

The prevalence and impairment effects of drugged driving in New Zealand

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Abbreviations and acronyms

ADHD	attention deficit hyperactivity disorder
ANOVA	analysis of variance
BAC	blood alcohol concentration
BZD	benzodiazepine
CAS	crash analysis system
DRUID	Driving Under the Influence of Drugs, Alcohol and Medicines (project)
ED	emergency department
ESP	Institute of Environmental Science and Research
FARS	fatality analysis reporting system
NMUPD	non-medical use of prescription drugs
NZADUS	New Zealand Alcohol and Drug Use Survey
OA	opioid analgesics
OR	odds ratio
SDLP	standard deviation of lane position
SSRI	selective serotonin re-uptake inhibitor
SWOV	Institute for Road Safety Research, The Netherlands
THC	tetrahydrocannabinol
UDA	unsafe driving action

Contents

Executive summary	7
Abstract	10
1 Introduction	11
2 Method	15
2.1 Stratified telephone survey.....	15
2.2 Internet survey.....	17
3 Respondent demographics	19
4 Incidence of drugged driving in New Zealand	22
4.1 Specific drugs consumed prior to driving	26
4.2 Drug combinations consumed prior to driving.....	28
4.3 Comparison of most commonly used drugs in New Zealand, Europe and Australia	29
5 Review of the impairment effects of the drugs of interest	31
5.1 Method.....	31
5.2 Results	32
5.2.1 Cannabis	34
5.2.2 Stimulants (amphetamine, methamphetamine, methylphenidate)	41
5.2.3 Strong painkillers	45
5.2.4 Benzodiazepines	49
5.2.5 Selective serotonin re-uptake inhibitors (SSRIs).....	53
5.3 Conclusion	53
6 Extent and timing of drugged driving	54
6.1 Summary	55
7 Modifications to driving behaviour	57
7.1 Summary	58
8 Perceptions and attitudes to drugged driving	60
8.1 Perceived impairment	60
8.2 Attitudes to drugged driving and police enforcement	62
8.3 Summary	65
9 Feasibility of a hospital- based toxicology study	67
10 Conclusions	69
11 Recommendations	72
12 References	73
Appendix A: Telephone survey: stage I	78
Appendix B: Telephone follow up survey: stage II	85
Appendix C. Internet survey	91

Executive summary

The overall purpose of the research described in this report was to establish a quantitative picture of the type and extent of drugged driving in New Zealand and investigate the level of driving impairment produced by the more commonly used drugs, both legal and illegal.

The research had five main objectives:

- 1 Conduct a statistically representative stratified telephone survey of New Zealand drivers to provide accurate and up-to-date information about the incidence of legal and illegal drugs consumed in New Zealand prior to driving.
- 2 Based on information collected in the survey, conduct a follow-up survey of drivers who had indicated they drove after drug use to determine the timing, type and extent of driving, presence of other vehicle occupants, and whether any self-selected countermeasures were used.
- 3 Carry out a systematic review of the available research literature on the degree of driving impairment produced by the most commonly taken drugs in New Zealand.
- 4 Conduct an internet survey of drivers' attitudes and perceptions of drugged driving, including the use of prescription drugs
- 5 Investigate the feasibility and approval requirements for establishing a procedure to obtain toxicology reports (based on blood samples) of trauma patients admitted to Waikato hospital as a result of a motor vehicle crash.

Phase 1 of the telephone survey focused on the incidence of drugged driving in New Zealand. A stratified sample (n=2,000; mean age = 47.62 years; 59.30% female) of drivers (representative of the age and gender of licensed drivers) from across New Zealand completed the telephone survey. Participants were asked to indicate if they took or used any prescription medications, over-the-counter medication, or drugs for recreational purposes. Specifically they were asked about their use of alcohol, amphetamine/methamphetamine, anti-anxiety drugs, antidepressants, anti-nausea medication, anti-psychotics, cannabis, cocaine/crack, ecstasy, kava, hallucinogens, strong painkillers, opiates, party pills, prescription stimulants, sedatives and synthetic cannabis. Of those surveyed, the drugs (other than alcohol) most commonly taken within three hours prior to driving were strong painkillers (9.81%), antidepressant medication (6.05%), anti-nausea medication (3.50%), cannabis (2.55%) and anti-anxiety medication (2.86%).

Information regarding the incidence of drugged driving was also obtained from the internet survey. Participants completing the online survey (n = 434; mean age = 34.54 years; 63.59% female) were younger compared with the telephone survey participants and the percentage of those driving within three hours of taking drugs was generally higher. The drugs taken most frequently just prior to driving were the same as in the phone survey: strong opioid-based painkillers (16.59%), antidepressant medication (14.29%), cannabis (12.67%), anti-nausea medication (5.76%) and anti-anxiety medication (5.53%).

Because the individual drugs belonging to some of these prescription medication types can have quite different actions, for analysis of their impairing effects they were re-classified by their mechanism of action (eg selective serotonin re-uptake inhibitors (SSRI)) rather than the illness they were prescribed to treat (eg antidepressants). Examining the drivers' characteristics associated with the specific drug types revealed some interesting differences between these drugged driving sub-groups. For example, the majority of those taking strong opioid-based painkillers within three hours of driving were female (58.80%) with an average age of 41.67 years. The average age of those taking SSRIs was similar (41.73

years) but there was an even greater proportion of females (78.70%). The benzodiazepine (BZD) users were slightly younger (mean age = 38.44 years) and again, over half of the sample was female (60.60%).

Participants using prescription stimulants prior to driving were on average aged 39.33 years, and half of the sample were female. The respondents reporting driving within three hours of using illegal substances (cannabis and amphetamine/methamphetamine) were generally younger (mean age = 30.32 years and 30.90 years respectively) and 59.60% of the cannabis users were male.

The follow-up phone survey focused on participants (n = 450, mean age = 48.10 years, 57.11% female) who reported taking strong painkillers (eg codeine, tramadol, methadone, morphine), SSRIs (fluoxetine, citalopram, paroxetine and sertraline), BZDs (diazepam, lorazepam, alprazolam), cannabis and stimulants (amphetamine, methamphetamine, methylphenidate). A significant proportion of the phone (16.59%) and internet survey participants (9.95%) reported taking combinations of different drugs prior to driving. The drug combinations frequently involved alcohol (43.01% overall), and different types of strong painkillers were often combined.

Using the information from the telephone survey regarding the most commonly used drugs, a systematic review was conducted to determine the degree of driving impairment caused by those drugs. The review focused on studies published between 2005 and 2015 and also drew on findings from the Driving Under the Influence of Drugs, Alcohol and Medicines project (DRUID) project funded by the EU 6th Framework Programme. The systematic review findings indicated that cannabis, opioid-based pain killers and BZDs are associated with increased crash risk. Controlled studies have shown that cannabis and BZDs impair driving-related skills, while codeine and oxycodone may have impairing effects. The effects of morphine and methadone are unclear due to variable results in the literature and a lack of reliable data. There is currently little evidence that SSRIs or tramadol are associated with increased crash risk or produce driving-related impairments, but in both cases further research is needed. In terms of the effects of stimulants on driving, most studies report improvements in driving-related performance (eg reaction time), but they may lead to increased risk taking and they do not compensate for the effects of fatigue. As described above, many drivers take more than one drug prior to driving. Combinations of BZDs or cannabis with alcohol lead to high levels of driving-related impairment, with estimates suggesting the odds ratios for crash risk are multiplicative (rather than additive) when substances are taken together.

The results of present surveys revealed that the extent of drugged driving in New Zealand is widespread, with over 50% of the participants who took SSRIs, BZDs or methylphenidate reporting 'drugged driving' once a week or more in the last 12 months. The proportion of those driving once a week or more was smaller for those driving after taking cannabis (42.6%), illegal stimulants (28.2%) and strong painkillers (25.5%). These proportions were similar to those indicating that it was 'very likely' they would drive within three hours of taking the drugs in the future. The timing of drug use differed markedly by drug type, with driving after legal/prescription drugs most frequently occurring in the morning prior to going to work or going shopping, and driving after cannabis use typically occurred in the evening (no data was available for stimulants).

There was evidence that the respondents were aware of the potentially impairing effects of the drugs on their driving behaviour with over half of the cannabis users, almost 40% of those taking strong painkillers and a quarter of those taking BZDs and deciding not to drive within three hours of taking the drugs. The main reason given was they thought their driving was negatively affected and they were worried for the safety of others. Only a small proportion of those taking SSRIs or stimulants had decided not to drive after taking them during the last 12 months (8.5% and 4.5% respectively). Cannabis users were also most likely to report changing when they took their drugs or changing when they drove after taking cannabis (50% in each case). For strong painkillers, SSRIs and BZDs, fewer than 20% of respondents reported using either strategy in the last 12 months.

Participants were also asked to provide a rating of the level of impairment produced by the drug they consumed. Cannabis was rated as producing the greatest impairment (2.8/10), followed by alcohol, strong painkillers, SSRIs and BZDs. Cannabis users also rated their driving speed and their ability to react to changing traffic as slower when driving after cannabis use compared with driving drug free. When asked to rate the degree of impairment produced by a range of different drugs in an average driver, hallucinogens, opiates, cocaine and stimulants were rated as most impairing and anti-nausea medication, antidepressants and anti-anxiety drugs were rated the least impairing.

Attitudes to drugged driving appeared to be primarily influenced by the legality of the drug being taken, with over 60% of participants stating they totally disagreed with the statement that 'it is ok to use illegal drugs and drive if you feel your driving skills have not been affected'. For prescription medications, however, opinions were nearly evenly divided, with almost a third agreeing with the statement and another third disagreeing with the statement. There was greater consensus with regard to police enforcement of alcohol, with over 80% of respondents believing that random roadside alcohol testing improved road safety. This statistic was lower for drugged driving, although over 60% of respondents thought it was a significant road safety issue and disagreed with the statement that random roadside drug testing would not improve road safety. Although a large majority of the respondents (> 60%) thought that people were likely to be caught by police for drinking and driving, only 26% of participants thought people were likely to get caught for drugged driving. There was also support from the respondents for more police time and resources to be directed towards enforcing drugged driving laws.

Another aspect of the study focused on the feasibility of an alternative approach to studying drugged driving which was not reliant on participant self-reporting. This was the analysis of blood or saliva samples from drivers involved in a crash. In New Zealand, several reports have been published based on drug levels found in blood samples of dead and injured drivers analysed for blood alcohol testing, but the sample sizes have been relatively small and limited to blood collected for evidential purposes. It is clear, however, that analysis of a larger sample of drivers involved in crashes would provide a more accurate picture of the extent (and impact) of drugged driving in New Zealand. Consultation was undertaken with staff from Waikato District Health Boards, the Institute of Environmental Science and Research, the Ministry of Transport and the Waikato Police Traffic and Alcohol group to explore the feasibility of carrying out additional toxicological analyses on blood samples routinely drawn from trauma patients admitted as a result of a car crash. Currently it would not be possible to carry out additional analyses on the blood samples already drawn, but an additional sample (of blood or saliva) could be taken close to the time of the crash and sent to an external laboratory (the Institute of Environmental Science and Research) for analyses. Approval would be required from the Waikato District Health Board and the National Health and Disability Ethics Committee.

The implications from the present study suggest that public education could include the effects of combined drug use, in particular the combination of alcohol and prescription medication. Drivers need to be aware that any amount of alcohol (even below the legal drink driving limit) in combination with prescription medication may affect their driving ability and increase their risk of being involved in a crash. One strategy would be to encourage people to plan when they take their medication in relation to when they need to drive and to continue to raise awareness of the fact that we are not good at judging our own levels of impairment.

Abstract

The purpose of the research was to establish a quantitative picture of the type and the extent of drugged driving in New Zealand and investigate the level of driving impairment produced by the most commonly used drugs, both legal and illegal. A stratified telephone survey (n=2,000) and internet survey (n=434) were conducted to explore the extent of drugged driving. Other than alcohol, the drugs most commonly taken prior to driving were strong opioid-based painkillers, antidepressant medication, anti-nausea medication, cannabis and anti-anxiety medication. A large proportion of drivers also reported taking combinations of different drugs prior to driving. Of the most commonly taken drugs, cannabis, opioid-based painkillers and benzodiazepines (typically used to treat anxiety or insomnia) have been associated with increased crash and driving-related impairment. The combination of drugs and alcohol leads to significantly higher crash risk and driving-related impairments. Between 25% and 50% of drivers who reported taking drugs admitted 'drugged driving' more than once a week over the last 12 months; for prescription drugs this most frequently occurred in the morning, while for illegal drugs this was typically in the evening.

1 Introduction

Motor vehicle crashes are a major cause of death and disability in New Zealand. Between 2011 and 2013, alcohol and other drugs contributed to 30% of fatal crashes, 20% of serious injury crashes and 12% of minor injury crashes. As well as the 164 drugged or alcohol-impaired drivers killed in crashes between 2011 and 2013, 77 passengers also died. The societal and public health cost of these crashes is high; in 2013 it was estimated to be in the region of \$669 million (Ministry of Transport 2014). In recognition of this fact, a key part of the Safer Journeys road safety strategy (Ministry of Transport 2010a; 2013) is to 'significantly reduce the incidence of alcohol and drug impaired driving' (Ministry of Transport 2011, p18) by 2020. Although the incidence and adverse consequences of alcohol-impaired driving is well understood and documented (Phillips and Brewer 2011; Starkey and Charlton 2014), the incidence of drugged driving (legal and illegal) in New Zealand has yet to be unequivocally established.

More comprehensive data is available from other countries, for example the Driving under the Influence of Drugs, Alcohol and Medicines (DRUID) study that was recently completed in Europe evaluated the impact of various drugs on fitness to drive, the prevalence of alcohol and other psychoactive drugs in crashes and in general driving and evaluated prevention strategies as well as a range of related issues (http://www.druid-project.eu/Druid/EN/Home/home_node.html). A key finding from this study was that the drug profile of drivers in each country differed, suggesting that data on the prevalence of drugged driving in Europe cannot be generalised to New Zealand (Houwing et al 2011).

An estimate of the likely incidence of drugged driving in New Zealand can be made from the most recent NZADUS face-to-face survey of over 6000 participants, which found that one in six New Zealanders aged 16 to 64 years had used drugs recreationally in the last year (Ministry of Health 2010). Of those who reported recreational drug use in the past year, 34.5% reported driving a car under the influence of drugs during that year. This equates to a drug driving rate of almost 6.0% of all adults aged 16 to 64 years. The NZADUS data also indicated that the drugs most commonly taken during the last 12 months (for recreational purposes) were cannabis (14.6%), BZD party pills (5.6%), ecstasy (2.6%), amphetamines (2.1%), and LSD and other synthetic hallucinogens (1.3%). In terms of prescription medicines used for recreational purposes, 0.6% of adults reported using sedatives and 0.5% had used stimulants in the last 12 months (however the numbers driving after taking these drug types were not available).

Men reported greater use of all types of recreational drugs compared with women (23.4% vs 16.1%) with use highest in those aged 18 to 24 years, with approximately 30% of respondents in this age group reporting drug use in the past year. The drug taking occurred primarily in peoples' own homes or someone else's home, but importantly, 16.9% of all recreational drug use in the last 12 months was reported as taking place in a private motor vehicle. Driving after drug use was reported most often by males aged 18 to 24 years; over half of respondents who reported drug use said they had driven while under the influence of drugs during the past year (Ministry of Health 2010). Although the NZADUS survey was extensive, the focus was not specifically on drugged driving, and thus no data were collected regarding the use of prescription drugs (for medical or non-medical purposes) prior to driving.

More recently, the New Zealand Drug Foundation undertook an internet survey of 1,164 New Zealanders focusing specifically on drug driving (NZ Drug Foundation 2009). Almost half of the drivers who completed the survey (41.7%) reported driving under the influence of at least one substance (including alcohol) in the previous 12 months. Overall, 26.2% of respondents reported driving under the influence of an illegal substance (most commonly cannabis, 93%). Almost 10% of respondents drove within three hours of using prescription medication (methadone, opiates prescriptions stimulants or benzodiazepines). Interestingly, a greater percentage of respondents reported driving under the influence of cannabis

(24.5%) than alcohol (21.4%) but this may be because people who used drugs were over-represented in the survey. Rates for consumption of other drugs (eg amphetamine, cocaine, methadone, opiates) prior to driving were all less than 5%; however, 11.9% of the total respondents reported driving after taking a combination of two or more substances. This survey also asked drivers about their perceptions of the risk associated with driving under the influence of specific drugs. Interestingly alcohol was perceived as the most dangerous, with cannabis being viewed as the safest.

Over the past 20 years, researchers have reported a dramatic increase in the non-medical use of prescription drugs (NMUPD) (Benotsch et al 2013). A recent US study indicated that 12.2% of their sample (college students) reported having driven while taking prescription drugs for non-medical purposes, and 7.9% of them reported engaging in the behaviour in the preceding three months (Benotsch et al 2013). Unlike the data for illegal drugs, men (13.2%) and women (11.7%) reported comparable rates of driving while engaged in NMUPD. The types of prescription drugs most commonly reported as being abused while driving were stimulants (6.8%), analgesics (5.2%), anxiolytics (4.2%) and sedatives (0.8%). While these rates of use while driving are lower than those reported for driving under the influence of alcohol (23.3%) or illegal drugs (23.1%), the level of driving impairment resulting from NMUPD is largely unknown.

One of the limitations of the research described above, however, is the reliance on self-reports of drug use while driving. Further, in the case of the internet survey conducted by the New Zealand Drug Foundation, the authors note the sample contained an over-representation of well-educated employed Pakeha females from the Auckland and Wellington regions, and possibly an over-representation of people who use drugs. Careful use of stratified sampling methods, such as employed in the NZADUS (Ministry of Health 2010) can ensure a more representative sample of the New Zealand driving population, but still rely on self-reports of drug use by drivers.

Alternative methods used to estimate the prevalence of drugged driving include roadside testing (similar to random breath testing) and analysis of blood samples taken after casualty crashes. Although the roadside testing methodology can provide accurate point prevalence data, the costs associated with data collection and analysis are very high. For example, a roadside survey conducted in Norway (Gjerde et al 2008) stopped 12,000 drivers; of these 88% (10,835) agreed to participate. Alcohol or drugs were detected in only 4.5% of the sample, medicinal drugs in 3.4% and illegal drugs in 1%. In order to reliably detect and classify the drugs present in that 4.5% of drivers, a two-step stratified sampling data collection procedure was required and analysis of nearly 11,000 oral fluid samples was necessary. Similarly, in Australia between 2007 and 2012 roadside screening tests for three illegal drugs were conducted on 80,624 drivers, resulting in 2,139 positive detections. Of these 10 were false positives, resulting in an overall detection rate of 2.7% (Davey et al 2014). Of the 2.7% of drugged drivers identified, the most commonly detected substance was methamphetamine (41%), followed by cannabis (30%), with almost 28% of cases showing evidence of polydrug use. The costs associated with these studies, along with the ethical and legal concerns associated with roadside sampling, means that relatively few studies of this type have been undertaken.

Other researchers have carried out supplementary toxicological analyses of blood samples collected for other reasons such as drink driving or following injury as a result of a crash. One such study of New Zealand drivers, conducted as part of a Master's thesis, reported that of 2,000 blood samples that tested positive for alcohol, 37% contained at least one other drug. Of the 37% of blood samples that contained a drug in addition to alcohol, cannabis was most common (89%, n=696), followed by benzodiazepines (4.7%), methamphetamine (1.1%) and morphine or heroin (0.1%) (Vergara 2006). It should be noted that these findings cannot be generalised to the New Zealand driving population, as the blood samples were from drivers who had a breath alcohol concentration above the legal limit and opted to provide an evidentiary blood sample. In a more recent study, blood samples from 1,046 fatally injured New Zealand

drivers were examined and it was found that almost half (48%) contained alcohol or other drugs (eg 30% had cannabis). In most cases the level of alcohol was above the legal limit, and 54% of those who had been drinking had also taken other impairing substances. Overall a greater proportion of fatally injured drivers had taken alcohol and cannabis in combination (14%) compared with either substance alone (alcohol 13%; cannabis 9%). The presence of other drugs was low; 5% tested positive for stimulants (most commonly methamphetamine), 4% for sedatives (most commonly diazepam), and 3% had used an opioid (eg methadone) (Poulsen et al 2012). Similar analyses of blood samples from injured at-fault (culpable) New Zealand drivers after a crash (n=453) found that 31% tested positive for cannabis, 9% for benzodiazepines, and 36% for opiates, (but some of the latter may have been due to medical treatment) (ESR 2011). The high rate of cannabis use is particularly concerning as habitual use is associated with a 10-fold increase in risk of injury in a car crash. (Blows et al 2005). These New Zealand-based studies provide an indication that patterns of drugged driving in New Zealand are substantially different from Europe (Houwing et al 2011; Isalberti et al 2011) and Australia (Drummer et al 2004; Drummer et al 2007) with higher rates of cannabis use and lower rates of stimulant use.

Although these findings are not representative of the general population of New Zealand drivers (they were sampled because of involvement in a crash or a failed alcohol test) they do provide important information and are much less costly than roadside sampling. In particular, evidence regarding the prevalence of individual drugs and drug combinations in the blood of crash-involved drivers, is needed for a better understanding of the degree and type of impairment produced by these drugs. To date, most research has focused on the impairing effects of alcohol on driving and relatively less attention has been paid to how other drugs (legal and illegal) affect driving. The amount of data regarding the effects of cannabis on driving has been increasing, and a review of the available research literature concluded that cannabis impairs a wide range of cognitive functions including attentiveness, vigilance, tracking, psychomotor coordination and divided attention (Sewell et al 2009). More recently, it has been reported that cannabis impairs psychomotor skills and brain activity associated with detecting and acting on important external information (Battistella et al 2013).

Furthermore, it appears that cannabis and alcohol impair different cognitive functions and the combination of the two drugs is particularly risky. For example, the driving impairment associated with cannabis appears to be greater for automatic components of driving and less on the complex tasks requiring effortful focus. It has been suggested that because drivers under the influence of cannabis are aware of their impairment on some aspects of driving, they may engage in compensatory behaviours (eg driving more slowly, avoiding passing manoeuvres) (Sewell et al 2009). When alcohol is used, however, insights into one's level of impairment is limited and highly inaccurate (Starkey and Charlton 2014), and thus the frequently observed combination of alcohol and cannabis would appear to curtail the likelihood of drivers undertaking compensation strategies.

Less information is available regarding driving impairment associated with use of prescription drugs. A large case control study conducted as part of the European Union's DRUID project (Driving under Influence of Drugs, Alcohol, and Medicines) obtained information about prescribed medications used by all drivers involved in motor vehicle crashes in the Netherlands between 2000 and 2007 (Ravera et al 2011). The findings of this study revealed that anxiolytics and SSRI antidepressants were associated with significantly increased crash risk. Similarly, older drivers (60+ years) who were prescribed benzodiazepines, antidepressants, or opioid analgesics were at greater risk of being involved in a crash resulting on hospitalisation (Meuleners et al 2011). These medications are increasing in use (prescription rates are increasing), and thus their use while driving, and use in combination with other drugs and alcohol could present an increasing challenge to road safety (Leung 2011).

Studies employing the analysis of blood samples from trauma patients, such as the ones described above, are essential to increasing our understanding of the scope of the drug-driving problem. In addition, the information related to the demographics of these drivers and the location and time of day of the drug-involved crashes is important data to inform both education and enforcement goals of the Safer Journeys strategy. A fuller picture is needed, however, particularly regarding the involvement of prescription drugs (either for medical or recreational purposes), and their use alongside substances such as alcohol and cannabis.

The purpose of the present research was to establish a quantitative picture of the type and the extent of drugged driving in New Zealand. A second purpose was to investigate the level of driving impairment produced by the more commonly used drugs, both legal and illegal. While the main focus of the research was on drivers' use of over-the-counter, prescription, and illegal drugs prior to driving, we also sought information on alcohol use prior to driving. This information was used to compare rates of driving under the influence of alcohol with drugged driving and provide a fuller picture of the drug combinations typically taken prior to driving.

The main objectives of the research were as follows:

- Conduct a statistically representative stratified telephone survey of New Zealand drivers to provide accurate and up-to-date information about the incidence of legal and illegal drugs consumed in New Zealand prior to driving.
- Based on information collected in the survey above, conduct a follow-up survey of drivers indicating they had driven after drug use to determine the timing, type and extent of driving, presence of other vehicle occupants, and whether any self-selected countermeasures had been used.
- Carry out a systematic review of the available research literature on the degree of driving impairment produced by the most commonly taken drugs in New Zealand.
- Conduct an internet survey of drivers' attitudes and perceptions of drugged driving, including the use of prescription drugs for both medical and non-medical purposes.
- Investigate the feasibility and approval requirements for establishing a procedure to obtain toxicology reports (based on blood samples) of trauma patients admitted to Waikato hospital as a result of a motor vehicle crash.

2 Method

All of the methods used in this study were submitted for review by, and received ethical approval from, the School of Psychology Research Ethics Committee at the University of Waikato. The questions for each of the surveys were developed from previous studies conducted by the New Zealand Household Travel Survey (Ministry of Transport 2008), the NZADUS (Ministry of Health 2010) and the Drug Driving in New Zealand Survey (New Zealand Drug Foundation 2009).

2.1 Stratified telephone survey

The overall aim of the stratified telephone survey was to provide a quantitative picture of the type and extent of drugged driving in New Zealand. DigiPoll, a private company that specialises in computer assisted telephone interviewing executed the survey.

The telephone survey was conducted in two phases. The aim of the first stage was to recruit a stratified sample (approximately $n=2000$) of drivers based on age from across New Zealand (the sampling procedure also ensured that the number of participants recruited from each geographic region was approximately the same proportion as the population distribution in New Zealand). Table 2.1 shows the percentage of licensed drivers by age group in New Zealand, the age groups used by DigiPoll and the targets for the percentage of the sample within each of the age bands. In order to be eligible to take part, respondents had to be over 16 years of age, a New Zealand resident, driven within the last 12 months and have a good understanding of English.

