Alcohol and other drug use in New Zealand drivers 2004 to 2009

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Executive Summary

Alcohol is a drug known to impair the ability to drive safely. It is acknowledged as a major factor in road crashes. The use of other impairing drugs by New Zealand (NZ) drivers is largely unknown. This study looks at the prevalence of drug use by drivers on NZ roads. The driving populations considered are biased populations and the results that have been obtained can be considered only as indicators of possible drug use in the wider driving population.

The driving populations considered in this study are:

Sample one: Drivers killed as a result of a crash over the period of 1 July 2004 to 30 June 2009, and;

Sample two: Drivers not involved in crashes but who had an evidential blood sample taken for alcohol analysis. The blood samples were collected over a six month period.

Sample one

Blood samples taken from 1,046 deceased drivers were analysed for the presence of drugs and alcohol. Based on the analyses carried out on these blood samples 546 (52%) deceased drivers were not impaired by alcohol or other drugs. 500 (48%) of the deceased drivers had alcohol or other drugs in their blood that may have impaired their ability to drive safely:

- 135 used alcohol alone (27% of the possibly impaired drivers);
- 96 used cannabis alone (19% of the possibly impaired drivers);
- 142 used a combination of alcohol and cannabis, but no other drug (28% of the possibly impaired drivers);
- 127 used some other combination of drugs, many including alcohol and/or cannabis (25% of possibly impaired drivers);
- Only 29 of the 500 drivers (6%) who had used a drug, had <u>not</u> used either cannabis or alcohol, and;
- 240 of the 500 possibly impaired drivers (48%) had used more than one potentially impairing drug.

Sample two

Blood samples taken from 1,999 drivers, who had an evidential blood sample taken but had not been injured in a crash, were analysed to determine the level of alcohol and were screened for evidence of the use of a limited range of other drugs:

- 1,258 used alcohol alone (63%);
- 695 used alcohol and cannabis (35%), and;
- 46 had used alcohol and some other drug (2%).

Introduction

The influence of alcohol on road crashes and fatalities has been acknowledged for many years. It is only in more recent years that the use of other types of drugs has been associated with road crashes. While illicit drugs such as cannabis and methamphetamine may dominate, prescription drugs such as sedatives and opioid pain killers can also impair driving skills.

There have been many reports from overseas studies that indicate that drugged driving is an increasing problem. However, it is difficult to use these reports to get a clear idea of the influence of drug use in driving because of different approaches taken in the reported studies. There are variations in biological samples analysed (blood, urine, oral fluid), the range of drugs studied (illicit drugs and/or or prescribed medication) and the driving populations included (deceased, injured, random selection). This led to the establishment of suggested guidelines for research in drugged driving [1].

This report is concerned principally with the prevalence of drugs in deceased drivers. Recent overseas reports that most closely match the methodology used in this report are:

- A ten year study of driver fatalities covering three states of Australia in which blood from 3,398 drivers were analysed. 50% of the drivers showed no alcohol or other drug use. 32.8% were alcohol positive, 13.5% were cannabis positive, 4.9% were opioid positive, 4.1% were stimulant positive and 4.1% were benzodiazepine positive [2];
- A two year study of driver fatalities under the age of 30 years in France in which 2,003 samples were analysed for drugs of abuse only. 28.9% were positive for cannabis, 1.9% were positive for morphine, 3.1% were positive for amphetamine type stimulants and 3% were positive for cocaine [3];
- A five year study of driver fatalities in Sweden in which blood from 1,403 drivers were analysed. 60% of the drivers showed no alcohol or other drug use. 22% were alcohol positive, 2.4% were cannabis positive, 3.8% were

amphetamine positive, 4.9% were opioid positive, and 6.6% were sedative positive [4], and;

- A six year study of driver fatalities in the United Kingdom in which blood from 603 drivers were analysed. 45% of the drivers showed no alcohol or other drug use. 42% were positive for alcohol only, 26% had used alcohol and other drugs and 32% had used drugs other than alcohol [5].

The prevalence of drugged driving in New Zealand (NZ) is not known. The NZ legislation does not permit random stopping of drivers for the purposes of drug testing, making it difficult to obtain any reliable information about drug use in the general driving population. Prior to a change in legislation in 2009 it was also not possible to carry out research on blood samples taken from drivers under the Land Transport Act 1998.

In 1992 blood samples received from 404 deceased drivers were analysed for the presence of alcohol and cannabis. This study found that 22% of the deceased drivers had used cannabis, a higher percentage than reported in other countries at that time [6].

This study, designed to get a current picture of drug use in the NZ driving population, can be considered only as a pilot study because the driving population available to study is biased and limited. A Cross Departmental Research Project (CDRP) Grant from NZ Police has enabled this study to be carried out. The original study proposal included three parts:

- **Part one** – identify the proportion of detected drinking drivers, who have provided an evidential blood alcohol specimen, that have also taken non-alcohol drugs;
- **Part two** – identify the association between non-alcohol drugs and fatal and serious injury crashes in five Police districts (3 Auckland districts and Waikato, with Southern District forming a control), and;
- **Part three** – identify the proportion of detected drinking drivers, who have provided an evidential blood alcohol specimen, that are likely to have alcohol abuse or alcohol dependency issues.

It was determined that a sample size of 2,000 drivers would be needed to get sufficient data for the results to carry some statistical weight. This determination was based on results from overseas studies reported prior to 2004 and the expectation that 3 to 5% of drinking drivers also used other drugs and about 20% of serious or fatally injured drivers would be positive for drugs other than alcohol. The study was carried out as follows:

Part one

2,000 randomly selected evidential blood alcohol samples received at ESR over a six month period were analysed for evidence of the use of cannabis, morphine, methamphetamine, MDMA and benzodiazepines. No deceased or hospitalised drivers were included in this part of the study. The results of this part of the study were reported in a University of Waikato Masters Thesis produced by Carolina Troncoso Vergara (2006) [7] and in a CDRP report [8]. A portion of the results from this part of the study will be discussed again in this document.

Part three

The blood specimens from the same set of 2,000 drivers as used for Part 1, were analysed for the presence of the volatile compounds, methanol, isopropanol and acetone, which may be associated with excessive alcohol use. The results of this portion of the study were reported by Dr Allan Stowell [9].

Part two

The proposal was to look at drug use in 2,000 hospitalised or deceased drivers. It was estimated that by taking drivers from five selected Police districts, namely the three Auckland districts (Auckland City, Counties Manukau and Waitemata) and Waikato, and using the Southern region as a control group, it would take about two years to collect the 2,000 samples. The purpose of selecting specific geographical areas was to avoid a biased sample being collected. An effort was to be made to get samples from all injured drivers, not just those who were suspected of drug or alcohol use.

This part of the study could not be carried out as proposed. Legal issues surrounded the use of blood samples taken from hospitalised drivers. Police lawyers determined that to comply with the current (2004) legislation, if we were to carry out research on

a blood sample taken from a hospitalised driver, we would need the driver's permission as well as a separate blood sample. Therefore hospitalised drivers could not be studied without a change in legislation (as enacted in the Land Transport Amendment Act 2009).

The scope of the study was changed to look at drug use and crash responsibility for deceased drivers only, acknowledging it would take more than the proposed two years to collect sufficient data. Blood samples from about 200 deceased drivers are received each year at ESR where analyses are carried out as part of a Coronial investigation. The extent of analyses requested by the pathologists is not consistent throughout the country, so this project enabled full analyses to be carried out on all deceased drivers. To collect data from 2,000 deceased drivers would take about 10 years. Having considered the consistency of the data collected over four years, it was agreed with Superintendant Paula Rose, National Manager: Road Policing, to cease study at five years, covering the time period on July 2005 to June 2009 inclusive, with approximately 1,000 samples.

Methodology

Deceased drivers – Drug use and culpability

Blood samples, identified as being from a person who had died as a result of a motor vehicle crash while they were driving, were used for this study. The samples analysed included those from both culpable and non-culpable drivers. Following analysis for the presence of alcohol, these blood samples were analysed for the evidence of the use of a range of potentially impairing drugs, including cannabis, methamphetamine, morphine, benzodiazepines and a range of prescription medication. The analytical methods used are set out in Appendix one – Analytical Methods.

Copies of the crash reports (POL 560) that are produced for all crashes involving fatalities, were received from the Ministry of Transport. Those involving driver fatalities were analysed for crash culpability independent of the knowledge of the presence of drugs in the deceased driver's blood samples. Culpability for the crash was determined using the Responsibility Analysis Guidelines (Appendix two) developed by Professor Olaf Drummer of the Victorian Institute of Forensic Medicine [10].

Not all drivers who died in a motor vehicle crash over the five year period have been included in the study. Reasons for exclusion are discussed in Appendix three – Driver Selection.

The data collated during the course of the study included more than just drug use and crash culpability. A number of brief discussions are included as Appendices which consider the profile of the drivers with respect to drug use (gender, ethnicity, age, licence status), the profile of the crashes with respect to drug use (district, time of day, road type, motorbikes and trains), the numbers of fatal crashes within each district, the number of crashes per month over the five year period, involvement of trains, trucks and motorbikes, multiple and single vehicle crashes, passengers and other drivers.
Additional data also collated in separate Appendices include alcohol levels in hospitalised drivers and alcohol and other drug use in drivers whose occupation is a 'driver'.

Uninjured drivers – Drug use

This report includes a brief summary of the drug use in the drinking driver population as a comparison to the drug use in driver fatalities. The full results of this part of the study were reported in a University of Waikato Masters Thesis produced by Carolina Troncoso Vergara (2006) [7] and in a CDRP report [8].

The blood samples for this part of the study were received at ESR for blood alcohol analysis. The driver having presumably failed the breath alcohol test has elected to have an evidential blood sample taken. That the driver was not seriously injured in a crash was determined by the Police form (POL535) accompanying the sample. When alcohol analyses were complete and certified, a random selection of blood samples was analysed for evidence of use of cannabis, morphine, methamphetamine, MDMA and a range of benzodiazepines using the methodology described in Appendix one.

Finding: Deceased drivers

Drug Use Summary

Blood samples taken from 1,046 deceased drivers were analysed for the presence of alcohol or other drugs. 504 blood samples contained no alcohol and no drugs and the drivers were deemed to be unimpaired.

A further 42 blood samples were also deemed to be taken from drivers who were not significantly impaired. These blood samples contained a drug or low levels of alcohol but the drivers were not likely to be significantly impaired by these because either:

- the drugs detected would have been administered by medical personnel, or;
- the drugs that were present are unlikely to impair, or;
- if alcohol was present, by itself, it was at a level unlikely to significantly impair, that is below 30 milligrams per 100 millilitres (30 mg/100 mL).

When there was evidence of alcohol use only in the blood, the youth limit (drivers under 20 years old) of 30 mg/100 mL was selected as an arbitrary threshold, as a measure that the driver was deemed unlikely to be significantly impaired. However, this does not mean someone with a blood alcohol level of below 30 mg/100 mL may not show significant impairment.

It should be acknowledged that not all potentially impairing drugs will be detected by the analyses carried out for this study. Furthermore it is also possible that a person may be impaired by not taking a drug.

Based on the analyses carried out, 546 of the 1,046 (52%) deceased drivers had no alcohol or other drug detected in their blood or were unlikely to be significantly impaired by alcohol or other drug present. 500 (48%) of the drivers had alcohol or other drugs in their blood that may have impaired their ability to drive safely:

- 135 of 500 had used alcohol alone (27%);
- 96 of 500 had used cannabis alone (19%);
- 142 of 500 had combined alcohol and cannabis use (28%), but had not used another drug, and;

- 127 of 500 had used some other combination of drugs (25%), which may have included alcohol and/or cannabis.

As stated above, when a driver had used alcohol alone, it was reported as present only when above the arbitrary threshold of 30 mg/100 mL (the youth limit). When a driver has used alcohol as well as a potentially impairing drug, the alcohol is been reported as being present at a blood level greater than 5 mg/100 mL. This is because when alcohol and impairing drugs are used together the effects are likely to be greater than when just one is used by itself.

There were 127 drivers who had used a combination of drugs that was not alcohol alone, cannabis alone, or alcohol and cannabis alone. This does not mean that these drivers had not used alcohol or cannabis, they had just not used them alone. Most of these 127 drivers had used either alcohol or cannabis with other drugs.

Only 29 drivers (6% of the 500 potentially impaired drivers) had not used either cannabis or alcohol. Of the 500 potentially impaired drivers, 240 (48%) had used more than one impairing drug.

Alcohol

There are legal allowable blood alcohol levels for driving throughout the world. A legal limit does not mean that above that level all people are impaired and below that level all people are not impaired. Alcohol affects everyone differently. The NZ limits are 30 mg/100 mL for a person under the age of 20 years, and 80 mg/100 mL for a person 20 or more years of age.

At blood alcohol levels between 10 and 50 mg/100 mL, the influence of the drug may not be apparent or obvious [8]. Behaviour is often nearly normal by ordinary observation but impairment may be detectable by special tests. At blood alcohol levels between 30 and 120 mg/100 mL a person is likely to exhibit an extended range of behaviour including mild euphoria, sociability, decreased inhibitions, a reduction in attention, judgement and control, some sensory-motor impairment, slowed information processing and loss of efficiency in critical performance tests [11].

Therefore it might be expected that blood alcohol levels below 30 mg/100 mL should generally cause minimal impairment. However, when other potentially impairing drugs are combined with alcohol, the effects of the alcohol or the other drug may be magnified. For the purposes of this study, if a deceased driver has only alcohol in their blood, and that alcohol level is below 30 mg/100 mL, then that person is deemed unimpaired. This is an arbitrary level and it is possible that a person with a blood alcohol level below 30 mg/100 mL is impaired. There were 28 drivers who had drunk alcohol alone and whose blood contained alcohol between 5 and 30 mg/100mL (Table 1).

However, if some other impairing drug is also present in the blood then a level of below 30 mg/100 mL is recognised as positive due to the potential enhancement of impairment effects. A blood alcohol level below 5 mg/100 mL is considered a trace level and for the purposes of this study a blood alcohol level of less than 5 mg/100 mL is deemed to be negative. Therefore, there is a distinction in the following discussion between the presence of alcohol, a level of more than 5 mg/100 mL, and possible impairment by alcohol, greater than 30 mg/100 mL if alone, greater than 5 mg/100 mL if other drugs are present.

