these, interviews were completed with 588 drivers (79% response rate).

Interviews for the drivers of case and control vehicles were conducted by telephone for 204 (36%) case drivers and 576 (98%) control drivers; the remaining interviews were conducted in person. Proxy respondents were interviewed for 57 case drivers and two control drivers who were fatally injured or unable to be interviewed for other reasons. All interviews were based on a structured questionnaire that included characteristics of the driver, circumstances of the crash, and vehicle characteristics. For control drivers, the interview was referenced to the time of being sampled in the roadside survey. Licence status was determined by asking drivers what type of car licence they held at the time of the crash or survey.

For these analyses, "unlicensed" drivers were those that had never held a car licence or whose licence was disqualified or suspended at the time of the crash/survey; other types of licence, including full licences, learner licences, and overseas licences, were considered valid. Blood alcohol level was determined using a breathalyser for controls and from hospital and police records for cases. Missing data for blood alcohol level was imputed according to self reported alcohol consumption prior to the crash and the suspicions of ambulance and hospital staff. Details of alcohol imputation have been previously published (Connor et al., 2004). Environmental surveys of crash and control recruitment sites were conducted to measure environmental factors potentially related to crashes.

Odds ratios (OR's) and 95% confidence intervals (CIs) were calculated from linear logistic regression models using SUDAAN software, which accounts for intra-cluster correlation of control data sampled from the same site (Shah et al., 1997). For the multivariable analyses, we identified potential confounders from the epidemiological literature and adjusted for these if they were significantly associated with car crash injury in our data after controlling for driver's age and sex. Because unlicensed driving may influence crash risk indirectly through its associations with other risky driving, we examined the association between unlicensed driving and car crash injury by first adjusting only for age and sex.

We then adjusted for ethnicity, education level, and driving exposure (average hours spent driving per week), plus acute driving-related exposures at the time of the crash/survey (passenger carriage, time of day, Stanford sleepiness score, year of vehicle manufacture, blood alcohol concentration, seatbelt use, and travelling speed). We also examined the contribution that each of these confounders made to the age and sex adjusted odds ratio for the association between unlicensed driving and car crash injury. This was done by adding each variable to this model individually and estimating the percentage by which this changed the odds ratio, using the formula $100\,([OR_U\text{-}OR_A]/[OR_U - 1])\%$ where OR_U and OR_A are, respectively, the odds ratios for unlicensed driving and car crash injury unadjusted (except by age and sex) and after further adjustment for each risk factor alone.

RESULTS

The mean age of case drivers was 36.6 years, and control drivers 40.8 years. The case group was 65% male and the control group was 59% male. There were no significant differences in age group, sex, or driving conditions, between drivers who were interviewed and all eligible drivers, for both case and control vehicles.

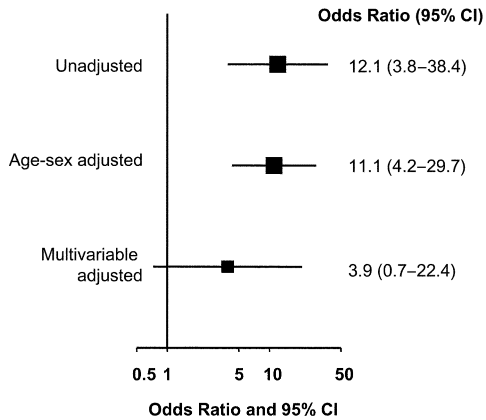

Figure 1 Unadjusted, age and sex adjusted, and multivariable adjusted odds ratios (95% confidence intervals) for the association between unlicensed driving and car crash injury, Auckland Car Crash Injury Study. The multivariable odds ratio is adjusted for age, sex, ethnicity, education, driving exposure, passenger carriage, time of day, sleepiness score, year of car manufacture, blood alcohol concentration, seatbelt use, and traveling speed at the time of crash.