Table 2.1 Percentage of the sample by age group for the stratified telephone survey

Age group (years)	% total licensed drivers	DigiPoll age group (years)	DigiPoll target % of sample
16–24	13.80	16–24	10–12.5
25–39	27.55	25–40	21.5–24
40–64	44.11	41–65	42–44.5
65+	14.54	66+	19–21.5

In the first stage of the survey (see appendix A) participants who met the eligibility criteria and consented to participate were asked to provide information on their general driving habits (number of trips per week and percentage of urban and rural driving) as well as their use of 17 different types of prescription and non-prescription psychoactive drugs (alcohol, amphetamine/methamphetamine, anti-anxiety medication, antidepressants, anti-nausea medication, anti-psychotics, cannabis, cocaine/crack, ecstasy, kava, hallucinogens, strong painkillers, opiates, party pills, prescription stimulants, sedatives/sleeping pills and synthetic cannabis) in the last 12 months.

For each drug where a respondent indicated use, they were asked to provide: the name of the drug; frequency of use in the last 12 months (daily, three to four times a week, twice a week, once a week, two to three times a month, once a month, three to six times, or once or twice); why the drug was taken (recreational or social purposes, medical reasons, general health, other); and if they had driven while they felt under the influence of the drug and/or within three hours of taking the drug. The latter two questions provided slightly different information and allowed us to examine how people's subjective experience of a drug's effects influenced their decision to drive and how many people drove when a drug was likely to be active and have potential performance impairing effects. Participants were then asked to provide some

demographic information including gender, date of birth, ethnicity, country of birth, residential area, occupation and income.

The survey took approximately 10 minutes to complete. Respondents were assured their responses were anonymous and confidential and those who reported driving within three hours of taking drugs were asked if they would be willing to be contacted for another more detailed follow-up survey. They were also asked if they would like to receive a summary of the findings and then they were thanked for taking part.

The follow-up telephone survey (stage II – appendix B) focused on the four most commonly taken drug types from the stage 1 survey (selective serotonin reuptake inhibitors ((SSRIs)), strong painkillers, benzodiazepines ((BZDs)) and prescription stimulants) and two illegal drugs of particular interest (cannabis and amphetamine/methamphetamine). The aim was to recruit 400–500 people to complete this stage of the survey.

When the respondents were contacted, they were reminded about the purpose of the study, the drug they were going to be asked about, and asked if they consented to take part. Then, the respondents were asked how frequently they had driven within three hours of taking the target drug in the last 12 months (daily, five to six times a week, three to four times a week, twice a week, once a week, two to three times a month, once a month, once every six weeks, three to six times, or once or twice). They were then asked to recall a recent specific occasion when they took the target drug and drove within three hours. With reference to this occasion they were asked if they took any other medicines or drugs at the same time, and if so the names of the other drugs.

Respondents were asked about the purpose of their drive on that occasion (to go home, to work, for education, shopping, personal business, medical/dental, social/entertainment, recreation, transport for someone else, to catch a bus or plane, or other). They were also asked if any passengers were present and if so, how many and who they were (partner/spouse, parent, own children, others' children, friend, work colleague, and/ or other). The next questions focused on the drive, in particular the percentage of urban and rural driving, their speed and ability to react to traffic compared to usual (on a 5-point scale from much slower than usual to much faster than usual), and how they felt their driving ability was affected by the drugs and medicines overall (from 1 = not at all impaired, equivalent to driving without taking an drugs, and 10 = very impaired). Respondents were then asked if they had made any changes to the route they drove because of the drugs and if they avoided any of the following situations: heavy traffic, highways with multiple lanes, high-speed roads, speed cameras, police checkpoints, car parks with tight spaces, unfamiliar roads and/or taking passengers.

The next group of questions focused on taking the target drug and driving generally (rather than a specific occasion) and respondents were asked if they usually changed when they drove as a result of taking the drug, and/or if they changed when they took the drug because they had to drive. Lastly respondents were asked to indicate a typical combination of drugs and medicines they took within three hours of driving (including legal or illegal products and those that are prescribed or purchased over-the-counter). The survey took around 10 minutes to complete and respondents were offered the opportunity to have their name placed in a draw to win a tablet computer (value approximately \$400) and if they wished to receive a copy of the study findings. Respondents were thanked for contributing to the survey and were asked to contact a member of the study team if they had any questions and to contact their GP or the Alcohol and Drug helpline if the survey had raised issues of concern for them.

2.2 Internet survey

The internet survey (target sample size =500) was conducted primarily to provide insights into New Zealand drivers' attitudes and perceptions toward drugged driving. Questions regarding the incidence of drugged driving were also included to supplement the data for the telephone survey and to provide context for the information gathered on the participants' attitudes and perceptions towards drugged driving (appendix C)

The survey was developed using the Qualtrics online survey software. The link to the survey was distributed via email and posted on relevant websites (eg Facebook, National Drug and Alcohol Foundation, Moodle, Salvation Army, local and national transport agencies and councils, and district health boards). The eligibility criteria were the same as for the telephone survey (ie aged >16 years, New Zealand resident, driven in the last 12 months, good understanding of English).

Participants that met the eligibility criteria were initially then asked a series of questions about their driving history including length of licensure, amount and type of driving per week, typical speed, perceived driving skill, crash and infringement history, and driving confidence in various situations (from 0 not confident to 10 completely confident). The focus of the survey then shifted to the effects of drugs on driving and participants were asked to indicate how much an average person's driving would be impaired by 17 different types of prescription and non-prescription psychoactive drugs (alcohol, amphetamine/methamphetamine, anti-anxiety medication, antidepressants, anti-nausea medication, anti-psychotics, cannabis, cocaine/crack, ecstasy, kava, hallucinogens, strong painkillers, opiates, party pills, prescription stimulants, sedatives/sleeping pills and synthetic cannabis), as in the stratified telephone survey. They were then asked to report if they had used any of these drugs in the last 12 months.

As in the telephone survey, for each drug a participant used they were asked to provide the name of the drug; frequency of use in the last 12 months (daily, three to four times a week, twice a week, once a week, two to three times a month, once a month, three to six times, or once or twice); why the drug was taken (recreational or social purposes, medical reasons, general health, other); and if they had driven while they felt under the influence of the drug (for alcohol) and/or within three hours of taking the other drug types.

For each drug taken within three hours prior to driving, participants were asked to indicate the frequency of this behaviour over the last 12 months (daily, three to four times a week, twice a week, once a week, two to three times a month, three to six times, or once or twice), the impact they thought the drug had on their driving (a lot worse, slightly worse, no change, slightly better, a lot better) and how likely they would be to drive within three hours of taking the drug in the next 12 months (not at all likely, somewhat likely, very likely) . They were also asked if they had decided not to drive within three hours of taking the medication and, if so, what were the main reasons for that decision (ability to drive was negatively affected, worried about getting caught, others convinced them not to drive, worried about safety of others, had another way to get home and/or other reasons).

The final section of the survey focused on enforcement and countermeasures and asked if the respondent had been breath tested for alcohol in the last 12 months, how likely they are to be breathalysed in the next 12 months (not at all likely, somewhat likely, very likely) and to select the current legal alcohol limit from four options (0.08, 0.03, 0.05 or 0.1%). They were also asked to indicate the likelihood (on a 5-point scale from highly likely to highly unlikely) of being caught for a number of traffic offences including speeding, dangerous driving, drinking and driving, failing to stop at a red light and drugged driving. The next question asked for their opinion (agree to disagree) on a series of statement about drugged driving and enforcement: it's ok to use medicines and drive if you feel your driving skills have not been affected;

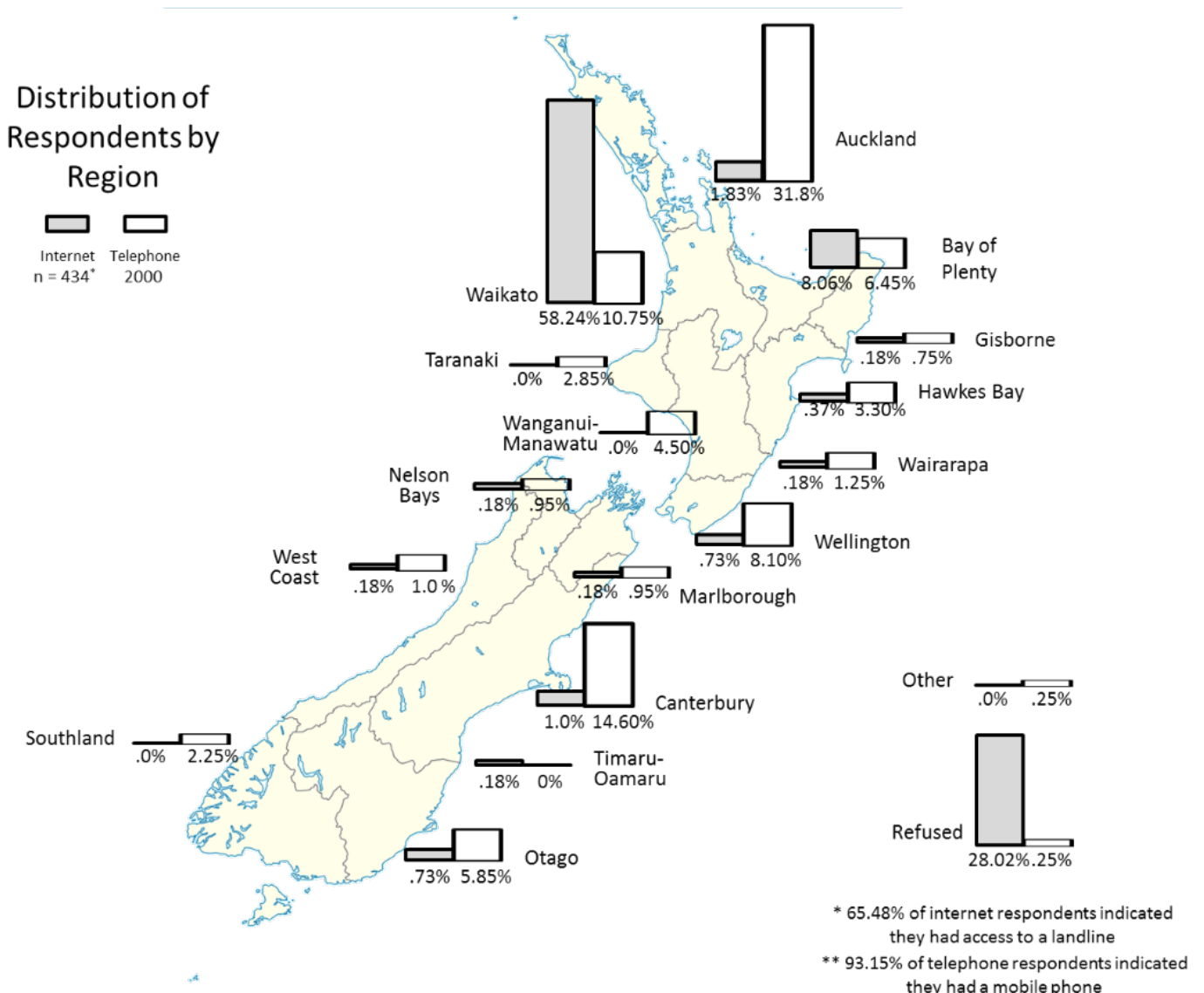
it's ok to use illegal drugs and drive if you feel your driving skills have not been affected; random roadside alcohol testing improves road safety; random roadside drug testing would not improve road safety in New Zealand; and drug driving is a significant safety issue in New Zealand. They were also asked if more police time and resources should be spent on enforcing drugged driving laws in New Zealand.

The final group of questions gathered demographic information (age, gender, ethnicity, country of birth, area of residence, occupation, income) and if they had access to a landline, and home phone (to determine the potential overlap between participants in the internet survey and the stratified telephone survey). The survey took around 15 minutes to complete and respondents were offered the opportunity to receive a copy of the study findings. Participants were thanked for contributing to the survey and were asked to contact a member of the study team if they had any questions and to contact their GP or the Alcohol and Drug helpline if the survey had raised issues of concern for them.

3 Respondent demographics

A total of 2,000 drivers completed the stage I telephone interview. Their average age was 47.26 years (ranging from 16 to 95, *standard deviation* (*SD*) = 17.13), with 40 respondents declining to state their age. For the 1959 respondents able to tell us how long they had held a driving licence, the average was 29.07 years (ranging from less than one year to 79 years, *SD* = 16.57). Sixteen respondents reported that although they had driven in the past 12 months, they did not hold a current driving licence. Of these, one respondent’s licence had expired, one had their licence suspended, eight had never applied for a licence, and six declined to say why they did not hold a current driving licence. The telephone respondents reported making an average of 15.35 vehicle trips per week (*SD* = 13.30) and their driving was predominantly urban 69.23% (*SD* = 31.37) as compared with rural (*M* = 30.77%). A large majority of the telephone survey respondents reported their ethnicity as being New Zealand European, and the distribution of answers regarding ethnicity is shown below in table 3.1. Also shown in table 3.1 is the distribution of answers as to their before-tax income in the past 12 months. Figure 3.1 shows the regional distribution of the respondents (the regional distribution of the telephone survey participants approximates the distribution of the New Zealand population).

Figure 3.1 Regional distribution of survey respondents



Of the 2,000 telephone survey respondents, 1,364 (68.20%) indicated they were willing to be contacted again for a follow-up telephone survey asking some more questions about drug and medicine use and driving. The participants who agreed to be re-contacted were an average of four years older ($M = 48.77$, $SD = 16.70$) than those who refused ($M = 44.98$, $SD = 17.72$), a statistically reliable difference; $t(1953) = 4.55$, $p < .001$. There was no significant difference, however, between the proportion of males (65.3%) and females (70.5%) who agreed to be re-contacted. For the phase 2 survey, 622 participants who had agreed to be contacted had driven within three hours of taking a drug (or alcohol). Of these, 450 completed the follow-up survey. There was no significant difference in the age of the participants who completed the survey ($M = 48.10$, $SD = 14.97$) and those who did not ($M = 47.87$, $SD = 16.13$; $t(616) = 0.19$, $p = .85$) or in the proportion of males (73.4%) and females (70.8%) who consented to follow up ($p > .05$). In addition, there was no significant association between the type of drug consumed and participation in the follow up survey, $\chi^2(9) = 11.56$, $p = .239$. The respondents completing the follow-up survey had an average age of 48.10 years (ranging from 18 to 90, $SD = 14.97$) and there were more females (57.11%, $n = 257$) than males (42.89%, $n = 193$).

A total of 434 drivers completed the internet survey. Their average age was 34.54 years (ranging from 17 to 74, $SD = 14.62$), with 38 respondents (8.75%) declining to state their age. These respondents comprised a somewhat younger sample than the telephone survey, with a difference of 13.09 years in the mean ages of the two samples. An analysis of variance (ANOVA) calculated to compare the ages of the telephone and internet respondents indicated the difference was reliable; $F(1,2354) = 201.46$, $p < .001$, $\eta_p^2 = .079$. Associated with this difference, the internet sample also reported a lower number of years of holding a driving licence ($M = 17.48$, $SD = 13.90$). The internet respondents also reported a slight, but statistically reliable lower percentage of urban driving; $M = 69.23$, $SD = 31.36$, $t(681.44) = 21.68$, $p < .001$.

As with the telephone survey, a large majority of the internet respondents reported their ethnicity as being New Zealand European, and the distribution of answers regarding ethnicity are shown in table 3.1. Also shown in table 3.1 is the distribution of answers as to their before-tax income in the past 12 months and, as can be seen, the internet sample had a slightly lower median income (\$30,001 – \$40,000) compared with the telephone sample (\$40,001 – \$50,000). As can be seen from figure 3.1 above, the respondents in the internet sample were predominantly from the Waikato region. This reflects where the notices for recruiting respondents were placed, there being no attempt for a regional or age stratified sample for the internet survey.

Table 3.1 Respondent ethnicity and income for the stratified telephone survey and internet survey

	Telephone survey (n=2000)		Internet survey (n= 434)	
	n	Percent of sample	n	Percent of sample
Ethnicity				
NZ European	1,503	71.67	321	73.96
Maori	170	8.11	45	10.237
Other European	147	7.01	36	8.29
Samoan	30	1.43	4	0.92
Tongan	14	0.67	1	0.23
Cook Island Maori	11	0.52	2	0.46
Niuean	4	0.19	2	0.46
Chinese	40	1.91	4	0.92
Indian	52	2.48	2	0.46
Other	118	5.63	20	4.61

	Telephone survey (n=2000)		Internet survey (n=434)	
	n	Percent of sample	n	Percent of sample
Refused to answer	8	0.38	3	0.69
Income (NZ\$)				
<5,000	156	7.80	39	8.99
5,001–10,000	73	3.65	40	9.22
10,001–15,000	79	3.95	38	8.76
15,001–20,000	88	4.40	28	6.45
20,001–25,000	98	4.90	12	2.76
25,001–30,000	100	5.00	16	3.69
30,001– 40,000	174	8.70	23	5.30
40,001–50,000	157	7.85	30	6.91
50,001–60,000	178	8.90	30	6.91
60,001–70,000	135	6.75	22	5.07
70,001–80,000	115	5.75	16	3.69
80,001–100,000	115	5.75	32	7.37
100,001–120,000	58	2.90	14	3.23
120,001–150,000	52	2.60	7	1.61
>150,000	58	2.90	8	1.84
Don't know	203	10.15	21	4.84
Refused	161	8.05	170	8.99

4 Incidence of drugged driving in New Zealand

The first part of the analyses focused on establishing the incidence of drugged driving from the survey data. As the sampling methods for the two surveys differed (the telephone survey was a stratified sample of drivers from across New Zealand, and the internet survey was an opportunity sample) the data is presented separately.

Figure 4.1 shows the number and percentage of telephone survey respondents reporting use of each of the drugs asked about. The most commonly used drugs were strong painkillers (33.16% of the sample), with 9.81% of the sample reporting they had driven within three hours of taking them, and 7.75% reporting that they had driven while they felt under the influence of the painkillers. Use of antidepressant medications in the past 12 months was reported by 8.17% of the sample, 6.05% reporting driving within three hours of taking them, and 5.04% driving while they felt under the influence of the medication. A somewhat higher number of respondents reported use of anti-nausea medications in the past 12 months (11.03% of the sample) but fewer respondents reported driving within three hours (3.50%), and driving while they felt under the influence of the medications (2.92%). The fourth most frequently reported drug was cannabis, 6.58% of the telephone respondents reporting using it in the past year, 2.55% reporting driving within three hours, and 2.18% driving while they felt under the influence of the drug.

A slightly lower number of telephone respondents reported using anti-anxiety medications in the past 12 months (5.25%) but a higher number in the sample drove within three hours of taking them (2.86%), and driving while they felt under the influence (2.24%). Other drugs were reported at much lower rates, but of particular interest to media and law enforcement were the rates of amphetamine and methamphetamine use. As shown in the figure (4.1), the numbers of respondents reporting using these drugs in the past 12 months were low (0.42%), with 0.05% reporting driving within three hours of consuming them and 0.11% of the sample reporting driving while they felt under the influence of these drugs. Prescription stimulants were more often reported, with 0.80% reporting consumption, 0.53% reporting driving within three hours, and 0.58% reporting driving while under the influence. As a point of comparison to the prescription and illegal drugs mentioned above, 83.82% of the telephone sample reported consuming alcohol in the past 12 months, 45.32% reported driving within three hours of consuming alcohol, and 13.74% reported driving while they felt under the influence of alcohol in the past 12 months.

The internet survey respondents provided a somewhat different drugged driving profile, but as shown in figure 4.2 the same five drug types were reported as having the highest incidence of use. Once again, strong painkillers were reported as being the most commonly used drugs, with 43.64% of the sample reporting using them in the past year and 18.70% of the sample reporting they had driven within three hours of consuming these medications (internet respondents were not asked about driving while they felt under the influence of the drugs).

Use of antidepressant medications in the past 12 months was reported by 18.37% of the internet sample, 15.82% reporting driving within three hours of taking them. A similar number of respondents reported use of anti-nausea medications in the past 12 months (17.95% of the sample), but as with the telephone sample, fewer respondents reported driving within three hours of consuming them (6.41%). Use of cannabis in the past 12 months was reported by 25.58% of the internet sample, with 14.21% reporting driving within three hours. Use of anti-anxiety medications in the past 12 months was reported by 11.93% of the sample, with 6.09% reporting having driven within three hours of taking them. Amphetamine and methamphetamine use in the past 12 months was reported by 3.54% of the internet respondents, with 2.28% reporting driving within three hours of using them. A similar number of the internet respondents reported use of prescription stimulants (3.39%) and driving within three hours (2.09%). Interestingly, of the

nine internet respondents reporting taking the most common prescription stimulant, methylphenidate, slightly over half of them (55.56%) said they had consumed it for recreational purposes.

Finally, comparing the prescription and illegal drugs reported by the internet respondents to their reported alcohol use, 88.89% of the sample reported consuming alcohol in the past 12 months, and 11.62% reported driving while they felt under the influence of alcohol in the past 12 months. In general terms, the rates of driving within three hours of consuming drugs were reported more frequently by the internet respondents, possibly the result of their somewhat lower age, or because the answers were entered privately (without a phone interviewer) reducing the influence of social desirability demand.

Figure 4.1 Number and percent of telephone survey respondents' medication and drug use (grey bars = percentage of respondents using the drug; white bars = the percentage driving within three hours; black bars = the percentage driving under the influence)

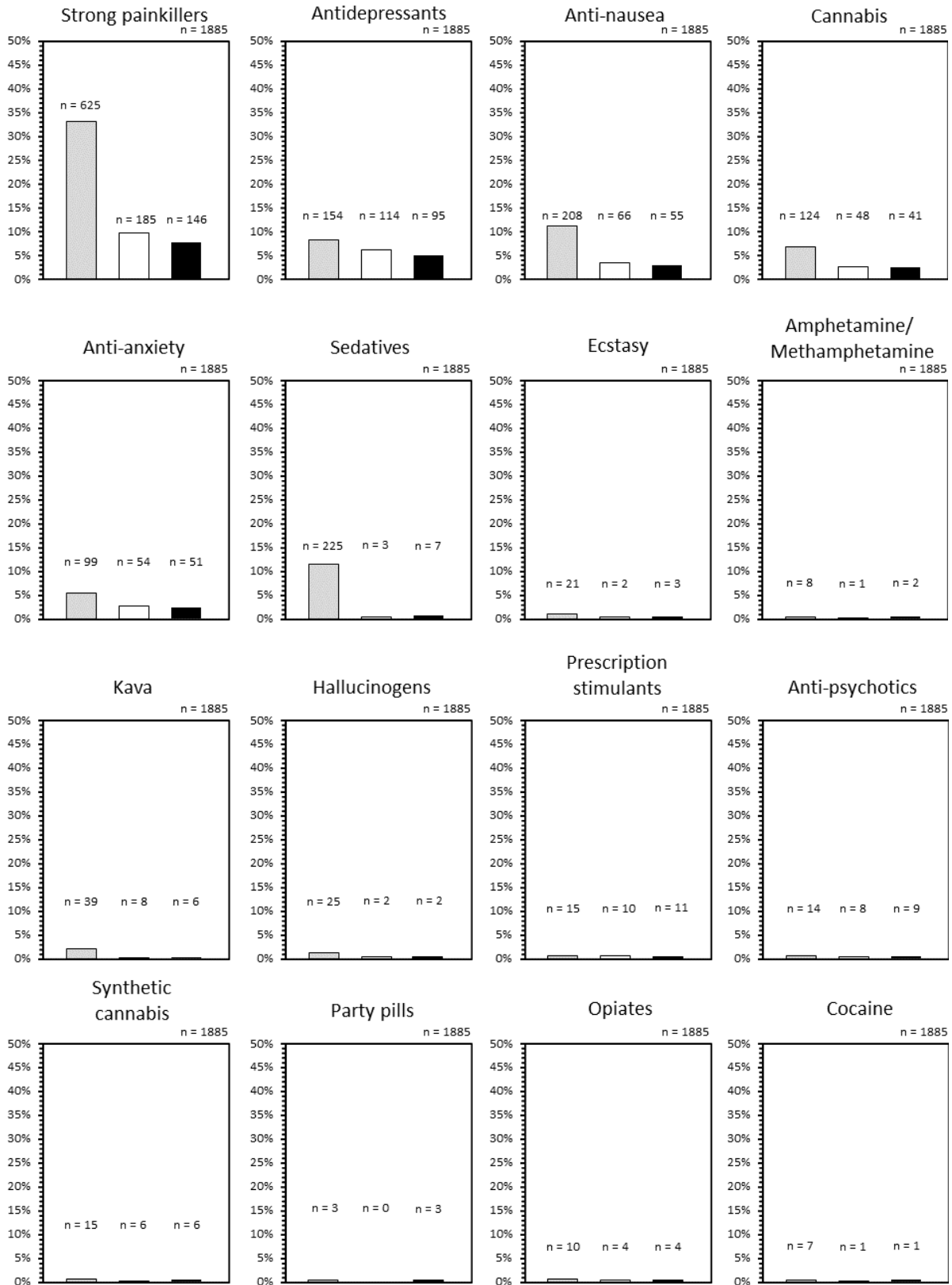
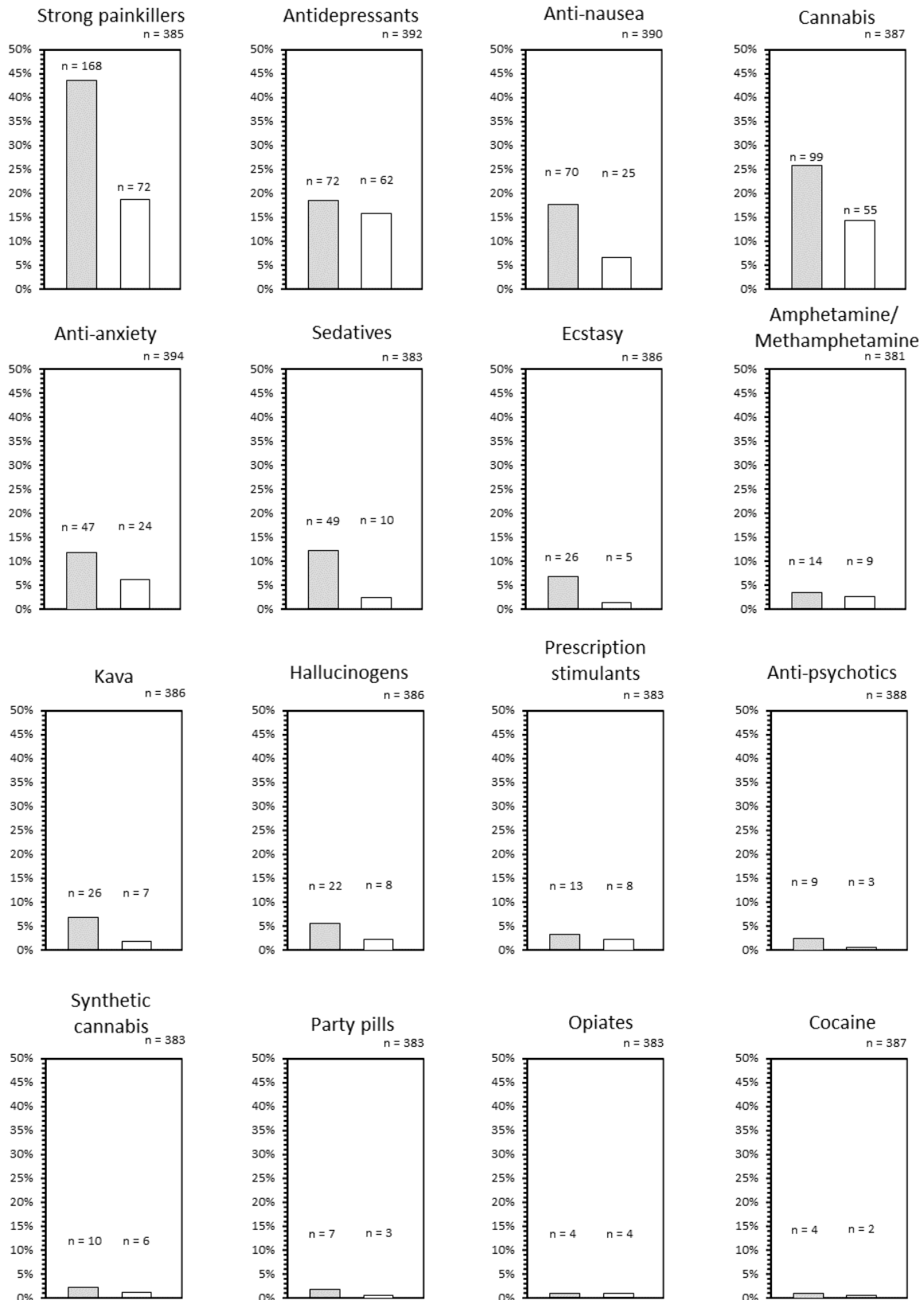