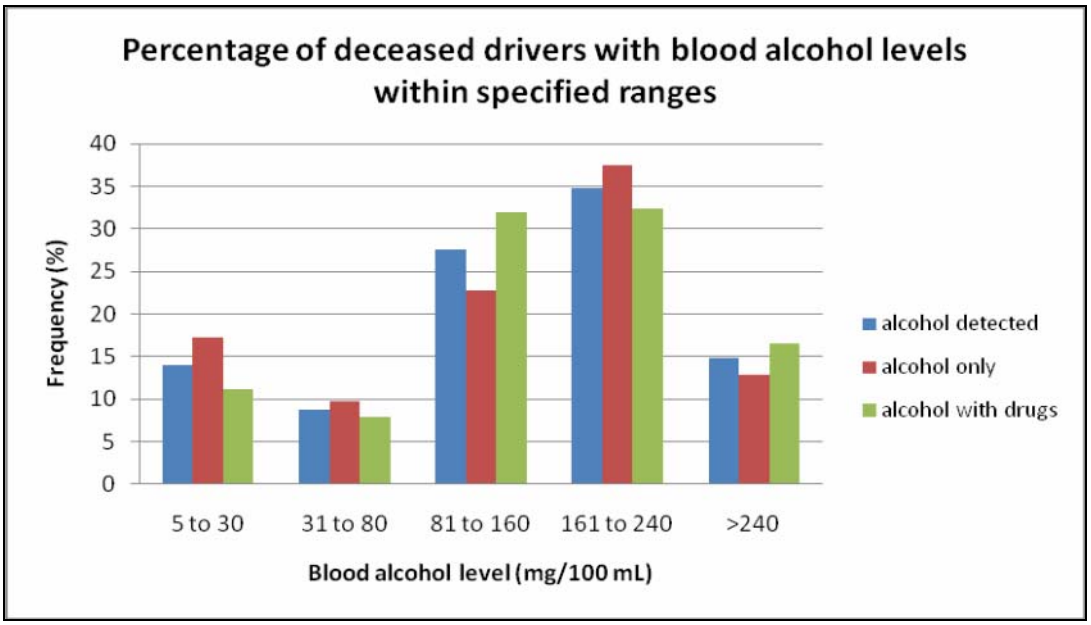
Of the 1046 deceased drivers, 351 (34%) drivers had some alcohol in their blood, that is, alcohol at a level of 5 mg/100 mL or more. Only 49 of the deceased drivers had blood alcohol levels between 5 and 30mg/100 mL, legally sober for any age group.
163 of the deceased drivers (16%) had used only alcohol. 28 of these drivers had an alcohol level below 30 mg/100 mL and impairment was assumed to be minimal. There were 135 drivers (13%) who had used only alcohol and had a blood alcohol level greater than 30 mg/100mL. Only 16 of these drivers had alcohol levels between 30 and 80 mg/100 mL, legally sober for a person 20 years old or more. As there were 351 drivers who had used alcohol, this means 188 deceased drivers (18%) had used alcohol with another potentially impairing drug.

The distribution of blood alcohol levels is presented in Table one and Graph one. The levels found in those drivers who have used only alcohol can be compared with the drivers who have also used other drugs. Looking at those who used only alcohol, 119 of the 163 (73%) had blood alcohol levels greater than 80 mg/100 mL. When a driver had combined the alcohol with another drug, a higher percentage of drivers, 152 of the 188 drivers (81%) were above the legal adult limit. Use of another drug with alcohol does not appear to result in a lower blood alcohol level at which drivers chose to drive.

Table one - Blood alcohol levels in deceased drivers

Alcohol levels (mg/100ml)	**Alcohol detected**		**Alcohol only**		**Alcohol with other drug use**	
	Number	**%**	**Number**	**%**	**Number**	**%**
5 to 30	49	14	28	17	21	11
31 to 80	31	9	16	10	15	8
81 to 160	97	28	37	23	60	32
161 to 240	122	35	61	37	61	32
>240	52	15	21	13	31	16
Total	351		163		188	

Graph one



The blood alcohol limit for a youth, someone under 20 years, is 30 mg/100 mL. Of the 351 drivers who have used alcohol, 40 drivers were under 20 years old. 30 of these 40 young drivers had alcohol levels greater than 30 mg/100 mL (range 47 to 267 mg/100 mL, average 142 mg/100 mL). Further to this, 18 of these young drivers, already over their legal limit, had also used cannabis. Of the 10 young drivers who were below their legal 30 mg/100 mL limit, 6 had used cannabis.

Recently concern has been raised about driving with a blood alcohol level above 50 but below 80 mg/100 mL. 9% of the deceased drivers (31) who had alcohol in their blood, had blood alcohol levels in the range of 31 to 80 mg/100 mL. 21 of these drivers had blood alcohol levels in the range of 51 to 80 mg/100 mL. That is, 6% of the 351 deceased drivers who had used alcohol, or 2% of the 1,046 deceased drivers in the study, had alcohol present within this range. Only 10 of these drivers had used alcohol alone, the other 11 had also used a potentially impairing drug.

Alcohol only

Does the distribution of blood alcohol levels in deceased drivers differ much from that found in living drivers? There are two sources of information on blood alcohol levels in living drivers:

- There are the drivers stopped by police, either at a check point or due to driver behaviour. These drivers have not been involved in a crash, are likely to have failed an evidential breath test and have elected to have a blood sample taken. The blood alcohol levels from this group may be biased by those who have accepted the breath alcohol reading. Someone with a very high breath alcohol reading may be less likely to challenge the test, by having a blood sample taken, than someone closer to the legal limit, and;

- There are drivers who are hospitalised as a result of a crash and have had an evidential blood sample taken. This group is also likely to be biased because not all drivers hospitalised following a crash have a blood sample taken for alcohol analysis.

Table two shows the number and proportion of drivers and their blood alcohol levels, from the three categories: deceased, hospitalised and those not injured in a crash. In this table, and the graphical representation (Graph two), blood alcohol levels below 5 mg/100 mL have been removed for the deceased and hospitalised drivers, as these levels are not found in the uninjured drivers because those drivers have generally been breath tested.

The blood samples taken from the non-injury drivers and the hospitalised drivers were taken from an approximate six month period of samples received at ESR for alcohol analysis.

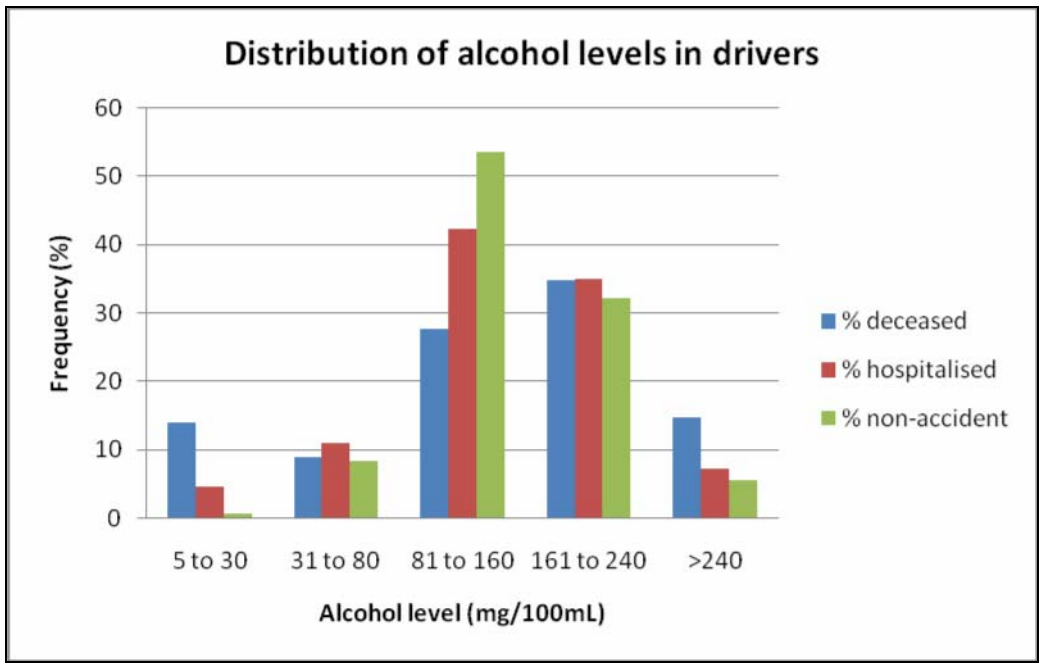
Table two - Alcohol levels in NZ drivers

Alcohol level	Deceased		Hospitalised		Non-injury	
mg/100 mL	**Number**	**%**	**Number**	**%**	**Number**	**%**
5 to 30	49	14	20	5	12	0.6
31 to 80	31	9	47	11	165	8
81 to 160	97	28	182	42	1065	53
161 to 240	122	35	150	35	639	32
>240	52	15	31	7	111	6
Total	**351**		**430**		**1,992**	

The hospitalised and non-injury drivers have a lower proportion with blood alcohol levels below 30 mg/100 mL. The non-injury drivers should have been largely excluded from this category via the breath test. A higher proportion of non-injury

drivers in the 80 to 160 mg/100 mL range may be expected as these are closer to the legal limit and the breath level is more likely to be challenged. The higher proportion of deceased drivers compared with uninjured drivers at the highest blood alcohol levels may also be explained by this breath screen bias. Why challenge a clearly over the limit breath test? The proportions of drivers with alcohol levels within the range 160 to 240 mg/100 mL are very similar for the three sources of samples.

Graph two



If a driver is hospitalised as a result of a crash, a blood sample should be taken for alcohol analysis even if the driver is not suspected of impairment or of being at fault. This does not always happen. The data given in Table three shows that a higher proportion of deceased drivers have no alcohol in their blood compared with the hospitalised drivers. It is not possible to determine if this is a real difference because it is not known what proportion of hospitalised drivers do not have a blood sample taken. Futhermore, with the hospitalised drivers, there will be a delay between the time of the crash and the time the blood is sampled. Alcohol levels will decrease over this time in a living person.

Table three - Proportion of drivers at the lower alcohol levels

Alcohol level (mg/100mL)	Hospitalised	%	Deceased	%
< 5	355	45	695	66
5 to 30	20	3	49	5
> 30	410	52	302	29
Total	**785**		**1,046**	

For each of the driver fatalities, information about the crash was analysed and driver culpability, or who was at fault, was determined for each crash. The methodology used is described in Appendix two. Having determined the numbers of drivers at fault or not at fault, a calculation of an odds ratio can be carried out. This odds ratio compares the proportion of 'culpable' and 'not culpable' drivers who may have used alcohol or another drug, to the same proportion of drivers who are drug free. The method of calculation of the odds ratio is also set out in Appendix two. This calculation places a numerical value on the impact of a drug, like alcohol, on the likelihood of a fatal injury in a crash. The greater the odds ratio is, the greater the impact. To determine the impact of a particular drug, the drivers who had used only that drug can be considered. Alcohol impairment is well known and is useful to demonstrate the odds ratio calculation.

The culpability ratio (# culpable/# not culpable) is determined for drivers using only alcohol. This culpability ratio is divided by the culpability ratio calculated for drug free drivers. From these ratios the odds ratio is determined. An odds ratio value greater than 1 shows the drug is having some impact on the likelihood of having a crash [7].

In this study, most of the drivers involved in a single vehicle crash were found to be at fault. For this reason it is necessary to consider the odds ratio, as calculated for alcohol, for single and multiple vehicle crashes separately. The results for these are given in Table four.

Table four - Odds ratio determination for deceased drivers using only alcohol

All vehicles		
	Unimpaired drivers	**Alcohol only**
Culpable	403	129
Not culpable	128	3
Unclear	15	3
Total	**546**	**135**
% culpable	74	96
% not culpable	23	3
Odds ratio		**14**

Single vehicle			**Multiple vehicle**		
	Unimpaired drivers	**Alcohol only**		**Unimpaired drivers**	**Alcohol only**
Culpable	152	104	culpable	251	25
Not culpable	7	0	not culpable	121	3
Unclear	6	1	unclear	9	2
Total	**165**	**105**	**Total**	**381**	**30**
% culpable	92	99	% culpable	66	83
% not culpable	4		% not culpable	32	4
Odds ratio		**	**Odds ratio**		**4**

**Odds ratio cannot be calculated because there are no 'not culpable' drivers

It should be noted that more weight can be placed on the odds ratio value if the population size is large. It also needs to be noted that for the odds ratio calculation to work, some drivers need to be not culpable, or the calculation involves a division by zero.

When the deceased drivers have used alcohol by itself, only three were determined to be not culpable. If the deceased driver has used alcohol, and both single and multiple vehicle crashes are considered, the culpability ratio with 129 culpable drivers and three not culpable, is 43. Similarly, when all crashes are considered, there are 403 unimpaired drivers at fault and 128 not at fault. That gives a culpability ratio of three for unimpaired drivers and an odds ratio of 14.

However, if single vehicle and multiple vehicle crashes are considered separately, it is not possible to determine an odds ratio for alcohol use in a single vehicle crash, because there are no 'not culpable' drivers. For the multiple vehicle crashes there were three drivers not at fault and 25 at fault, giving an odds ratio of four. Not much weight should be placed on this result because a sample population of 28 is not large enough to give statistical significance.

It is generally accepted that at higher blood alcohol levels, impairment is greater. Therefore the odds ratio should increase with increasing alcohol levels. The effect of the blood alcohol levels on the odds ratio is considered in the data found in Table five. These odds ratios have been calculated against the same number of unimpaired drivers for each crash type as given in Table four.

Table five - Calculation of odds ratio at different alcohol levels

Alcohol levels mg/100 mL					
All vehicles	**Number**	**Odds ratio**	**Culpable**	**Not culpable**	**Unclear culpability**
30 to 80	16	4.7	15	1	0
81 to 160	37	5.2	33	2	2
161 to 240	61	**	60	0	1
>240	21	**	21	0	0
Total	**135**				
Multiple vehicles	**Number**	**Odds ratio**	**Culpable**	**Not culpable**	**Unclear**
30 to 80	6	2.4	5	1	0
81 to 160	16	3.1	13	2	1
161 to 240	7	**	6	0	1
>240	1	**	1	0	0
Total	**30**				
Single vehicle	**Number**	**Odds ratio**	**Culpable**	**Not culpable**	**Unclear**
30 to 80	10	**	10	0	0
81 to 160	21	**	20	0	1
161 to 240	54	**	54	0	0
>240	20	**	20	0	0
Total	**105**				

**odds ratio cannot be calculated because there are no 'not culpable' drivers

Again the lack of not culpable drivers in most categories makes calculation of an odds ratio impossible. The only odds ratios that can be calculated are for the drivers whose blood alcohol levels are in the ranges of 30 to 80 mg/100 mL and 80 to 160 mg/100 mL. The difference in the odds ratios for these two ranges is small, but as the population sizes are small little significance can be placed on the results.

There are only 30 drivers who have used only alcohol and have been involved in multiple vehicle crashes. When the data for multiple vehicle crashes is separated into different alcohol levels, any difference determined in the odds ratio values is not significant because there are too few samples.

There were 135 drivers (13% of the 1,046 deceased drivers in this study, or 27% of the 500 potentially impaired drivers) who had used alcohol only and had an alcohol level greater than 30 mg/100 mL, a level that may impair driving. 105 of these alcohol only drivers died as a result of a single vehicle crash. The study includes a total of 460 single vehicle crashes. Therefore 23% of the drivers who died in a single vehicle crash had used alcohol alone. Compare this with drivers involved in multiple vehicle crashes. This study includes 560 multiple vehicle crashes, which resulted in 586 deaths. In the multiple vehicle crashes there were 30 deceased drivers who had used alcohol alone. Therefore 5% of deceased drivers involved in multiple vehicle crashes had used alcohol by itself.