Table I shows the frequency distributions of licence status and confounding variables by case/control status. The prevalence of unlicensed driving at the time of the crash/survey was 11.6% (n = 66) amongst cases and 1.1% (n = 7) amongst controls. Missing data for both cases and controls was less than 1% for licence status, and less than 10% for all variables used in these analyses after imputation for blood alcohol level.

Figure 1 shows the unadjusted, age and sex adjusted, and multivariable adjusted odds ratios and 95% confidence intervals for the association between unlicensed driving and car crash injury. Unlicensed drivers were at significantly higher risk of car crash injury than those holding a valid licence in the unadjusted model (OR 12.1, 95% CI 3.8 to 38.4), and after adjustment for age and sex (OR 11.1, 95% CI 4.2 to 29.7) However, after adding education level, ethnicity, driving exposure, time of day, sleepiness score, year of vehicle manufacture, passenger carriage, seatbelt use, blood alcohol concentration, and travelling speed at time of crash, the increased risk was no longer significant (OR 3.9, 95% confidence interval 0.7 to 22.4). These adjustments had a similar effect when restricted to the subset of participants with complete data.

Figure 2 shows the proportion of the age and sex adjusted odds ratio for unlicensed driving and car crash injury explained by the confounders we examined. Ethnicity and education level were the two largest contributors, accounting for 47% and 34% of the odds ratio respectively, followed by Stanford sleepiness score (32%), blood alcohol level (25%) and driving exposure (22%).

DISCUSSION

This population based case control study allowed us to examine the prevalence of unlicensed driving the Auckland regional driving population and the excess risk of car crash injury for unlicensed drivers. Driving unlicensed was reported by 12% of cases in this study, of whom 10% had never held a licence and 2% held a licence that was currently suspended or disqualified. Unlicensed drivers had about 11 times higher risk of being

Table I Frequency distributions of licence status and confounding variables by case/control status, Auckland Car Crash Injury Study

	Cases (n = 571)		Controls[1] (n = 588)	
	No.	(%)	No.	(%)
Licence status				
Unlicensed (total)	66	(11.6)	7	(1.1)
Never held	55	(9.6)	6	(1.1)
Disqualified/suspended	11	(1.9)	1	(0.02)
Valid	502	(87.9)	580	(98.8)
Don't know/missing	3	(0.5)	1	(0.1)
Age of driver (years)				
< 25	195	(34.2)	91	(13.7)
25–34	133	(23.3)	125	(22.3)
35–44	85	(14.9)	154	(24.5)
45–54	61	(10.7)	107	(19.6)
55–64	39	(6.8)	80	(14.2)
65+	58	(10.2)	31	(5.6)
Sex				
Female	198	(34.7)	226	(41.3)
Male	373	(65.3)	362	(58.7)
Education level				
Post secondary	178	(31.5)	276	(49.3)
Secondary school, >3 years	137	(24.2)	154	(25.1)
Secondary school, ≤3 years	252	(44.4)	157	(25.6)
Ethnicity				
White/European	313	(54.8)	444	(74.7)
Maori	117	(20.5)	61	(9.2)
Pacific Islander	86	(15.1)	36	(6.1)
Other	55	(9.6)	47	(10.0)
Driving exposure (average hours per week)				
≤5	219	(42.1)	171	(30.5)
6–10	205	(39.4)	216	(39.3)
11–20	63	(12.1)	135	(22.3)
21–30	11	(2.1)	32	(3.8)
>30	22	(4.2)	27	(4.1)
Time of day				
Not between 2–5 am	525	(91.9)	571	(99.6)
Between 2–5 am	46	(8.1)	17	(0.4)
Stanford Sleepiness Score				
1–3 (sleepy)	447	(87.7)	578	(99.0)
4–7 (not sleepy)	63	(12.3)	8	(1.0)
Year of vehicle manufacture				
<1984	118	(23.9)	58	(8.9)
1984 to 1988	157	(31.8)	164	(31.0)
1989 to 1993	169	(34.2)	207	(37.8)
≥1994	50	(10.1)	133	(22.4)
Number of passengers				
0	285	(50.3)	355	(62.9)
1	140	(24.7)	144	(23.4)
2 or more	142	(25.0)	88	(13.7)
Seatbelt use				
Yes	469	(82.1)	568	(97.4)
No	81	(14.2)	4	(0.8)
Blood alcohol concentration (mg %)[2]				
<3	397	(69.7)	565	(96.6)
3–50	41	(7.2)	16	(2.6)
>50	132	(23.2)	6	(0.8)
Travelling speed				
0–30 kph	87	(16.9)	78	(13.9)
31–50 kph	113	(21.9)	229	(41.5)
51–80 kph	196	(38.1)	220	(33.7)
>80 kph	119	(23.1)	55	(11.0)