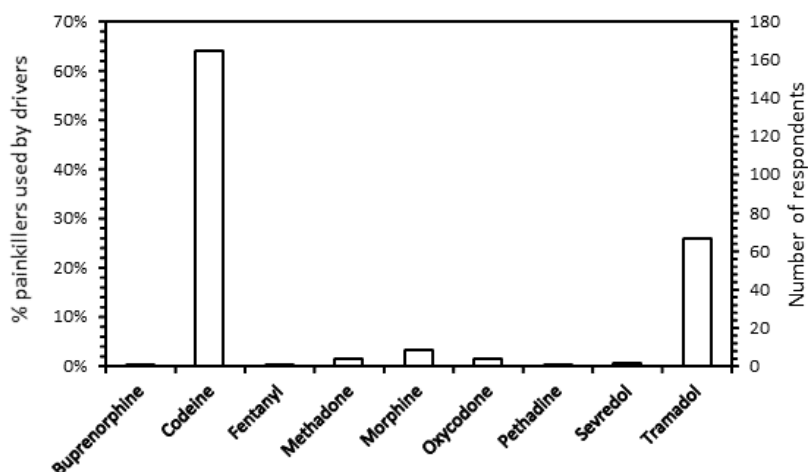
Figure 4.2 Number and percent of internet survey respondents' medication and drug use (grey bars = percentage of respondents using the drug; white bars = the percentage driving within three hours)



4.1 Specific drugs consumed prior to driving

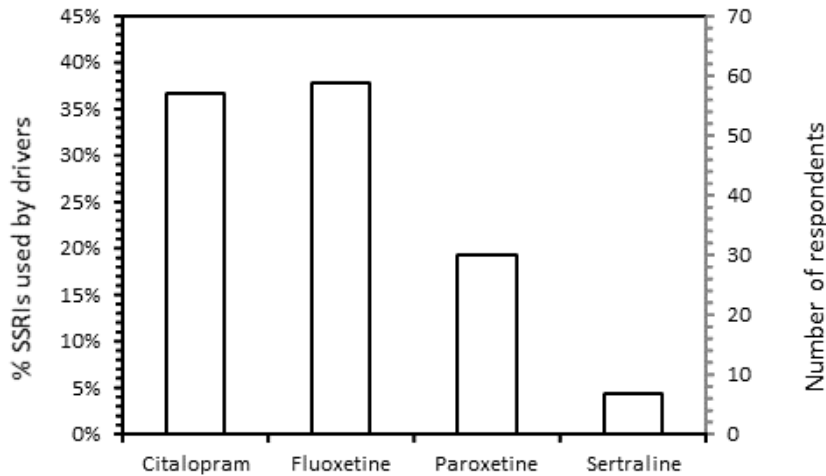
While some of the drug types reported by the telephone and internet respondents, such as cannabis, can be considered as a whole, other drug types, such as painkillers, antidepressants and anxiolytics (antianxiety drugs) are more diverse and comprise several different drugs with different actions. Figure 4.3 shows the individual drugs taken by respondents reporting driving within three hours of using strong painkillers. Of the 257 drivers (185 phone, 72 internet) reporting driving within three hours of taking strong painkillers, the most common was codeine 64.20% (n = 165), followed by tramadol at 26.07% (n = 67). The average age of the respondents reporting driving after taking strong painkillers was 41.67 years: 45.37 for the telephone respondents and 32.61 for internet respondents. Of these respondents 58.80% were female (52.20% telephone, 75.0% internet).

Figure 4.3 Types of painkillers used by respondents reporting driving within three hours of taking them



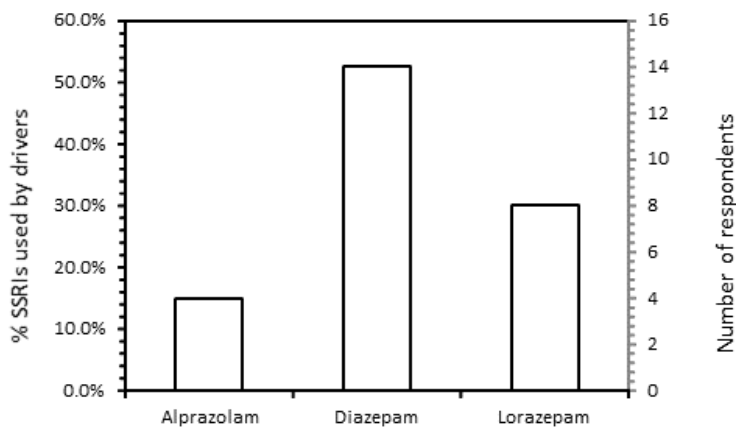
Use of SSRIs were reported by respondents taking them either as antidepressants or anxiolytics. Figure 4.4 shows the specific SSRI drugs reported by respondents who drove within three hours of taking them. As can be seen in the figure, the most commonly reported SSRIs were fluoxetine 38.56% (n = 59) and citalopram 37.25% (n = 57), followed by paroxetine at 19.61% (n = 30) and sertraline 4.58% (n = 7). The average age of these respondents was 41.73 years (46.23 for telephone respondents, 33.25 for internet). The majority of these responders were female, 78.70% (77.1% for telephone and 81.8% for internet).

Figure 4.4 Types of selective serotonin reuptake inhibitors used by respondents reporting driving within three hours of taking them



Finally, of the 26 respondents driving within three of taking benzodiazepines (BZDs) for antianxiety, over half (53.85%) were taking diazepam ($n = 14$), followed by lorazepam at 30.77% ($n = 8$) and alprazolam 15.38% ($n = 4$). These results are shown in figure 4.5. The average age of these respondents was 38.44 years (44.75 for telephone, 31.55 for internet), and 60.90% were female (41.7% for telephone and 81.8% for internet).

Figure 4.5 Types of benzodiazepines used by respondents reporting driving within three hours of taking them



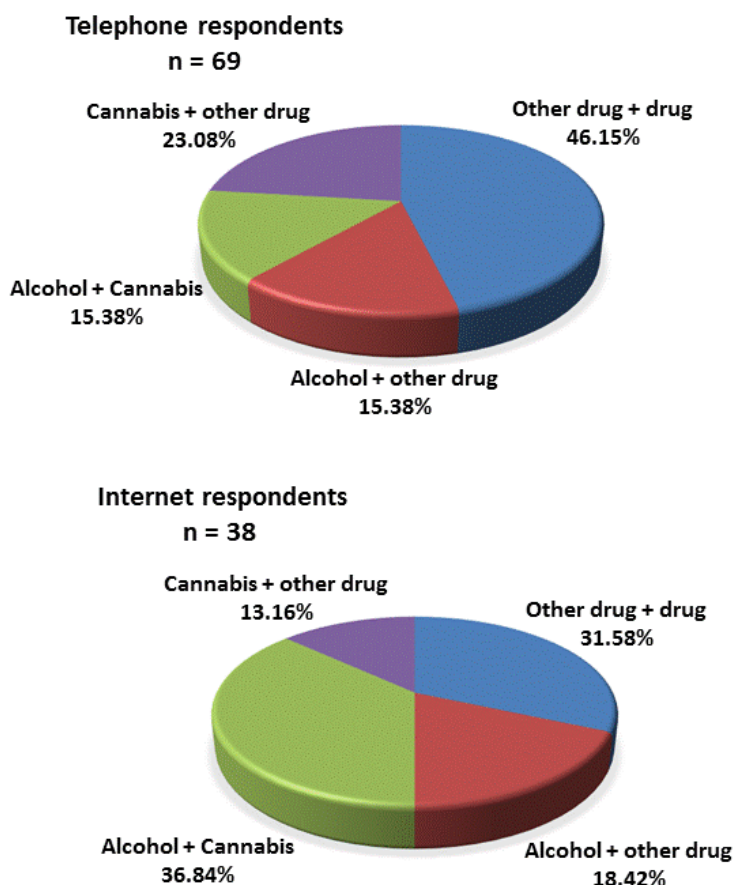
For the remaining drugs of interest, the average age of respondents reporting driving within three hours of using cannabis was 30.32 years (33.08 for telephone, 27.81 for internet) and 40.60% were female (29.2% for telephone, 50.9% for internet). The average age of respondents driving within three hours of using amphetamine or methamphetamine was 30.90 years (a mean of 31.11 for internet, and 29 years for the sole telephone respondent). The internet respondents were 66.67% female as was the one telephone respondent. Finally, the average age of the respondents driving within three hours of taking prescription stimulants was 39.33 years (46.20 for telephone, 30.75 for internet) and 50% were female (40.0% for telephone, 62.5% for internet).

4.2 Drug combinations consumed prior to driving

The respondents were also asked about driving within three hours of using drug combinations. When asked about drug combinations, 16.59% (n = 69) respondents in the follow-up telephone survey said they had driven within three hours of taking a combination of drugs. The drug combinations these respondents indicated they usually consumed prior to driving are shown in figure 4.6. The top panel of the figure shows that drug combinations frequently involved alcohol. When cannabis was combined with other substances, the most frequent was alcohol, followed by synthetic cannabis. When drugs other than cannabis and alcohol were combined, the most common combinations were multiple types of strong painkillers. When alcohol was combined with drugs other than cannabis, the most common were strong painkillers.

Respondents in the internet survey were also asked about their polydrug use. 9.95% (n = 38) of these respondents indicated they drove within three hours of using drug combinations, as shown in the lower panel of figure 4.6. Alcohol combined with cannabis was somewhat more frequent in this group, compared with the telephone respondents, but the types of drugs combined were the same as reported above.

Figure 4.6 Drug combinations used by respondents reporting driving within three hours of taking them



4.3 Comparison of most commonly used drugs in New Zealand, Europe and Australia

As outlined above the most commonly reported drugs taken within three hours of driving in New Zealand were strong painkillers, antidepressants, anti-nausea medication, cannabis, anxiolytics and sedatives. Given that the use of prescription and non-prescription medication varies between countries, studies were reviewed to identify the most commonly taken psychoactive drugs prior to driving in other countries for comparison purposes.

Two key sources were used: the European DRUD project and the Australian Drug Foundation survey because both groups reported prevalence of drugged driving in the general population, rather than focusing on injured drivers. The DRUID project collected over 50,000 blood and/or saliva samples across 13 countries (Belgium, the Czech Republic, Denmark, Spain, Italy, Lithuania, Hungary, the Netherlands, Poland, Portugal, Finland, Sweden, Norway) (SWOV 2011), at all times of the day across all days of the week. Samples were tested for 23 substances including some active metabolites (the full list can be found in the original report). These were grouped into four over-arching categories: alcohol, illicit drugs (amphetamine, cocaine, tetrahydrocannabinol (THC; the principal psychoactive constituent of cannabis) and illicit opiates); medicinal drugs (benzodiazepines, Z-drugs, medicinal opioids); and various combinations (alcohol-drugs and multiple drugs). Other frequently used psychoactive medication including antidepressants, antihistamines, anti-epileptics and antipsychotics were included by some of the individual countries, but did not form part of the 'core' group of substances assessed. The findings, in rank order of frequency of detection, are presented in table 4.1. As can be seen, alcohol was the most commonly detected drug in each area. After this however, differences were observed with cannabis being the second most detected in Southern and Western Europe, medical opiates in Northern Europe and benzodiazepines in Eastern Europe. Overall illicit drugs were detected much less frequently than alcohol (alcohol 5.4%; THC 1.32%; cocaine 0.42%; amphetamines 0.08%; illicit opioids 0.07%), and medicinal drugs (benzodiazepines 0.9%; medicinal opioids 0.35%; z-drugs 0.09%) were generally less prevalent than either alcohol or illicit drugs. Prevalence of drugged driving was much higher in Southern Europe, with 14.5% of drivers testing positive to any substance, compared with Western Europe (7.5%), Northern Europe (2.7%) and Eastern Europe (2.4%). Comparing this data to the current study, the profile of drugs taken in New Zealand most closely reflects Northern Europe, with the exception of the Z drugs (zolpidem and zopiclone) which are rarely taken in New Zealand.

The New Zealand drugged driving prevalence data was also compared with rates in Australia. The Australian Drug Foundation conducted a survey of prevalence, attitudes and perceptions of drugs and driving (Mallick et al 2007). Participants (n=6801) completed an internet survey and were asked if they had driven within three hours of taking a range of legal and illegal substances. These findings are also summarised in table 4.1. As can be seen in the table, analgesics are the most commonly reported drugs taken prior to driving in Australia, exceeding the number reporting alcohol use. Interestingly, cannabis use prior to driving is almost as frequent as alcohol use. In comparison with New Zealand, drug consumption prior to driving appears to be much more common in Australia; self-reported cannabis use is three times higher, and benzodiazepine use four times higher in Australia compared with New Zealand.

The data presented to date has revealed the types of drugs most commonly taken in New Zealand prior to driving; the next section explores the crash risk and levels of impairment produced by these drugs.

Table 4.1 Most common psychoactive drugs used within three hours of driving in New Zealand, Europe and Australia

Rank	New Zealand ^(a)	% of sample	Australia ^(a)	% of sample	Northern Europe	Eastern Europe ^(b)	Southern Europe ^(b)	Western Europe ^(b)	Europe overall
1	Alcohol	11.6	Medical opiates and opioids (analgesics)	15.0	Alcohol	Alcohol	Alcohol	Alcohol	Alcohol
2	Medical opiates and opioids (analgesics)	10.0	Alcohol	12.6	Medical opiates and opioids	Benzodiazepines	THC	THC	THC
3	SSRIs	8.75	THC	12.3	Benzodiazepines	THC	Benzodiazepines	Benzodiazepines	Benzodiazepines
4	THC	3.8	Amphetamines	6.9	Z-drugs	Amphetamines	Cocaine	Medical opiates and opioids	Cocaine
5	Benzodiazepines	1.0	Ecstasy	5.8	THC	Medical opiates and opioids	Medical opiates and opioids	Cocaine	Medical opiates and opioids
6	Amphetamine	0.4	Benzodiazepines	4.0	Amphetamines	Illicit opiates	Illicit opiates	Amphetamines	Z-drugs
7	Illicit opiates	0.3	Cocaine	3.1	Cocaine	Z drugs	Amphetamines	Z drugs	Amphetamines
8	Cocaine	0.1	Prescription stimulants	2.3		Cocaine		Illicit opioids	Illicit opioids

^(a) = self-report survey ^(b) = random roadside testing. Percentage data is not presented for the European studies as they are not comparable due to differing methodologies.

5 Review of the impairment effects of the drugs of interest

The aim of this part of the study was to evaluate the crash risk and impairing effects of the most commonly taken prescription drugs in New Zealand (strong painkillers, SSRIs, benzodiazepines) and two illegal drugs of interest (cannabis and methamphetamine). The recently completed European Community financed project 'Driving under the Influence of Drugs, Alcohol and Medicines (DRUID) was used as a key initial resource for research conducted prior to 2006 and was completed by carrying out a systematic review of the research literature published after 2005.

5.1 Method

The systematic review was developed using the guidelines provided by Kahn et al (2003). Briefly, a systematic search of the literature was conducted the following electronic databases: PsychInfo, Scopus, Science Direct, Google Scholar, Pub Med and Cochrane's database. The search terms were identified from those used in the systematic review in the DRUID study and other relevant articles and included the drug name (ie cannabis (or 9-THC, marijuana, 'cannabinoid), benzodiazepine, selective serotonin reuptake inhibitor, amphetamine, methamphetamine, narcotic painkillers, analgesics, opiate-based painkillers) along with each of the following keywords – driv*, mva, crash*, DUID, impair* driving under the influence of drugs. As the aim was to build on the systematic review conducted for the DRUID study the search was limited to articles published since 2005. To ensure all relevant articles were identified, two researchers undertook independent searches of the databases searching for all instances of the keywords appearing in the Abstract, Title and/or Keywords fields.

During the first search, titles were screened to identify relevant articles resulting in 2,132 articles. After removal of 1,671 duplicates, 461 articles remained. These articles were then examined on the basis of the inclusion and exclusion criteria (based on those used for the DRUID systematic review) to ensure the eligibility of the articles. Studies were included if they used a control group design, reported their own experimental data, the drug-only conditions did not include special populations (eg attention deficit hyperactivity disorder ((ADHD)) patients), and the study reported drug concentration in blood (except for New Zealand studies where this criterion was waived). Studies were excluded if they were set up non-experimentally or non-epidemiologically (eg anecdotal without statistical analysis), did not include variables that were connected to performance abilities related to driving safely, used animal subjects, examined fewer than six subjects, investigated a dependent population, and/or used participants under 16 years of age.

After applying the inclusion and exclusion criteria, 35 articles remained for full-text review. The articles were then summarised in a series of tables to include information about the study design, the sample, the measures used and a summary of the findings.

As explained above, the systematic review focused on the broad drug categories (ie BZDs, SSRIs), rather than specific drugs within each category (eg diazepam, fluoxetine). Once the survey data collection was complete we were able to focus the next part of the literature search on the effects of specific drugs on driving performance and driving-related skills. Initially, data was collated from the DRUID meta-analysis (Berghaus et al 2011), the additional experimental studies that were conducted to examine the effects of stimulants and medicinal drugs on actual and simulated driving (Ramaekers 2011a; 2011b) and the literature review of driving after administration of opioids, narcoanalgesics and hallucinogens (Strand et al 2011). This data is summarised in table 5.1. After this, another search was undertaken of the electronic

data bases using the specific drug names and driv*, mva, crash*, DUID, impair* driving under the influence of drugs.

5.2 Results

It is important to note that the studies summarised here used a wide variety of methodologies which may explain some of the variability in the findings. For example, in the studies focusing on the prevalence of drugs in injured or killed drivers, there are differences in the type of biological specimen being analysed (blood, urine, saliva), the substances looked for (the drug itself, or its metabolites), the time lapse between the crash and the sample being taken, the specificity of the analyses, the pharmacokinetics of the drug, and which drivers provided samples (some countries have mandatory drug screening for injured and/or killed drivers whereas in other countries the approach is less systematic). Experimental studies also differ in terms of the dose of drugs used, route of drug administration, the sample (drug naïve participants or current users) and the time between drug dosing and testing.

The results are organised by drug type/category. Table 5.1 summarises the data from the DRUID meta-analysis for all the drugs of interest. The table includes information on whether the drug had dose dependent effects, the length of time between ingestion and maximal impairment, the percentage of tests showing significant impairment, the time for impairment to drop to levels equivalent to a blood alcohol concentration (BAC) of .03% (< 15% of statistically significant effects), the effect of repeated administration of the substance and the degree of impairment. An impairment curve was constructed for each drug (the degree of impairment over time). The area under the curve was calculated to take into account the degree and length of impairment, and then the minor effects (equivalent to .03% BAC) were excluded. Thus, the measure 'degree of impairment' takes into account both the level and duration of significant impairment. Information from the systematic review is summarised in the relevant section for each drug.

Table 5.1 A summary of the impairing effects of drugs commonly used in New Zealand prior to driving (data adapted from Berghaus et al 2011)

	Dose dependent effects	Peak impairment	Percent showing sig impairment ^(b)	Time to <15% impaired	Alcohol equiv of max impairment (%)	Effect of multiple administration	Degree of impairment
Cannabis (oral)	Y	1-2.25 h	10-55	0-5	<.03->.08	Not avail	0-215
Cannabis (smoked)	N	.27-.75	50-69	2.5-4.75	.08	Not avail	66-70
Stimulants		0	0	0	<.03 but may increase risk taking	Not avail	0
Opioid analgesics/ codeine	Insufficient evidence for analyses						
Diazepam	Y	0.75-1.25 h	23-74	4.5-6.25 h	.03->.08	Improvement in 1 week. Residual impairment	17-171
Alprazolam	Y	2 h	74	14 h	>.08	Tolerance after few days, minor deficits up to 1 week	369
Lorazepam	Y	2-3.25 h	32-77	7.5-19.75 h	.03->.08	Improvement in 1 week. Residual impairment	64-571
Fluoxetine ^(a)	N	NA	0	0	0	No sig deficits expected	0
Paroxetine ^(a)	N	3-5 h	<10	0	<.03	No impairment	0
Citalopram/ Escitalopram	No negative effects on driving (Brunnauer and Laux 2013)						
Sertraline	Effects thought to be similar to paroxetine (Amado-Boccaro et al 1994)						0

^(a) Limited studies so evidence may be unreliable. ^(b) 15% showing significant impairment is equivalent to BAC of .03 (classified as a minor effect).

5.2.1 Cannabis

Numerous studies have been conducted in an attempt to determine if crash risk increases as a result of cannabis consumption. These studies can be divided into two types: 1) the study focuses on the role of cannabis consumption in crash risk by comparing crash-involved drivers (injured or killed) with either cannabis free crash-involved drivers or with a sample of non-crash-involved drivers from the general population and: 2) the study examines the relationship between cannabis consumption and crash responsibility by comparing at fault and not at fault injured/killed drivers who have consumed cannabis.

In terms of crash risk, most studies find odds ratios (ORs) of around 2 for cannabis alone (eg Dussault et al 2002; Biecheler et al 2008; Mura et al 2003). There is also evidence to suggest that cannabis contributes to an increased risk of performing unsafe driving actions (UDAs) (OR 1.29, Bédard et al 2007; OR 5.25, Dubois et al 2015) and this is dramatically increased in drivers who have also consumed alcohol. In contrast, cannabis consumption does not appear to increase the likelihood of non-use of safety belts in fatal crashes (Bogstrand et al 2015). In a summary of the epidemiological studies conducted as part of DRUID, the relative risk of getting injured or killed as a result of cannabis consumption was estimated to be between 1 and 3, (defined as 'slightly increased risk') (Bernhoft 2011), but as the estimates from each country were highly variable, these findings should be interpreted with caution.

With regard to the role of cannabis in crash responsibility, the majority of studies have failed to find ORs significantly different from 1 for cannabis alone, but this may be due to poor study design, in particular failure to control for confounding factors (such as gender, time of day, age) and failure to account for the timing of cannabis use. Studies that have accounted for these factors have found adjusted ORs of 2.7 (Drummer et al 2004) and 1.8 (Laumon et al 2005; Biecheler 2008) for crash responsibility. A more recent study found an adjusted OR of 1.89 for cannabis and 8.39 for alcohol for crash responsibility (Gadegbeku et al 2011) as well as a dose response relationship between cannabis and crash responsibility (see table 5.2). The dose response relationship between cannabis and crash responsibility was also noted as part of the DRUID project (OR of 6.6 for THC levels over 5mg/ml compared with an OR of 2.7 for all levels of cannabis) (Drummer et al 2004; Biecheler 2011). The combination of alcohol and cannabis leads to much higher ORs than either substance alone and the effects appear to be multiplicative (OR for alcohol and cannabis combined 14.1; alcohol 8.5; cannabis 1.8) (Laumon et al 2005; Biecheler 2008). The DRUID study concluded that in car drivers, positive detection of cannabis was associated with increased risk of responsibility (OR=1.89) taking into account age, gender and alcohol.

Shifting the focus to the degree of impairment produced by cannabis, the findings from the DRUID meta-analysis are summarised in table 5.1. Overall, oral cannabis consumption caused considerable impairment at some doses, but smoking cannabis did not produce the same degree of impairment. As well as providing an overall classification of the likely driving impairment related to a substance, where data allowed, an impairment curve was constructed to show how impairment changed over time. From this a numerical value of 'degree of impairment' was calculated based on the area under the curve. Minor impairment effects (equivalent to .03% BAC) were excluded from this calculation. As can be seen in the table, the effects of smoked and oral cannabis differ. There are clear dose-dependent effects for oral cannabis and the overall impairment effects are greater than when cannabis is smoked. The impairment effects associated with cannabis may last up to five hours and a significant proportion of users (up to 70%) show significant levels of impairment.