It appears from this study that drivers using alcohol by itself are more likely to be killed in a single vehicle crash than in a multiple crash:

- 135 of the 500 potentially impaired drivers had blood had used alcohol alone (level greater than 30 mg/100mL);
- 105 of the 135 drivers using alcohol only died in a single vehicle crash, and;
- 30 of the 135 drivers died in a multiple vehicle crash.

Cannabis

Cannabis use in this study has been determined by the presence of tetrahydrocannabinol (THC), the active ingredient of cannabis, in the blood. Cannabis use can be detected in the body for a number of days after use, but this is by the detection of THC-acid, the major metabolite of THC, usually in the urine, not by the detection of THC itself. The presence of THC in blood can be used to indicate recent use.

The rates at which THC levels in the blood decrease are extremely variable and are dependent on the individual. Peak levels may be as high as 100 nanograms per millilitre (ng/mL), but these occur while cannabis is being smoked. Blood THC levels drop rapidly. Even a heavy user of cannabis is unlikely to have a level of THC greater than 1 ng/mL in the blood, for more than 12 hours after use [12]. An infrequent user of the drug may have no detectable THC in the blood four hours after use. Effects of cannabis are reported to last up to about four hours [12]. The presence of THC in the blood does not mean that a person is impaired by the drug.

There is not a strong correlation between THC blood levels and impairment. The presence of THC in blood indicates use, possibly recent use, but not the degree of impairment. Drummer reports that a person with a blood THC level of above 5 ng/mL is likely to show signs of impairment [13]. Certainly a THC blood level greater than 5 ng/mL does indicate recent use, but the extent of impairment will depend on the individual. It is important not to exclude the possibility of impairment at levels below 5 ng/mL [14]. In this study the level of THC in the deceased driver's blood has been determined. This was to determine if there was a correlation between THC blood levels and the likelihood of being at fault for a crash. In this study 314 of the 1,046 (30%) deceased drivers had used cannabis. This is very close to the number of drivers who had used alcohol (34%).

Over the two year period of 1995 to 1997, a small study was carried out looking at just alcohol and cannabis use in deceased drivers. In that study of 404 deceased drivers, 22% (88 drivers) had used cannabis as determined by the presence of THC in the blood.

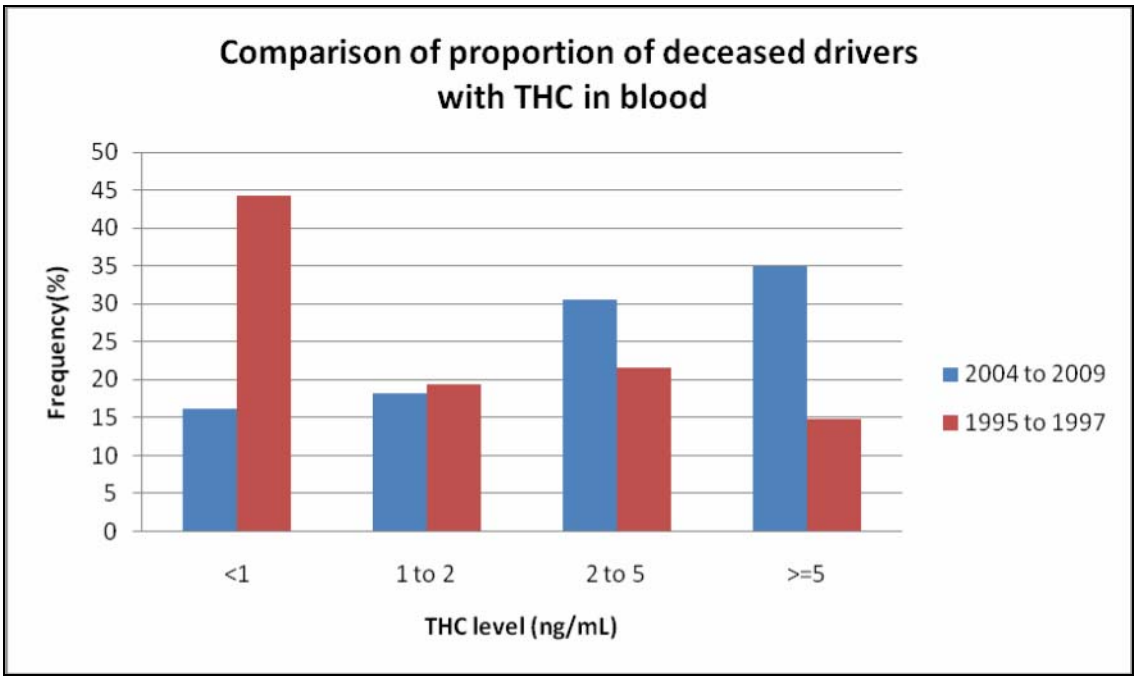
The numbers of drivers using cannabis and the blood THC levels detected in these drivers, for the two separate studies, are given in Table six. Cannabis use by deceased drivers appears to have become more common in NZ over the last ten to fifteen years.

Table six - THC levels found in blood of deceased drivers

THC levels	2004 to 2009		1995 to 1997	
ng/mL	**Number**	**%**	**Number**	**%**
<1	51	16	39	44
1 to 2	57	18	17	19
2 to 5	96	31	19	22
>=5	110	35	13	15
Total	**314**		**88**	

The figures from the two studies (Table six) also indicate that drivers appear to be less cautious about smoking cannabis and driving. In the 1995 to 1997 study over 60% of the drivers had THC levels lower than 2 ng/mL. In the current study over 60% of the drivers have THC levels over 2 ng/mL, indicating that these drivers are driving (and dying) sooner after smoking the drug. This data is shown graphically in Graph three.

Graph three



Although there is no direct correlation between a blood THC level and impairment, the level can give an indication of how recently the drug was used. The higher the blood THC level, the more recent the use, and therefore the greater likelihood of impairment. THC is a lipophilic drug and as such leaves the blood rapidly after smoking. Even regular users of cannabis will have low levels of THC in the blood several hours after use.

While 314 deceased drivers had used cannabis prior to their crash, most (218, 69% of the cannabis users) had combined cannabis use with some other potentially impairing drug.

Cannabis only drivers

96 of the 1,046 deceased drivers had used just cannabis. That is 9% of all deceased drivers or 31% of the cannabis using drivers, had used cannabis by itself. The culpability of these drivers for their crashes is shown in Table seven.

61 of the drivers who had used only cannabis were involved in a multiple vehicle crash. That is 10.4% (61 of the 586 drivers killed in multiple vehicle crashes) had used cannabis by itself. This is twice the number of drivers using alcohol alone. Only 30 of the 586 drivers who died in a multiple vehicle crash had used alcohol by itself.
35 cannabis only using drivers were involved in a single vehicle crash. That is 35 of the 460 (7.6%) drivers who died in a single vehicle crash had used cannabis by itself. This is considerably fewer than the number of drivers who had used alcohol by itself (105 of the 460 single vehicle crashes).

This indicates that alcohol users are more likely to be involved in single vehicle crashes while cannabis users are more likely to be involved in multiple vehicle crashes, when these drugs are used by themselves.

The culpability of the drivers using cannabis by itself was determined and odds ratios have been calculated as described in the alcohol section and in Appendix two. The results are given in Table seven. The odds ratio calculated for cannabis only use is only slightly greater than one, implying that cannabis does not significantly impact on

the likelihood of having a crash. This is not consistent with Australian studies which report odds ratios of 2.7 to 6.6 [13].

Table seven - Determination of odds ratio for cannabis users

All vehicles		
	Unimpaired drivers	**Cannabis only**
Culpable	403	74
Not culpable	128	18
Unclear	15	4
Total	**546**	**96**
% culpable	74	77
% not culpable	23	19
odds ratio		**1.3**

Single vehicle			**Multiple vehicle**		
	Unimpaired drivers	**Cannabis only**		**Unimpaired drivers**	**Cannabis only**
Culpable	152	33	Culpable	251	41
Not culpable	7	1	Not culpable	121	17
Unclear	6	1	Unclear	9	3
Total	**165**	**35**	**Total**	**381**	**61**
% culpable	92	94	% culpable	66	67
% not culpable	4	3	% not culpable	32	28
odds ratio		**1.5**	**odds ratio**		**1.2**

The population size of 96 cannabis only users should be big enough to give some statistical weight to the results. Even when the odds ratio is calculated separately for single or multiple vehicle crashes, the value does not change much although with the smaller population size results are less significant.

Perhaps it is necessary to consider the odds ratios at different THC levels. There is an expectation that at higher THC levels, impairment should be greater and therefore the odds ratio should reflect this. The results of this analysis are given in Table eight. The odds ratios for the different THC levels have been calculated against the unimpaired drivers as given in Table seven. Again the lack of 'not culpable' drivers in the single vehicle crash category makes calculation of an odds ratio meaningless.

In this study the blood THC levels where cannabis use appears to have a greater impact on the likelihood of having a crash, are the lower levels, below 2 ng/mL. For blood THC levels below 2 ng/mL the odds ratio calculated is close to the value for alcohol use. This result contrasts with the Australian study [13] which showed greater odds ratios at the higher blood THC levels.

Table eight - Calculation of odds ratio at different THC levels

THC levels ng/mL					
All vehicles	**Number**	**Odds ratio**	**Culpable**	**Not culpable**	**Unclear culpability**
<=2	40	3.7	35	3	2
>2 to <=5	26	0.7	17	8	1
>5	30	1	22	7	1
Total	**96**				
Multiple vehicle	**Number**	**Odds ratio**	**Culpable**	**Not culpable**	**Unclear**
<=2	24	3.0	19	3	2
>2 to <=5	17	0.5	9	8	0
>5	20	1	13	6	1
Total	**61**				
Single vehicle	**Number**	**Odds ratio**	**Culpable**	**Not culpable**	**Unclear**
<=2	16	**	16	0	0
>2 to <=5	9	**	8	0	1
>5	10	0.4	9	1	0
Total	**35**				

**Odds ratio cannot be calculated because there are no 'not culpable' drivers

Cannabis is unlike most drugs that can impair. Other impairing drugs affect the central nervous system, and if a person is impaired by that drug, they can't compensate. Cannabis does not significantly affect the central nervous system. A person can be aware of their impairment and have some control over some of the effects that the drug has [15]. They can compensate, often observed by extremely cautious driving, for these perceived effects.

Some of the major implications of cannabis use and driving would be due to a changed perception of time and distance and taking longer to respond to events. The

user has less ability to pay attention and may respond to an emergency in an inappropriate way.

For this study the culpability of a driver involved in a crash was determined using the Responsibility Guidelines (Appendix two). This methodology was used so that the results obtained for this study could be compared with the Australian study [13].

As given in Table seven, 18 of the 96 cannabis only drivers were found to be 'not culpable', 17 were involved in a multiple vehicle crash. Looking at the circumstances around these crashes (Table nine), it could be proposed that had these drivers not used cannabis, they may have avoided the crash. This is a proposal only based on the potential impact of cannabis on the ability to react to an unexpected occurrence and to correctly judge time and distance. The crash circumstances described below are exactly the same as many crashes that have involved drivers who have not used drugs. But how many times does this circumstance occur on the road and a fatality or serious injury is avoided due to evasive action taken by the driver? Perhaps, if these drivers who had used cannabis had been more aware of what was going on around them, they may have anticipated the behaviour of the other drivers involved and been able to avoid the crash.

Table nine - Circumstances of the crashes of drivers who had used cannabis but were determined to be 'not culpable'

THC level (ng/mL)	Circumstance
6	Misjudged side of road when passing another car on a narrow road, went down bank (single vehicle)
1	Car crossed centre line into path of deceased
1.2	Struck from behind by a truck
5	Motorcyclist – car did not see motorbike, turned across path of deceased
1	Speeding car crossed centre line into path of deceased
5.4	Motorcyclist – car did not see motorbike, turned across path of deceased
3	Truck crossed centre line into path of deceased
2.2	Motorcyclist – car did not see motorbike, pulled out into path of deceased
2.2	Car crossed centre line into path of deceased
2.2	Car crossed centre line into path of deceased
17	Car cut corner crossed centre line into path of deceased
7	Motorcyclist – truck did not see motorbike, turned across into path of deceased
3.8	Motorcyclist – car did not see motorbike, turned across path of deceased
18	Motorcyclist – car did not see motorbike, turned across path of deceased
4.6	Motorcyclist – truck did not see motorbike, turned across into path of deceased
7	Car crossed centre line, clipped truck driven by deceased, forcing it into culvert
16	Car hit another then crossed centre line into path of van driven by deceased
5	Motorcyclist – car did not see motorbike, did U turn into path of deceased

An issue highlighted by the above table is the number of motorcyclists who use cannabis. Motorcyclists accounted for 17 % of deceased drivers (174 of 1,046 deceased drivers) in this study. However, amongst the 96 drivers who had used only cannabis, 23 (24%) were on motorbikes. Motorcyclists were not similarly over-represented in the deceased driving population who had used alcohol only (14 of 135, 10%).

This study has not clarified the impact of cannabis use on driving ability using Responsibility Analysis Guidelines and odds ratios calculations. However, results

found in other studies indicate that given the effects that cannabis has on a person, it is not advisable to drive after using the drug.

The types of crashes in which drivers have used alcohol or cannabis are different. In this study the drivers who have drunk alcohol alone, or have combined their alcohol ingestion with smoking cannabis, are more likely to have a single vehicle crash than the driver who has used cannabis alone. The driver who has used cannabis alone is more likely to be in a multiple vehicle crash.

Combined use of cannabis and alcohol

It is understood that cannabis users can compensate for some of the effects that the drug may have on them [12, 15]. However, when cannabis use is added to alcohol ingestion, the ability to compensate is lost, and the combined effects are similar to those expected for greater alcohol consumption [12, 15].

In this study the combined use of cannabis and alcohol was the most common combination of drugs found in the deceased drivers. 142 of the 1,046 deceased drivers (13.6%) had used alcohol and cannabis together, but with no other drug. This combination was more common than the use of these two drugs by themselves, cannabis use alone 96 (9.1%) and alcohol use alone 135 (12.6%).

Of the 586 drivers who died as a result of a multiple vehicle crash, 44 (7.5%) had used both cannabis and alcohol. This is more than the number of drivers who had used alcohol by itself (30) but less than the number of drivers using cannabis by itself (61). 98 drivers who had used both drugs, died in a single vehicle crash. That is, 21% of the drivers in the 460 single vehicle crashes had used both drugs. This is very similar to the percentage of the alcohol only drivers (105 of 460, 23%) and greater than the percentage of drivers who had used cannabis by itself (35 of 460, 7.6%).

Like those who drink and drive, a person who uses cannabis and alcohol is more likely to be involved in a single vehicle crash while cannabis only users are more likely to be involved in multiple vehicle crashes. This implies that alcohol has a greater influence on driver behaviour than cannabis.

Table 10 shows the distribution of blood alcohol levels and blood THC levels in the drivers who had used both drugs. The levels of alcohol were not low, with 81% of the deceased drivers over the legal limit for an adult, as well as using cannabis. Nor are the levels of THC low with a third of the drivers with blood THC levels greater than 5 ng/mL, indicating very recent use.

