

## ORIGINAL ARTICLE

## A cohort study of 20 822 young drivers: the DRIVE study methods and population

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**Background and objective:** Research on young drivers directly linking risk factors to serious injury and death outcomes is required. The DRIVE Study was established to facilitate this aim. This paper outlines the study methods and describes the population that has been recruited, in order to demonstrate that the necessary heterogeneity in risk factors has been attained.

**Design, setting and participants:** Drivers aged 17–24 years holding their first-stage provisional driver's licence from New South Wales, Australia, were recruited into a prospective cohort study. The participants were contacted by mail and asked to complete the study questionnaire at an online site or via a mailed questionnaire. Baseline data collection involved a questionnaire with questions to drivers about their training, risk perception, driver behavior, sensation-seeking behavior and mental health. Participants gave consent for prospective data linkage to their data on licensing, crashes and injuries, held in routinely collected databases.

**Results:** 20 822 drivers completed the baseline questionnaire, of whom 45.4% were men, 74.3% resided in capital cities and 25.7% in regional or remote areas. The recruited study population showed a wide variation in the risk factors under examination. For example, almost 40% of drivers reported drinking alcohol at hazardous levels and about 32% of participants seemed to be at a high or very high risk of psychological distress. Participants reported a mean of 67.3 h (median 60 h) of supervised driver training while holding their learner's permit.

**Conclusions:** The DRIVE Study has a robust study design aimed at minimizing bias in the collection of outcome data. Analyses of baseline data showed substantial heterogeneity of risk factors in the study population. Subsequent prospective linkages comparing relative differences in exposures at baseline with the outcomes of interest have the potential to provide important new information needed to develop targeted interventions aimed at young drivers.

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Young drivers are over-represented in crash, injury and death statistics in Australia and other high-income countries, crashing at almost double the rate of other drivers.<sup>1,2</sup> Although death rates of young drivers have declined in Australia over the past 20 years in line with death rates for all drivers, this over-representation of young drivers has not changed.<sup>1</sup>

Several risk factors are obvious for injury from car crash in young people. Driving at a young age,<sup>3</sup> having little driving experience,<sup>4</sup> being male,<sup>5</sup> driving after drinking alcohol,<sup>4</sup> driving at night<sup>6–8</sup> and passenger carriage<sup>9–11</sup> are all associated with an increased risk of crashing (and associated injury) in young drivers. The identification of these risk factors has been instrumental in the design and implementation of specifically targeted intervention strategies such as graduated licensing schemes, which have been shown in a recent Cochrane review<sup>12</sup> to be successful in reducing the risk of crashing in populations where they have been introduced.

However, despite the gains made as a result of the introduction of population-wide strategies, further research in the area is required if the burden of injuries among young drivers has to reduce to levels comparable to those in other age groups. Several key risk factors still warrant further investigation. For example, the role of training and education for young drivers is constantly on the political agenda in Australia and other countries,<sup>13</sup> but little research on the associations between the amount and the type of driver training and the risks of crash and injury is available. The role of mental health conditions, which are common and often

inadequately managed in young people,<sup>14</sup> is little understood in relation to car crash injury. Similarly, the role of risk perception, driver behavior and sensation-seeking behavior in young driver crashes is under debate. Although a substantial body of research has examined these risk factors, they have primarily been the subject of small-scale or simulator studies, with most studies examining the relationships between these factors and involvement in risky driving rather than the extent to which exposure to these factors increases the risk of driver injury.<sup>15</sup> Identification of the roles that each of these factors has in injuries of young drivers will be crucial in developing additional, evidence-based strategies for injury prevention in young drivers.

The use of objectively recorded outcomes such as serious injury and death has been rare in research on young drivers, partly because of the logistical issues and cost involved in recruiting large numbers of participants. To understand more clearly the risk factors that lead to injury and death in young drivers, a large-scale, well-designed and well-conducted study that would examine injury and, particularly, moderate to serious injury, as an outcome measure in young drivers is needed. The method of cohort studies has been successfully used in previous large-scale studies on injury<sup>16</sup>; and provided that it is possible to recruit appropriate numbers of participants displaying heterogeneity with respect to the risk factors of interest, the design is an excellent mechanism to

**Abbreviation:** NSW, New South Wales.

examine the associations between risk factors and outcomes under consideration.

The DRIVE Study is a prospective cohort study established with the aim of examining risk factors for injuries in young drivers. The purpose of the study is to link baseline exposures, prospectively, to the outcomes of interest. This paper documents the methods used in the study and provides information describing the study population, in order to demonstrate the attainment of necessary heterogeneity of risk factors.