More recent studies identified as part of the systematic review are summarised in table 5.2. Findings indicate that more frequent cannabis use (ie habitual use) has been associated with increased reckless driving and speeding in a driving simulator task (Bergeron et al 2014; Bergeron and Paquette 2014) as well as more signalling errors and greater driving impairment when tested under the influence of cannabis

(Downey et al 2013). Cannabis has also been found to impair control of speed, headway and lateral position in a simulated driving task (Lenne et al 2010; Hartman et al 2015), and as task demand increased, participants' car control was observed to decrease (Lenne et al 2010). In addition cannabis led to decreased performance on tracking tasks (Menetray et al 2005), and increased the likelihood of being classed as impaired on a clinical test of impairment (Bramness et al 2010; Khiabani et al 2006).

Overall, cannabis (when taken alone) results in a slightly increased crash risk, increased likelihood of crash responsibility and impairments in driving-related skills. When taken in conjunction with alcohol, both crash risk and impairment are significantly elevated.

Table 5.2 Summary of articles from the systematic review on the effects of cannabis on driving performance

Article	Design	Sample	Measure	Summary
Bédard et al (2007). The impact of cannabis on driving	Case control cross-sectional study of drivers in a fatal crash. Cases: drivers with UDA in relation to crash (eg speeding) with confirmed cannabis consumption but negative for alcohol.	32,543 drivers tested, aged 20–49.	Crude and adjusted ORs of UDAs, confirmed cannabis consumption and zero BAC.	Cannabis had a negative effect on driving and is a risk factor in fatal crashes.
Blows et al (2005) Marijuana use and car crash injury	Population-based case control study. Cases: cars involved in crashes where at least 1 occupant hospitalised or killed. Controls: random sample of cars on Auckland roads.	571 cases (mean age 36.6 years; 65% male) and 588 controls (mean age 40.8 years; 55% male).	Interview: demographics; circumstances of the crash; and personal, vehicle and environmental factors. Survey of the crash and control recruitment sites for road and traffic characteristics. Medical records of cases examined. Blood alcohol levels estimated. Acute cannabis use (3 hours prior to the crash/roadside survey); chronic use (freq. of marijuana in past 12 months).	Habitual THC users, 10x risk of car crash injury or death compared with infrequent/ non-users. THC use prior to the crash/survey reported by 5.6% of cases and 0.5% of controls. Acute use assoc. with 4x the risk of car crash injury with adjustment for non-risk taking variables.
Dubois et al (2015) The combined effects of alcohol and cannabis on driving: impact on crash risk	Case control. Cases: drivers with one or more UDA in relation to a fatal crash; controls had none. Outcomes were prevalence of driving under the influence of alcohol and cannabis.	150,010 drivers involved in a fatal collision in the US 1991–2008.	UDA (eg weaving), speeding, drivers' past three-year driving records. Previous driving history: crashes, convictions for driving while impaired, speeding convictions, other harmful moving violation convictions, and licence suspensions and revocations.	Drivers with a zero BAC and positive for THC had 16% increased odds of committing a UDA. Drivers at typical BAC legal limits of 0.05 and 0.08 had greater odds of committing a UDA of 66% and 117%, compared with sober, THC-free, drivers. Combined with THC, odds increased to 81% and 128%. Drivers positive for both alcohol and THC had greater odds of errors than drivers positive for alcohol or cannabis only.

Article	Design	Sample	Measure	Summary
Gadegbeku et al (2011). Responsibility study: main illicit psychoactive substances among car drivers involved in fatal road crashes	Case control study. Systematic screening for illicit drugs for drivers involved in fatal crashes. Cases: drivers responsible for the crash. Controls: drivers not responsible.	Data from 2001–2003. Cases: 4,946. Controls: 1,986 drivers were > 18 years.	Crash responsibility: fully responsible, partially responsible and non-responsible. Concentration of illicit drugs.	Dose-response relationship between cannabis and risk of crash responsibility. Effect of cannabis on crash responsibility not as strong as effect of alcohol. Adjusted OR for cannabis 1.89 [1.43–2.51]; alcohol 8.39 [6.95–10.11]. Consumption of both multiplies risks.
Laumon et al (2005) Cannabis intoxication and fatal road crashes in France: population based case-control study	Population-based case control. Cases: drivers at fault in fatal crashes in France. Controls: not at fault drivers.	6,766 responsible drivers and 3,006 controls. 681 cases tested positive for cannabis (643 males and 38 females).	Crash responsibility (driving offences, responsibility assignment by police, vehicle and road conditions, crash type). Concentration of drugs and alcohol in the blood.	Fatal crashes resulted from cannabis use even after controlling for confounders (inc alcohol). (OR=3.32) Cannabis had a dose dependent effect; increasing dose lead to greater crash responsibility.
Van Elslande et al (2012) Influence of cannabis on fatal traffic crashes	Case control. Cases: drivers involved in a fatal crash who tested positive for cannabis. Controls: no blood or alcohol in their system.	174 drivers (mean age 25 years) who tested positive for cannabis and 174 matched controls without drugs or alcohol in their blood.	Analysis of crash reports, including perception (eg non-detection in a situation of limited visibility), diagnosis (eg poor evaluation of temporary difficulty), prognosis (eg expectation of no obstacle), decision (deliberate violation of safety rule), execution (eg guidance problem, generalised (eg total loss of psychophysiological capacities).	Cannabis drivers had more generalised failures involving sensorimotor and cognitive capacities and more diagnostic errors (eg navigating a bend). Cannabis drivers also showed low levels of vigilance and attention and risky driving behaviours. A dose effect is observed at lower levels, drivers commit other failures but generalised failures occur at higher blood concentrations of cannabis.
Bergeron et al (2014) An examination of the relationships between cannabis use, driving under the influence of cannabis and risk-taking on the road	Correlational design.	48 males, 18–26 years driven under the influence of cannabis in the previous 12 months.	Self-reported frequency of driving under the influence of cannabis and alcohol (1 hr), and general risk taking. Reckless driving (mean and max speed) in a timed drive in the simulator.	Driving under the influence of cannabis is related to reckless driving generally. Efforts should target general levels of driver risk taking.

Article	Design	Sample	Measure	Summary
Bergeron and Paquette (2014) Relationships between frequency of driving under the influence of cannabis, self-reported reckless driving and risk-taking behaviour observed in a driving simulator	Correlational design.	72 adult male cannabis users, 18–25 years of age, with valid driver licence, and drove at least twice a week.	Self-reported frequency of driving under the influence of cannabis and alcohol (1 hr), Dula dangerous driving index and general risk taking. Reckless driving (mean and max speed) in a timed drive in the simulator.	Increased frequency of driving under the influence of cannabis associated with speeding in the simulator and with an aggregate score of observed risky driving behaviours.
Bramness et al (2010) Impairment due to cannabis and ethanol: clinical signs and additive effects	Retrospective cross-sectional data base study.	589 cases positive for THC; 894 cases with THC and alcohol. 3,480 drivers with only alcohol and 79 drivers who tested negative.	Clinical test of impairment includes tests of alertness, cognitive function. vestibular function, eyes, cardiac action, signs of iv drug abuse, motor activity and coordination, and appearance. Physician concludes whether the driver is 'not impaired' or 'impaired'.	Increased risk of being judged impaired for those with high THC concentrations. Impairing effects when THC is combined with alcohol. Even a small amount of alcohol with THC increases impairment.
Bogstrand et al (2015) Associations between driving under the influence of alcohol or drugs, speeding and seatbelt use among fatally injured car drivers in Norway	Retrospective, observational, cross sectional, multisite study.	369 drivers fatally injured in RTCs in Norway 2005–2010.	Blood samples analysed for alcohol and psychoactive drugs. Non-use of safety belt and speeding. Crash investigation team measures of road- and road conditions, motor vehicles and the driver (ie driving skills, distraction and drugs).	Sig assoc. between BACs above 0.5g/L or amphetamine concentrations above 200mg/L and non-compliance with safety-belt laws and speeding. Most fatalities impaired by alcohol or drugs were unbelted or speeding.
Khiabani et al (2006) Relationship between THC concentration in blood and impairment in apprehended drivers	Observational study of drivers suspected of driving under the influence of non-alcoholic drugs.	486 DUI cases that tested positive for THC.	Blood samples from suspected driving under the influence drivers with positive THC concentrations in blood were compared to their clinical test of impairment results. Controlled for other factors (gender, needle marks and regular use.)	Drivers categorised as impaired on the basis of the clinical test of impairment had higher THC concentrations than non-impaired drivers. Significant dose dependent effect observed; increasing cannabis concentration associated with higher likelihood of being categorised as impaired.

Article	Design	Sample	Measure	Summary
Downey et al (2013) The effects of cannabis and alcohol on simulated driving: influences of dose and experience	Double-blind, placebo-controlled. Low and high alcohol group BAC 0.04%/0.06% Two levels of THC: low and high (1.8%/3% THC) Placebo for alcohol and cannabis. Driving assessed 20 min post-drug.	80 participants (49 male, 31 female), recreational users of alcohol and cannabis. Mean age = 26.45, SD = 5).	Driving simulator performance reflecting common errors (collisions, skidding, straddling the barrier line), scored on a presence/occurrence basis; speeds at diff. moments during the simulation (eg initial speed) and following and stopping distances.	Driving and signalling performance impaired by the comb. of alcohol and THC. Regular users displayed more driving errors. Ability to control speed and maintain safe distance and lane position were affected. Reg. users had more signalling errors and greater driving impairment.
Lenne et al (2010) The effects of cannabis and alcohol on simulated arterial driving: Influences of driving experience and task demand	Experimental design, counterbalanced. Three doses of alcohol and cannabis alone and in combination. Alcohol low dose, 0.4 g/kg and high dose 0.6g/kg. Cannabis low dose, one placebo and 8 puffs of a 19mg 9-THC cannabis cigarette, high dose, two 19mg 9-THC cannabis cigarettes, 8 puffs per cigarette.	22 novice drivers (18–21 years) and 25 experienced drivers (25–40 years). All had history of alcohol and cannabis use.	Simulated driving performance with varied workload via secondary tasks. Mean speed, SD of speed, SD of steering wheel angle, SD of lateral position, mean and SD of headway and reaction time (s).	Cannabis impaired variability in speed, headway and lateral position. High dose of cannabis resulted in slower RT, increased mean headway and decreased mean speed. Under dual task conditions participants under the influence of cannabis left larger headway but showed greater variability potentially signifying reduced car control.
Hartman et al (2015) Cannabis effects on driving lateral control with and without alcohol	Within subject placebo-controlled design. Driving performance under the influence of alcohol (placebo or low dose, 0.065%) and/or cannabis (placebo, low 2.9%THC or high 6.7% THC vapourised cannabis) was examined on a driving simulator.	Eighteen healthy adults (13 men, 21–37 years).	Participants drove for 45 minutes on a predetermined route (urban, interstate and rural night-time segments).	Higher blood THC concentrations lead to greater standard deviation of lane position (SDLP). A combination of THC and alcohol had additive effects.
Menetrey et al (2005) Assessment of driving capability through the use of clinical and psychomotor tests in relation to blood cannabinoids levels following oral administration of 20mg	Double blind case crossover, placebo-controlled design. Participants administered placebo, low or high doses of cannabis or dronabinol on four separate occasions and then	8 healthy males who were occasional cannabis smokers (22–30 years).	Clinical observations(conjunctival reddening, pulse rate, arterial pressure), psychomotor tests (road sign testing, tracking test), willingness to drive, visual analogy scale.	Ingestion of oral THC increases perception of intoxication and impairs skills necessary for driving.

Article	Design	Sample	Measure	Summary
dronabinol or of a cannabis decoction made with 20 or 60mg Delta9-THC	asked to perform on the driving simulator and complete psychomotor tests.			
Bosker et al (2012) Medicinal Δ 9-tetrahydrocannabinol (dronabinol) impairs on-the-road driving performance of occasional and heavy cannabis users but is not detected in standard field sobriety tests	Double-blind, placebo-controlled randomised 3-way cross-over study. Participants received oral single doses of placebo, 10 and 20mg dronabinol.	12 occasional and 12 heavy cannabis users (14 males/10 females) Occasional users: 5–36 times a year; heavy users >160 times a year.	Driving simulator and field sobriety test. SDLP (ie weaving) the primary measure of road-tracking control. Time to speed adaptation the primary reaction-time measure. Percentage of impaired individuals on the standard field sobriety tests and subjective high on a visual analogue scale.	Drivers under the influence of dronabinol needed more time to react and adjust to speed changes. A single dose of dronabinol severely impairs driving performance of drivers with a history of occasional cannabis use.
Battistella et al (2013) Weed or wheel! fMRI, behavioural, and toxicological investigations of how cannabis smoking affects skills necessary for driving	Two experimental sessions (smoked cannabis or placebo). Tested 45 minutes post-smoking 0.7g of pure cannabis or placebo.	31 males, 18–30 years, occasional cannabis smokers.	Critical tracking task and fMRI.	Smoking cannabis significantly decreased task performance and altered brain activity even at low concentrations

5.2.2 Stimulants (amphetamine, methamphetamine, methylphenidate)

The only stimulants taken prior to driving by participants in the current study were methylphenidate and amphetamine or methamphetamine. Due to the relatively small number of injured or killed drivers testing positive for amphetamines in the DRUID study it was only possible to calculate the relative risk of being killed or injured for three countries (Finland, Norway and Sweden). Across these countries the relative risk of getting killed was 24.09, and the risk of being seriously injured was 8.35, but as these estimates are based on relatively small sample sizes they should be interpreted with caution (Bernhoft 2011). In terms of crash responsibility, the adjusted OR indicated that drivers taking amphetamine were at no higher risk of responsibility than non-drugged drivers (ie the OR was not significantly different from 1). However, a more recent study of truck drivers involved in fatal crashes (table 5.3) found a significant increase in the risk of committing a UDA after taking stimulants (OR=1.47 for 1 stimulant; OR= 2.79 for 2+ stimulants). The most common UDAs were failure to keep in the proper lane, driving too fast for the conditions and failing to give way (Gates et al 2013).

In terms of driving impairment, the DRUID meta-analysis failed to find any evidence for negative effects on driving performance for amphetamines; in fact there was more evidence of improvement rather than impairment, with only 1% of 515 tests in healthy adults showing significant impairment (Schulz et al 1997 in Berghaus et al 2011). Furthermore, there was no evidence of dose-dependent effects (see table 5.1). Anecdotal evidence and case studies do, however, suggest that amphetamines may increase agitation and risky driving, and are often taken to address issues of fatigue, which were not assessed in the studies included in the meta-analysis. To address this, studies were undertaken to determine the effects of amphetamines and sleep deprivation on driving performance. Overall amphetamines appeared able to attenuate the deficits in road tracking that arose as a result of sleep deprivation. However, there was a high degree of variability in outcomes, with some individuals showing no impairment and others showing impairment above that of .05% BAC. Similar effects were observed when amphetamines were given in combination with alcohol (BAC .08%), that is, some participants showed impairments whereas others did not (Raemakers 2011b).

Table 5.3 summarises the papers identified as part of the systematic review. Overall, the experimental studies in recreational stimulant users found some minor performance impairments including poorer speed adaptation, reduced signalling and higher numbers of infringements (Raemakers et al 2006; Silber et al 2005; 2012; Stough et al 2012) as well as improvements in tracking performance. Regular methamphetamine users were more likely to drive in a risky manner (speed and weave when driving) compared with non-methamphetamine users. Interestingly these effects were not related to current levels of methamphetamine in the blood (or its metabolite) (Bosanquet et al 2103). A very recent on-road study of medicated (with methylphenidate) and unmedicated drivers with ADHD found that medicated drivers performed at similar levels to control drivers, whilst unmedicated drivers showed significantly more inattentive and impatient driving errors (Randell et al 2016). Finally, studies suggest that amphetamines are able to be detected via clinical tests of impairment, particularly when taken in combination with benzodiazepines (Gustavsen et al 2006; Hoiseth et al 2014).

Overall research findings suggest that amphetamines may lead to a general increase in risky driving (or this could be a characteristic of those who take the drug). In combination with fatigue or alcohol, the effects are unpredictable and differ across participants. In drivers with ADHD, the effect of stimulant medication appears to improve their driving safety.

Table 5.3 Summary of articles from the systematic review on the effects of amphetamine/methamphetamine on driving performance

Article	Design	Sample	Measure	Results	Summary
Gates et al (2013) The influence of stimulants on truck driver crash responsibility in fatal crashes	Case control using the fatality analysis reporting system (FARS) database. Cases: truck drivers with at least one UDA recorded. Controls: no UDAs recorded. Stimulant presence or absence.	Stimulant positive truck drivers n = 302 from total eligible case of 8,325 (with confirmed BAC of 0).	UDAs including: failure to keep in the proper lane; driving too fast for conditions; failure to yield or obey traffic signs; erratic or reckless vehicle operation; making improper turn.	Stimulant positive truck drivers at increased odds of committing a UDA: 1 stimulant OR= 1.47; 2 or 3 stimulants OR = 2.79. Most common UDA was failure to keep in the proper lane, driving too fast for the conditions and failing to yield.	Stimulant-positive truck drivers at increased odds of committing a UDA, especially with multiple stimulants. Presence of narcotic meds increased the odds of a UDA by 63%. Having a previous crash, speeding, or other previous driving infraction increased the odds of a UDA by a minimum of 14%.
Ramaekers et al (2006). Stimulant effects of 3, 4-methylenedioxyamphetamine (MDMA) 75mg and methylphenidate 20mg on actual driving during intoxication and withdrawal	Double blind placebo controlled 3 way crossover study. MDMA 75mg/ methylphenidate 20mg/ placebo in the intoxication phase; withdrawal phase (27–29 hrs post-drug)	Eighteen recreational MDMA users (9 males, 9 females) aged 21–39 years. All subjects were healthy with no reported history of drug addiction.	Road tracking test – 1 hr drive on a 100km highway while maintaining lateral position in the lane. SDLP is main measure of road tracking error. Car-following test – 25 min driving test on a 70km/h secondary highway maintaining a distance of 15–30m of the leading car. Time to speed adaptation, BRT and gain measures.	Road tracking test: significant effect of treatment, MDMA (p= .005) and methylphenidate (p=.001) reduced SDLP compared with placebo during intoxication but not withdrawal. Lateral position, speed and SD speed showed no sig. results. Car-following test-significant effect of treatment on gain measure during intoxication but not withdrawal phase, MDMA (p = .011) but not methylphenidate significantly increased gain. No sig effects for BRT and time to speed adaptation. Withdrawal did not affect driving performance.	MDMA improves driving performance in certain aspects (road tracking) but reduces performance on other aspects (accuracy of speed adaptation).
Silber et al (2005) The effects of dexamphetamine on simulated driving performance	Counterbalanced double-blind placebo controlled. 0.42mg/kg d-methamphetamine or placebo.	Twenty healthy recreational stimulant users (10 males) aged 21–32 years (M=25.4)	Free-way and traffic driving in day and night conditions (5 minutes each, total of 20 min). Overall impairment score on 34 variables (driving too fast, inappropriate braking, no signal) on vehicle management and conformance.	Reduction in performance in the dexamphetamine compared with placebo condition (p<.05) for daytime driving condition but not night-time driving condition (p>.05,). Reduced signalling adherence under amphetamine at	Dexamphetamine negatively impacted on performance mainly during daytime simulated driving rather than night-time driving. Results consistent with perceptual narrowing or tunnel vision.

Article	Design	Sample	Measure	Results	Summary
				intersections, entering a freeway and lane changes. No significant differences with regard to night time driving except a trend towards slower RT.	
Silber et al (2012) The effect of d,l-methamphetamine on simulated driving performance	Counter-balanced, double-blinded, placebo-controlled design. 0.42mg/kg d-methamphetamine or placebo.	Twenty healthy participants (10 males, 10 females) aged 21–32 years (M=25.4).	Free-way and traffic driving in day and night conditions (5 minutes each, total of 20 min). Overall impairment score on 35 variables (no safe following distance, incorrect signalling at intersection, did not stop at red traffic light).	No significant difference between day and night time driving simulations ($p = .76$) so overall impairment scores were assessed. Drivers in d-methamphetamine condition travelled at a slower speed than placebo condition when an emergency situation occurred ($T = 44, p < .05$).	Dexamphetamine did not impair driving performance. Trend for dexamphetamine drivers to carry out more infringements.
Stough et al (2012) The acute effects of 3,4-methylenedioxymethamphetamine and methamphetamine on driving: A simulator study	Double-blind, counter-balanced and placebo-controlled study. Oral consumption 100mg of MDMA, 0.42mg/kg meth and placebo.	Sixty-one healthy participants (33 females and 28 males) aged 21–34 years (mean age 25.45, SD 3.25).	City traffic driving and freeway driving in day and night-time conditions.	During the daytime simulation and signalling was worse in the MDMA and methamphetamine compared with placebo. Ability to keep a safe distance was affected in the methamphetamine and MDMA compared with placebo. Speed limits were broken more in the MDMA compared methamphetamine or placebo conditions.	MDMA and methamphetamine impaired driving performance. Impairment was worse in the MDMA than methamphetamine condition. MDMA led to occurrence of reduced car following, inappropriate braking and skidding, speeding. Methamphetamine administration led to inappropriate braking, car following and cancellation of signals.
Bosanquet et al (2013) Driving on ice: impaired driving skills in current methamphetamine users	Experimental design current meth users compared with non-meth users on driving simulator performance.	Meth group ($n=15$, mean age = 36.5, 12 male); control group ($n =15$, mean age = 37.3, 13 male). >3 years driving exp. Meth group: used meth at least weekly in	Risky driving behaviour (speeding, freq. of collisions with oncoming vehicles, centreline crossing, weaving gap acceptance when turning). Personality and neuropsychological screening tests. Blood samples for current drug levels.	Meth users sig. more likely to speed and weave when driving. They left less distance between their vehicle and oncoming vehicles when making a right-hand turn.	Association between Meth use and risky driving although it is not related to current blood levels of Meth or its metabolite amphetamine. Meth users more likely to speed and weave when driving.

The prevalence and impairment effects of drugged driving in New Zealand

Article	Design	Sample	Measure	Results	Summary
		past 3 months.			
Gustavsen et al (2006) Impairment related to blood amphetamine and/or methamphetamine concentrations in suspected drugged drivers.	Correlational design	878 cases with amphetamine or methamphetamine in the blood selected from the impaired driver registry, Norwegian Institute of Public Health. Ages 17 to 60 years (mean = 31.2). 786 of participants were male.	Clinical test for impairment administered by police physician (25 tests of motor coordination, cognitive performance, degree of alertness). Concentration of amphetamine and methamphetamine in blood samples.	235 (27%) drugged drivers judged as not impaired. Impaired drivers were younger ($p < 0.05$). Blood amphetamine concentrations did not differ significantly between impaired and non-impaired drivers. Female drivers more often judged as impaired (χ^2 -test, $p < 0.05$). Drivers < 25 judged as impaired more often than older drivers (χ^2 -test, $p < 0.01$).	Modest, but sig. relationship between blood amphetamine concentration and impairment. Younger drivers more often judged impaired than older drivers at similar blood amphetamine concentrations. Positive concentration-effect between blood amphetamine concentrations and clinical impairment as assessed by the clinical test for impairment.
Hoiseith et al (2014) Impairment due to amphetamines and benzodiazepines, alone and in combination	Correlational	153 drivers on benzodiazepines, 267 drivers on amphetamines, 777 drivers on benzodiazepines and amphetamines.	Clinical test for impairment administered by police physician (25 tests of motor coordination, cognitive performance, degree of alertness). Concentration of amphetamine and benzodiazepines in blood samples.	84% of the combined group, 75% of the BZD group and 64% of the amphetamines group categorised as impaired (mildly, moderately or considerably). Significantly more impaired drivers in the combination group.	Larger percentage of drivers under the combined influence of BZD and amphetamine were considered impaired relative to drivers under the influence of either drug alone. BZD drug concentrations were higher in impaired drivers compared with non-impaired drivers

5.2.3 Strong painkillers

In the context of the current study, strong painkillers (medicinal opioids and analgesics) included codeine, tramadol, morphine, oxycodone and methadone. The epidemiological data conducted as part of the DRUID study concluded that the relative risk of getting killed or seriously injured was over 1 for medicinal opioids. Specifically the relative risk of serious injury related to medicinal opioids was 9.06 (CI: 6.40–12.83) based on data from six countries (Denmark, Finland, Lithuania, Italy, Belgium and the Netherlands) and 4.82 (CI: 2.60–8.93) for getting killed, based on data from four countries (Finland, Norway, Portugal and Sweden). In terms of the relationship between strong painkillers and crash responsibility in fatal crashes, the DRUID study found that the adjusted ORs were not significantly different from sober/drug-free drivers (Bernhoft 2011). A more recent study (Corsenac et al 2012; table 5.4) found that when two opiates were considered together (buprenorphine and methadone), the likelihood of crash responsibility increased two-fold. When the substances were considered alone, however, only buprenorphine led to a significantly increased risk of crash responsibility (this drug was only taken by one of our participants).

More recent work (table 5.4) has focused on the link between opiates and UDAs preceding a fatal crash. Studies of car drivers (Dubois et al 2010) and truck drivers (Reguly et al 2014) suggest that the presence of opiates leads to a significant increase in the likelihood of drivers committing a UDA (OR 1.72 for car drivers; 1.83 for truck drivers). In both groups of drivers the most common UDA was failure to keep in the proper lane.

The DRUID study found there were too few studies conducted to carry out a meta-analysis of the effects of opioids (either used as substitution treatment or to treat pain), and carried out a review instead (Strand et al 2011). Driving related skills were categorised under eight main areas (reaction time, attention, divided attention, psychomotor skills, visual functions, tracking, en/decoding driving). Codeine resulted in impairment of psychomotor function in seven out of eight tasks, oxycodone led to impairment in five types of tasks (attention, divided attention, psychomotor skills reaction time, and visual functions) and had some dose-dependent relationship. No effects were evident for tramadol in healthy volunteers with lower doses, or at higher doses in those on chronic treatment. When considering the typical doses of these drugs, the authors concluded that typical codeine and oxycodone doses might cause some level of driving-related impairment. In contrast, there was no evidence that tramadol led to impairment in healthy or tolerant individuals.