[1]Proportions of controls are adjusted for the clustered sampling design.
[2]Missing data imputed (Connor et al., 2004).

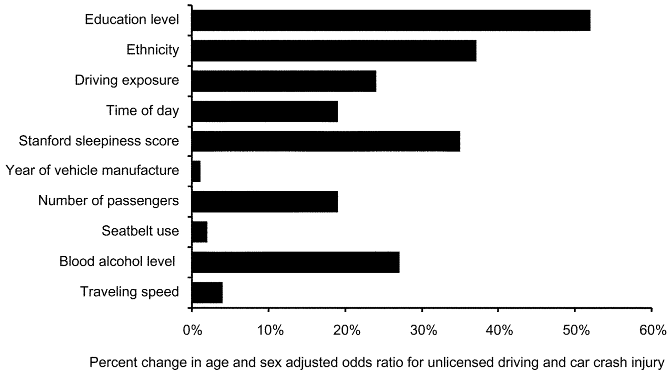

Figure 2 Proportion of the age and sex adjusted odds ratio for unlicensed driving and car crash injury explained by other risk factors, Auckland Car Crash Injury Study.

involved in a serious injury crash compared to drivers holding a valid licence after adjustment for age and sex. This positive association was still present after adjusting for other crash-related factors, although it was no longer significant probably due to lack of power.

Our prevalence estimates are consistent with several previous studies. Crash statistics from New Zealand indicate that in 1998, 11% of fatal crashes involved a disqualified or unlicensed driver (Land Transport Safety Authority, 2000). Griffin and DeLaZerda (2000) examined 278,078 drivers involved in fatal crashes using the Fatal Accident Reporting System in the United States. Of these drivers, 11% of these held an invalid licence or had no known licence. Harrison (1997) found that of fatal crashes in Victoria, Australia, 2% had a disqualified licence. However, there are few previous estimates of the frequency of unlicensed driving amongst the general driving population. In the control population of our study, conceptually representing the Auckland regional driving population, 1% reported being unlicensed or disqualified/suspended at the time of the roadside survey. Using a "quasi-induced" exposure method, also using data from the Fatal Accident Reporting System, DeYoung et al. (1997) estimated that 9% of the driving population in California had a suspended or revoked licence. This is higher than our estimate, but the authors of this study note several serious limitations of their estimation methods. Further representative surveys are required to measure the prevalence of unlicensed driving more accurately.

We also found a strong association between unlicensed driving and car crash injury after adjustment for age and sex. Even after adjustment for other crash-related risk factors, the point estimate for the odds ratio was about four, although this was no longer significant. This lack of significance is likely to be due to small numbers producing wide confidence intervals. Our finding that unlicensed drivers are a high-risk driving population is consistent with previous research. Two studies have examined the effect of driving unlicensed on crash severity. Shibata & Fukuda (1994) used data from police-reported traffic crashes of both cars and motorcycles in Fukuoka Prefecture, Japan, comparing characteristics of crash-involved drivers who died to those who were uninjured (Shibata & Fukuda, 1994). After adjustment for age, unlicensed drivers of cars were three times more likely, and drivers of motorcycles nine times more likely, to be killed when involved in a car crash compared to licensed drivers. The association was significant only for motorcycle drivers.