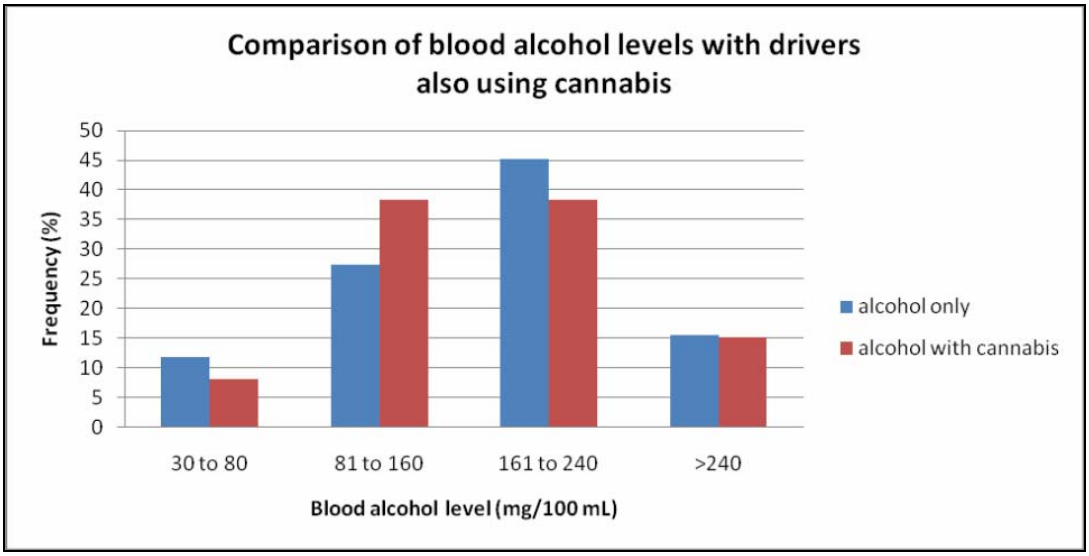
Table 10 - Levels of THC and alcohol found in drivers using these drugs together

		THC levels (ng/mL)		
Number of drivers	**Alcohol (mg/100mL)**	**<=2**	**>2 to <=5**	**>5**
17	<=30	8	5	4
10	30 to 80	4	1	5
48	81 to 160	21	9	18
48	161 to 240	16	15	17
19	>240	9	7	3
142		**58**	**37**	**47**

Graph four compares the alcohol levels found in the percentage of deceased drivers who used only alcohol with those who also used alcohol and cannabis together. For this graph the lower blood alcohol levels, less than 30 mg/100 mL, have been excluded, as these levels were not considered when alcohol was used by itself.

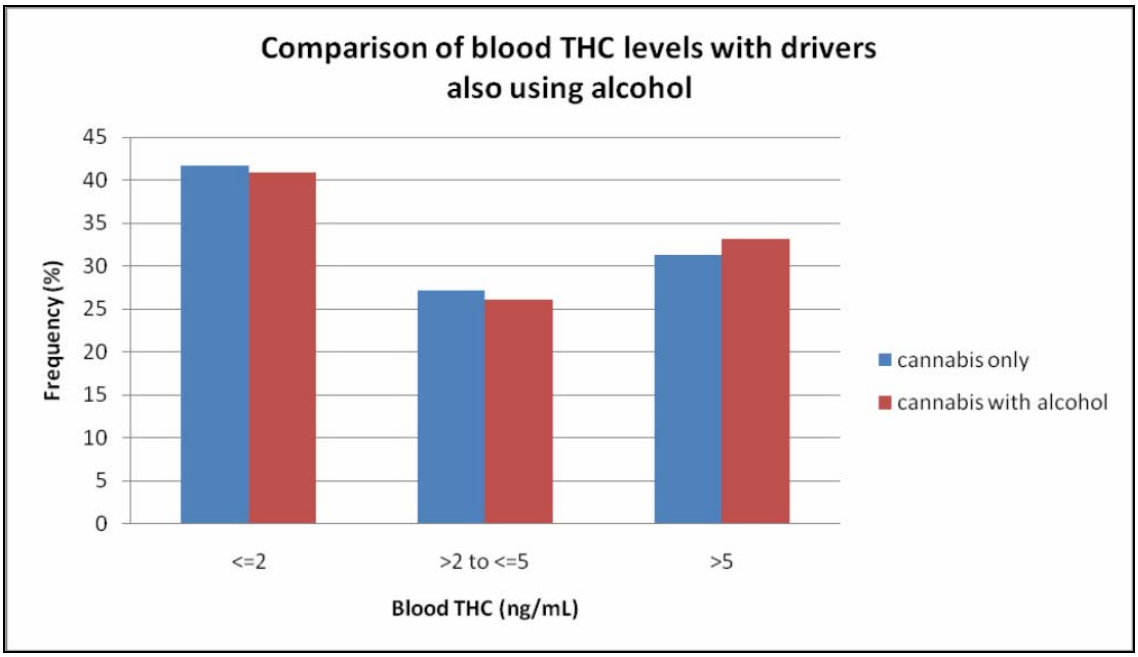
The distribution of blood alcohol levels is not greatly dissimilar for the 135 deceased drivers who used alcohol alone compared with the 125 deceased drivers who had used both alcohol (at a level greater than 30 mg/100 mL) and cannabis. There is a higher proportion of deceased drivers using both drugs, than using alcohol alone, in the 81 to 160 mg/100 mL alcohol range. This may be a result of the use of cannabis accentuating the effect of alcohol.

Graph four



Graph five compares the THC levels found in the percentage of deceased drivers who used only cannabis with those who also used alcohol as well as cannabis. Where high blood alcohol levels reflect the amount of alcohol that has been consumed, the level of THC does not reflect the amount of cannabis that has been smoked. THC blood levels reflect how recently the drug has been used. The distribution is very similar. This indicates that people who crash after using cannabis, do so just as soon after smoking the drug, whether they have drunk alcohol or not.

Graph five



Of the 142 deceased drivers who had used both alcohol and cannabis, 130 were determined to be at fault, using the Responsibility Analysis Guidelines. The distribution of alcohol and THC levels found in these culpable drivers is given in Table 11.

Table 11 - Levels of alcohol and THC in blood of drivers at fault for the crashes

Culpable drivers		THC levels (ng/mL)		
Number of drivers	**Alcohol (mg/100mL)**	**<=2**	**>2 to <=5**	**>5**
15	<=30	6	5	4
9	30 to 80	4	0	5
44	81 to 160	20	8	16
44	161 to 240	15	14	15
18	>240	8	7	3
130		**53**	**34**	**43**

A comparison of this distribution can be made with the levels of alcohol and THC found in the six drivers whose culpability was unclear and the six who were found not to be at fault (Table 12).

Table 12 - Levels of alcohol and THC in drivers who were not found to be at fault

Unclear culpability		Not culpable	
Alcohol (mg/100mL)	**THC (ng/mL)**	**Alcohol (mg/100mL)**	**THC (ng/mL)**
80	2.3	11	0.7
150	9	160	1.6
146	15	226	3
187	5	5	1.5
169	12	211	0.8
300	0.1	113	3

The blood levels of alcohol and THC are high in the drivers whose culpability was unclear. These six crashes were all single vehicle crashes and the deceased was not found immediately. Therefore not enough was known about the circumstances at the time of the crash to determine culpability.

Calculation of the culpability ratio and odds ratio to determine the impact of a drug on the likelihood of crashing generally is used only when a single drug is present. With so many deceased drivers using cannabis and alcohol together, it was worthwhile looking at the odds ratio for the combined drug use. If cannabis accentuated the effects of alcohol, a higher odds ratio would be expected for the combined drug use.

It is also useful to look at the odds ratio calculated for single and multiple vehicle crashes separately, because in this study a very high proportion of the deceased drivers involved in single vehicle crashes were found to be at fault. The results for these calculations are given in Table 13.

The culpability ratio (culpable/not culpable) determined for drivers using alcohol and cannabis is divided by the same ratio calculated for unimpaired drivers. For the drivers who had used cannabis alone the odds ratio calculated was only just above one. For drivers who had used alcohol alone the odds ratio was 14.

Table 13 - Calculation of odds ratio for combined use of cannabis and alcohol

All vehicles		
	Unimpaired drivers	**THC and alcohol**
Culpable	403	130
Not culpable	128	6
Unclear	15	6
Total	**546**	**142**
% culpable	74	92
% not culpable	23	4
odds ratio		**7**

Single vehicle			**Multiple vehicle**		
	Unimpaired drivers	**THC and alcohol**		**Unimpaired drivers**	**THC and alcohol**
Culpable	152	91	Culpable	251	39
Not culpable	7	1	Not culpable	121	5
Unclear	6	6	Unclear	9	0
Total	**165**	**98**	**Total**	**381**	**44**
% culpable	92	93	% culpable	66	89
% not culpable	4	1	% not culpable	32	11
odds ratio		**4.2**	**odds ratio**		**3.7**

Where deceased drivers have used both cannabis and alcohol, six were determined to be not culpable. If the deceased driver has used cannabis and alcohol and both types of crashes are considered, the culpability ratio with 130 culpable drivers is 22. When all crash types are considered, there are 403 unimpaired drivers at fault and 128 not at fault. This gives a culpability ratio of three for unimpaired drivers and therefore the

odds ratio is seven. This is lower than the odds ratio calculated for deceased drivers who had used only alcohol. This does not support the claim that cannabis potentiates the effects of alcohol.

Single vehicle and multiple vehicle crashes can be considered separately. For the multiple vehicle crashes there were five drivers not at fault and 39 at fault, giving an odds ratio of 3.7. This is very close to the odds ratio (4) calculated for deceased drivers in multiple vehicle crashes who had used alcohol alone. Again this does not support the claim that cannabis use accentuates the effects of alcohol.

There was only one driver who had used cannabis and alcohol, and was in a single vehicle crash that was not his fault. The culpability ratio for this drug combination and a single vehicle crash is 91 and the culpability ratio for the unimpaired drivers in a single vehicle crash is 21.7. The odds ratio is therefore 4.2. Comparison with alcohol only drivers is not possible. The odds ratio could not be calculated for deceased drivers in single vehicle crashes who had used alcohol alone because there were no 'not culpable' deceased drivers.

It is possible to further analyse this data, to determine odds ratios at the different blood alcohol levels (Table 14) but again there are a number of alcohol levels at which there are no 'not culpable' drivers. This means that odds ratios cannot be calculated and an attempt at clarifying the impact of combined use of cannabis and alcohol as compared with alcohol use by itself, cannot be made.

Table 14 - Calculation of odds ratio at different alcohol levels when cannabis has been used

Alcohol mg/100mL					
All vehicles	**Number**	**Odds ratio**	**Culpable**	**Not culpable**	**Unclear culpability**
<=30	17	2.4	15	2	0
30 to 80	10	**	9	0	1
81 to 160	48	7.1	44	2	2
161 to 240	48	7.1	44	2	2
>240	19	**	18	0	1
Total	**142**				
	Number	**Odds ratio**	**Culpable**	**Not culpable**	**Unclear culpability**
Multiple vehicle					
<=30	11	2.1	9	2	0
30 to 80	4	**	4	0	0
81 to 160	12	5.2	11	1	0
161 to 240	12	**	10	2	0
>240	5	2.4	5	0	0
Total	**44**				
	Number	**Odds ratio**	**Culpable**	**Not culpable**	**Unclear culpability**
Single vehicle					
<=30	6	**	6	0	0
30 to 80	6	**	5	0	1
81 to 160	36	1.5	33	1	2
161 to 240	36	**	34	0	2
>240	14	**	13	0	1
Total	**98**				

**odds ratio cannot be calculated because there are no ‘not culpable’ drivers

Use of other impairing drugs

Over the period of five years 500 deceased drivers were found with a potentially impairing substance in their blood. Alcohol and cannabis use, either individually or combined, with no other drug use detected, accounted for 75% (373) of these drivers. There were 127 deceased drivers who had used some other drug that can impair. That is not to say they hadn't used alcohol or cannabis, but they have used some other drug. Of these 127 drivers using another drug, only 29 (6%) had not used cannabis or alcohol. 94% of the drivers (471 of 500) who had used drugs, had used either or both of cannabis and alcohol, with or without another drug.

To consider the impact of a drug on crashes using the odds ratio methodology, it is necessary to consider the drug by itself, with no influence from another drug. Apart from alcohol and cannabis, there is no other drug used by NZ drivers that could be studied in this way.

The drugs used by the 29 drivers who had not used cannabis or alcohol are listed in Table 15. Six of these drivers were determined to be 'not culpable' for their crash.

Table 15 - Potentially impairing drugs used by drivers who had not used alcohol or cannabis

	Drugs detected		
1	Methamphetamine	16	Dextropropoxyphene
2	Zopiclone	17	Morphine
3	Methamphetamine	18	Zopiclone
4	Toluene (solvent)	19	Kava
5	Methamphetamine	20	Methadone triazolam
6	Tramadol amitriptyline	21	Methadone zopiclone
7	Diazepam pseudoephedrine	22	Bromazepam
8	Clonazepam carbamazepine	23	Methamphetamine
9	Methamphetamine valproic acid phenytoin	24	Methamphetamine
10	Solvents (sniffing glue)	25	Morphine
11	Methadone tramadol diazepam zopiclone	26	Codeine
12	Tramadol	27	Zopiclone fluoxetine
13	Dextropropoxyphene	28	Diazepam
14	Zopiclone	29	Zopiclone
15	Morphine citalopram		

Most of the drugs listed in Table 15 are prescribed medication. The purpose of these drugs is discussed in later sections. Not all of the drugs listed in Table 15 will impair, but in each case the deceased driver has used at least one drug that has the potential to impair.

The presence of a drug in the blood does not mean the person is impaired. When drugs are being taken by the person for whom they are prescribed, in an appropriate way, it is likely they will not significantly impair a driver. For a lot of medication that can cause impairment, tolerance to most effects that may affect driving may be established with regular use [13].

There are a number of issues that can cause concern when dealing with impairment and the detection of prescription medication:

- Why has the medication been prescribed? Medication to help a person sleep should not be taken during the day;

- Was the medication being taken by the right person? Do they have a valid, current prescription?;
- Was the correct dose being used? An individual's response to a medicinal dose is dependent on the individual;
- Was the prescribed medication being taken with alcohol, or other drugs that might change the effect of the drug or tolerance to the drug?, and;
- Was a person who should be taking a medication actually taking it? The absence of a medicinal drug may cause impairment.

It is not possible to determine from the level of a drug in a person's blood if the person is impaired or if they had taken medication as prescribed.

A person who has been on long term drug therapy may experience withdrawal symptoms severe enough to have a significant impact on driving ability, if that person stops taking the drug [12].

Of the drugs listed in Table 15, methamphetamine, kava and the solvents are not prescribed medications. Fluoxetine is unlikely to cause impairment and the anticonvulsants carbamazepine, valproic acid and phenytoin should not impair a driver who is prescribed these drugs and takes these drugs regularly. Although all of the other drugs listed are prescribed medication, there is no way of knowing if the deceased driver was prescribed that medication.

Opioids

Opioids are a wide ranging class of drugs that are generally prescribed to treat pain. Most affect the central nervous system and may impair driving skills. Most of the opioid drugs have sedative side effects to some degree.