The literature on morphine and methadone effects on driving is scarce and inconsistent. In terms of methadone, current evidence suggests that in long-term users there is little evidence of impairment. In contrast, impairment is evident after a single dose of methadone in healthy volunteers (impaired in three out of five tests) but fewer acute effects were evident in opiate/opioid abusers. Drivers on methadone maintenance showed limited effects of a single dose (impaired in 10 out of 50 tests), but in general people on methadone maintenance tend to perform more poorly overall than controls (impaired in 110 out of 236 tests). The authors suggest that the findings from the review be interpreted with caution due to a high degree of variation between the studies, little information on the drug history of the patients, the validity/relationship of many of the tests to driving, and the lack of an appropriate positive control group (usually participants with a BAC of .05%). They concluded that the drugs have 'impairing potential, but that the scientific literature so far does not allow us to draw any firm conclusions on whether this group or certain subgroups of maintenance patients should be allowed a driving license' (p20, Strand et al 2011).

To address the lack of information about the effects of analgesics on driving, experimental studies were also undertaken as part of the DRUID study (Raemakers 2011a). The first examined the effects of three doses of codeine/paracetamol (20/400, 40/800 and 60/1200mg) on simulated driving in healthy volunteers (mean age 22.4 years) using a double-blind cross-over design. There were no significant

effects of drug dose on any of the driving-related measures or on a measure of sustained attention, but the authors caution that further research is needed in crash scenarios, urban driving and older drivers and at higher doses.

Another study examined the effects of analgesics on on-road driving in patients who had been receiving long-term treatment for chronic pain, compared with healthy controls. The positive control group comprised participants with a BAC of .05%. The patients were taking a variety of medication including buprenorphine, fentanyl, hydromorphone, morphine and oxycodone. Findings indicated that .05% BAC led to increased SDLP, compared with sober controls, but there were no differences between the medicated and control drivers on any of the measures. It should be noted, however, that there was a high degree of variability in the performance of the drivers and the findings could not be analysed by drug type due to small sample sizes.

The final DRUID study looked at the effect of opioid analgesics on driving related skills using the Vienna test systems. These are designed to assess driving-related skills and participants need to score above the 16th percentile of an age-independent reference group on five standardised tests assessing stress tolerance, visual orientation ability, concentration, attention and reaction speed to meet the criteria of being fit to drive according to the German Driving Licensing Act. Overall, those on long-term opioid treatment showed greater impairment in driving-related skills compared with controls (8% of the opioid users passed all five tests compared with 22% of those with a BAC of .05% and 33% of sober controls). When performance was examined on each test, there were no consistent differences due to the large variability in the data. Given the low pass rate of all groups it is difficult to conclude that long-term opiate use leads to driving-related impairments.

In summary, there is evidence that opioids may increase crash risk, likelihood of crash responsibility and of committing a UDA related to fatal crashes. The extent to which strong painkillers impair driving or driving-related skills is somewhat unclear. Tramadol does not appear to produce driving-related impairments whereas codeine and oxycodone may (depending on the test scenario). Data for other opioids is too variable to draw any firm conclusions and further research is needed, in particular for patients with chronic pain who may be taking combinations of drugs.

Table 5.4 Summary of articles from the systematic review on the effects of strong painkillers on driving performance

Article	Design	Sample	Measure	Results	Summary
Corssenac et al (2012) Road traffic crashes and prescribed methadone and buprenorphine: a French registry-based case-control study	Registry-based case control analysis of responsible versus non-responsible drivers involved in injurious crashes.	72,685 drivers were involved in an injurious crash in France over 2005 – 2008. 196 drivers were exposed to methadone or buprenorphine on day of crash.	Responsibility levels: road, vehicle and driving cond., type of crash, traffic rule obedience, difficulty of task. Score assigned to each driver for each factor from 1 (favourable to driving) to 4 (not favourable to driving). Drivers grouped into two levels of crash responsibility: responsible (score < 15) or non-responsible (score ≥ 15).	Two-fold increased risk assoc. with the use of buprenorphine or methadone (OR = 2.02, 95% CI: 1.40–2.91). Increased risk of crash responsibility buprenorphine alone but not methadone. The 387 drivers who received at least one dose of buprenorphine or methadone in the six months preceding their crash, showed an increased responsibility risk (OR = 1.70, 95% CI: 1.36–2.14). The OR was 1.52, 95% CI: 1.14–2.03 when excluding the 159 drivers who had received drugs in the eight days before the crash.	Increased risk of being responsible for a crash under buprenorphine or methadone (OR = 2.02, 95% CI: 1.40–2.91). Buprenorphine assoc. with responsibility risk, but no assoc. for methadone (but small no. of drivers exposed). Users of methadone and buprenorphine were at increased risk of being responsible for road crashes. Increased risk could be explained by the combined effect of risky behaviours and treatments.
Dubois et al (2010) The association between opioid analgesics and unsafe driving actions preceding fatal crashes	Case control analysis on data from FARS. Drivers with confirmed BAC of 0 involved in fatal crashes. Cases one or more UDA; controls had none.	72,026 drivers tested for drugs. Mean age of approximately 46 years. Approx two-thirds were male.	Failure to keep in proper lane; driving too fast for conditions; failure to yield right of way, obey signs or other safety zone traffic laws, making improper turn, erratic, reckless, careless or negligent vehicle operation.	Drivers positive for opioids had a worse driving record and 16% higher UDAs. Testing positive for presence of opioids increased crude odds of performing a UDA by 57%. With age centred at 45, adjusted OR of committing a UDA was 1.72 (95% CI: 1.45; 2.03). Younger age, males, testing positive for other medications (except opioids), and poorer driving records assoc. with higher odds of UDA. Younger, middle-aged males on opioids had the greatest increases in predicted odds and largest ORs. Stimulants and depressants interacted sig. with opioids.	For drivers positive for opioids, the odds of UDA increased by 30–42% for females and 40–74% for males. Failure to keep in lane the top UDA, followed by driving too fast; improper turns; erratic, reckless, careless or negligent vehicle operation. Opioid grp had 32% more crashes in the previous 3 years compared with controls, 38% more other traffic convictions, 12% more speeding violations, and 88% more licence suspensions. Opioids negatively affect safe driving.

The prevalence and impairment effects of drugged driving in New Zealand

Article	Design	Sample	Measure	Results	Summary
Reguly et al (2014) Examining the impact of opioid analgesics on crash responsibility in truck drivers involved in fatal crashes	Case control analysis on data from FARS. Drivers with one or more UDA were cases; non UDAs were controls. Comparison between drivers positive and negative for opioids.	10,190 truck drivers were tested for drugs. 8,531 had BAC of zero. Female truck drivers (n = 205) removed from sample leaving 8,325 drivers.	Any UDA, Controlled for other drugs (depressants, stimulants, cannabinoids, narcotics and other drugs), past driving history (collisions, driving while intoxicated convictions, other convictions, speeding and license suspension), age, alcohol use.	Greater UDAs for truck drivers under the influence of opioid analgesics (OA)(56.9%) than those not (41.9%). The main UDA was failing to keep to proper lane (35.3% vs. 17.8%). OA drivers 83% more likely to commit a UDA compared with non-OA drivers (OR: 1.83, 95% CI: 1.23; 2.71). Adjusted OR (for age, poly-drug use and driving history). OA drivers 180% more likely to commit a UDA than non OA drivers (OR:2.8, 95% CI:1.64; 4.81).	Most common OAs detected were morphine, hydrocodone, methadone and codeine (60.8% of OAs).Truck drivers using OAs 2.8 times more likely to commit UDA than non-users controlling for other factors such as age, poly drug use and previous driving history and alcohol.

5.2.4 Benzodiazepines

The BZDs most commonly taken by participants in the current study were diazepam, lorazepam and alprazolam. In terms of increased risk of crash and fatal injury as a result of taking BZDs, data from DRUID indicates a relative risk of 1.99 (CI: 1.36–2.91) for serious injury and 5.40 (CI: 3.90–7.46) of getting killed (Bernhoft 2011). Overall they were classed as resulting in medium-increased risk of serious injury or death (equivalent to a BAC between .05% and .08%). Case-control studies using the FARS database (table 5.5) found that drivers taking intermediate (eg alprazolam and lorazepam) or long half-life BZDs (eg diazepam) had increased odds of a UDA (intermediate OR= 1.78; long OR = 1.47) in a fatal crash (Dubois et al 2008; Maxwell et al 2010). Drivers testing positive for intermediate or long-acting BZDs in combination with alcohol had significantly greater odds of a UDA compared with drivers under the influence of alcohol only with BACs of .08% and .05% respectively. The odds of a UDA when short-acting BZDs were taken in combination with alcohol were no different than for alcohol alone.

In terms of the degree of impairment produced by BZDs, the findings from the DRUID meta-analysis are summarised in table 5.1. As can be seen in the table, the three most commonly taken BZDs in New Zealand may cause significant impairment, with alprazolam leading to the greatest degree of impairment (>.08% BAC). For all three drugs, there was evidence of tolerance developing within a week, but some residual impairment was evident. In patients, evidence suggests that diazepam and lorazepam may lead to persistent performance deficits, but there was insufficient evidence to draw conclusions for alprazolam (Berghaus et al 2011). To clarify the effects of alprazolam on driver behaviour, three groups of participants (treated anxiety patients, untreated anxiety patients and a control group) were given 0.5mg of alprazolam and their performance in a lane tracking task and a car following scenario was assessed. Alprazolam increased weaving in all three groups in the lane tracking task and the authors concluded that alprazolam had a detrimental effect on driver behaviour (Ramaekers 2011a).

More recent studies (table 5.5) indicate that lorazepam at therapeutic doses (2mg) leads to a significant increase in SDLP (weaving) which far exceeded that produced by legal BACs (Daurat et al 2013). Shorter-acting BZDs (eg triazolam, which was not reported as being taken prior to driving in our sample) may also lead to increases in SDLP and poorer driving-related performance (Miyata et al 2015). There is also evidence to indicate that commonly used tests of impairment (eg the field sobriety test) can pick up the effects of BZDs (Stephenson et al 2013), particularly in combination with methadone (Bernard et al 2009), and there is evidence that dose-dependent effects can be observed (Smink et al 2008).

Overall, BZDs (and alprazolam in particular) appear likely to lead to driving-related impairment whether taken acutely or on an ongoing basis. This suggests it is vital for GPs to inform patients about the possible effects of this medication on driving behaviour.

Table 5.5 Summary of articles from the systematic review on the effects of benzodiazepines on driving performance

Article	Design	Sample	Measure	Results	Summary
Dubois et al (2008) The impact of benzodiazepines on safe driving	Case control using the FARS database. Cases: drivers with at least one UDA (eg weaving) Controls: drivers with no UDAs. Excluded: drivers <20. 72,026 drivers with a BAC of zero.	2,200 (3% of 72,026) of drivers tested positive for BZD.	UDAs including: failure to keep in the proper lane; driving too fast for conditions; failure to yield or obey traffic signs; erratic or reckless vehicle operation; making improper turn.	Drivers with intermediate- or long-half-life BZDs had an 11–14% higher UDA compared with those not exposed. Also had sig. higher reports of failure to keep in proper lane/running off road and driving too fast. Younger age, male and poorer driving records were assoc. with a higher risk of a UDA. In particular, previous crashes, previous other convictions, or previous speeding convictions increased the odds of a UDA by 15%, 11%, and 8%.	Drivers taking intermediate or long half-life BZDs had increased odds of an UDA from ages 25. Drivers taking short half-life BZDs did not demonstrate increased odds compared with drivers not using BZDs. Depending on the age of the driver and type of BZD half-life exposure, the odds of a UDA increased. Drivers aged 25 had the highest odds of committing a UDA when exposed to either intermediate- or long-half-life BZDs.
Maxwell et al (2010) The additive effects of alcohol and benzodiazepines on driving	Case control using the FARS database. Cases: drivers with at least one UDA (eg weaving), Controls: drivers with no UDAs.	116,510 drivers from FARS (71.6% were males and mean age = 41.88 years). Investigated drivers under the influence of alcohol, BZD alone and in combination. Included age, sex, driver history and use of other medications (depressants, narcotics, stimulants, cannabinoids and other meds).	Alcohol levels from 0.00 to 0.08 at .01mg/100ml intervals. BZDs classified by half-life: short (≤ 6 hours), intermediate (>6 and ≤ 24) or long (>24). UDAs, eg weaving, speeding, previous driver history (convictions such as speeding in the past 3 years).	OR for committing a UDA increased from short (0.85) to intermediate (1.78) to long (1.47). Odds of committing a UDA significantly increased with depressants (OR=1.58), narcotics (OR=1.32), stimulants (OR=1.85), and other drugs (OR=1.10), but not for cannabinoids (OR=1.06). Drivers with BAC levels from .05 to .08g/100ml more likely to commit UDA when using intermediate BZD than on alcohol alone. Drivers with BAC levels at .05 mg/ml + long BZD were more likely to commit UDA than alcohol alone.	Drivers who tested positive for intermediate- and long-acting benzodiazepines in combination with alcohol had significantly greater odds of a UDA compared to those under the influence of alcohol alone, up to blood alcohol concentrations (BACs) of 0.08 and 0.05 g/100 ml, respectively. The odds of a UDA with short-acting benzodiazepines combined with alcohol were no different than for alcohol alone.

Article	Design	Sample	Measure	Results	Summary
Daurat et al (2013) Lorazepam impairs highway driving performance more than heavy alcohol consumption	Randomised, crossover, double-blind, placebo-controlled. Two treatments administered: 2 milligrams (mg) of lorazepam and a lorazepam-like placebo (lactose).	16 healthy males, 25–35 yrs. Driving licence for at least 3 years, drove weekly and showed no signs of simulator sickness after a 30-min practice drive. Final sample of 14 drivers. Regular sleep-wake cycle (ie 11 pm to 7am for 3 days prior to each test day).	Drivers rated sleepiness on a 100mm visual analogue scale. Performance analysed by the no. of inappropriate line-crossings and SDLP in the driving simulator. Real-world driving sessions were also videoed.	Drivers committed more line-crossings under lorazepam. No. of line-crossings higher when driving the simulator than the real world. SDLP higher under lorazepam and higher in the simulated driving than the real-world.	Lane-keeping worse under BZD than placebo. The driving simulator reproduced BZD induced effect (vs placebo) on SDLP observed in real-life driving. Even a 2mg dose of lorazepam can cause an increment in weaving that far exceeds that induced by alcohol within known legal limits. Simulated driving may magnify hypovigilance, without distorting the effect of BZD vs placebo on the stability of the car's trajectory.
Miyata et al (2015) The effects of acute treatment with ramelteon, triazolam and placebo on driving performance, cognitive function, and equilibrium function in healthy volunteers	Double-blind, placebo-controlled, 3-way crossover design. Participants exposed to ramelteon, triazolam and matched placebo with each condition spaced out with a 7-day washout period. Control for caffeine intake for 12hrs prior to testing.	Seventeen healthy males (Mean= 34.1 +- 10.1 years, range= 23-44 years)	Driving tasks- road-tracking, car-following, and harsh-braking test and cognitive tasks (N-back test, continuous performance test, trail-making test A and B. Self-report measure of alertness (Stanford sleepiness scale) and computerised posturography (body balance test).	11.8% of the participants on ramelteon and 17.6% on triazolam slid off the track 1 hr post dosing. 29.4% on ramelteon and 23.5% on triazolam slid off the track 4 hr post dosing. SDLP of triazolam significantly higher than ramelteon (p= .002) and placebo (p=.005) 1 hr post dosing. Completion times for trail making tests A with ramelteon and triazolam were slower than placebo. Sleepiness in the ramelteon and triazolam conditions significantly greater than the placebo.	Ramelteon may affect road-tracking performance, visual attention and/or psychomotor speed measured by trail-making test part A, and body balance in acute dosing. Lower dose of triazolam also impaired performance worse than ramelteon. Physicians should consider risks and benefits when prescribing both drugs, especially in the initial period of administration.
Stephenson et al (2013) Phenazepam and its effects on driving	Case review	9 males and 2 females suspected impaired drivers submitted to Georgia Bureau of Investigations Division of	Officers' observations, field sobriety tests (number of clues - indicators of impairment).	Field sobriety tests with clues (indicators of impairment), 6 clues for horizontal gaze nystagmus, 8 clues for walk and turn and 4 clues for one-leg	Phenazepam users were associated with traffic crashes and failure to maintain lanes. Phenazepam users showed signs of balance impairment, slurred speech, slow reactions, drowsiness, confusion.

The prevalence and impairment effects of drugged driving in New Zealand

Article	Design	Sample	Measure	Results	Summary
		Forensic Sciences.		stand.	Memory loss observed in one case.
Bernard et al (2009) Methadone and impairment in apprehended drivers	Correlational	635 cases with methadone in the blood selected from the impaired driver registry, Norwegian Institute of Public Health. Majority (>80%) men aged between 30 and 40 years.	Clinical test for impairment administered by police physician (25 tests of motor coordination, cognitive performance, degree of alertness). Concentration of psychoactive drugs blood samples.	Most drivers had taken multiple substances and the majority of drivers (>90%) testing positive for multiple drugs (including BZDs) were classed as impaired on the clinical test for impairment (>90%). No dose impairment relationship between methadone and the test.	Combination of methadone and BZDs can be detected by clinical tests of impairment.
Smink et al (2008) The relation between the blood benzodiazepine concentration and performance in suspected impaired drivers	Retrospective case file evaluation of drivers with (sub therapeutic- $\leq .35$ mg/L, therapeutic- $.35-1.65$ mg/L and elevated- >1.65 mg/L concentrations of BZDs.	171 drivers suspected of DUI were extracted from the Netherlands Forensic Institute's toxicology database.	Field sobriety tests (walking, walking after turn, nystagmus, Romberg's test, behaviour, pupils and orientation).	Significant associations between observations of behaviour and walking, walking after turn and Romberg's test and BZD concentrations.	Increasing concentrations of BZDs led to increasingly reduced performance on behaviour and motor function components of sobriety tests.

5.2.5 Selective serotonin reuptake inhibitors (SSRIs)

In the current study participants reported driving within three hours of taking a range of SSRIs, specifically fluoxetine, citalopram, paroxetine and sertraline. The epidemiological studies conducted as part of the DRUID study did not routinely test for SSRIs, but a few studies have been conducted and are summarised in a literature review (Ravera et al 2012). The findings from the studies vary with one study reporting no association between SSRI use and crash risk (Barbone et al 1998 in Ravera et al 2012) and the others reporting a statistically significant association, with ORs of 2.03 and 2.15, higher than the risk associated with the older tricyclic antidepressants (eg imipramine) (Ravera et al 2011; Rapoport et al 2008 in Ravera et al 2012). In some cases, however, the increased risks were only observed in at-fault drivers who were taking a combination of medication (Rapoport et al 2008 in Ravera et al 2012). The inconsistencies in findings across the studies may be due to differences in methodology, including the population being studied, the study design and medication exposure.

In contrast to the epidemiological studies, the data from the DRUID meta-analysis and other experimental studies are much more consistent in that there is very little evidence that SSRIs produce driving-related impairments. With regard to fluoxetine and paroxetine the DRUID meta-analysis concluded they were unlikely to produce significant deficits after multiple administrations or in patients (Berghaus et al 2010). These findings were reflected in two review papers (Ravera et al 2012; Brunnauer and Laux 2013) that summarised the findings from nine and 21 studies respectively. Brunnauer and Laux concluded that 'acute or chronic use of citalopram, escitalopram, fluoxetine, fluvoxamine, and paroxetine had no negative effects on psychomotor measures, driving simulator performance and on-road tests in healthy volunteers' (p230). Studies with sertraline also reveal similar findings, that is, no impairment in patients (Wingen et al 2006 in Brunnauer and Laux 2013) or healthy individuals (Mattila et al 1988 in Brunnauer and Laux 2013). The majority of the experimental studies on SSRIs and driving were conducted before the DRUID study and no articles (other than the two review articles cited above) were identified in the systematic review.

Overall, the experimental studies strongly suggest that SSRIs are unlikely to result in impairments in driver behaviour, while the epidemiological studies indicate they may result in an increased crash risk. There is a clear need for further systematic studies to be conducted in a diverse population to fully understand whether SSRIs do lead to driving-related impairment.

5.3 Conclusion

Data from our study suggests that the most commonly taken drugs prior to driving are codeine (n=165), SSRIs (n=153), cannabis (n=103), tramadol (n =67) and BZDs (n=26). Data gathered from the systematic review suggests that of these drugs only cannabis and BZDs are associated with significantly increased driving-related risks. Thus it seems that the majority of those driving within three hours of taking single *prescription* drugs in New Zealand are unlikely to have an elevated crash risk (as only a small proportion of participants drove within three hours of taking BZDs). It should be noted, however, that drugs are rarely taken in isolation, and for most substances when combined with alcohol the effects are multiplicative. Many of our drivers were taking a variety of different medication combinations prior to driving and the consequences of this on crash risk and driving-related impairment is poorly understood. Ensuring doctors and pharmacist warn patients about the possible impairing effects of their prescription drugs is important, but it is equally important they are also made aware of the safety issues around taking combinations of prescription drugs and/or alcohol.

6 Extent and timing of drugged driving

In both the internet and follow-up telephone survey respondents were asked how often in the past year they had driven within three hours of taking drugs. The top panel of figure 6.1 shows the percentage of respondents driving within three hours of consuming the drugs of interest reporting that they did so once a week or more often. As can be seen, large percentages of the respondents consuming SSRIs did so weekly or more often (95.56% in telephone survey, 78.72% in internet survey), followed by the consumers of BZDs (50.0% telephone and 45.45% internet). This pattern of consumption reflects the fact that the majority (>99%) of participants were taking the drugs on prescription for medical reasons. Respondents driving within three hours of using cannabis or methylphenidate were also likely to do so once a week or more (40% telephone and 45.28% internet for cannabis and 50% for methylphenidate for the internet survey – no methylphenidate drivers were available for the follow-up telephone survey). Strong painkillers were not as likely to have been used once a week or more (28.21% telephone, 22.79% internet). Of the 14 amphetamine/methamphetamine users reporting driving within three hours of consuming, 28.57% reported doing so once a week or more, but the small number of respondents means this figure should be treated with caution (there were no respondents in this category available for the follow-up telephone survey).

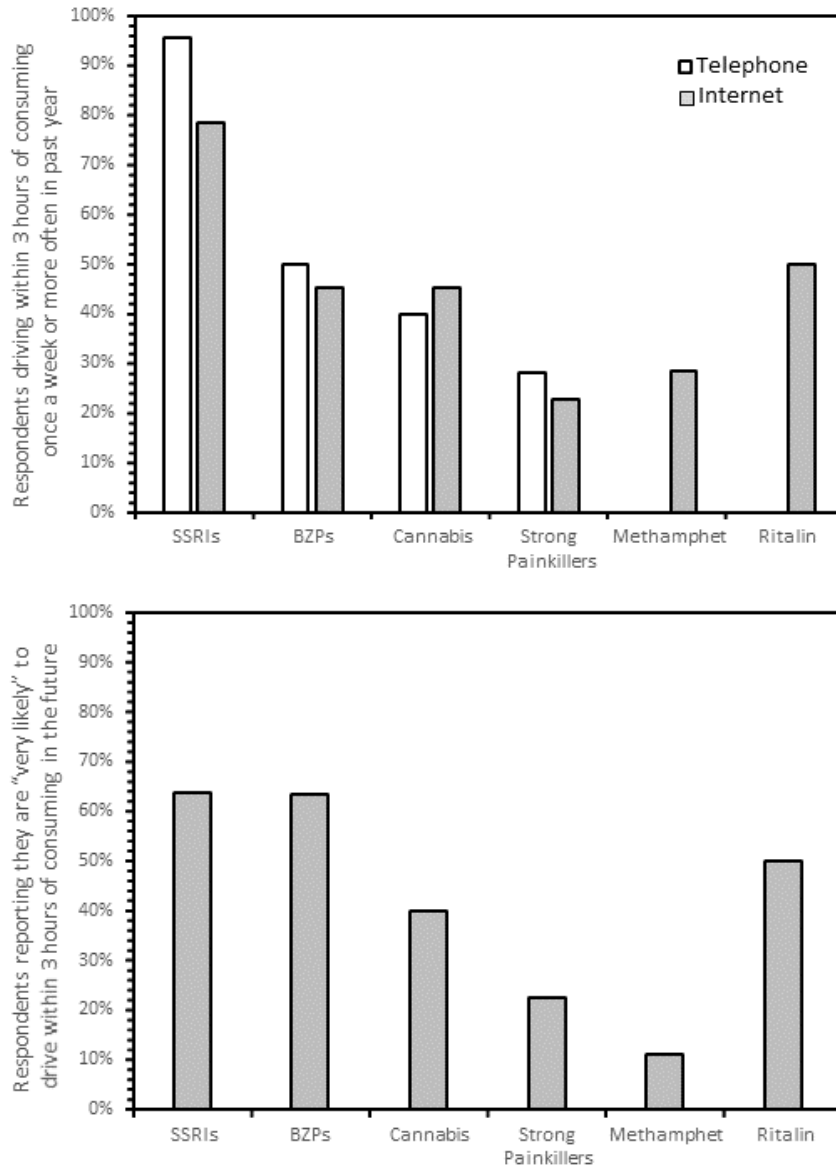
The lower panel of figure 6.1 shows the percentage of internet respondents reporting it 'very likely' that they would drive within s hours of taking the medication or drug in the future (this question was not asked of telephone respondents). The respondents' estimates were largely the same as their reports of the past year; 63.83% of SSRI drivers, 63.64% of BZD drivers, 40.0% of cannabis drivers, 22.79 of strong painkillers, 50.0 % of methylphenidate drivers and 11.1% of methamphetamine drivers.

The follow-up telephone survey of 450 drivers asked respondents to 'think about a recent specific occasion' when they drove within three hours of consuming one of the drugs of interest. For respondents driving within three hours of taking strong painkillers the most frequent time of day was the morning, with 47.69% of the trips reported occurring between 7am and 10am. 66.67% of the trips were reported as being entirely on urban roads and 17.95% of the trips carried at least one passenger, 3.85% with more than one passenger. The most common trip purpose was 'work' (38.46%), followed by 'home' (14.10%), and 'shopping' (12.82%).