Harrison (1997) conducted a similar study of crash-involved drivers in Victoria, Australia, and found a significant difference between the frequency of disqualified licences amongst fatally injured drivers (4.6%) compared to uninjured drivers (0.7%) in unadjusted analyses (Harrison, 1997). Another study examined the effect of various driver characteristics, including licence status, on involvement in an at-fault crash (Perneger & Smith, 1991). Using paired crash data from the Fatal Accident Reporting System in the United States, this study found that drivers with an invalid licence were about twice as likely to have initiated the crash compared to those holding a valid licence. Our results confirm unlicensed drivers to be a population at high risk of serious car crashes and suggest that unlicensed drivers have three times excess risk of involvement in an injury crash compared to licensed drivers.

Driving unlicensed is unlikely to directly increase the risk of car crash injury and the mechanism by which this population is at risk is probably through associations with other crash-related factors. Of the acute risky driving behaviors we examined, sleepiness and blood alcohol level accounted for the largest proportion of the age and sex adjusted odds ratio. Other studies have also found evidence that unlicensed drivers may be more likely to display risky driving behaviors, including speeding, drink driving, red-light running, and non-use of seatbelts (Federal Office of Road Safety, 1997b; Retting et al., 1999; Griffin & DeLaZerda, 2000; Kim & Kim, 2003). In our data, education level, ethnicity, and driving exposure were also important contributors to the relationship between unlicensed driving and car crash injury.

There were significant associations between unlicensed driving and ethnicity ($p = 0.01$), with more Maori and Pacific Islanders being both never licensed and holding a disqualified or suspended licence. There were no significant associations between licence status and other demographic variables, including age ($p = 0.2$). Because of small numbers we were not able to fully investigate the relationships between licence status and other associated variables; this will be an interesting area for future research. However, although a variety of crash-related variables may account for the relationship between unlicensed driving and car crash injury, explicit knowledge of these need not be a prerequisite for the implementation of countermeasures aimed at unlicensed drivers.

Our study has several potential limitations. Licence status and many of the other variables were self reported. Because driving unlicensed is illegal in New Zealand, this may be underreported and is therefore a potential source of measurement bias. However, questions on illegal behaviors were embedded in a large questionnaire containing multiple items relating to driving; interviewers were highly trained and assured participants of complete confidentiality. Our data on excess alcohol consumption prior to driving (also illegal in New Zealand) suggest that self report is a valid measure, as the correlation between self reported and objective measures of alcohol consumption was high (Spearman correlation coefficient = 0.77).

The differential response rate between cases and controls may have introduced selection bias, particularly if non-responders amongst the control population tended to be unlicensed. If this is the case, we are likely to have underestimated the prevalence of unlicensed driving in controls, which would result in an overestimate of the risk of injury crashes. Confounding variables, particularly those that relate to risky and illegal driving, may have also been inaccurately measured. Case control studies using self-reported data may also be subject to recall bias (Woodward, 2005), although it is difficult to predict what effect this would have on our estimate of effect.

The increased risk of injury to vehicle occupants when the driver is unlicensed supports the need for interventions aimed at this population. Other authors have suggested a variety of measures that may be effective, including increasing police resources to enable enforcement, reviewing and broadening the penalties applied, and increasing public awareness of the dangers of unlicensed driving and the penalties involved (Knox et al., 2003). Others have proposed applying barriers to driving including vehicle impoundment, electronic driver licences, and ignition interlocks when licences are suspended or disqualified (Griffin & DeLaZerda, 2000).

For most jurisdictions, interventions in the short term are likely to focus on enforcement and education strategies. Unlicensed driving is unlikely to be a randomly distributed characteristic and the identification of high-risk groups and risk factors for unlicensed driving, for example, age, gender, ethnicity, socioeconomic status, or lifestyle factors such as hazardous alcohol use, would aid in targeting health promotion strategies. There may also be value in reviewing the suitability of current licensing processes and driver training for these specific groups. Although the primary aim of such interventions should be to reduce unlicensed driving, a harm minimisation approach aiming to decrease risky driving amongst unlicensed drivers may also achieve a reduction in injuries.

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