Some opioids are opiate based, that is, they are based on drugs obtained from the opium poppy. Codeine and morphine are commonly prescribed opiate type drugs. Heroin is closely related to morphine but it is not prescribed. Other opioid drugs are synthetic. They are not derived from, or related to, naturally occurring plant compounds. Methadone and tramadol are well known synthetic opioids.

When opioid type drugs are taken regularly, the user becomes tolerant to their sedative effects. Once tolerant, the user's driving ability should not be significantly affected. However, tolerance is easily lost or compromised. If the drug user does not follow their prescription, doesn't take the drug at regular intervals, or mixes the medication with other drugs, impairment may occur [17, 18].

There were 29 deceased drivers with opioids in their blood. That is 6% of the drug using deceased drivers had used opioids (29 of 500 drivers) or 3% of the deceased drivers in this study (29 of 1046).Three of these drivers had used some alcohol, but only one was over the legal adult blood alcohol limit. 15 of these drivers had also used cannabis.

Table 16 lists the opioid type drugs detected in the deceased drivers. Although there were 29 deceased drivers with opioids in their blood, there were 34 instances of opioid use. This means some drivers were using more than one opioid. It is not known if the drugs were prescribed to the deceased, or if the deceased was tolerant to the effects of the drug. 23 of the drivers using opioids were determined to be at fault for their crash.

Table 16 - Opioids found in deceased drivers

Opioids	29
Opioids alone	6
Dextropropoxyphene	3
Codeine	2
Methadone	16
Morphine	8
Oxycodone	1
Tramadol	4

All of the opioid drugs listed are prescribed medication. Morphine is a strong pain killer, sometimes administered to injured people in emergency situations. In the eight cases in which the presence of morphine was confirmed, there was nothing on the documentation accompanying the blood sample to suggest the deceased had been treated at the scene or in hospital. However, this cannot be totally discounted and is a possible source of morphine for some of these drivers. Another possible source for the morphine detected is heroin use. Heroin breaks down in the body to form morphine within minutes of injection. Tramadol and codeine are mild opioids and should not significantly affect driving if they are taken as prescribed [16, 19].

Oxycodone is a strong pain killer and the analyses carried out in this study will not usually detect the low levels associated with therapeutic use. The detection of this drug in a deceased driver indicates the driver may have been taking too much of the medication. Methadone is prescribed to opiate addicts, to help them with their addiction. A person on a methadone maintenance program should become tolerant to the sedative effects, the effects that may affect the ability to drive safely, after a few weeks. Once tolerant, such a person should remain tolerant and be able to drive safely if they follow their prescription, take the prescribed dose, no more, no less, and don't take other drugs. None of the 16 deceased drivers who had used methadone, had used methadone alone. All 16 had used other impairing drugs as well as the methadone, usually with sedatives or cannabis.

Only six of the 29 drivers who had used opioids, had taken just one opioid drug by itself (see Table 15).

Sedatives

Sedatives are a group of drugs generally prescribed to help induce sleep (hypno-sedatives), reduce anxiety (anti-anxiety agents) and reduce muscle spasms (anti-convulsants). All have an effect on the central nervous system and will affect the ability to drive [19]. When these drugs are prescribed, they usually come with the warning not to operate heavy vehicles or attempt to drive until the user is aware of the effects. It is strongly recommended that alcohol should be avoided when using these drugs.

Benzodiazepines are a large group of drugs that have sedative effects. Diazepam, clonazepam, triazolam, temazepam and bromazepam are all benzodiazepines. Not all sedatives are benzodiazepines.

Some of the sedative drugs are short-acting and leave the body quickly. Some can be detected in the blood for a long time, well after any sedative effects are gone. The presence of the drug in the blood does not necessarily mean the person is impaired and some of the sleep-inducing drugs can have an impact on driving ability even after a good night's sleep [20].

There were 39 deceased drivers with sedatives in their blood. That is 8% of the drug using deceased drivers had used sedatives (39 of 500 drivers) or 4% of the deceased drivers in this study (39 of 1046).

Table 17 lists the sedative type drugs detected in the deceased drivers. Although there were 39 deceased drivers with sedatives in their blood, there were 42 instances of sedative use. This means some drivers were using more than one sedative. It is not known if the drugs detected were prescribed to the deceased, or if the deceased was tolerant to the effects of the drug. 33 of the drivers using sedatives were determined to be at fault for their crash.

It is not possible to determine what impact sedative use has on crash culpability because only six of the 39 drivers who had used sedatives, had taken just one sedative drug by itself (see Table 15). Multi–drug use was common with the drivers who had

used sedatives. 12 had also used alcohol, 21 had used cannabis, six had used methamphetamine and 10 had used an opioid type drug.

Table 17 - Sedatives found in deceased drivers

Sedatives	39
Sedatives alone	6
Bromazepam	1
Clonazepam	8
Diazepam	19
Temazepam	1
Triazolam	2
Zopiclone	10
GHB	1

Bromazepam, temazepam and triazolam are all benzodiazepines that are prescribed to induce sleep. Zopiclone is a commonly prescribed hypno-sedative in NZ, but is not common overseas. Diazepam is primarily prescribed as an anti-anxiety medication but is also used to control muscle spasms. Clonazepam is usually prescribed as an anti-convulsant. Both of these drugs are benzodiazepines.

GHB, also known as gamma-hydroxybutyrate or Liquid Fantasy, is an illegal night club drug. In low doses the effects of GHB are similar to alcohol, but at high doses a user can become comatose very quickly [21]. GHB is not a drug that would be detected by the analyses carried out for this study. The test for this drug was specifically requested by the pathologist for the driver involved.

Stimulants

Stimulants are a group of drugs that have the ability to keep people awake, to overcome feelings of fatigue. At low levels and under controlled conditions, these drugs have been found to improve driving ability, because the driver is more alert and has faster reactions [22].

Although some of these drugs have a legitimate medicinal purpose, generally they are misused or abused [12]. Those with medicinal uses are milder stimulants than the well known methamphetamine ("P"). Stimulants may improve alertness, but can also result in increased risk taking and aggression [22]. When a person has used a stimulant to stay awake for several days, the onset of sleep may occur rapidly and with little warning [22].

There were 54 deceased drivers with stimulants in their blood. That is 11% of the drug using deceased drivers had used stimulants (54 of 500 drivers) or 5% of the deceased drivers in this study (54 of 1046).

Table 18 lists the stimulant type drugs detected in the deceased drivers. There were 54 deceased drivers with stimulants in their blood and there were 54 instances of stimulant use. This indicates that when a driver was using a stimulant they only used one stimulant type drug.

However, drivers taking stimulant type drugs very rarely just had the single drug in their blood. Most of the drivers who had taken a stimulant type drug had also used other potentially impairing drugs that did not have a stimulant effect. 16 of the deceased drivers had also used alcohol, 41 had used cannabis, two had used an opioid and four had used sedative type drugs.

There were only six drivers who had taken a single stimulant-type drug, one had pseudoephedrine alone, the other five had used methamphetamine. It is not possible to consider the impact of stimulant use on crash culpability based on six drivers. 49 of the 54 drivers using stimulants were determined to be at fault for their crash.

Table 18 - Stimulant drugs found in deceased drivers

Stimulants	54
Stimulant only	6
Amphetamine	1
BZP	3
MDMA	3
Methamphetamine	44
Pseudoephedrine	2
Methylphenidate	1

Pseudoephedrine is a component of common cold and flu medication available over the counter. It has mild stimulant effects and doesn't tend to be abused much. The analyses carried out for this study do not usually detect therapeutic use of this drug. Its presence in the blood indicates either very recent ingestion or overuse of the drug. Methylphenidate is usually prescribed for treatment of ADD or ADHD. It has sufficiently strong stimulant effects that it is abused. Again the analyses carried out would not normally detect therapeutic use of this drug, so its detection indicates that it might have been taken in excess.

BZP(benzylpiperazine) is a component of the party pills that were banned in 2008. Stimulant effects are reported to be mild and unlikely to affect driving if taken at recommended doses [23].

Amphetamine is a milder stimulant than methamphetamine but it is widely abused and commonly encountered in drivers in Europe [24]. The source materials for the clandestine manufacture of amphetamine are not as easy to obtain as those for methamphetamine and therefore access to this drug is difficult in NZ.

MDMA (Ecstasy) is a night club drug, as well as being a mild stimulant it also increases feeling of sociability. Its impact on driving skills is not well known as it is rarely taken by itself [12].

The most common stimulant found in the deceased drivers was methamphetamine. Of the 500 deceased drug using drivers, 44 (9%) had used methamphetamine. Only five of the drivers who had used methamphetamine, had used methamphetamine by

itself. The other drivers had combined its use with one or more of cannabis, alcohol, sedatives or other medicinal drugs. 20 of the drivers using methamphetamine were involved in a single vehicle crash and 24 in a multiple vehicle crash. Three of the drivers using methamphetamine were determined to be 'not at fault' for their crash.

Other drugs

Most of the potentially impairing drugs detected in the deceased drivers have been covered under the headings of opioids, sedatives, stimulants, cannabis and alcohol. Table 15 listed the potentially impairing drugs taken by 29 drivers who had not used cannabis or alcohol. Few other drugs were detected. Four instances of drug types not covered were:

- Two cases of a driver sniffing glue while driving (solvents detected);
- Kava – a traditional Fijian drink with sedating and euphoric effects, and;
- LSD – a hallucinogen not detected by normal analyses. Analysis for the drug was specifically requested by pathologist, other drugs also detected in this blood sample.

The analyses carried out on the blood samples will not detect all drugs. There are thousands of drugs prescribed. A lot of drugs will not affect the ability to drive. What may affect driving ability is the health problem that medication is being taken for. Driving could also be affected by someone not taking their prescribed medication.

There were 546 drivers who have been deemed to be not impaired by drugs. For most of these drivers no drugs or alcohol were detected in the blood. Some blood samples contained only the types of drugs that are given by hospital personnel in emergency situations, and if the documentation supported attempted medical intervention, these drivers have been deemed unimpaired.

There were 42 drivers who were deemed unimpaired but they had either low levels of alcohol or some prescription medication in their blood. If alcohol was present, by itself, at a level below 30 mg/100 mL (the youth blood alcohol limit) it was deemed unlikely to impair. Some medication, if taken as prescribed, should not affect driving skills. The blood of these 42 drivers contained a low alcohol level (27), paroxetine (3), fluoxetine (4), venlafaxine (1), orphenadrine (1), diltiazem (1), metoclopramide (1), carbamazepine (1), quinine (1), pseudoephedrine (1) or citalopram (1). Although accurate levels of these prescription medications were not determined, the approximate levels indicated use was consistent with therapeutic doses.

Table 19 lists the number of instances and the prescription medication found in deceased drivers' blood. This is prescription medication that has not already been discussed under the headings of opioids, sedative or stimulants. Most of these medications should not impair driving, particularly if taken as prescribed.

The table lists more than the 15 instances of prescription drug use mentioned in the paragraph above, concerning the 42 unimpaired drivers. The additional cases where prescription medication was detected, was where it was taken in combination with some other impairing drug, most likely alcohol and/or cannabis. In this case the impairing drug use has been accounted for in the earlier sections.

Table 19 - Prescription medication detected in deceased driver's blood (other than those covered in the previous sections)

Prescribed medication		Total
Anti-convulsants	Carbamazepine	4
	Phenytoin	1
	Valproate	3
Anti-depressants	Amitriptyline	4
	Citalopram	9
	Fluoxetine	11
	Paroxetine	4
	Venlafaxine	4
Heart medication	Diltiazem	3
	Metoprolol	1
Muscle relaxant	Orphenadrine	1
Anti-malarial	Quinine	1

Findings: Drug use in drunk drivers

The following section looks at drug use by drivers stopped for drink driving offences and who have not been injured in a crash. The range of drugs screened for was limited to cannabis, morphine, methamphetamine, MDMA and benzodiazepines.

This data has been reported in a Masters Thesis written by Carolina Vergara [7] and in a CDRP report issued in 2006/7 [8]. These previous reports also considered the possible drug use by these drivers in relation to age, gender, criminal convictions, traffic convictions and alcohol consumption. That discussion will not be repeated in this report.

It must be noted that in these two reports [7, 8] the blood alcohol levels discussed were those given in the Certificate of Analysis issued for the driver. These Certificates report a level of alcohol that is six less than the actual analytical result, to ensure statistically that the alcohol level reported does not overstate an alcohol level present in the blood. The following discussion considers 1999 of the same blood samples, but a value of six has not been taken from the alcohol result.

It is important to remember throughout this section that, although drug use by drivers is reported, **none of this drug use was confirmed to a standard that is required for a court prosecution**. All the drug use discussed in this section must be interpreted as 'indications of possible use of the drug'. It is also important to remember that the presence of a drug in the blood use does not mean a person is impaired.

ESR laboratories receive and analyse blood samples, taken for evidential purposes under the Land Transport Act, for the presence of alcohol. Analysis of these blood samples for evidence of drug use, will give information on another section, again biased, of the driving population.

The evidential blood samples are generally taken as a result of a failed breath alcohol test and the driver has elected to have the breath test confirmed by a blood alcohol analysis. The driver may have been picked up at a check point or stopped due to some driving behaviour. The driver may have been involved in a crash but has not been

injured to the extent of needing hospitalisation. The evidential blood samples from these groups of drivers are accompanied by a POL535 Blood Specimen Form.

Drivers who are injured in a crash and are hospitalised, may have a blood sample taken for evidential purposes. These blood samples are accompanied by the POL530 Hospital Blood Specimen Medical Certificate. Drivers who had been hospitalised were not used for this study because morphine and some benzodiazepines are sometimes administered by medical personnel in emergency situations.The analytical technique used is discussed in Appendix one.

Results

Over the period of one year, a random selection of blood samples taken from uninjured drivers and already analysed to determine alcohol levels, were analysed for evidence of the use of drugs. The results of these analyses are given in Table 20. The drugs tested for (cannabis, morphine, methamphetamine, MDMA and benzodiazepines) all have the potential to impair driving skills. Multiple drug use means that the blood contained evidence of the use of alcohol and at least two of the other drug types tested for.

The blood from 1,258 drivers (63%) contained alcohol only. Therefore 37% of the drivers, from the randomly selected group of uninjured drivers, had elected to drive while drunk and after consuming another potentially impairing drug.

Table 20 - Drug use in uninjured drivers

Drug use detected	Number	Percent
Alcohol alone	1,258	63
Alcohol + cannabis	661	33
Alcohol + methamphetamine	8	0.4
Alcohol + morphine	1	0.1
Alcohol + benzodiazepine	35	1.8
Multiple drug use	36	1.8
Total	**1,999**	

Cannabis is the drug most commonly used by the drunk drivers that had been randomly selected for this study. 661 drivers had used cannabis as well as alcohol. Furthermore of the 36 drivers who had used multiple drugs, only two had not used

cannabis. Cannabis is reported to accentuate the effects of alcohol [12, 15]. Therefore, of the 741 drunk drivers who had also used another drug, 94% (695) had used cannabis.