## POPULATION AND METHODS

The eligible population included drivers aged 17–24 years holding their first-stage provisional motor vehicle driver's license from New South Wales (NSW), Australia. Eligible participants were identified via the licensing database of the state road authority—namely, the Roads and Traffic Authority of NSW—and were mailed a letter inviting them to visit a secure study website to complete the survey or, where internet access was not available, to call a tollfree 1-800 number to request a printed questionnaire and reply-paid envelope. The introductory letter was accompanied by a letter from the Roads and Traffic Authority encouraging eligible participants to join the study, but mentioning that participation was voluntary.

Letters were sent to all eligible drivers in NSW from June 2003 to December 2004. To maximize the numbers of participants, mail-outs to drivers in the various geographical regions of NSW were accompanied by regional media campaigns aimed at raising awareness of the study. This involved sending a press release about the study to all media agencies in the area and conducting media interviews highlighting the importance of regional participation in the study.

### Questionnaire

Participants in the study completed a questionnaire, either online or on an identical print version. The online questionnaire was housed on a secure website that contained online consent forms and the questionnaire. The questionnaire was designed to be completed in 15–20 min and included questions about the potential risk factors for injuries in young drivers. Participants were assured that all information was confidential and that information related to their identification would not be stored or used in conjunction with the answers they supplied. Participants gave consent for their information to be linked in future to databases holding their licensing and car crash records, and databases of injuries, hospitalizations and deaths caused by car crashes. These prospective linkages will start in late 2006.

The questionnaire contained several questions about demographics, ethnicity, driving experience and training, risk perception, driver behavior, lifestyle habits including alcohol and marijuana use, sensation seeking, mental health and sleep habits. Demographic questions were adapted from the Australian Bureau of Statistics questionnaires. Area of residence was coded using the Australian Bureau of Statistics Remoteness Structure.<sup>17</sup>

Questions related to driver training and driver exposure were adapted from the Western Australian Young Driver Cohort Study<sup>18</sup> and the University of Otago Young Driver Pilot Study.<sup>19</sup> Drug use was measured using two questions from the Centers for Disease Control and Prevention's Youth Risk Behavior Surveillance System<sup>20</sup> on the use of marijuana (cannabis) and other recreational drugs in the past 12 months. Alcohol use was measured using a three-item subscale of the Alcohol Use Disorders Identification Test.<sup>21–22</sup> Risky driving behaviors were measured by questions about the current frequency of specific risky driving behaviors,

adapted from Donovan and Jessor<sup>23</sup> and from the University of Otago Young Driver Pilot Study.<sup>19</sup> Risky driving outcomes related to drug and alcohol use were measured using questions from the Youth Risk Behaviour Surveillance System on the frequency of driving a car after drinking alcohol and driving a car after smoking marijuana in the past 4 weeks.<sup>20</sup> Other scales used in the study included the Impulsive Sensation Seeking Scale of the Zuckerman-Kuhlman Personality Questionnaire,<sup>24</sup> the Kessler-10 Psychological Distress Scale<sup>25</sup> and a question from the Beck Suicide Intent Scale that was also used in the Victorian Adolescent Cohort Study.<sup>26</sup>

The University of Sydney Human Research Ethics Committee and the New South Wales Health Ethics Committee approved the study. Participants were reimbursed for their time with a cinema ticket voucher.

Data were analyzed using SAS V.8.

### Study population and sample size

The study was designed to detect with 90% power and a type I error rate of 5% ( $\geq 50\%$ ) increases in risk of injury for drivers who are exposed to the risk factors considered. On the basis of the data from the Western Australian Young Driver Study,<sup>18</sup> it was estimated that a total sample size of about 20 000 would be required to make comparisons for injuries and deaths in the prospective component of the study.

## RESULTS

Of the 20 822 people who completed the questionnaire, 95% did so online. Initial response rates were very low (3%), but improved once participants were reimbursed for their time with a cinema ticket. The overall response rate was 15.9% (range 5.5–22.9%). Higher response rates were achieved in north and northwest metropolitan Sydney. A higher response rate (22.1%) was also achieved in the Northern Rivers area, which had major media coverage for the study. A lower response rate was achieved in the more remote regions of NSW (6.5% in Broken Hill, 9.6% in New England). Resending study information to non-responders resulted in a minor increase in the mean response rate (4%), but incurred substantial costs and so was not continued.