Drivers describing a specific occasion of driving within three hours of taking SSRIs reported time for the trips was the morning, 73.33% between the hours of 7am and 10am. 62.22% of the trips were reported as being entirely on urban roads and 28.89% of the trips carried at least one passenger, 17.78% with more than one passenger. The most common trip purpose was "work" (55.56%), followed by 'giving someone a ride' (15.56%), and 'shopping' (11.11%).

Similarly, driving within three hours of taking BZDs was most often reported in the morning, 60.0% of trips occurring between 7am and 10am. 83.33% of the trips were entirely urban and 50.0% carried one or more passengers (33.0% with more than one). The most common trip purpose was 'shopping' (33.33%), followed by 'work' (16.67%), and 'home' (16.67%). In contrast, respondents describing trips taken within three hours of taking cannabis reported that 52.63% of them occurred after 6pm and only 55% were entirely urban (30.0% entirely rural). 30.0% of the trips were to travel 'home' while 20.0% were for 'recreation' and 15.0% were for 'social/entertainment' purposes. 55.0% of trips carried one or more passengers and 25.0% had more than one passenger. No trips for amphetamine/methamphetamine or prescription stimulants were included in the follow-up phone survey.

Figure 6.1 Percentage of respondents reporting driving within three hours of consuming the drugs of interest once a week or more often (top panel) and the percentage of internet respondents reporting it 'very likely' that they would drive within taking the medication or drug in the future



6.1 Summary

A large proportion of participants reported drugged driving at least once a week. Drivers taking SSRIs were most likely to drive within three hours of taking their medication, with lower rates for BZDs, cannabis and strong painkillers. This is likely due to the way the different medications are used; SSRIs are typically prescribed for long time periods (months or years) whereas benzodiazepines tend to be used for short time periods as they may cause dependence. Strong painkillers also tend to be used to treat acute rather than chronic conditions, while cannabis and methamphetamine are both used recreationally. The timing of use also reflected the different patterns of drug use. Driving after using prescription medication was most likely to occur in the morning, whereas driving following cannabis use most commonly occurred in the evening. Those driving after taking strong painkillers and SSRIs were most likely to be driving to work,

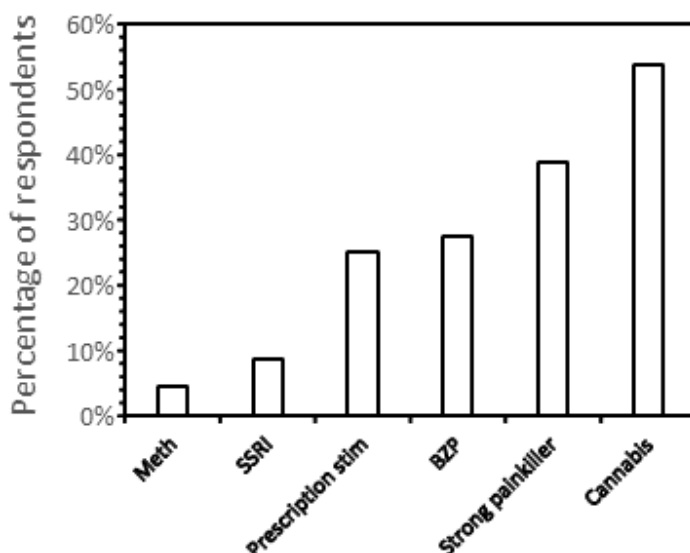
driving after BZD use was most commonly to go shopping and after cannabis use, people most frequently drove home. Those driving after taking BZDs and cannabis were more likely to take one or more passengers when driving compared with those driving after SSRIs or strong painkillers. Given the relatively large proportion of people driving after taking psychoactive medication we were also interested if people made changes to when and how they drove after drug use. This is examined in the next section.

7 Modifications to driving behaviour

The surveys asked respondents about drug drive countermeasures, things they had done to reduce the risk associated with driving after taking drugs. The internet survey respondents were asked whether there were any occasions in the past 12 months when they had decided not to drive within three hours of taking a medication or drug of interest. Their answers to this question are shown in figure 7.1. As can be seen in the figure, the respondents were generally more cautious with regard to cannabis, 53.50% having made a decision not to drive after taking cannabis at some point in the past year. Strong painkillers were the drug next most likely to be mentioned, with 38.79% of respondents who had used strong painkillers in the past year saying they had decided not to drive within three hours of consuming them. In contrast, relatively few respondents decided not to drive after taking amphetamine/methamphetamine (4.55%) or SSRIs (8.51%) (for those participants using amphetamine or SSRIs in the past year).

The respondents also provided the reason for their decisions not to drive. For participants who had consumed cannabis, the most commonly mentioned reason was 'because I felt my ability to drive was negatively affected' (32.23%), followed by 'I was worried about the safety of others' (19.83%) and 'I was worried about getting caught by the police' (17.36%). For respondents deciding not to drive after consuming strong painkillers the top reasons were 'I felt my ability to drive was negatively affected' (36.13%), 'I was worried about the safety of others' (21.01%) and 'I had another way to get home' (15.97%). In contrast, the only reason not to drive mentioned by amphetamine/methamphetamine users was 'I had another way to get home'.

Figure 7.1 Percentage of respondents who made the decision not to drive within three hours of consuming a drug or medication in the past 12 months

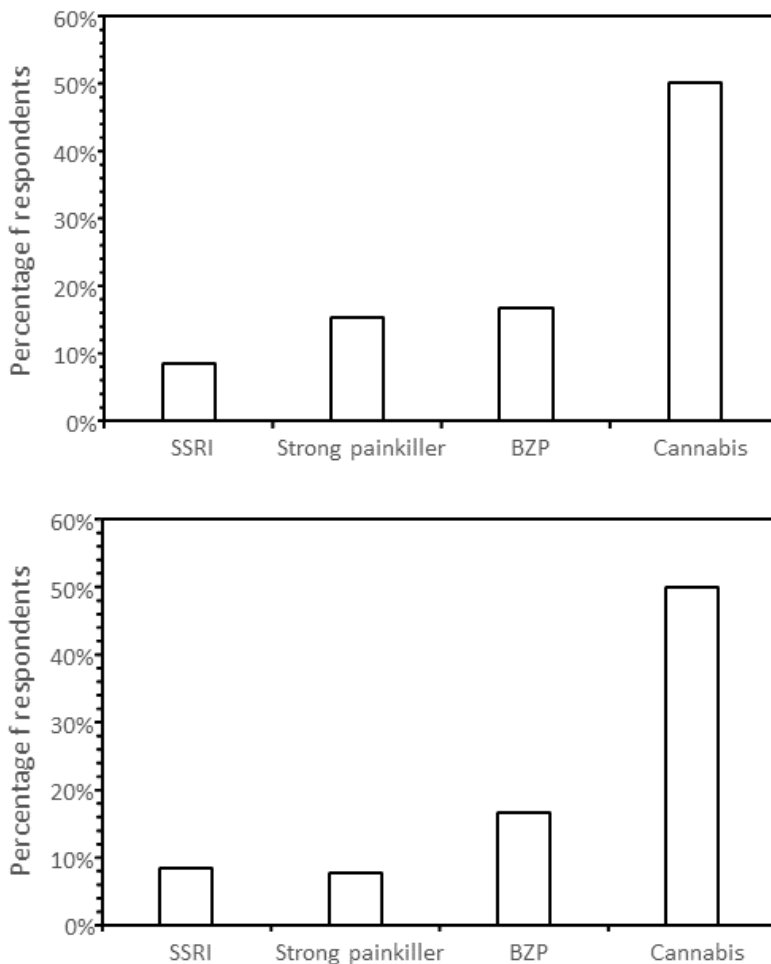


The follow-up telephone survey respondents were asked whether they changed when they took their medication or drugs and whether they changed when they drove after taking the drugs and medications of interest. Their answers are shown in figure 7.2. Once again, cannabis users were the most likely to change when they consumed their drugs (50.0%) or change when they drove after consuming cannabis (50.0%).

Finally, the follow-up telephone survey respondents were asked whether they had made any changes to the route they took when driving within three hours of taking the medication or drug of interest. By far

and away the two most common countermeasures were avoiding heavy traffic and avoiding police checkpoints, in both cases mentioned predominantly for the situation of driving within three hours of consuming alcohol. No other reasons were mentioned by more than two or three respondents for any of the drug categories.

Figure 7.2 Percent of respondents indicating they changed when they consumed their medication/drugs (top panel) or changed when they drove (bottom panel)



7.1 Summary

Participants using cannabis were most likely to choose not to drive after using, predominantly because they thought their driving was affected. They also altered when they drove or when they used cannabis. Drivers taking strong painkillers and BZDs also reported choosing not to drive on some occasions, again because they thought their ability to drive was impaired. This does suggest that some drivers using these substances are aware that these types of drugs may affect their ability to drive safely. It does seem however that drivers who use cannabis are much more aware of the potential impacts of the drug on driving compared with those taking prescription medications (albeit this could also be because the drug is illegal). In addition, as cannabis is a recreational drug, drivers have flexibility in deciding when to use it whereas this is not the case for prescription drugs taken for medical conditions. Given the relatively low rates of decisions not to drive after taking prescription medication (BZDs and strong painkillers), it does

suggest that more work could be done to ensure people are aware of the possible side effects of the medication they are taking, and that they receive advice from their GP and/or a pharmacist on how best to time their medication dose with respect to driving. Drivers should also be made aware of how hard it is to objectively judge one's own impairment (Starkey and Charlton 2014) and be encouraged to plan their medication use when driving.

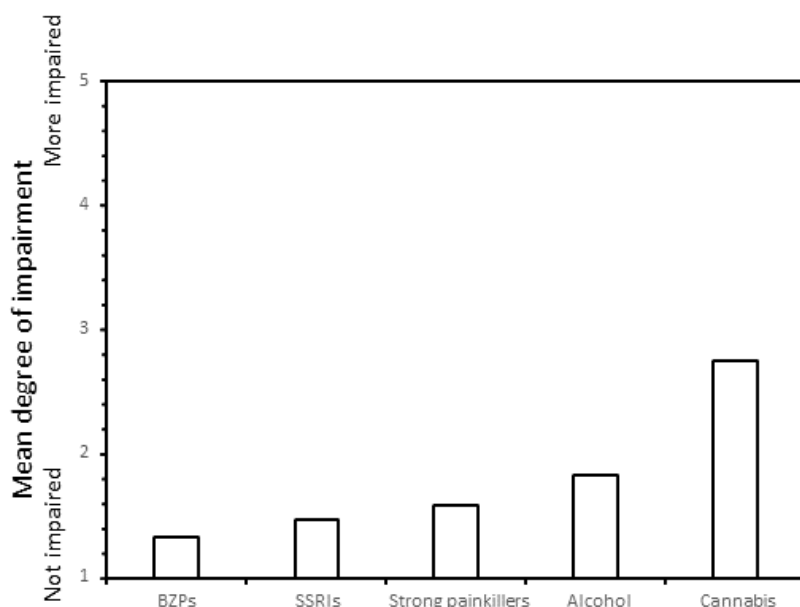
These findings suggest that people taking psychoactive drugs prior to driving have some insights into their possible impairing effects. To explore this further the next section examines driver perceptions of impairment associated with various drugs and their attitudes to drugged driving and enforcement.

8 Perceptions and attitudes to drugged driving

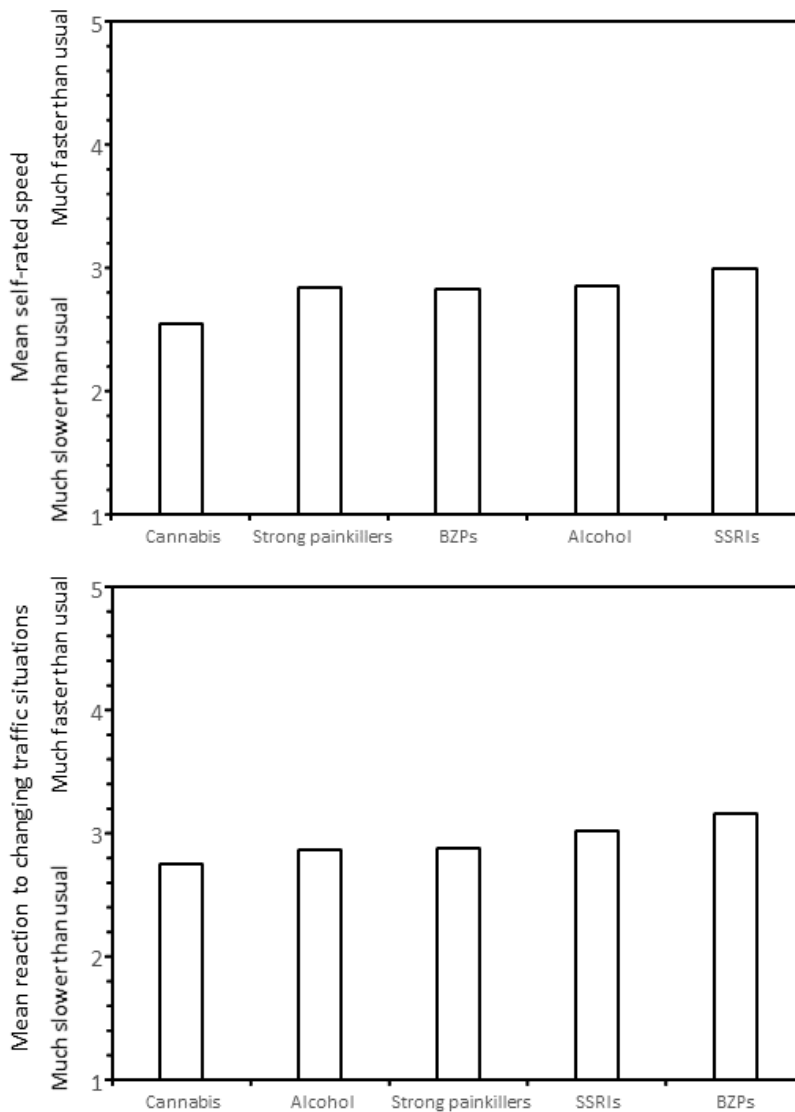
8.1 Perceived impairment

As explained previously, the follow-up telephone survey of 450 drivers asked respondents to 'think about a recent specific occasion' when they drove within three hours of consuming one of the drugs of interest. Respondents were also asked to rate the degree to which their driving was impaired during the trip on a scale of 1 to 10 (with 1 being not at all impaired and 10 being very impaired/high risk of crashing). Figure 8.1 shows the mean self-ratings of impairment for each drug, along with their rating of impairment associated with trips taken within three hours of drinking alcohol. As shown in the figure, trips taken within three hours of consuming BZDs were associated with the lowest impairment ratings ($M = 1.33$), cannabis had the highest ratings of impairment ($M = 2.75$) and trips with alcohol were in the middle ($M = 1.83$). An ANOVA indicated these differences were statistically reliable; $F(4,415) = 4.54$, $p < .001$, $\eta_p^2 = .042$. Bonferroni-adjusted post-hoc pairwise comparisons indicated the source of this difference was the ratings of cannabis, which were significantly higher than all other categories except alcohol ($ps < .05$).

Figure 8.1 Respondents' self-ratings of impairment

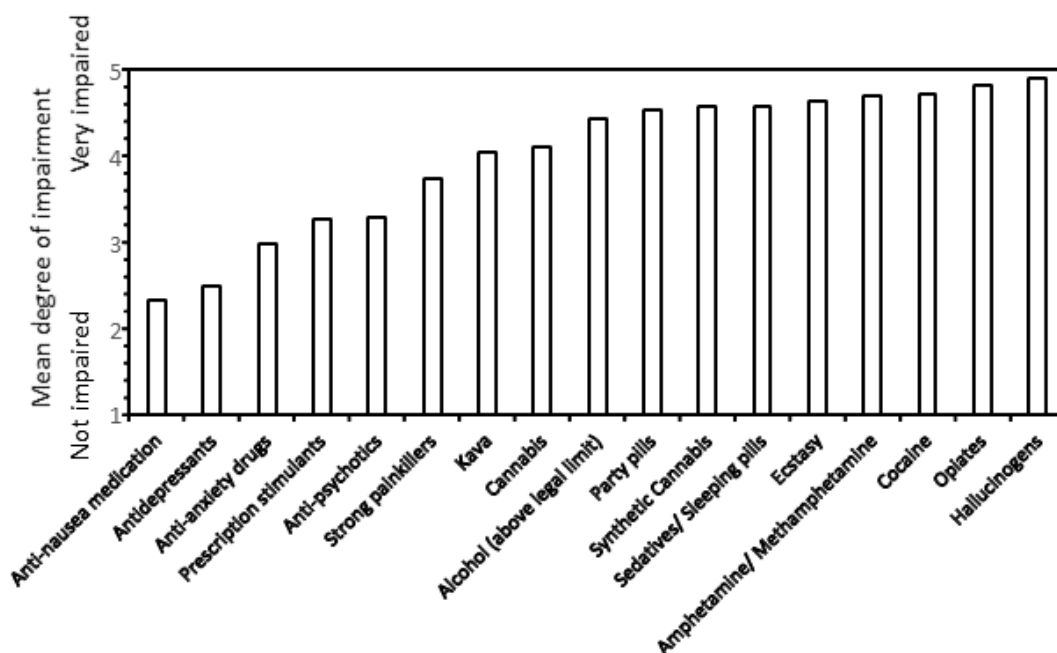


The participants also rated the degree to which their speed and ability to react to changing traffic situations was affected during these drives. Figure 8.2 shows the ratings of speed (top panel) and reactions (bottom panel) for each drug type. Comparison of self-rated speeds with ANOVA indicated a significant difference between the drug types; $F(4,416) = 5.12$, $p < .001$, $\eta_p^2 = .047$. Bonferroni-adjusted post-hoc pairwise comparisons indicated the source of this difference was the ratings of speeds, which were slower for cannabis than any drug category except BZDs ($ps < .05$). Similarly, there was a significant difference between the five drug types for the self-rated reactions to traffic; $F(4,413) = 3.22$, $p = .013$, $\eta_p^2 = .030$, primarily as a result of cannabis reactions that were marginally lower than SSRI reactions ($p = .065$).

Figure 8.2 Respondents' self-ratings of driving speed and reactions to changing traffic situations

Finally, the internet survey respondents were asked to rate the degree of impairment the average person's driving would be impaired on a scale of 1 to 5, where 1 was not at all impaired (safe) and 5 was very impaired (dangerous) for each of the drug types included in the survey. Their answers to this question are shown in figure 8.3, and as shown, anti-nausea medications were rated as producing the lowest level of impairment and hallucinogens the highest. A comparison of the drug categories with a within-subject ANOVA indicated a statistically reliable difference; $F(16,3184) = 211.28, p < .001, \eta_p^2 = .515$. Bonferroni-adjusted pairwise comparisons indicated hallucinogens were rated more impairing than all drugs ($p < .001$) other than opiates, and anti-nausea medications were rated lower than all other drugs ($p < .001$) except for antidepressants.

Figure 8.3 Ratings from the internet survey of the degree of impairment the average person would experience while driving



8.2 Attitudes to drugged driving and police enforcement

Finally, the internet survey asked respondents to answer several questions about their attitudes towards driving in conjunction with the use of medicines and drugs. Their answers to the first two of these are shown in figure 8.4. As shown in the figure, there was a difference of opinion when asked whether they thought it was all right to drive after taking prescription medicines as long as they felt fine; one group of respondents answering ‘somewhat agree’ (33.75%) and another group answering ‘somewhat disagree’ (25.25%). A significant correlation between age and attitudes towards driving after taking prescription drugs indicated younger participants were more likely to agree with the statement ($r(396) = .13, p = .01$), but there was no significant effect of gender ($M(\text{male}) = 2.91, SD = 1.19, M(\text{female}) \text{ rating} = 3.02, SD = 1.25$, where 1 is totally agree and 5 is totally disagree; $t(393) = .85, p = .4$). In contrast, a large majority of respondents answered ‘totally disagree’ (62.50%) when asked whether it was all right to drive after taking illegal drugs provided they felt fine to drive. Further analyses revealed younger participants showed a more accepting attitude to driving after taking illegal drugs ($r(396) = .12, p = .02$). On average females indicated stronger disagreement with the statement compared with males ($M(\text{male}) = 4.04, SD = 1.13, M(\text{female}) = 4.46, SD = 0.97$, where 1 is totally agree and 5 is totally disagree; $t(393) = .3.78, p < .001$) but it should be noted the average rating for both groups indicated they disagreed with the statement.

When asked about their attitudes to random roadside testing for alcohol and drugs (see figure 8.5), most of the respondents answered ‘totally agree’ (40.00%) or ‘somewhat agree’ (42.50%) when asked if they felt roadside testing for alcohol had improved road safety in New Zealand. When asked about roadside testing for drugs, the majority indicated they felt it would improve road safety (by disagreeing with the statement that it would **not** improve road safety), 32.50% answered ‘totally disagree’ and 34.00% answered ‘somewhat disagree’. Their answers to the next question in the survey, the degree that they felt drug driving was a significant road safety issue, tended to mirror these attitudes; 33.50% answering ‘totally agree’ and 38.50% answering ‘somewhat agree’. Interestingly, the perception of drug driving being a significant road safety issue increased with age ($r(396) = -.16, p = .001$) and female drivers rated it as

more of a safety problem compared with males (M (male) = 2.44 SD = 1.22, M (female) = 1.97, SD = 1.03, where 1 is totally agree and 5 is totally disagree; $t(393) = 3.89$, $p = <.001$).

Figure 8.4 Percent of respondents indicating their attitude towards driving after taking medicines (top panel) or illegal drugs (bottom panel) if you felt your driving skills had not been affected

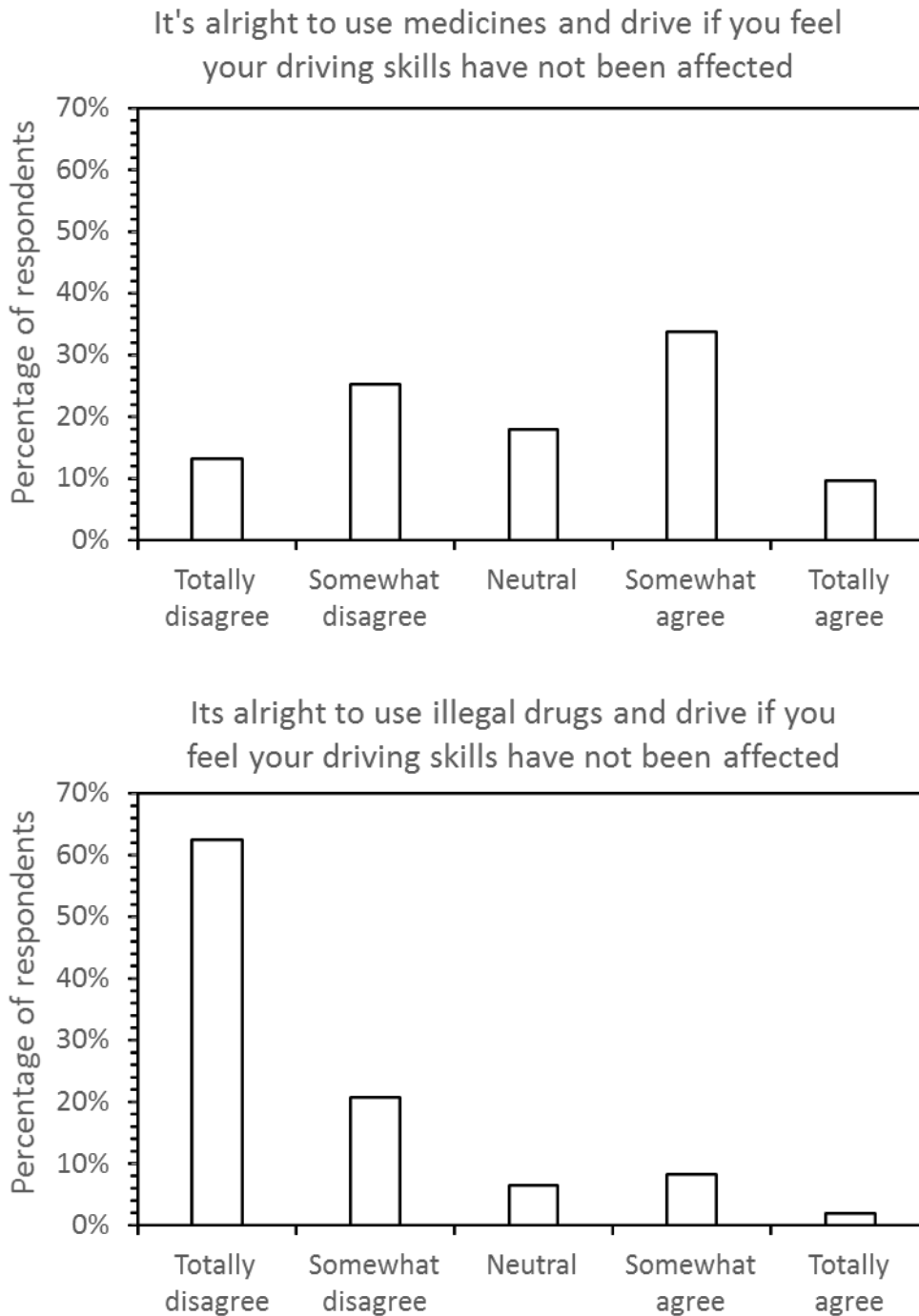
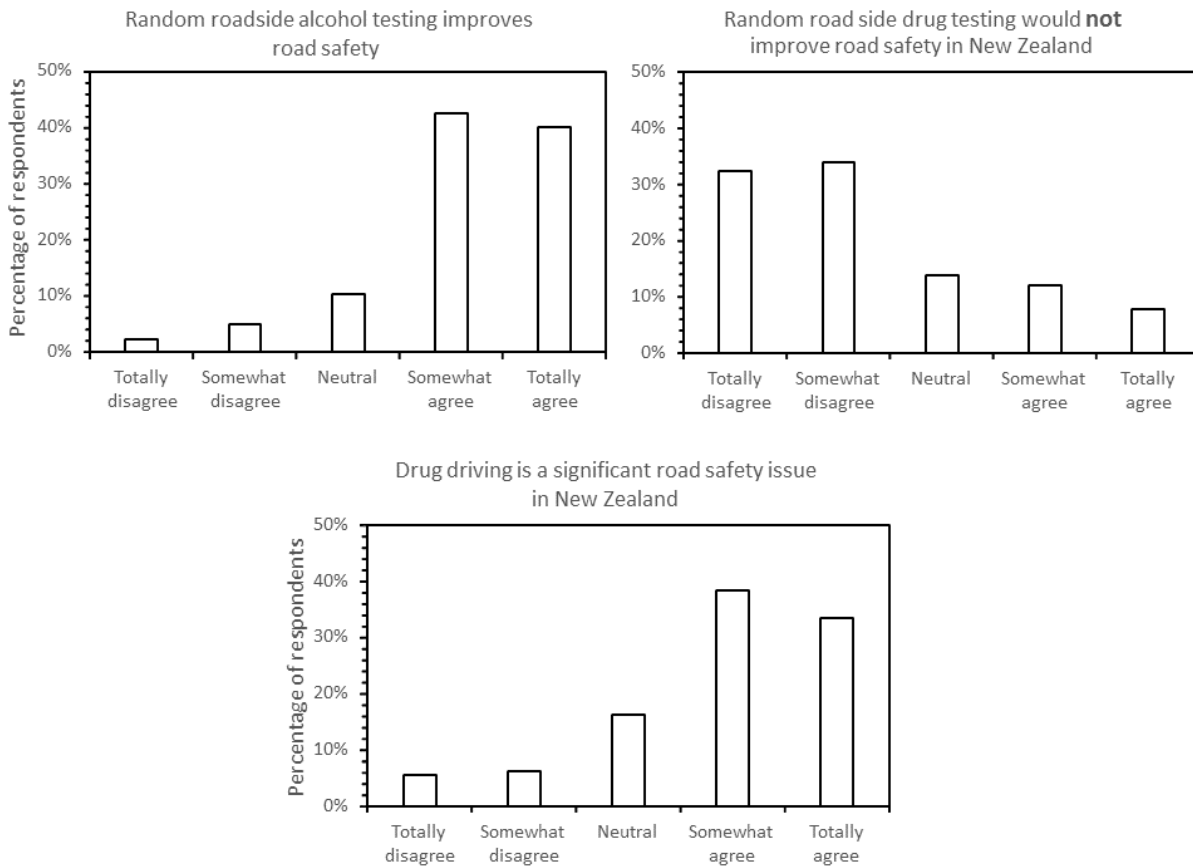


Figure 8.5 Percent of respondents indicating their attitudes towards random roadside testing for alcohol and drugs and the degree to which they felt it was a significant road safety issue



The final two questions asked about police enforcement. Figure 8.6 shows the respondents' answers to the question 'how likely is it that a person will be caught by the police for the following offences?'. As can be seen in the figure, the respondents felt it was much more likely for someone to be caught for speeding (16.50% 'highly likely' and 39.25% 'likely'), dangerous driving (16.50% 'highly likely' and 38.25% 'likely'), or drink driving (12.25% 'highly likely' and 47.50% 'likely'). In contrast, getting caught driving while under the influence of drugs other than alcohol was seen as relatively unlikely (only 6.00% 'highly likely' and 22.00% 'likely'), only slightly less likely than getting caught for not stopping at a traffic light (11.00% 'highly likely' and 28.50% 'likely'). Further analyses revealed a small but statistically significant correlation between age and the rating for likelihood of getting caught when affected by drugs other than alcohol, ($r_{396} = .12, p = .02$), indicating that the younger participants thought they were more likely to be caught. There was no statistically significant difference between males and females in their response to this question (M (male) = 3.33 $SD = 1.01$, M (female) = 3.13, $SD = 1.11$, where 1 is highly likely and 5 is highly unlikely; $t(393) = 1.66, p = .10$). When asked whether more police time and resources be spent on enforcing drugged driving laws 61.21% of the respondents answered 'yes' (see figure 8.7).