Excluding cannabis, drug use by drunk drivers appears to be minimal. There were 741 drunk drivers who had used another impairing drug. Only 46 of these drivers had not used cannabis. That is 6% of the 741 drug using drunk drivers, or 2% of the 1,999 drunk drivers tested, had used a drug other than cannabis: eight used methamphetamine, one used morphine, 35 had used benzodiazepines and two had used a combination of drugs that did not include cannabis.

There is a higher incidence of benzodiazepine use in this driving population than methamphetamine use. The deceased driver population had a greater number of drivers who had used methamphetamine (44) than benzodiazepines (28).

There were 19 drivers who had used both cannabis and benzodiazepines with the alcohol as well as the 35 drivers who had used the benzodiazepines with just alcohol. More drivers had combined methamphetamine with cannabis and alcohol (12) than drivers who used methamphetamine drug with just alcohol (8). Multiple drug use was detected in 36 drivers as set out in Table 21.

Table 21 - Drugs found in the drivers who had used more than one drug

Multiple drug use	Number
Alcohol + cannabis + methamphetamine	12
Cannabis + methamphetamine + morphine	1
Alcohol + cannabis + benzodiazepine	19
Alcohol + methamphetamine + benzodiazepine	1
Alcohol + cannabis + morphine + benzodiazepine	1
Cannabis + benzodiazepine	2
Total	**36**

No alcohol was detected in the blood of three of these drivers. This may have been due to a delay between stopping the driver and taking the blood sample, resulting in loss of alcohol, or the officer observed sufficient impairment to distrust the breath alcohol reading.

Table 22 shows the distribution of blood alcohol levels for these 1,999 drunk drivers. The table also separates the drivers who had drunk only alcohol from those who had also used other drugs. This is to determine if there is a difference in the blood alcohol levels at which these drivers feel confident to drive.

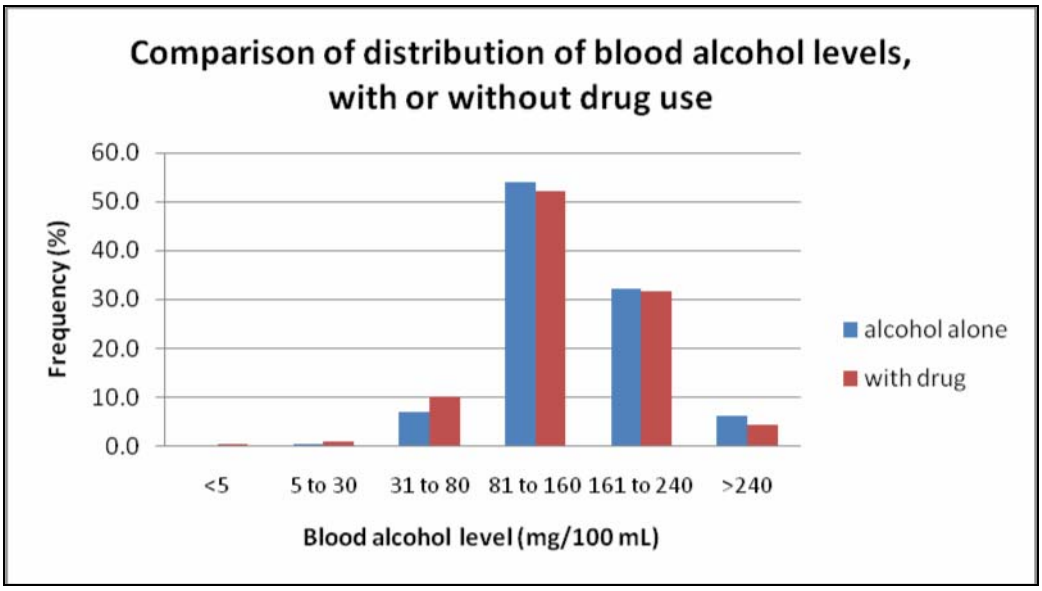
Over half of the drivers who had an evidential blood sample taken, had alcohol levels between 80 mg/100 mL (the adult limit) and 160 mg/100 mL. 85% of the drivers (1704 of 1999) had alcohol levels between 80 and 240 mg/100 mL. When the drivers had combined alcohol with other drugs, 84% had blood alcohol levels in the range of 80 to 240 mg/100 mL.

Table 22 - Alcohol levels in uninjured drivers

Alcohol levels (mg/100mL)	Total		Alcohol alone		Alcohol with a drug	
	Number	Frequency (%)	Number	Frequency (%)	Number	Frequency (%)
<5	7		3		4	
5 to 30	12		5		7	
31 to 80	165	8	89	7	76	10
81 to 160	1065	53	678	54	387	52
161 to 240	639	32	405	32	234	32
>240	111	6	78	6	33	4
Total	**1,999**		**1,258**		**741**	

Drug use in addition to alcohol does not appear to impact on the blood alcohol levels detected in drunk drivers. As can be seen in Graph six there is a slightly higher proportion of drug users at the lower alcohol range and a slightly higher proportion of alcohol only drivers at the high end of the alcohol range. However, for the majority of drivers, there is no evidence that would support a claim that those using other drugs as well as alcohol, feel more impaired.

Graph six



The blood samples selected for this study were taken from drivers who were uninjured, as determined by the sample being accompanied by a POL535 form as opposed to the POL530 Hospital Blood Form. It would be expected that these drivers had failed the breath test prior to their sample being taken. This process should eliminate all drivers with blood alcohol levels below the legal limit for the appropriate age group. Therefore there should not be any drivers with blood alcohol levels below 30 mg/100 mL which is the limit for a youth (someone under 20 years old).

Of the 1,999 blood samples taken from the uninjured drivers, 184 had alcohol levels below the legal limit for adults (Table 23) and 19 had alcohol at or below 30 mg/100 mL. The ages of these drivers is not known as such information is not included on the Police forms accompanying the samples. These samples may have been sent with the incorrect form and were actually from hospitalised drivers. Alternatively the driver may have appeared significantly impaired to the officer who therefore asked for a blood sample. Also, if there was a delay between breath test and blood sampling, it is possible that the blood alcohol level could have dropped to a level below the appropriate limit.

Table 23 - Low blood alcohol levels in uninjured drivers

Blood alcohol (mg/100 mL)	All drivers	Alcohol alone	With drug use
<5	7	3	4
5 to 30	12	5	7
31 to 80	165	89	76

There were seven drivers with alcohol levels below 5 mg/100 mL, essentially a zero blood alcohol level. Three of these also had no drugs detected. The other four drivers had used drugs: one methamphetamine, one cannabis and the other two drivers had used a combination of drugs (Table 24).

Table 24 - Drug use detected in drivers with low blood alcohol levels

Blood alcohol (mg/100 mL)	No drug detected	Cannabis	Methamphetamine	Morphine	Benzos	Multiple drugs
<5	3	1	1	0	0	2
5 to 30	5	7	0	0	0	0
31 to 80	89	74	0	0	2	0

A further 12 drivers had blood levels below 30 mg/100 mL. These could be youth drivers whose blood level dropped after the breath test. Only five of these drivers showed no evidence of drug use. Cannabis use was indicated in the other seven drivers.

Eight drivers had low blood alcohol levels and no indication of drug use. If these blood samples had been taken because the officer thought the driver appeared impaired, a drug that was not covered by the drug screens in this study, may have been present, or some health problem may have been observed.

There were 165 drivers with blood alcohol levels between 30 and 80 mg/100 mL. Even so, 76 of these drivers had indications of additional drug use with the alcohol. Cannabis use was detected in 74 of these drivers and benzodiazepine use was detected in the other two drivers. It is possible that these drivers appeared more impaired than indicated by their breath test results so a blood sample was taken.

Concern is often raised about drug and alcohol use in drivers under 20 years old. Table 25 shows that for this age group, with the lower blood alcohol limit of 30 mg/100 mL, 44% had used drugs as well as being over the allowed blood alcohol level. However, Table 25 shows that concern should also be raised for older drivers (20 years and over) who, with the higher blood alcohol limit, also show a high proportion of drug use while legally over the limit. This data was obtained from the Thesis produced by Carolina Vergara [7].

Table 25 -Drug use in drivers over the blood alcohol limit for their age who also use drugs

Age	Number	Above blood alcohol limit and drug use (%)
15 to 19	241	107 (44)
20 to 24	351	135 (38)
25 to 34	466	196 (42)
35 to 44	449	161 (36)
45 to 64	435	79 (18)
65+	41	6 (15)

Drug use summary

Blood samples taken from 1,999 drivers, who had an evidential blood sample taken but had not been injured in a crash, were analysed to determine the level of alcohol and were screened for evidence of the use of other drugs. The range of drugs was limited to cannabis, morphine, methamphetamine, MDMA and benzodiazepines. Of these samples:

- 63% (1,258 of 1,999) used alcohol alone;
- 35% (695 of 1,999) used alcohol and cannabis together, and;
- 2% (46 of 1,999) had used alcohol and some other drug.

A more comprehensive analysis of data concerning these blood samples is found in a separate document “Drug use in New Zealand drinking drivers” [8].

Comparison of drug use in uninjured and deceased drivers

It was found in the deceased driving population that 500 (48%) of the drivers had alcohol and/or other drugs in their blood that may have impaired their ability to drive safely. The uninjured drivers were almost all over the legal blood alcohol limit and they were screened for use of only a limited selection of drugs, cannabis, morphine, methamphetamine, MDMA and benzodiazepines.

To make a valid comparison between the two populations, the analyses carried out on the both of the driver populations must be reassessed in the following way:

- Only deceased drivers who have used alcohol are considered, that is the 351 drivers with blood alcohol greater than 5 mg/100 mL;
- The drug use considered for the deceased drivers is restricted to those drugs that would be detected by the immunoassay tests carried out for the uninjured drivers, and;
- The uninjured drivers with zero blood alcohol levels (7) must be excluded. This leaves 1,992 uninjured drivers.

Table 26 - Comparison of drug use in deceased and uninjured drivers

Drug use	Deceased drivers		Uninjured drivers	
	(n=351)	%	(n=1,992)	%
Alcohol + cannabis	166	47	693	35
Alcohol + methamphetamine or MDMA	15	4.3	21	1.1
Alcohol + benzodiazepine	9	2.6	56	2.8
Alcohol + morphine	1	0.3	2	0.1
Multiple drug use	14	4.0	33	1.7

There were 1,992 uninjured drivers with blood alcohol levels greater than 5 mg/100 mL. Of these, 693 drivers (35%) showed evidence of cannabis use. A higher proportion of deceased drivers had used cannabis with alcohol, that is 47%, or 166 of the 351 deceased drivers with alcohol in their blood had also used cannabis. Also note that cannabis use in deceased drivers is confirmed by the presence of THC in the

blood. This was not the case for the uninjured drivers and if confirmation of cannabis use was carried out for the uninjured drivers, the actual percentage of uninjured drivers using cannabis is likely to be less. Not all positive immunoassay screens can be confirmed as positive by the presence of THC in the sample.

Use of methamphetamine and alcohol together was found in 13 deceased drivers and two deceased drivers had used MDMA (Ecstasy). The immunoassay test used for the uninjured drivers does not distinguish between methamphetamine and MDMA and can also give a positive result if some other amphetamine type stimulant is present. Therefore the proportion of uninjured drivers using alcohol and methamphetamine will be less than that given in Table 26, and is considerably less than that found in the deceased drivers.

The proportion of the two driving populations using alcohol with benzodiazepines is very similar. Morphine use is not common in either population. Use of more than one of the drugs listed, together with alcohol, is more common in the deceased driver population.

The studies carried out on these two small driving populations have shown that in NZ drug use other than alcohol is prevalent enough to be of concern. There is a higher proportion of drivers in NZ using cannabis than reported in overseas studies. The use of other drug types (stimulants, opioids and benzodiazepines) is similar to that seen overseas, although the drugs used may differ.

Although the culpability analysis in this study does not show a strong correlation of crash culpability and cannabis use, enough is known about the effects of cannabis that its use by drivers should be of concern. There were insufficient drivers using other drugs to enable culpability analysis.

Summary

The influence of alcohol on road crashes and fatalities has been acknowledged for many years. It is only in more recent years that the use of other types of drugs has been associated with road crashes. While illicit drugs such as cannabis and methamphetamine may dominate, prescription drugs such as sedatives and opioid pain killers can also impair driving skills.

The prevalence of drugged driving in NZ is not known. The NZ legislation does not permit random stopping of drivers for the purposes of drug testing, making it difficult to obtain any reliable information about drug use in the general driving population. This study, designed to get a current picture of drug use in the NZ driving population, can be considered only as a pilot study because the driving population available to study is biased and limited.

The study reported in this document principally considers drug use and crash responsibility of drivers killed in road crashes. Blood samples, identified as being from a person who had died as a result of a motor vehicle crash while they were driving, were analysed. The samples analysed included those from both culpable and non-culpable drivers.

Blood samples taken from 1,046 deceased drivers were received at ESR over the period of five years. Following analysis for the presence of alcohol, the blood samples were analysed for the evidence of the use of a range of potentially impairing drugs including cannabis, methamphetamine, morphine, benzodiazepines and a range of prescription medication.

504 blood samples contained no alcohol and no drugs and the drivers were deemed to be unimpaired.

A further 42 blood samples were also deemed to be taken from drivers who were unimpaired. These blood samples contained a drug or low levels of alcohol but the drivers were not likely to be significantly impaired by these because either:

- the drugs detected would have been administered by medical personnel, or;
- the drugs that were present are unlikely to impair, or;
- if alcohol was present, by itself, it was at a level unlikely to significantly impair, that is below 30 milligrams per 100 millilitres (30 mg/100 mL).

Based on the analyses carried out, 546 of the 1,046 (52%) deceased drivers had no alcohol or other drug detected in their blood or were unlikely to be significantly impaired by alcohol or other drug present.

500 (48%) of the drivers had alcohol or other drugs in their blood that may have impaired their ability to drive safely:

- 135 of 500 had used alcohol alone (27%);
- 96 of 500 had used cannabis alone (19%);
- 142 of 500 had combined alcohol and cannabis use (28%), but had not used another drug, and;
- 127 of 500 had used some other combination of drugs (25%), which may have included alcohol and/or cannabis.

There were 127 drivers who had used a combination of drugs that was not alcohol alone, cannabis alone, or alcohol and cannabis alone. This does not mean that these drivers had not used alcohol or cannabis, they had just not used them alone. Most of these 127 drivers had used either alcohol or cannabis with other drugs.

Only 29 drivers (6% of the 500 potentially impaired drivers) had not used either cannabis or alcohol. Of the 500 potentially impaired drivers, 240 (48%) had used more than one impairing drug.

There were 29 deceased drivers with opioids in their blood. That is 6% of the drug using deceased drivers had used opioids (29 of 500 drivers) or 3% of the deceased drivers in this study (29 of 1046). Opioids include drugs such as methadone, morphine and dextropropoxyphene. Most of the opioid using drivers (23) had used more than a single drug.

There were 39 deceased drivers with sedatives in their blood. That is 8% of the drug using deceased drivers had used sedatives (39 of 500 drivers) or 4% of the deceased drivers in this study (39 of 1,046). Sedatives include drugs such as diazepam and zopiclone. Only six drivers had used the sedative drug by itself.