Table 1 shows the demographic data on the study population. Of the 20 822 participants, 9457 (45.4%) were men, 10 258 (49.3%) were aged 17 years, 74.3% resided in capital cities and 25.7% in regional or remote areas of NSW. Most participants ( $n = 17\ 715$ , 85.3%) were born in Australia, as were most of their parents (mothers:  $n = 13\ 755$ , 66.2%; fathers:  $n = 13\ 123$ , 63.3%).

Figures 1 and 2 and table 2 outline the characteristics of the study population. Most participants ( $n = 19\ 296$ , 94.4%) reported taking lessons from a parent or other supervising driver while holding their learner's license, and 80.9% ( $n = 16\ 521$ ) reported taking lessons from a professional driving instructor. Participants reported a mean of 67.3 h (median 60 h) of total supervised driving experience (including hours accrued with a professional driving instructor or with a parent or other supervising driver) while holding their learner's license. Figure 1 shows the distribution of hours.

Almost 30% ( $n = 5928$ ) of the drivers reported that they, or someone they knew, had been involved in a crash involving serious injury or death. When asked to compare their own driving with someone at the same stage of licensing, 18.6% ( $n = 3736$ ) considered that they were much better, 43.7% ( $n = 8776$ ) said they were better and 36.1% ( $n = 7252$ ) reported they were about the same. Likewise, when asked to compare their driving with all drivers, 6.4% ( $n = 1293$ ) considered themselves to be much better, 23.5% ( $n = 4723$ ) considered themselves better and 56.3% ( $n = 11\ 316$ ) thought they were about the same. Some participants

**Table 1** Demographic details of the DRIVE Study participants

| Characteristic                       | n (%)         |
|--------------------------------------|---------------|
| Age (years)                          |               |
| 17                                   | 10 258 (49.3) |
| 18                                   | 5265 (25.3)   |
| 19                                   | 2382 (11.4)   |
| 20                                   | 1158 (5.6)    |
| 21                                   | 700 (3.4)     |
| 22                                   | 457 (2.2)     |
| 23                                   | 342 (1.6)     |
| 24                                   | 260 (1.3)     |
| Sex                                  |               |
| Female                               | 11 365 (54.6) |
| Male                                 | 9457 (45.4)   |
| Area of residence                    |               |
| Major cities                         | 15 477 (74.3) |
| Inner regional                       | 4401 (21.1)   |
| Outer regional                       | 896 (4.3)     |
| Remote or very remote                | 48 (0.2)      |
| Marital status                       |               |
| Single                               | 19 191 (92.6) |
| Married or de facto                  | 1012 (4.9)    |
| Separated, widowed or divorced       | 527 (2.5)     |
| Live with parents                    |               |
| Yes                                  | 18 811 (90.6) |
| No                                   | 1952 (9.4)    |
| Occupation                           |               |
| High school                          | 10 289 (50.2) |
| College or university                | 5591 (27.3)   |
| Fulltime work                        | 2419 (11.8)   |
| Part-time work                       | 1304 (6.4)    |
| Unemployed or social security        | 634 (3.1)     |
| Not looking for work                 | 278 (1.4)     |
| Aboriginal or Torres Strait Islander |               |
| No                                   | 20 418 (98.7) |
| Yes                                  | 271 (1.3)     |

**Table 2** Characteristics of the DRIVE Study participants

| Characteristic                                     | n (%)         |
|--|---------------|
| AUDIT-C score                                      |               |
| At risk  | 7851 (39.3)   |
| Not at risk  | 12 149 (60.8) |
| Kessler-10 score                                   |               |
| Low  | 5822 (29.1)   |
| Moderate   | 7664 (38.3)   |
| High   | 4992 (24.9)   |
| Very high  | 1535 (7.7)    |
| Self-harm*   |               |
| No   | 18 000 (92.1) |
| Yes  | 1544 (7.9)    |
| Driven after drinking alcohol in the past 4 weeks  |               |
| Never  | 18 574 (93.4) |
| 1–2 times  | 1173 (5.9)    |
| ≥3 times   | 89 (0.5)      |
| Don't know   | 47 (0.2)      |
| Driven after smoking marijuana in the past 4 weeks |               |
| Never  | 19 250 (96.8) |
| 1–2 times  | 398 (2.0)     |
| ≥3 times   | 176 (0.9)     |
| Don't know   | 56 (0.3)      |
| How often would you smoke marijuana?               |               |
| Never  | 17 292 (86.1) |
| ≤1 times a month                                   | 2098 (10.4)   |
| 2–4 times a month                                  | 400 (2.0)     |
| 2–3 times a week                                   | 121 (0.6)     |
| ≥4 times a week                                    | 176 (0.9)     |
| How often do you take other drugs?                 |               |
| Never  | 18 681 (93.2) |
| ≤1 time a month                                    | 1033 (5.2)    |
| 2–4 times a month                                  | 238 (1.2)     |
| 2–3 times a week                                   | 52 (0.3)      |
| 4 times a week or more                             | 43 (0.2)      |

AUDIT-C, Alcohol Use Disorders Identification Test Consumption sub-Scale.