Figure 8.6 Percent of respondents' beliefs about how likely it is to be caught by the police for a range of motor driving offences

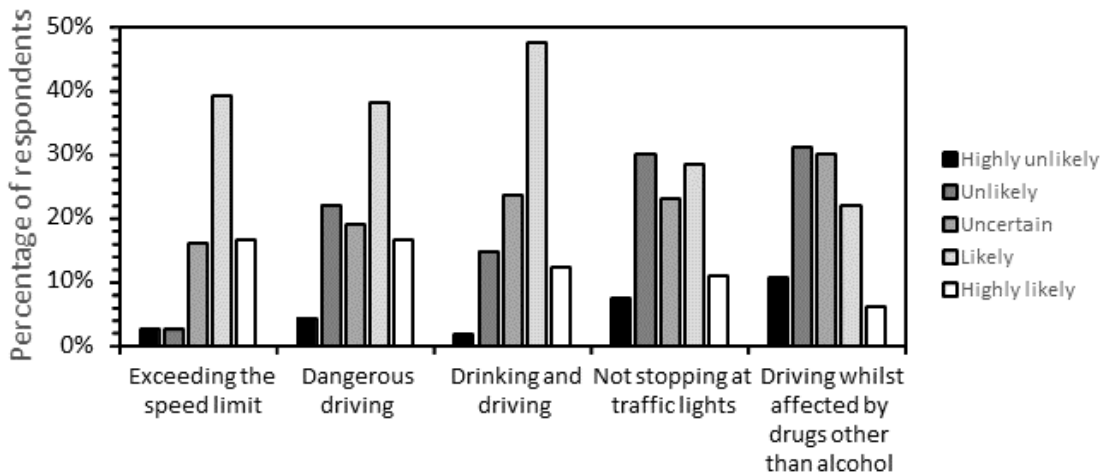
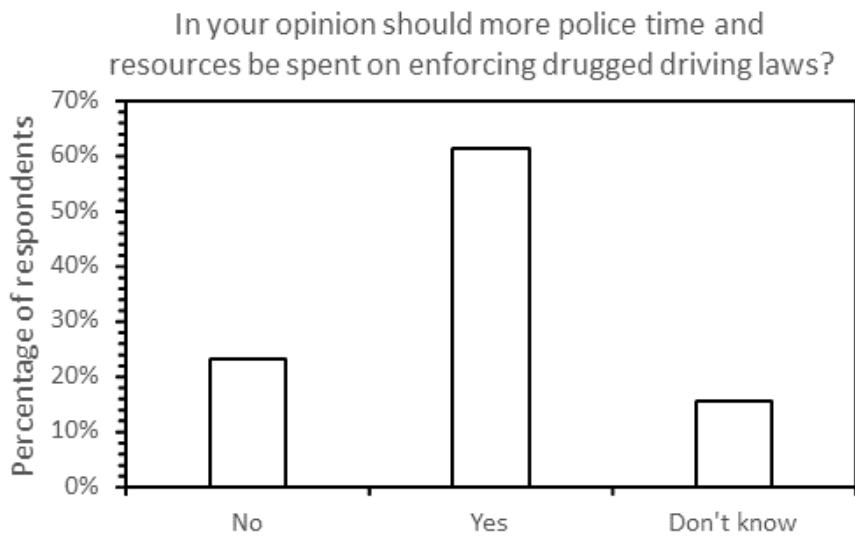


Figure 8.7 Internet respondents' attitudes regarding the amount of police time and resources spent on enforcing drug driving laws



8.3 Summary

In terms of the degree of impairment produced by the drug the respondents had taken, the cannabis users rated their level of impairment as the highest and above that of alcohol. Interestingly the other drugs were rated as causing less impairment than alcohol. In terms of how the drugs affected their driving ability, on average participants reported driving slightly slower than usual and thought their reactions were also slightly slower than usual. This effect was most pronounced for those driving within three hours of taking cannabis. All drugs apart from anti-nausea and antidepressant medications were rated as causing some degree of driving impairment in an average person. In general illegal substances were rated as producing higher levels of impairment than prescription medications. Interestingly sleeping pills and sedatives were

rated as causing a high degree of impairment in an average person which is in contrast to the low ratings of impairment provided by the drivers who drove after taking BZDs.

The majority of respondents (>80%) felt random roadside testing for alcohol improved road safety and almost 70% thought random roadside drug testing would also improve road safety. A similar proportion of respondents reported they thought drugged driving was a significant road safety issue in New Zealand. Overall participants thought it was quite unlikely people would be caught for drugged driving and were supportive of more time and resources being devoted to enforcement of drugged driving laws.

9 Feasibility of a hospital- based toxicology study

The aim of this part of the study was to examine the feasibility of conducting analyses of blood drawn from patients injured in car crashes to identify the drugs most closely associated with serious crashes as well as provide essential information regarding driving impairment resulting from different drug doses and drug combinations. It is anticipated the toxicology screen would include alcohol, and six classes of drug: cannabis, benzodiazepines and other tranquillising agents, opioids, stimulants [amphetamine, cocaine, methamphetamine, MDMA], antidepressants, and antihistamines.

Current New Zealand legislation allows an individual to opt to provide an evidentiary blood sample, if a breath screening test for alcohol is above the legal limit. The police can require an individual to provide an evidentiary blood sample if they refuse an evidentiary breath test; if they suspect the individual is under the influence of drugs other than alcohol; or if they have failed a compulsory impairment test. In addition, if an individual is in hospital as a result of a crash, a blood sample can be taken (to test for drugs and/or alcohol) whether or not they agree.

The feasibility analyses took the form of a series of interviews with key informants from Waikato District Health Board including the Director of Trauma, the Head of the Emergency Department, an Emergency Department Consultant, and the clinical nurse manager from the Emergency Department and received information from the toxicology department. Phone interviews were also held with relevant staff from the Institute of Environmental Science and Research (ESR) and the Ministry of Transport. An interview was also held with the supervisor of the Waikato Police Traffic and Alcohol group.

Waikato Hospital is a large (600 bed) tertiary teaching hospital which serves the Midland region of New Zealand (incorporating Waikato, Bay of Plenty and Lakes, Tairāwhiti and Taranaki District Health Boards). The hospital is the main provider of trauma care for the region and hosts the Midland Trauma Research Centre. Currently all trauma patients receiving treatment at Waikato Hospital have a blood sample taken which is routinely screened for alcohol (in addition to tests requested by the attending doctor to inform treatment decisions). The analyses of the blood samples are undertaken by the toxicology department at the hospital and the results become part of the patient's medical file. As well as this, separate evidentiary blood samples are occasionally taken at the hospital (at the request of the police) and these samples are sent to ESR for analyses.

As a starting point we investigated if additional toxicological analyses could be conducted on the blood samples already drawn from the patients. Currently additional screening cannot be carried out on the trauma bloods, as the immunoassays used by the toxicology department are only validated for urine samples. If urine samples were taken (they are not routinely taken from trauma patients), in house toxicological screens could be conducted for a limited range of substances (BZDs, opioids, THC and amphetamines) and the results would typically be linked to the patient's medical records. There are several problems with this approach; patients would have to provide another sample, the toxicology screen available at the hospital laboratory is limited, and if the results form part of the patient's medical file it is likely to significantly decrease the proportion of patients consenting to participate (particularly those who have used illegal substances). These issues could be addressed by drawing a separate sample (of blood or saliva) to send to an external laboratory (ie ESR) for analyses. This would also provide data directly comparable to that obtained from the evidentiary blood samples and the results of the toxicology screen would be separate from the patient's medical file.

A number of other sampling issues were also considered as part of the feasibility analysis. To obtain reliable data for this type of study, the timing of the sample collection relative to the time of the crash is crucial. The data from the Midland Regional Trauma Registry would enable us to calculate the delay between the crash and the sample being taken, but another option would be to approach St John's ambulance to discuss the feasibility of their ambulance officers taking a saliva swab as soon as is practicable. Finally, using saliva samples as an alternative to (invasive) blood samples would make the study more attractive to participants, and the study could be extended to all drivers attending an emergency department who have been involved in a crash, rather than limiting participation to those with more severe injuries. Increasing the sample size would allow for more robust data analysis and firmer conclusions could be drawn regarding the role of specific drugs and drug combinations in crash risk.

The next issue to address was obtaining consent from the patient. Approaching patients and relatives during the acute stage of treatment following a trauma or injury is clearly inappropriate but as noted above, samples need to be taken as close to the time of injury to provide an accurate indication of drug levels. One approach would be to collect samples (either blood or saliva) close to the time of injury and then store the samples until the patient is recovered sufficiently to be approached for consent to participate in the study. Once consent is obtained, the sample would be sent to ESR (samples from non-consenters would be destroyed). As part of the study, participants would be asked to provide details of their current medication regime, any medical conditions (this would be verified with the patient's medical records), details of the crash and their driving history. Where available, the details and police reports relating to each crash would be obtained from the Crash Analysis System (CAS) and data regarding crash location, travel time to hospital and medical treatment would be drawn from the Midland Regional Trauma Registry. To ensure timely collection and storage of sample, we would recommend that research nurse based in the emergency department is appointed to coordinate the study. Approval for the study would need to be obtained from Waikato District Health Board and the Ministry of Health, Health and Disability Ethics Committee (HDEC).

In summary, it would be possible to carry out a hospital-based toxicology study to examine the relationship between specific drugs and minor or serious injury crashes following the relevant approvals. To address privacy and confidentiality issues, we recommend samples are analysed outside the hospital setting. Providing patients with the option of providing a saliva sample rather than blood sample would likely increase participation rates.

10 Conclusions

The overall purpose of the present research was to establish a quantitative picture of the type and extent of drugged driving in New Zealand and to investigate the level of driving impairment produced by the more commonly used drugs, both legal and illegal.

The stratified telephone survey of New Zealand drivers found the drugs most commonly taken within three hours of driving were strong painkillers (9.81%), antidepressant medication (6.05%), anti-nausea medication (3.50%), cannabis (2.55%) and anti-anxiety medication (2.86%). The number of participants reporting using illegal stimulants prior to driving was low (0.05%); those taking methylphenidate (prescription stimulant) prior to driving were slightly higher (0.53%). By comparison, almost half (45.32%) of the respondents reported driving within three hours of drinking alcohol. The same drug types were reported as having the highest incidence of use in the internet survey, although the rates of drug use prior to driving were somewhat higher; strong painkillers (18.70%), antidepressant medication (15.82%), cannabis (14.21%), anti-nausea medication (6.41%), anti-anxiety medication (6.09%), illegal stimulants (2.28% and prescription stimulants 2.09%). A significant proportion of the telephone and internet survey respondents (16.59% and 9.95% respectively) reported taking drug combinations prior to driving. The drug combinations frequently involved alcohol (43.01% overall) and different types of strong painkillers were often combined. These rates are lower than those reported by the New Zealand Drug Foundation (NZDF 2009), but this may be a result of the differing approaches to participant recruitment. A comparison with the most commonly taken drugs overseas indicated the drug profile of our drivers is most similar to drivers in Northern Europe, with the exception of the 'Z' drugs (zolpidem and zopiclone), which were rarely reported by New Zealand drivers (SWOV 2011). In addition, rates of drug use by NZ drivers appeared to be much lower than in Australia across all drug types.

The follow-up telephone survey focused on respondents who reported taking strong painkillers (eg codeine, tramadol, methadone, morphine), SSRIs (fluoxetine, citalopram, paroxetine and sertraline), BZDs (diazepam, lorazepam, alprazolam), cannabis and stimulants (amphetamine, methamphetamine, methylphenidate) to find out more about their drug use and driving. Over three quarters of those taking SSRIs and more than half of those taking strong painkillers and BZDs before driving were female aged in their late 30s or early 40s. In contrast, the respondents who reported driving within three hours of using illegal substances (cannabis and amphetamine/ methamphetamine) were mainly males in their early 30s

In terms of the extent of drugged driving more than half of the respondents who took SSRIs, BZDs or methylphenidate reported 'drugged driving' once a week or more in the last 12 months. This proportion was smaller for those driving after taking cannabis (42.6%), illegal stimulants (28.2%) and strong painkillers (25.5%). Over half of those who reported driving within three hours of taking SSRIs, BZDs and methylphenidate reported it was very likely they would do this in the future. Rates were somewhat lower for cannabis (40%), strong painkillers (22.8%) and methamphetamine. Interestingly, the timing of drug use differed by drug type, with driving after taking prescription drugs most frequently occurring in the morning (prior to going to work or shopping), whereas driving after cannabis use typically occurred in the evening.

There was evidence the respondents were aware of the potentially impairing effects of the drugs on their driving behaviour with over half of the cannabis users, almost 40% of those taking strong painkillers and a quarter of those taking BZDs, deciding not to drive within three hours of taking the drugs. The main reason given was they thought their driving was negatively affected and they were worried for the safety of others. Fewer than 10% of drivers taking SSRIs or stimulants had decided not to drive after taking them during the last 12 months. Cannabis users were also most likely to report changing when they took their

drugs or changing when they drove after taking cannabis (50% in each case). For strong painkillers, SSRIs and BZDs, fewer than 20% of respondents reported using either strategy in the last 12 months.

When respondents were asked to provide a rating of the level of impairment produced by the drug they consumed, cannabis was associated with the highest impairment ratings, but the absolute level of the ratings was low (2.8 out of 10), followed by alcohol, strong painkillers, SSRIs and BZDs. Cannabis users also rated their driving speed and their ability to react to changing traffic as slower when driving after cannabis use compared with driving drug free. When asked to rate the degree of impairment produced by a range of different drugs in an average driver, hallucinogens, opiates, cocaine and stimulants were rated as most impairing and anti-nausea medication, antidepressants and anti-anxiety drugs the least.

Attitudes to drugged driving appeared to be primarily influenced by the legality of the drug being taken, with over 60% of respondents stating they totally disagreed with the statement that 'it is ok to use illegal drugs and drive if you feel your driving skills have not been affected'. In contrast, for prescription medications, opinions were split with around a third agreeing and a third disagreeing with the statement. With regards to police enforcement, respondents generally thought random roadside breath testing had improved road safety, and over half thought drugged driving was a significant road safety issue and would be supportive of random roadside drug testing. Only a quarter of respondents thought it likely drivers would be caught for drugged driving compared with over half who thought it likely drivers would be caught drinking and driving.

Findings from the systematic review revealed that cannabis, opioid-based pain killers and BZDs are associated with increased crash risk. Cannabis and BZDs have also been shown to impair driving-related skills while codeine and oxycodone may have impairing effects. The effects of morphine and methadone are unclear due to lack of data and very variable findings. There is currently little evidence that SSRIs or tramadol are associated with increased crash risk or produce driving-related impairments, but in both cases further research is needed. In terms of stimulants, most studies report improvements in driving related behaviour (eg reaction time), but they may lead to increased risk taking and they do not compensate for the effects of fatigue. As described above, many drivers take more than one drug prior to driving. Combinations of BZDs or cannabis with alcohol lead to high levels of driving-related impairment, with estimates suggesting that the ORs for crash risk are multiplicative (rather than additive) when substances are taken together.

Although questionnaire studies provide interesting insights into driver behaviour there are issues around the reliability of self-reported data. Objective data, such as that based on toxicological analyses of blood samples, are likely to provide a more accurate picture of the extent and impact of drugged driving in New Zealand. Consultation with key stakeholders indicated support for this type of study, which could focus on collecting and analysing blood or saliva samples from drivers attending the emergency department who had been involved in a car crash. While it would not currently be possible to carry out additional analyses on the blood samples already drawn from trauma patients (which are routinely analysed for alcohol), an alternative approach would be to collect an additional sample (of blood or saliva) close to the time of the crash and this sample could be sent to an external laboratory (ESR) for analyses. The use of an external laboratory would help maintain the confidentiality of the toxicological results as they would not be associated with the participant's medical records. Approval for this type of study would be required from the appropriate District Health Board and the National Health and Disability Ethics Committee.

The findings from the study suggest public education should focus on the effects of combined drug use, in particular the combination of alcohol and prescription medication. Drivers need to be aware that any amount of alcohol (even below the legal drink driving limit) in combination with prescription medication may affect their driving ability and increase their risk of being involved in a crash. One strategy would be

to encourage people to plan when they take their medication in relation to when they need to drive and to continue to raise awareness of the fact that we are not good at judging our own levels of impairment. With regard to the populations most at risk, these findings suggest that women in their late 30s or early 40s taking prescriptions medications may be a target demographic. Although the majority of driving after prescription drug use occurred during the day, some driving did occur in the evening, when the potential for the drug effects to be exacerbated by alcohol consumption is heightened.

The study is the first stratified telephone survey of drugged driving in New Zealand that addressed the limitations of previous studies such as biased sampling (eg NZDF 2009) or the scope of the survey (Ministry of Health 2010). While we acknowledge the limitations of self-reported data, every attempt was made to ensure that the data were accurate; a well-regarded telephone survey company was used to carry out the stratified survey, and participants were repeatedly assured of the confidentiality and anonymity of the information they provided. There may also be some bias in the samples as only those with a home phone could take part in the stratified survey, whereas the online survey was limited to those with internet access. There was however some overlap between the samples, with over two thirds of the internet survey respondents indicating they had access to a landline. Having two data sources (telephone and internet survey) lends additional credibility to the findings as although the incidence differed the pattern or reported drug use prior to driving was consistent.

11 Recommendations

- 1 Convey the risks associated with combined drug use prior to driving to the public, in particular the high degree of impairment associated with combined alcohol and prescription drug use.
- 2 Consider the development of a marketing campaign directed toward women in their late 30s and early 40s that focuses on the crash risk and driving-related impairments associated with prescription drug use.
- 3 Engage general practitioners and pharmacists in providing accurate information to patients and encourage them to discuss with patients how the medication may affect or impair their driving skills.

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Appendix A: Telephone survey: Stage I

Q1.1 Drugs and Driving Survey. We are conducting research into prescription and non-prescription drug and medicine use and driving in New Zealand. We are approaching people from across New Zealand to complete our survey to find out what types of drugs and medicines people take before they drive, the types of driving people do and peoples' perceptions of how drugs may affect driving. The survey will take about 15 minutes to complete. We would appreciate you agreeing to be part of this study and taking the time to complete our survey. Please note, you can stop taking the survey at any time – just tell the interviewer. The survey is anonymous. The record of your survey responses does not include any identifying information about you and there is no way to identify you from your responses. If you have any questions please contact a member of the research team: Nicola Starkey (nstarkey@waikato.ac.nz) or Samuel Charlton (samiam@waikato.ac.nz) from the University of Waikato The research has received ethical approval from the School of Psychology Ethics Committee at the University of Waikato with funding from the New Zealand Transport Agency. Are you willing to take part?

- Yes (1)
- No (2)

If No Is Selected, Then Skip To End of Survey

Screening questions

Q1.2 Are you a New Zealand resident? (Do you live permanently in NZ?)

- Yes (1)
- No (2)

If No Is Selected, Then Skip To End of Survey

Q1.3 Have you driven in the last 12 months?

- Yes (1)
- No (2)

If No Is Selected, Then Skip To End of Survey

Q1.4 Do you have a good understanding of English?

- Yes (1)
- No (2)

If No Is Selected, Then Skip To End of Survey

Q1.5 Are you aged 16 years or over?

- Yes (1)
- No (2)

If No Is Selected, Then Skip To End of Survey

Quota Question

Q2.1 What is your age?

- 16-24 years (1)
- 25-40 years (2)
- 41-65 years (3)
- 65 years and over (4)

Driving History

Q2.2 What type of driving licence do you hold?

- Learner's licence (1)
- Restricted licence (2)
- Full driving licence (3)
- I don't hold a current driving licence (4)
- Don't know (5)

Answer If What type of driving licence do you hold? I don't hold a current driving licence Is Selected

Q2.3 Why do you not hold a current driving licence?

- Licence has expired (1)
- Never applied for driving licence (2)
- Licence is currently suspended (3)
- Other (4)

Answer If What type of driving licence do you hold? I don't hold a current driving licence Is Not Selected

Q2.4 How long have you been a licenced driver? (how long since you passed your learner's test)

- Enter number of years (1) _____
- Don't know (2)

Q2.5 Thinking about driving during a typical week, can you tell me how many times you drive in a typical week? To and from work would count as twice)

Drives per week (1)

Q2.6 Still thinking about your driving in a typical week....What percentage of your time do you drive on rural roads (state highways with a high speed limit) and urban roads (in town, typically with 50km/h speed limit)? (The total must sum to 100).

_____ Rural roads (state highways) (1)

_____ Urban roads (in town / city centre) (2)

Q3.1 I'm now going to ask you some questions about any drugs or medicines (legal, illegal, prescribed or purchased over the counter) that you have taken over the last twelve months. In the past year have you...

	Yes (1)	No (2)	Don't know (3)	Refuse to answer (4)
taken any prescription medications for a medical condition? (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
taken any over-the-counter medications (e.g. for colds, coughs, allergies) (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
taken any drugs for recreational purposes (e.g., alcohol, tobacco, cannabis, party pills, prescription medicines etc.) (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

If No Is Equal to 3, Then Skip To End of Block

Q3.2 I am going to read out a list of different types of drugs and medicines. The list includes legal and illegal drugs. As I read each name I would like you to let me know, by saying 'yes' or 'no' after I read each name, if you have taken or used it in the last twelve months. For each drug you have taken I will also ask you how frequently you take have taken it; why you took it (e.g. for a medical condition, for recreational / social purposes) and if you have driven soon after taking it. Please remember that the answers you provide for this survey are anonymous and confidential.

	Yes (1)	No (2)	Refuse to answer (4)
<input type="radio"/> Alcohol (beer, wine spirits, RTD's) (1)			

If Alcohol (beer, wine spirits... Is Not Selected, Then Skip To Have you taken Amphetamine/ Methamphe...

Q3.3 Thinking about your alcohol consumption in the last 12 months.

How frequently do you drink alcohol?

Daily/ 3-4 times a week/ twice a week/ once a week/ 2-3 times a month/ once a month/ 3-6 times in last 12 months/ 1 or 2 times in last 12 months

Why do you drink alcohol?

Recreational /social purposes; Medical reasons; General Health; Other; Don't know; Refuse to answer

Have you driven a car or motorcycle whilst you felt you were under the influence of alcohol?

Yes; No; Don't know; refuse

Have you driven within 3 hours of drinking alcohol

Yes; No; Don't know; refuse

Q3.4 Have you taken Amphetamine/ Methamphetamine (P) in the last 12 months?

- Yes (1)
- No (2)
- Don't know (3)
- Refuse (4)

If Yes Is Not Selected, Then Skip To Have you taken Anti-anxiety drugs in ...