There were 54 deceased drivers with stimulants in their blood. That is 11% of the drug using deceased drivers had used stimulants (54 of 500 drivers) or 5% of the deceased drivers in this study (54 of 1046). Stimulants include such drugs as methamphetamine, amphetamine and BZP. 44 of the drivers had used methamphetamine. Only six drivers had used only a single stimulant drug. Most stimulant using drivers had also used other potentially impairing drugs.

Culpability analyses were carried out for 1,046 deceased drivers whose blood samples were analysed. 81 % of these drivers were culpable, that is, were at fault for their accidents. When a driver is killed in a single vehicle crash the driver is at fault most of the time. For the 460 single vehicle crashes, the deceased was at fault in 95% (437) of the crashes. When considering the 586 drivers killed in multiple vehicle crashes, the deceased driver was determined to be at fault in 411 crashes. That is 70% of deceased drivers in multiple vehicle crashes were culpable.

ESR laboratories receive and analyse blood samples, taken for evidential purposes under the Land Transport Act, for the presence of alcohol. Over the period of six months blood samples that had taken from 1,999 suspected drunk drivers, who had not been injured in a crash, were analysed. After the samples had been analysed to determine the level of alcohol, they were screened for evidence of the use of a limited range of other drugs. The range of drugs screened for was limited to cannabis, morphine, methamphetamine, MDMA and benzodiazepines.

The analytical technique used does not confirm drug use or identify which drug might have been used. As with road side testing devices, the technique does not confirm drug use to a standard that is required for a court prosecution. All the drug use discussed in this section must be interpreted as ‘indications of possible use of the drug’. Of these samples:

- 1,258 used alcohol alone (63%);
- 695 used alcohol and cannabis (35%), and;
- 46 had used alcohol and some other drug (2%).

Within this 2% of drunk drivers, there were indications that eight had used methamphetamine, one used morphine, 35 had used benzodiazepines.

Appendix one: Analytical methods

One of the purposes of this study was to get an indication of the prevalence of drug use in the NZ driving population. Two parts of the driving population have been considered: deceased drivers and the portion of the drunk driving population who elected to have an evidential blood sample taken but who had not been injured as a result of a crash.

The analyses carried out on the blood samples taken from deceased drivers were more comprehensive than those carried out on the drunk drivers. The analytical methodology is described below.

Drug use in deceased drivers

Blood samples received at ESR identified as having been taken from drivers fatally injured in a crash were analysed for alcohol and a range of other drugs. Sometimes only urine or liver samples are available for the deceased drivers. These drivers were not included in the study because blood is considered the gold standard for toxicological analyses. A full discussion on selection of samples is given in Appendix three.

Alcohol was analysed using head-space gas chromatography, the same method as is used for all Land Transport Act blood samples.

The blood samples were analysed for the presence of cannabis, morphine, methamphetamine and MDMA by immunoassay. This technique (ELISA) is a simple inexpensive colorimetric test which detects the presence of compounds that are related to drug families. An immunoassay does not confirm the presence of a particular drug or a level of that drug. It provides evidence of possible drug use. If evidence of drug use needs to be presented in court, an immunoassay is not sufficient. Further analyses are required to confirm and identify the drug that may be present.

Three immunoassay kits were used:

- Cannabis – The cannabis kit detects the presence of tetrahydrocannabinol (THC), the active ingredient of cannabis. It also detects metabolites, or

breakdown products formed in the body after cannabis use. These metabolites remain in the blood stream for a longer time than THC;

- Morphine - Morphine is a drug in the opiate family. It is prescribed for legitimate use as a strong pain killer but it is also known to be abused. Other drugs in the opiate family, such as codeine and dihydrocodeine, may also give a positive immunoassay response, and;
- Methamphetamine – Methamphetamine is part of a large family of amphetamine type stimulants, some of which are abused but some of which have legitimate uses. The methamphetamine immunoassay kit targets methamphetamine and MDMA (Ecstasy) but, if sufficient is present, may also detect other amphetamine type compounds. The immunoassay cannot distinguish between methamphetamine and MDMA.

For this study if the immunoassay was positive, further analyses were carried out to confirm the presence and determine the level of THC, to determine which amphetamine type stimulant was present, and to confirm the presence of morphine. These confirmatory analyses were carried out using liquid chromatography with mass spectrometry (LCMS).

The blood was also analysed for the presence of a range of prescription medication. The analytical technique used will not detect all drugs that may impair and will detect some drugs that do not impair. The analytical technique uses gas chromatography and mass spectrometry to positively identify the presence of the drug.

These analyses were carried out in conjunction with routine Toxicology analyses and results were held in a spreadsheet set up specifically for the purpose.

Drug use in drunk drivers

The blood samples used were received at ESR for alcohol analysis. The driver having presumably failed the breath alcohol test has elected to have a blood sample taken. That the driver was not seriously injured was determined by the Police form accompanying the sample. Evidential blood alcohol samples taken in hospitals are accompanied by a POL530 form. If a blood sample was accompanied by POL530 form it was not included in the study. The samples selected for analysis were

accompanied by a POL535 form. This method of selection does not exclude the involvement in a crash in which the driver was not seriously injured.

When alcohol analyses were complete and certified, a random selection of blood samples were analysed for evidence of use of cannabis, morphine, methamphetamine, MDMA and a range of benzodiazepines. The immunoassay technique described above was used for this analysis.

In addition to the immunoassay kits previously described a kit which tested for the presence of benzodiazepine type drugs was also used. Benzodiazepines are a large family of prescribed drugs, which have sedative effects. The benzodiazepine immunoassay kit will give a positive response to the many benzodiazepines that are commonly available in NZ.

For this part of the study a positive immunoassay result was not confirmed by further analyses. The test provided only evidence of possible drug use. Such evidence is not proof that someone has used a drug because the test is known to give rise to a small number of false positive results.

Appendix two: Culpability

Another purpose of this study was to look at the relationship between drug use and crash culpability. This analysis was carried out for the deceased drivers only. Who was at fault for a crash which resulted in the death of a driver was determined using Guidelines developed for this purpose and that have been published in the scientific literature [10]. These guidelines are given below. Only after culpability for a crash has been determined is the drug use by the driver considered.

Culpability analysis

Full crash reports for all crashes involving fatalities were received from Stuart Badger of the Ministry of Transport in six month batches at six monthly intervals over the five year period studied. Those crash reports involving driver fatalities were analysed for crash culpability. Culpability was determined independent of the knowledge of the presence of alcohol or other drugs in the driver's blood samples.

Culpability for the crash was determined independently of any Police assessment, using the Responsibility Analysis Guidelines given below. These guidelines were developed by Professor Olaf Drummer of the Victorian Institute of Forensic Medicine [10].

Each crash was analysed with respect to the factors described and a score was assigned to that driver. This analysis was carried out independently by two people and any differences were discussed and resolved.

Because information concerning all of the factors is not available for all crashes, each score was normalised. That is, the score determined for the driver was divided by the number of factors considered and multiplied by eight, the maximum number of factors. If less than five factors could be assessed for a crash, that crash and driver were excluded from the study as there was insufficient information to determine culpability. This occurred most commonly in the situation of a single vehicle crash where the vehicle was not discovered for several days.

Responsibility Analysis Guidelines

Category	Factors		Score
Condition of the road	Sealed road*	Two or more lanes and smooth	1
		Divided road	1
		Two or more lanes and rough	2
		Unmarked, thin and smooth	2
		Unmarked, thin and rough	3
	Unsealed road	Smooth	2
		Rough and/or corrugated	3
	** add 1 if newly sealed*		
Condition of the vehicle		Roadworthy	1
		Unroadworthy (contribution unclear)	2
		Unroadworthy (contributory)	4
Driving conditions	Day	Clear and/or cloudy	1
		Fog and/or mist, clear and windy**	2
		Visibility good and road wet**	2
		Showers and/or rain	3
	Night	Clear**#	1
		Cloudy#	2
		Fog/mist/showers/rain/ice wind	3
	*** add 1 if in heavy traffic*	*# add 1 if road not lighted*	
Type of accident	Single vehicle	No influence for other vehicles	1
		Influence from other vehicles or objects	3
	Multiple vehicle	Striking vehicle attempting to avoid	2
		Striking vehicle not attempting to avoid	1
		Struck vehicle in the wrong	1
		Struck vehicle in the right	3
Witness observations	No apparent reason		1
	Reckless	Swerving	1
		Irregular driving	1
	Negligent	Witnessed road law infringement	1
		Lack of road sense	1
	Vehicle fault		3
	Driver not to blame		4
Road law obedience	Was driver obeying the road laws?	Yes	3
		No	1

Difficulty of task involved ##	Straight road or sweeping bend		1
	Across lanes in	Heavy traffic	2
		Light traffic	1
	Winding road/sharp bend/U turn		2
	Overtaking		2
	Avoiding unexpected traffic or object		3
		##score 1 if under guidance of traffic signals	
Level of fatigue		Only if mentioned in police report	2

Score

8 – 12	Fatality due to driver performance
13 – 15	Fatality due, in part, to driving conditions
16 – 26	Fatality due to factors other than driver performance

The Responsibility Analysis Guidelines aim to analyse a crash without knowledge of drug or alcohol use. The purpose is to treat all deceased drivers equally before culpability with respect to drug use was determined. By considering the condition of road, the condition of the vehicle, driving conditions, the type of accident, witness observations and road law obedience, the difficulty of the task facing the driver at the time of the crash can be assessed.

Odds ratios

To determine the effect of a drug on culpability, the numbers of drivers using the drug and their culpability are compared with a control group. For this study the control group is the deceased drivers who had not used alcohol or other drugs. A culpability ratio (CR), number of culpable over not culpable, is determined for the driving population using a particular drug. This is divided by the culpability ratio for the non-drug using driving population.

$$CR_{drug} = \frac{\text{Number of culpable drivers using drug}}{\text{Number of not culpable drivers using drug}}$$

$$\text{Odds ratio} = CR_{drug}/CR_{\text{no drug}}$$

Drummer and Robertson [10] proposed that the determination of an odds ratio enables statistical significance to be placed on results. Similarly the odds ratio may be calculated

$$\frac{(\#\text{ culpable drivers with drug}) * (\#\text{ non-culpable drivers no drugs})}{(\#\text{ culpable drivers no drugs}) * (\#\text{ non-culpable drivers with drugs})}$$

An odds ratio greater than one indicates the drug has some influence. The significance of the effect is determined statistically and will be affected by the size of the population studied.

Appendix three: Driver population selected

In a study of drug use by deceased drivers, it would be ideal to obtain blood samples from all deceased drivers. As determined from the crash reports supplied by the Police we know this study covers only 89% of deceased drivers from the five year period of the study. Why some drivers have been excluded is discussed below.

Discussion on selection of deceased drivers and crash reports

For every motor vehicle crash involving a fatality, the police conduct an investigation and produce a crash report, POL565. The death may be of the driver, passengers, a cyclist or a pedestrian. Only drivers who have died as a result of a crash involving their motor vehicle, while travelling on a designated road, were selected to be included in this study. This includes drivers of cars, trucks and motorbikes.

Biological samples are sent to ESR from pathologists carrying out an autopsy for Coronial investigations. The deaths involved in these investigations may be accidental, unexpected or suicide, and may or may not have involved drug use. Blood samples, identified by the accompanying POL47 (Report for Coroner) form, as being from a person who had died as a result of a motor vehicle crash and were deemed to have been driving, were analysed for this study. The samples were taken from drivers who had died in the period of 1 July 2004 to 30 June 2009.

A small number of additional blood samples were received as evidential blood alcohol samples as taken from living drivers. These were identified when the POL565 (Fatal Crash reports) were received. In these cases, usually the driver had been transported to hospital following a crash and later died of their injuries. About 30 deceased drivers were identified in this way.

In some cases, following an autopsy and a police investigation it is determined that a deceased driver has died as a result of a medical issue rather than the crash. That is, a medical problem arose while the deceased was driving, and this caused them to crash. Injuries sustained during the crash were not sufficient to cause death. Sometimes the death is determined to be a suicide rather than an accidental death. Often in these cases, no crash report is produced. ESR may receive blood samples for these cases,

but these drivers have not been included in this study because they have not died due to an accidental motor vehicle crash.

One of the purposes of this study was to determine the influence of a drug on a crash. Therefore some drivers have been excluded to maintain consistency. A number of drivers for whom either samples were received at ESR or crash reports were produced, have been excluded for reasons set out in Table 27. There were 127 such drivers excluded.

Table 27 - Deceased drivers excluded from the study

Reason for exclusions	Number	Explanation
Not enough information	15	Deceased found a long time after the crash Couldn't be sure the deceased was the driver
Medical	52	The crash did not cause death, the death caused the crash
Suicide	21	Only when documentation confirmed intention of suicide
Off road	26	Beach, dirt track, race track
WPA	8	Work place accident
Sport vehicle	4	Not a registerable vehicle eg miniature motorbike, go-kart
Drug death	1	Driver was dead due to drug overdose

Over the five year period covered by this study, 1,873 fatal crash reports were produced, as determined by the reference number given to the crash by the Police. These crash reports identified 1,177 deceased drivers. Thirty of the crashes resulted in the deaths of two drivers, therefore there were 1,147 crashes involving driver fatalities. Passengers may also have died in these crashes. There were 726 crash reports that did not involve the death of a driver and therefore involved the death of one or more passengers, a pedestrian or a cyclist.

Although 1,177 driver deaths have been identified by the crash reports, only 1,046 deceased drivers have been included in this study. The only biological sample considered was blood. This is considered the best sample for toxicology analyses as it represents what is present in the body and what is likely to be having an effect at the time.

For nine drivers only a urine sample was sent to ESR, a liver sample was all that was provided for another and vitreous humor was all that was available for two drivers. For 11 of the drivers so little blood was provided that there was not enough to carry out a full set of analyses. These 23 drivers had to be excluded from the study.

No samples at all were received for 108 deceased drivers. There are a number of possible reasons for this. It is possible that no pathologist was available to take a sample. It is possible no blood was available due to the severity of the trauma. In some cases the deceased was not found for several days and putrefaction may have prevented a sample being available. No blood sample was provided for 131 identified deceased drivers so these drivers could not be included in the study.

During the course of the study I felt there was a bias in the samples being sent to ESR for analysis, and this bias was age related. Samples were less likely to be sent from older people. In Table 28, the number from each age group, where no sample was received, is compared with the number for that same age group where blood was received and analysed. No sample was sent in for analysis for about a quarter of the deceased drivers who were over 60 years.

Table 28 - Comparison of age groups for samples being sent or not

Age group	Number of no sample received	Number analysed	% no sample to analyse
<20	17	140	12
20 to 39	39	432	9
40 to 59	25	326	8
>=60	49	148	33
unknown	1	0	
Total	**131**	**1,046**	

This highlights the difficulty in getting an unbiased population for analysis.

Appendix four: Number of fatal crashes per district

The following is a brief analysis on the distribution of driver deaths with respect to the estimated populations within the police districts within NZ. This analysis includes the 1,177 identified deceased drivers rather than the 1,046 deceased drivers who blood was analysed.