\*Question related to self harm: "In the past 12 months have you ever deliberately hurt yourself or done anything that you knew might have harmed you or even killed you?"

reported that road risk behaviors were very common, such as driving while playing loud music and carrying passengers; other behaviors such as not wearing seatbelts were rare (fig 2).

The mean (standard deviation (SD)) score on the Impulsive Sensation Seeking Scale of the Zuckerman–Kuhlman Personality Questionnaire was 6.4 (4.2) for women and 7.8 for men (4.3). Table 2 shows the characteristics of drivers relating to risk-taking behavior, mental health and other factors. Almost 40% (n = 7851) of the drivers reported drinking alcohol at hazardous levels as measured by the Alcohol Use Disorders Identification Test-C scale; about 32% (n = 6527) of the drivers were at high or very high risk of psychological distress as measured with the Kessler-10 scale and 7.9% (n = 1544) reported self-harm behavior in the previous 12 months.

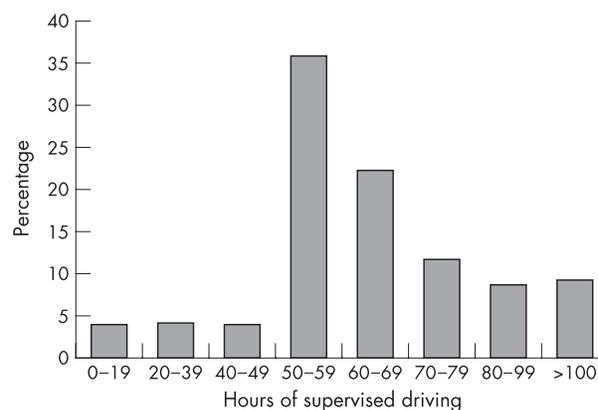
## DISCUSSION

The DRIVE Study is one of the largest known cohort studies examining risk factors for injuries in young drivers. A novel array of methods, including web-based data collection methods, media coverage and reimbursement for participants' time with a movie ticket, was used to recruit >20 000 young drivers into the study over an 18-month period.

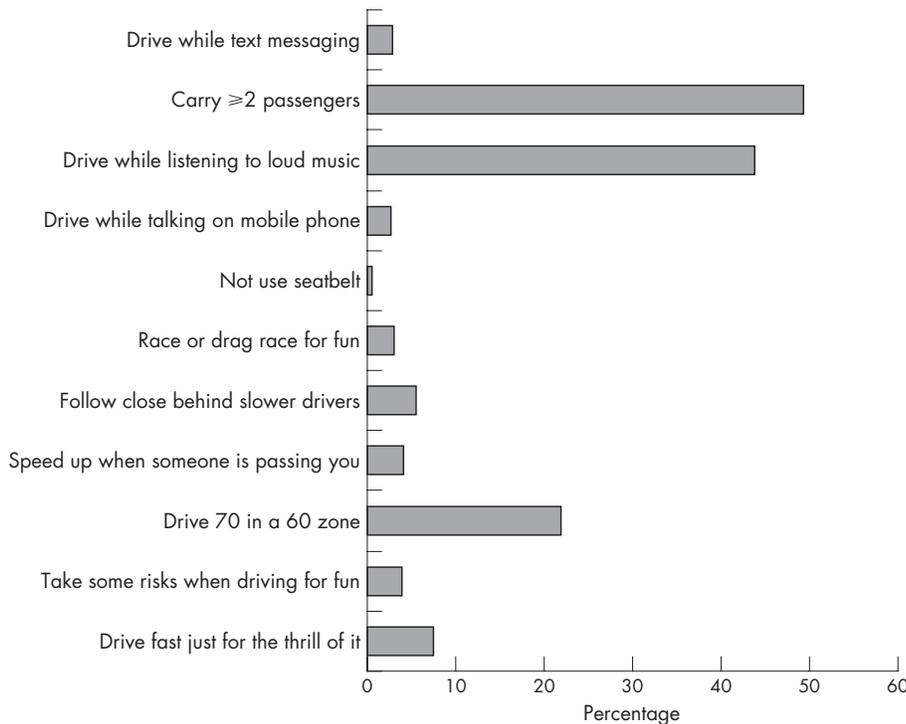
Recruitment of large numbers of participants into cohort studies is a challenging and often expensive task. Personal approaches were successfully used in both the Western Australian Young Driver Study<sup>18</sup> and the University of Otago Young Driver Pilot Study,<sup>19</sup> where people were approached by study staff at registry offices. However, with a sample size of 20 000 and a limited budget, this approach was not financially viable for the DRIVE Study. A mailed letter and online data collection were cheaper alternatives than face-to-face or telephone interviews, or mailing a printed