Q3.5 Thinking about you Amphetamine / Methamphetamine (P) use in the last 12 months..

How frequently do you taken Amphetamine/ Methamphetamine (P)?

Daily/ 3-4 times a week/ twice a week/ once a week/ 2-3 times a month/ once a month/ 3-6 times in last 12 months/ 1 or 2 times in last 12 months

Why do you taken Amphetamine/ Methamphetamine (P)?

Recreational /social purposes; Medical reasons; General Health; Other; Don't know; Refuse to answer

Have you driven a car or motorcycle whilst you felt you were under the influence of Amphetamine/ Methamphetamine (P)?

Yes; No; Don't know; refuse

Have you driven within 3 hours of taking Amphetamine/ Methamphetamine (P)

Yes; No; Don't know; refuse

The same questions were asked for anti- anxiety drugs, antidepressants, anti- nausea medication, anti- psychotics, cannabis, cocaine/crack, ecstasy, kava, hallucinogens, strong painkillers, opiates (e.g., heroin), party pills, prescription stimulants, sedatives or sleeping pills and synthetic cannabis.

Demographic questions

Q4.1 What is your gender?

- Male (1)
- Female (2)
- Other (3)
- Prefer not to answer (4)

Q4.2 What is your date of birth?

- dd/mm/yyyy (4) _____
- Don't know (5)
- Prefer not to answer (6)

Q4.3 Which ethnic groups do you belong to? Identify any that apply.

- New Zealand European (1)
- Other European (12)
- Maori (2)
- Samoan (3)
- Tongan (4)
- Cook Island Maori (5)
- Niuean (6)
- Chinese (7)
- Indian (8)
- Other (e.g., Dutch, Japanese) (9)
- Don't know (10)
- Refused to answer (11)

Q4.4 Were you born in New Zealand?

- Yes (1)
- No (2)

Answer If Were you born in New Zealand? No Is Selected

Q4.5 What year did you arrive in New Zealand?

- Record 4 digit year (1) _____
- Don't know (2)
- Prefer not to answer (3)

Q4.6 Where do you live in New Zealand (which province / district)?

- North Island (1)
- Northland (2)
- Auckland (3)
- Waikato (4)
- Bay of Plenty (5)
- Gisborne (6)
- Hawkes Bay (7)
- Taranaki (8)
- Wanganui (9)
- Manawatu (10)
- Wairarapa (11)
- Wellington (12)
- South Island (13)
- Nelson Bays (14)
- Marlborough (15)
- West Coast (16)
- Canterbury (17)
- Timaru-Omaru (18)
- Otago (19)
- Southland (20)

Q4.7 What is your occupation (e.g., student, teacher, mechanic)?

- Enter occupation (1) _____
- Not in paid work (3)
- Don't know (5)
- Prefer not to answer (6)

Q4.8 What is the total income that you yourself got from all sources, before tax or anything was taken out of it, in the last twelve months?

- Less than \$5,000 (1)
- \$5,001 - \$10,000 (2)
- \$10,001 - \$15,000 (3)
- \$15,001 - \$20,000 (4)

- \$20,001 - \$25,000 (5)
- \$25,001 - \$30,000 (6)
- \$30,001 - \$40,000 (7)
- \$40,001 - \$50,000 (8)
- \$50,001 - \$60,000 (9)
- \$60,001 - \$70,000 (10)
- \$70,001 - \$80,000 (11)
- \$80,001 - \$100,000 (12)
- \$100,001 - \$120,000 (13)
- \$120,001 - \$150,000 (14)
- \$150,001 or more (15)
- Don't know (16)
- Refused (17)

Q4.9 Do you have a mobile phone?

- Yes (1)
- No (2)

Q4.10 Would you be happy to be contacted again within the next 1 to 2 months about the possibility of answering some more questions about drug and medicine use and driving?

- Yes you can contact me again (1)
- No I don't want to be contacted again (2)

If No I don't want to be conta... Is Selected, Then Skip To Would you like to receive a summary o...

Q4.11 What is your name and phone number? We need this so we can ask for the right person if we contact you for the follow up survey. Your name will only be used so that we can get in touch with you and will not be linked to your survey answers.

Name (1)

Phone Number (2)

Q4.12 Would you like to receive a summary of the findings from the study? If so please provide your email address. Please note the findings will be available late 2015 or early 2016.

Appendix B: Telephone follow- up survey: Stage II

Drugs and Driving Survey Follow Up. You recently completed a survey into prescription and non-prescription drug and medicine use and driving in New Zealand. At that time you agreed for us to contact you again about completing another survey about drug and medication use and driving. This survey aims to find out. The survey will take about 10 minutes to complete. As a thank you for taking part, you will be eligible to enter a draw to receive a tablet computer. Please note, you can stop taking the survey at any time - just tell the interviewer. Be assured that the survey is anonymous. The record of your survey responses does not include any identifying information about you and there is no way to identify you from your responses. If you have any questions please contact a member of the research team: Nicola Starkey (nstarkey@waikato.ac.nz) or Samuel Charlton (samiam@waikato.ac.nz) from the University of Waikato. The research has received ethical approval from the School of Psychology Ethics Committee at the University of Waikato with funding from the New Zealand Transport Agency.

Are you willing to take part?

Yes

No

Q1 In the previous survey you reported taking DRUG NAME (will vary depending on which drug the participant reported using in the previous survey), within 3 hours of driving. In the last 12 months how often have you taken XXXX within 3 hours of driving?

- Daily (1)
- About 5-6 times a week (2)
- About 3-4 times a week (3)
- Twice a week (4)
- Once a week (5)
- Two to three times a month (6)
- Once a month (7)
- Once every 6 weeks in the last 12 months (8)
- 3 to 6 times in the last 12 months (9)
- 1 or 2 times in the last twelve months (10)
- Don't know (11)
- Prefer not to say (12)

Q2 For the next few questions I want you to think about a recent specific occasion when you took XXXX within 3 hours of driving....

What time of day did you take XXXX? (1)

What time of day did you drive? (2)

Q3 On this occasion, did you take any other prescription, social, or recreational drugs at the same time (or within 3 hours) as XXXX? This includes alcohol, painkillers, sedatives, travel sickness pills, cough and cold remedies etc.

- Yes (1)
- No (2)
- Don't know (3)
- Refuse (4)

Answer If Did you take any other prescription, . Yes Is Selected

Q4 Which other medicines or drugs did you take?

Drug 1 (1)

Drug 2 (2)

Drug 3 (3)

Drug 4 (4)

Drug 5 (5)

Drug 6 (6)

Q5 Still thinking about the same occasion and the drive that you took....what was the purpose of your drive? Was it to go....(read the list of options below and select the purpose of the trip)

- Home (1)
- Work (2)
- Education (e.g., university or college) (3)
- Shopping (4)
- Personal Business (e.g., bank) (5)
- Medical/Dental (6)
- Social / entertainment (7)
- Recreation (e.g., sport) (8)
- Give someone a lift (9)
- Change mode (e.g. drive to catch a bus, plane or train) (10)
- Other (11)

Q6 Thinking about the same drive, did you take any passengers in the car with you?

- Yes (1)
- No (2)

Answer If Did you take any passengers in the car? Yes Is Selected

Q7 How many passengers did you take? If it differed during your drive, please tell me the maximum number of passengers you carried in your car at any point on the trip.

- 1 (1)
- 2 (2)
- 3 (3)
- 4 (4)
- 5 (5)
- 6 (6)
- more than 6 (7)

Answer If Did you take any passengers in the car? Yes Is Selected

Q8 Which of the following categories best describes your passengers (if you had more than one passenger, select as many as apply).

- Partner/ spouse (1)
- Parent (2)
- My child/children (3)
- Others child /children (4)
- Friend (5)
- Work colleague (6)
- Other (7)

Q9 Thinking about the drive specifically... what proportion of your drive was on urban (town) versus rural roads? If all of your driving was in town, you would say 100% urban. If you drove half of your time out of town (that is rural), the percentage for urban and rural would be 50% each. The total should add up to 100.

Percentage of drive (1)

Urban (town) (1)

Rural (2)

Q10 Thinking about how you drove on this occasion compared to when you usually drive, would you describe your speed as being.....

- Much slower than usual (1)
- Slightly slower than usual (2)
- Same speed as usual (3)
- Slightly faster than usual (4)
- Much faster than usual (5)

Q11 Thinking about your ability to react to changing traffic situations on this occasion. Would you describe your ability to respond as....

- Much slower than usual (1)
- Slightly slower than usual (2)
- Same as usual (3)
- Slightly faster than usual (4)
- Much faster than usual (5)

Q12 Overall, how much do you think your driving ability was affected by the drugs/medicines you had taken? I'd like you to give me a number between 1 and 10, where 1 is not at all impaired (equivalent to taking the same drive without taking any drugs) and 10 is very impaired (high risk of crashing). Remember 1 is as safe as usual and 10 is very impaired.

- 1 (1)
- 2 (2)
- 3 (3)
- 4 (4)
- 5 (5)
- 6 (6)
- 7 (7)
- 8 (8)
- 9 (9)
- 10 (10)

Q13 Still thinking about the same occasion...Did you make any changes to the route you drove because of the drugs/ medicine you had been taking? We would like to know if you tried to avoid any of the following during the drive....

	Yes (1)	No (2)	Don't know (3)	Refuse (4)
Heavy traffic (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Highways with multiple lanes (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
High speed roads (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Speed cameras (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Police checkpoints (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Car parks with tight spaces (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Unfamiliar roads (7)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Taking passengers (8)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q14 Up to now the questions I have asked have focused on a specific occasion when you took XXXX within 3 hours of driving. I'd now like to ask you about taking XXXX and driving generally. So thinking more generally about when you take XXXX. Do you

	Yes (1)	No (2)	Don't know (3)	Refuse (4)
Change when you drive as a result of taking XXXX? (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Change when you take XXXX because you have to drive? (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q15 Again, still thinking generally about taking XXXX and driving, how many other medicines or drugs do you usually take in combination with XXXX within 3 hours of driving? This may include legal or illegal products, those that are prescribed or purchased. This might include alcohol methamphetamine, anti-anxiety drugs, antidepressants, antihistamines, anti-nausea medication, anti-psychotics, cannabis, cocaine, cough and cold remedies, ecstasy, hallucinogens, kava, strong painkillers, opiates, party pills, stimulants, sedatives / sleeping pills, and synthetic cannabis.

0 (1) Enter number if 0 is selected, then skip to Q17 As a thank you for completing the sur...

Q16 What is a typical combination of drugs that you take with XXXX within 3 hours of driving? (*Record the name of each drug or medicine*)

I take X with drug type

(1)

and (2)

and (3)

and (4)

and (5)

and (6)

Q17 As a thank you for completing the survey we would like to offer you the opportunity to go into a draw to win a tablet computer. If you would like to enter the draw please could you provide your name and phone number? Please be assured that this will not be linked to your responses on the survey. Name (1)
Phone Number (2)

Q18 Would you like to receive a summary of the findings from the study? If so please provide your email address. Please note the findings will be available late 2015 or early 2016.

End of survey

You have now reached the end of the survey. Thank you for taking part. If you have any questions please contact a member of the research team: Nicola Starkey (nstarkey@waikato.ac.nz) or Samuel Charlton (samiam@waikato.ac.nz). If the survey has raised issues of concern for you, we would encourage you to speak to your GP in the first instance. Alternatively there is help and advice available on the Alcohol Drug Helpline, the website is <http://alcoholdrughelp.org.nz/> or telephone 0800787797.

Appendix C. Internet survey

Q1.1 Drugs and Driving Survey We are conducting research into prescription and non-prescription drug and medicine use and driving in New Zealand. We are approaching people from across New Zealand to complete our survey to find out what types of drugs and medicines people take before they drive, the types of driving people do and peoples' perceptions of how drugs may affect driving. The survey will take about 15 minutes to complete. We would appreciate you agreeing to be part of this study and taking the time to complete our survey. Please note, you can stop taking the survey at any time by closing the browser. The survey is anonymous. The record of your survey responses does not include any identifying information about you and there is no way to identify you from your responses. If you have any questions please contact a member of the research team: Nicola Starkey (nstarkey@waikato.ac.nz) or Samuel Charlton (samiam@waikato.ac.nz) from the University of Waikato. The research has received ethical approval from the School of Psychology Ethics Committee at the University of Waikato with funding from the New Zealand Transport Agency. Are you willing to take part?

- Yes
- No

If No Is Selected, Then Skip To End of Survey

Q1.2 Are you a New Zealand resident? (Do you live permanently in NZ?)

- Yes
- No

If No Is Selected, Then Skip To End of Survey

Q1.3 Have you driven in the last 12 months?

- Yes
- No

If No Is Selected, Then Skip To End of Survey

Q1.4 Do you have a good understanding of English?

- Yes
- No

If No Is Selected, Then Skip To End of Survey

Q1.5 Are you aged 16 years or over?

- Yes
- No

If No Is Selected, Then Skip To End of Survey

Q2.1 What type of driving licence do you hold?

- Learner's licence
- Restricted licence
- Full driving licence
- I don't hold a current driving licence
- Don' t know

Answer If What type of driving licence do you hold? I don't hold a current driving licence Is Selected

Q2.2 Why do you not hold a current driving licence?

- Licence has expired
- Never applied for driving licence
- Licence is currently suspended
- Other

Answer If What type of driving licence do you hold? I don't hold a current driving licence Is Not Selected

Q2.3 How long have you been a licenced driver? (how long since you passed your learner's test)

Q2.4 How many times do you drive in a typical week (a trip to and from work would be 2 trips)? How far do you usually drive (in kilometres) each week?

Number of trips each week

Km driven per week

Q2.5 In a typical week, what percentage of your time do you drive on rural roads (state highways with a high speed limit) and urban roads (in town, typically with 50km/h speed limit)? (The total should sum to 100).

_____ Rural roads (state highways)

_____ Urban roads (in town / city centre)

Q2.6 In good conditions how fast do you think THE AVERAGE DRIVER usually drives in a 100km/h zone and in a 50km/h zone? Select your answer from the drop down list.

Q2.7 In good conditions how fast do YOU usually drives in a 100km/h zone and in a 50km/h zone? Select your answer from the drop down list.

Q2.8 How skillful are YOU compared with the average driver (of the same age, gender and driving experience as you) in NZ? From 1 (least skillful 10% of all drivers) through 6 (average) to 11 (most skillful 10% of all NZ drivers).

- 1 (least skillful 10%)
- 2
- 3
- 4
- 5
- 6 (average)
- 7
- 8
- 9
- 10
- 11 (most skillful 10%)

Q2.9 How skillful is THE AVERAGE NZ DRIVER (someone the same age, gender and driving experience as you), when compared to NZ drivers overall? From 1 (least skillful 10%) through 6 (average) to 11 (most skillful 10%).

- 1 (least skillful 10%)
- 2
- 3
- 4
- 5
- 6 (average)
- 7
- 8
- 9
- 10
- 11 (most skillful 10%)

Q2.10 How many crashes have you been involved in over the past year when you were the driver?

- 0
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- Don't know

Q2.11 How many times in the past year have you been pulled over by the police, regardless of whether you received a ticket, infringement notice or fine?

- 0
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10
- more than 10
- Don't know

Q2.12 How many times in the past year have you been fined for a traffic offence (including speeding but not parking) regardless of whether or not you think you were at fault?

- 0
- 1
- 2
- 3

- 4
- 5
- 6
- 7
- 8
- 9
- 10
- more than 10
- Don't know

Q2.13 Thinking about driving, how confident do you feel doing the following activities? Allocate a number from 0-10, where 0 is not confident and 10 is completely confident.

Driving in your local area

Driving in heavy traffic

Driving in unfamiliar areas

Driving at night

Driving with people in the car

Responding to road signs/traffic signals

Driving around a roundabout

Attempting to merge with traffic

Turning right across oncoming traffic

Planning travel to a new destination

Driving in high speed areas

Parallel parking

Q3.1 How much you think an average person's driving would be affected by taking the following drugs or medicines? Give your rating assuming that the person is above the legal alcohol limit allowed to drive, or within 3 hours after using a typical amount of any other substance. Select a rating between 1 and 5, where 1 is not at all impaired (safe) and 5 is very impaired (dangerous).

Alcohol (above the legal limit)

Amphetamine/ Methamphetamine (P)

Anti-anxiety drugs

Antidepressants

Anti-nausea medication (e.g. for travel sickness)

Anti-psychotics

Cannabis

Cocaine/ Crack

Ecstasy

Hallucinogens (LSD, acid, mushrooms)

Kava

Strong painkillers (e.g., codeine, tramadol, morphine)

Opiates (e.g. heroin)

Party pills

Prescription stimulants (e.g. methylphenidate)

Sedatives/ Sleeping pills

Synthetic Cannabis (e.g., K2, Kronic, Spice)

Q4.1 Please remember that the answers you provide for this survey are anonymous and confidential and we encourage you to answer honestly. The next questions ask about your drug and medicine use. In the last 12 months have you...

	Yes	No	Don't know	Refuse to answer
taken any prescription medication?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
taken any over-the-counter medications (e.g. painkillers)?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
taken any drugs for recreational purposes (e.g., alcohol, cannabis, party pills, prescription medicines etc.)?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q5.1 Have you been breath tested for alcohol in the last 12 months?

Yes

No

Answer If Have you been breath tested for alcohol in the last 12 months? Yes Is Selected

Q5.2 Were you over the legal limit?

- Yes
- No

Q5.3 How likely are you to be breathalysed over the next 12 months?

- Not at all likely
- Somewhat likely
- Very likely
- Don't know

Q5.4 What is the current legal alcohol limit for drivers over 20 years of age?

- 0.08% (grams per 100ml blood)
- 0.03%
- 0.05%
- 0.10%

Q5.5 How likely do you think it is that a person will be caught by the police for the following offences (including red light and speed cameras)?

	Highly likely	Likely	Uncertain	Unlikely	Highly unlikely
Exceeding the speed limit	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Dangerous driving	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Drinking and driving	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Not stopping at traffic lights	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Driving whilst affected by drugs other than alcohol	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q5.6. Please indicate you level of agreement with the following statements.

	Totally agree	Somewhat agree	Neutral	Somewhat disagree	Totally disagree
It's alright to use medicines and drive if you feel your driving skills have not been affected	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

- It's alright to use other illegal drugs and drive if you feel your driving skills have not been affected
- Random roadside alcohol testing improves road safety
- Random road side drug testing would not improve road safety in New Zealand
- Drug driving is a significant road safety issue in New Zealand

Q5.7 In your opinion should more police time and resources be spent on enforcing drugged driving laws in New Zealand?

- Yes
- No
- Don't know

Q5.8 What is your gender?

- Male
- Female
- Other

Q5.9 How old are you?

Q5.10 Which ethnic groups do you belong to? Identify any that apply.

- New Zealand European
- Other European
- Maori
- Samoan
- Tongan
- Cook Island Maori
- Niuean
- Chinese
- Indian
- Other (e.g., Dutch, Japanese)

Refused to answer

Q5.11 Were you born in New Zealand?

- Yes
- No

Answer If Were you born in New Zealand? No Is Selected

Q5.12 What year did you arrive in New Zealand?

Q5.13 Where do you live in New Zealand (which province / district)?

- Northland
- Auckland
- Waikato
- Bay of Plenty
- Gisborne
- Hawkes Bay
- Taranaki
- Wanganui
- Manawatu
- Wairarapa
- Wellington
- Nelson Bays
- Marlborough
- West Coast
- Canterbury
- Timaru-Omaru
- Otago
- Southland

Q5.14 What is your occupation (e.g., student, teacher, mechanic)?

- Enter occupation _____
- Not in paid work

Q5.15 What is the total income that you yourself got from all sources, before tax or anything was taken out of it, in the last twelve months?

- Less than \$5,000
- \$5,001 - \$10,000
- \$10,001 - \$15,000
- \$15,001 - \$20,000
- \$20,001 - \$25,000
- \$25,001 - \$30,000
- \$30,001 - \$40,000
- \$40,001 - \$50,000
- \$50,001 - \$60,000
- \$60,001 - \$70,000
- \$70,001 - \$80,000
- \$80,001 - \$100,000
- \$100,001 - \$120,000
- \$120,001 - \$150,000
- \$150,001 or more
- Don't know
- Refused

Q5.16 Do you have access to the following?

- | | | |
|-----------------------|---------------------------|--------------------------|
| Mobile phone | <input type="radio"/> Yes | <input type="radio"/> No |
| Home phone (landline) | <input type="radio"/> Yes | <input type="radio"/> No |
| Internet | <input type="radio"/> Yes | <input type="radio"/> No |

Q5.17 Would you like to receive a summary of the findings from the study? If so please provide your email address. Please note that your email address will not be linked to your responses in the survey. The findings will be available late 2015 or early 2016.

Q6.1 Have you consumed alcohol in the last 12 months?

- Yes
- No

If No is selected, then skip to end of block

Q6.2 Have you driven when you felt under the influence of alcohol (when you felt you were over the legal limit) in the last 12 months?

- Yes
- No
- Prefer not to answer

Answer If Have you driven when you felt under the influence of alcohol (when you felt you were over the le... Yes Is Selected

Q6.3 Thinking about driving under the influence of alcohol (when you felt over the legal limit) in the last 12 months

How frequently have you driven under the influence of alcohol (when you felt you were over the legal limit) in the last 12 months?

The last time your drove under the influence of alcohol, what impact did it have on your driving?

How likely is it that you will drive under the influence of alcohol in the next 12 months?

Q6.4 Have you made the decision not to drive under the influence of alcohol (when you felt you were over the legal limit) in the last 12 months?

- Yes
- No

Answer If Have you made the decision not to drive under the influence of alcohol (when you felt you were over the legal limit) in the last 12 months? Yes Is Selected

Q6.5 The last time you made the decision not to drive under the influence of alcohol, what were the main reasons for your decision? (Select as many as apply)

- My ability to drive was negatively affected
- I was worried about getting caught by the police
- People I was with convinced me not to drive
- I was worried about the safety of others
- I had another way to get home
- Other reason/s

Q7.1 Have you taken Amphetamine/ Methamphetamine in the last 12 months?

- Yes
- No

If No is selected, then skip to end of block

Q7.2 Have you driven within 3 hours of taking Amphetamine/ Metamphetamine in the last 12 months?

- Yes
- No

Answer If; Have you driven within 3 hours of taking Amphetamine/ Metamphetamine in the last 12 months? Yes Is Selected

Q7.3 Thinking about driving within 3 hours of taking Amphetamine/ Metamphetamine in the last 12 months

How frequently have you driven within 3 hours of taking Amphetamine/ Metamphetamine in the last 12 months?

The last time your drove within 3 hours of taking Amphetamine/ Metamphetamine, what impact did it have on your driving?

How likely is it that you will drive within 3 hours of taking Amphetamine/ Metamphetamine in the next 12 months?

Q7.4 Have you made the decision not to drive within 3 hours of taking Amphetamine/ Metamphetamine in the last 12 months?

- Yes
- No

Answer If Have you made the decision not to drive within 3 hours of taking Amphetamine/ Metamphetamine in t... Yes Is Selected

Q7.5 The last time you made the decision not to drive within 3 hours of taking Amphetamine/ Metamphetamine, what were the main reasons for your decision? (Select as many as apply)

- My ability to drive was negatively affected
- I was worried about getting caught by the police
- People I was with convinced me not to drive
- I was worried about the safety of others
- I had another way to get home
- Other reason/s

Q8.1 Have you taken anti-anxiety medication (e.g., diazepam, buspirone) in the last 12 months?

- Yes
- No

If No is selected, then skip to end of block

Q8.2 What is the name of the medication?

Q8.3 Why do you take this medication?

- Recreational / social purposes
- Medical reasons (on prescription)General health
- Other

Q8.4 Have you driven within 3 hours of taking anti-anxiety drugs in the last 12 months?

- Yes
- No

Answer If Have you driven within 3 hours of taking anti-anxiety drugs in the last 12 months? Yes Is Selected

Q8.5 Thinking about driving within 3 hours of taking anti-anxiety drugs in the last 12 months

How frequently have you driven within 3 hours of taking anti-anxiety medication in the last 12 months?

The last time your drove within 3 hours of taking anti-anxiety medication, what impact did it have on your driving?

How likely is it that you will drive within 3 hours of taking anti-anxiety medication in the next 12 months?

Q8.6 Have you made the decision not to drive within 3 hours of taking anti-anxiety medication in the last 12 months?

- Yes
- No

Answer If Have you made the decision not to drive within 3 hours of taking anti-anxiety medication in the I... Yes Is Selected

Q8.7 The last time you made the decision not to drive within 3 hours of taking anti-anxiety medication, what were the main reasons for your decision? (Select as many as apply)

- My ability to drive was negatively affected
- I was worried about getting caught by the police
- People I was with convinced me not to drive
- I was worried about the safety of others
- I had another way to get home

- Other reason/s

The same questions were asked for antidepressants, anti-nausea medication, anti-psychotics, cannabis, cocaine/crack, ecstasy, kava, hallucinogens, strong painkillers, opiates (e.g., heroin), party pills, prescription stimulants, sedatives or sleeping pills and synthetic cannabis.

Q9.1 Have you driven within 3 hours of taking a combination of drugs and medicines (e.g., alcohol and cannabis, antidepressants and strong painkillers)?

- Yes
- No

If No Is Selected, Then Skip To End of Block

Answer If Have you driven within 3 hours of taking a combination of drugs and medicines? Yes Is Selected

Q9.2 On the last occasion you took a combination of drugs and medicines within 3 hours of driving, what drug types did you take?

- Alcohol
- Amphetamine / Methamphetamine (P)
- Anti-anxiety drugs
- Antidepressants
- Anti-nausea medications (for travel sickness)
- Anti-psychotics
- Cannabis
- Cocaine / Crack
- Ecstasy
- Kava
- Hallucinogens (e.g., LSD, Acid)
- Strong painkillers (e.g. codeine, tramadol, morphine, methadone)
- Opiates (e.g. heroin)
- Party pills
- Prescription stimulants (e.g. Methylphenidate)
- Sedatives/ sleeping pills
- Synthetic cannabis

Q9.3 How do you think this combination of medicines / drugs affects your driving?

- A lot worse

- Slightly worse
- No change
- Slightly better
- A lot better