questionnaire, as it saved on the costs for staffing, return postage and data entry, although the savings were tempered somewhat by the cost of the cinema tickets.

As a cohort study, the DRIVE Study was not set up to be representative of any particular population. Opportunist recruitment of the study population means that calculations of prevalence or injury incidence are not possible and, indeed, were not intended. As evidenced by the results of other cohort studies, such as the British Doctors Study and the Nurses' Health Study, studies involving specific population groups have provided robust and widely generalizable findings about the nature of associations between a range



**Figure 1** Total hours of supervised driving experience with a professional instructor, parent or other supervising driver, while holding a learner's license.



**Figure 2** Proportion of respondents who reported road risk behaviors often or very often.

of risk factors and various major outcomes.<sup>27–28</sup> Such studies can only provide reliable population estimates of the relative associations between risk factors and outcome, but not absolute numbers or proportions.<sup>29</sup> Thus, there is no intention to extrapolate data on the prevalence of risk factors identified at baseline or the incidence of injuries identified in the linkage analyses from the study sample population to the population of young drivers in NSW or elsewhere, but rather the study identifies key risk factors in drivers for road traffic injury.

Although the response rate for the study is therefore of little consequence, it is, however, important that the study population exhibit wide variation in the exposures of interest at baseline. This was indeed found to be the case. The study population had almost equal proportions of women and men; roughly one quarter of participants reported residing in regional or remote settings. Heterogeneity also exists in the proportion of participants reporting hours of supervised driving experience, risk-taking behavior, and drug and alcohol use on scales of risk taking, road risk behavior and mental health. Variation in ethnicity of study participants was also found, with 15% of study participants born outside of Australia, and about 30% with a mother or father born elsewhere.

Although comparable data are unavailable from representative samples of young drivers, the study population has characteristics similar to those of other sampled populations of young people when compared on some key risk factors. For example, 39% of study participants reported drinking at hazardous levels, comparable to figures (39.7% for men and 36.6% for women aged 18–24 years) reported in the Bettering the Evaluation of Care and Health surveys of Australian general practice.<sup>22</sup> About 8% of the participants reported self-harm behavior compared with 10% in the Victorian Adolescent Cohort Study.<sup>26</sup> However, a higher proportion (32.6%) seemed to be at high or very high risk of psychological risk compared with the 16.3% found in the 2001 National Health Survey.<sup>30</sup>

Recruiting adolescents and young adults into research studies is often difficult, and following on from this, achieving high response rates for follow-up questionnaires can be problematic. For the main outcomes of the DRIVE Study—car crash, injury and death—linkages will be carried out to routinely collected data collections and are not reliant on participant response. Data linkages to outcome data may therefore be achieved without the introduction of selection bias from participant non-response, which is a considerable strength of the study.

### Implications for prevention

Given the large numbers of young drivers recruited to this study and the substantial heterogeneity observed in baseline risk factors, the DRIVE Study clearly has the potential to provide results that will have important implications in road

### Key points

- Research on young drivers directly linking risk factors to serious injury and death outcomes is required.
- The DRIVE study is a prospective cohort study of 20 822 new drivers aged 17–24 years in New South Wales, Australia, that will link baseline questionnaire data to data on road traffic offences, crashes and injuries.
- Analyses of baseline data have shown substantial variation across the population in several of the risk factors of interest—a necessary requirement for a successful cohort study.
- Once linkages to outcome data are complete, the study has the potential to provide important new information needed to develop targeted interventions aimed at young drivers.

safety policy for Australian and other jurisdictions. The use of a cohort methodology and, particularly, linkage to routinely collected data sources for objectively measured outcomes such as crash, injury and death, rather than risky driving or other proxy outcomes, is an important development in research on young drivers. The study thus has a robust design that enables the provision of useful data in the research on injuries in young drivers in the years to come.

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