District

NZ is divided into 12 Police districts. From the NZ Statistics website [25] an estimate of the population, for each of these districts in 2008, was made. Table 29 shows the number of deceased drivers for every 10,000 of estimated population. The average death rate of drivers over the five year period was 2.5 driver deaths per 10,000.

The districts with a lower than average driver road toll are those where most of the population live in the cities. The districts that have a higher than average proportion of drivers death are those with smaller towns and the population is spread over more sparsely populated areas.

Table 29 - Driver deaths and population

District	Estimated population	Number of deceased drivers	Per 10,000 population
Auckland	438,100	20	0.45
Bay of Plenty	306,910	175	5.72
Canterbury	547,500	128	2.33
Central	331,250	157	4.74
Counties Manukau	908,100	94	1.03
Eastern	198,580	69	3.47
Northland	154,700	83	5.36
Southern	298,100	84	2.81
Tasman	171,850	57	3.31
Waikato	347,520	169	4.86
Waitemata	520,700	93	1.78
Wellington	473,850	48	1.01
Total	**4,697,160**	**1,177**	**2.50**

A comment was made in a study carried out in the Southern District [26] by people living there, that road deaths were not a big issue because the fatalities usually

involved people who were not local. How a 'local' is defined will be influenced by the area in which you live.

For the deceased drivers in this study, if a local is considered to live within 50 kilometres of the crash site, then 74% (775 of 1,046) of the deceased were local.

Appendix five: Crashes per month

Over the five year period of the study, considerable variation in the numbers of driver deaths each month was noted. The following looks at the proportion of people killed in road crashes that are drivers and also the variation of driver deaths for each month. There is little attempt to explain the variations.

Monthly analysis

This study of driver deaths has covered five years starting 1 July 2004 through to 30 June 2009, a period of 60 months. Graph seven plots the monthly variation of driver deaths. Usually each year the worst month is December but there is no clear pattern of increases or decreases throughout the years. Because this includes driver deaths only, it is possible that the variations observed in the monthly numbers will not match those of the overall road toll which includes passengers, cyclists and pedestrians.

February 2005 and December 2008 were the worst months, the only ones when there were over thirty driver deaths. This is reflected by the total road toll for these months, 52 and 50 respectively, as given in the MOT website [27]. The only other month over the five year period given in the website that had over 50 deaths was December 2004 (51). The number of driver deaths that month was relatively low with 26 deaths.

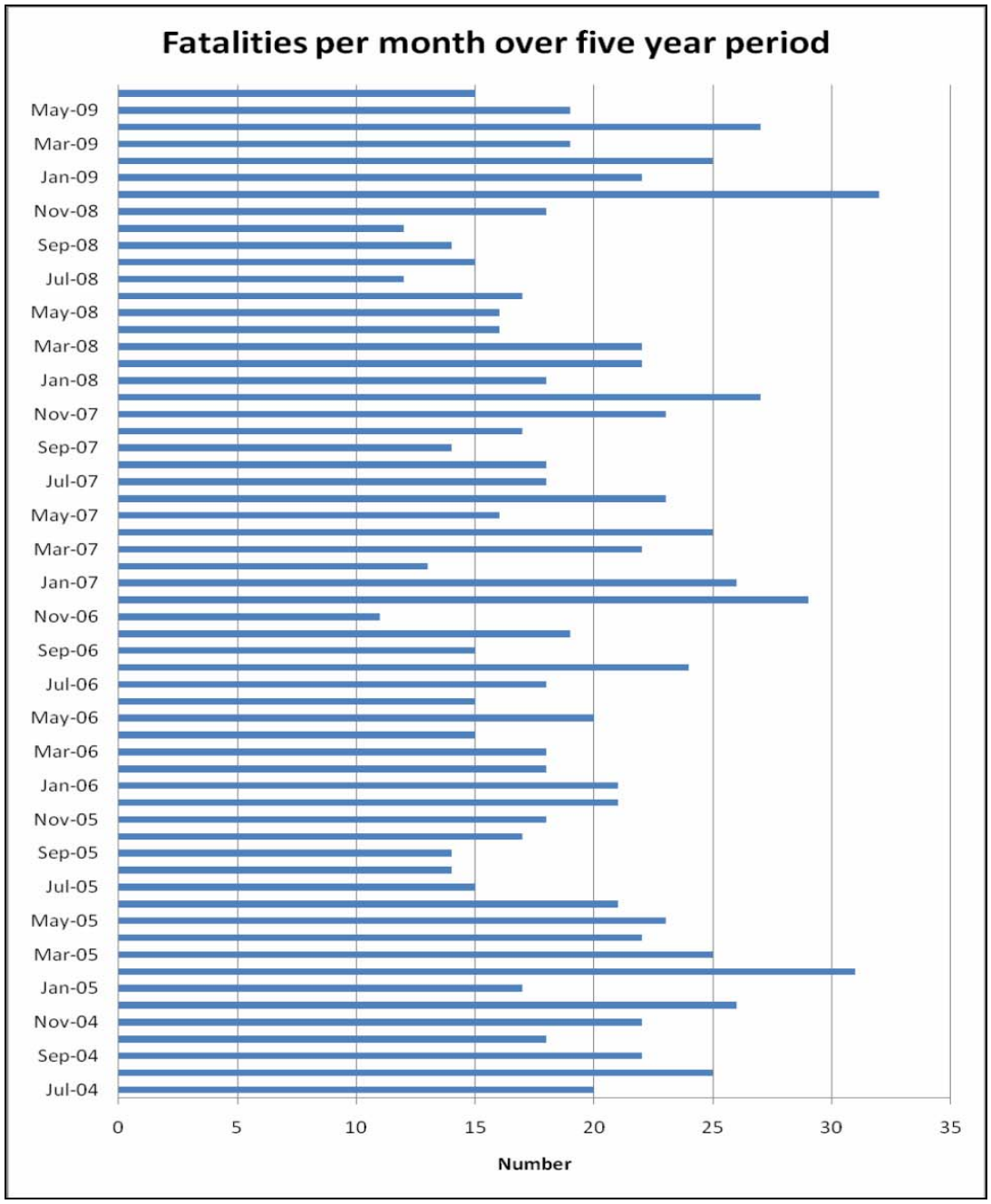
The lowest driver death month was November 2006 with only 11 deaths. The lowest month for total road toll for this period was February 2007 with 19 deaths. Table 30 looks at the total road toll [27] and the number of driver deaths over the four full calendar years covered by this study. The proportion of driver deaths is fairly consistent.

Table 30 -Comparison of driver deaths with official road toll

Year	Driver fatalities	Total road toll	Drivers as % of Total
2005	238	405	59
2006	223	393	57
2007	242	421	57
2008	214	366	58

There were 1,177 drivers deaths identified during the five year period, which is an average of 20 driver fatalities per month. The four months from July 2008 to October 2008 showed four months in a row with less than 15 driver fatalities. This was also reflected in the total road toll for July to September with 20, 23, 24 deaths respectively, lower than the average of 33. This was the same period during which there were very high petrol prices.

Graph seven - Driver fatalities over 60 month period



Appendix six: Multiple and single vehicle crashes

This study has looked at who was at fault for the crash that resulted in the death of a driver. A crash that involves a single vehicle is most likely to be the fault of the driver. In a multiple vehicle crash, the deceased driver may not be at fault. The following discussion considers the proportion of drivers killed in single or multiple vehicle crashes who were determined to be at fault.

Culpability of drivers in single and multiple vehicle crashes

Culpability analyses were carried out for 1,177 drivers who were killed on the roads over the five year period studied. 81% of these drivers were culpable, that is, were at fault for their accidents. The same percent of drivers were culpable if the 1,046 drivers who blood samples were analysed are considered. 190 drivers (16%) died in a crash that was not their fault. For 38 drivers (3%) it was not clear if the driver was at fault and it is likely that difficult driving conditions had some influence on the crash.

Table 31 considers the culpability of drivers who blood samples were analysed and involved in single and multiple vehicle crashes.

Table 31 - Culpability of deceased drivers in single and multiple vehicle crashes

	Deceased drivers	Culpable	% Culpable	Not culpable	Unclear culpability
Crash Type					
Single vehicle	460	437	95%	9	14
Multiple vehicle	586	411	70%	159	16
Total	**1,046**	**848**	**81%**	**168**	**30**

For a single vehicle crash the driver was at fault most of the time. It has been determined that for the 460 single vehicle crashes, the deceased was at fault in 95% (437) of the crashes. The circumstances surrounding 14 of the crashes were not clear enough to determine culpability and for 9 crashes the driver was not at fault. Three drivers hit a horse, and one a cow, where the animals were loose on the road. One motorcyclist was hit by a tree branch, two drivers hit debris (large debris in the form of a motorbike or a car unoccupied on the road), one driver's truck suffered brake failure going down a steep hill and the last died trying to avoid a pedestrian on the road.

In considering the 586 drivers killed in multiple vehicle crashes, the deceased driver was determined to be at fault in 411 crashes. That is 70% of deceased drivers in multiple vehicle crashes were culpable. In 16 of the crashes the circumstances were not clear enough to determine fault, and in 159 multiple vehicle crashes the deceased driver was not at fault.

There is a notable difference in culpability between drivers involved in single and multiple vehicle crashes. One of the purposes of this study was to look at the effect of drug use by a driver on culpability for the crash. With such differences in proportions of culpability between single and multiple vehicle crashes it is necessary to consider the types of crashes separately.

Appendix seven: Trains, trucks and motorbikes

All of the driver deaths considered in this study occurred on public roads. A crash that results in the death of a driver may be due to the types of vehicles involved in the crash. The relative vulnerability of the driver due to the vehicle type may be considered by looking at discussion below.

Trains, trucks and motorbikes

A motor vehicle crash involving a single driver and no other moving vehicle is defined as a single vehicle crash. The alternative is a multiple vehicle crash in which more than one driver is in control of more than one moving vehicle.

The crashes analysed in this study include 560 multiple vehicle crashes in which 586 drivers died. The other 460 drivers were killed in single vehicle crashes. In 18 of the 560 multiple vehicle crashes (3%) the 'other' vehicle, the vehicle not being driven by the deceased, was a train.

In 175 of the 560 multiple vehicle crashes (31%) the 'other' vehicle was a truck. This seems high in relation to the observed relative numbers of trucks and cars on the road. In 29 of these crashes the surviving truck driver was determined to be at fault for the crash, using the Responsibility Analysis Guidelines. It therefore follows that in 146 crashes, the deceased driver accidently placed themself in the path of a truck, a vehicle with poor ability to manoeuvre or stop quickly.

In 52 of the 1,020 crashes (5%) the deceased was driving a truck. 28 of these crashes were single vehicle crashes and 24 were multiple vehicle crashes. Following the Responsibility Analysis Guidelines the truck driver was found to be at fault in 25 of the 28 single vehicle crashes. In the remaining three crashes, one situation was unclear (it may have been driving or vehicle conditions that influenced the crash), one driver was trying to avoid a pedestrian and the other was driving a truck that had brake failure. For the 24 multiple vehicle crashes where the truck driver died, 12 were determined to be at fault for the crash.

174 of the 1,046 deceased drivers (17%) were riding motorbikes. Again this seems high in relation to the numbers of motorbikes and cars using the roads. Single vehicle crashes accounted for 62 of the deceased motorcyclists. For 60 of these crashes the motorcyclist was determined to be at fault. In the two cases where the rider was not at fault, one was found too much later to determine if there were other influences involved and the other was hit by a tree branch. There were 112 crashes in which the motorcyclist struck another vehicle. 66 of these crashes (59%) were determined to be the fault of the motorcyclist.

Appendix eight: Passengers in fatal crashes and drivers who survive a crash

A question was raised by a Minister of Parliament about the number of people who had been killed by drivers under the influence of alcohol or other drugs. To determine this it would be necessary to analyse blood samples from all drivers involved in a motor vehicle fatality, not just those who were killed. It is not only drivers who are killed in the accidents. Many of the deceased drivers also had passengers. Passengers, cyclists and pedestrians may be killed in a crash where the driver survives.

The following looks at the numbers of passengers who were involved in crashes where the driver was killed and also considers the lack of information about drivers who survive a crash involving a fatality.

Passengers in fatal crashes and drivers who survive the crash

This study has analysed for alcohol and other drug use only in deceased drivers. The number of passengers involved in these crashes was documented in the POL565 Fatal Crash Report.

The fatal crash reports where the driver has survived, but someone else has been killed, have not been examined for this study. When the driver survives the crash, blood samples are not always taken. When a blood sample is taken usually only analysis for alcohol is carried out. Only rarely are analyses for other drugs requested. Therefore possible impairment of a surviving driver is not often established.

Table 32 gives the number of deceased drivers involved in single vehicle crashes who also had passengers. Most of the drivers who died in a single vehicle crash, 340 of the 460 (74%), were travelling alone. With or without passengers, 95% of the drivers were at fault for the crash.

Table 32 - Single vehicle accidents

	Number of deceased drivers	Number of drivers who were culpable (%)
Single vehicle crash	460	437 (95%)
With passengers	120	114 (95%)
Alone	340	323 (95%)

There were 205 passengers in the 120 single vehicle crashes in which the driver died. 22% (45 of the 205) of these passengers were killed in the crash. The other passengers suffered injuries ranging from serious to nil, as stated in the crash report.
A number of the drivers had used alcohol or another drug that could impair driving. It is not possible to determine just from the presence of a drug if someone is impaired. Table 33 shows that 119 people, 22 of whom were killed in a crash, were in a car with a potentially impaired driver. Just under half of the passengers killed in a single vehicle crash were with a potentially drug impaired driver.

It should be noted that the driver is found not-culpable in very few single vehicle crashes.

Table 33 - Injuries of passengers with deceased drivers in single vehicle crashes

Passengers	Total	Fatal (%)	Serious	Minor	Nil
Number involved	205	45 (22%)	72	82	6
Number with a possibly impaired driver	119	22 (10%)	43	52	2

In the multiple vehicle crashes there are too many unknowns to determine the influence of driver drug use on passenger fatalities. There may be passengers in both or all of the cars involved in a crash. Possible impairment of the surviving drivers is unknown as a blood sample is not often analysed.

There were 586 drivers who died in 560 crashes involving more than one vehicle. There were 26 crashes where both drivers died. Therefore there are at least (some crashes involved more than two vehicles) 534 drivers who survived a fatal crash.
Examination of the crash reports for these 560 multiple vehicle crashes showed that 110 passengers were also killed. Further to this 322 people, passengers and other

drivers, were seriously injured, while 319 suffered minor injuries. These are crashes that involved the death of a driver. There are many crashes that may result in the death of a passenger, pedestrian or cyclist and the driver survives.

There were at least 534 drivers who were involved in a fatal crash (as covered by the scope of this study) and survived. The names of these surviving drivers, and the dates of the crashes, were matched against the blood samples sent to ESR under the Land Transport Act for alcohol analysis. It was found that 145 (27%) of these drivers had a blood sample taken and submitted for analysis.

Of the 145 surviving drivers who did have blood taken, 118 (81%) had zero blood alcohol. There were 27 drivers who had alcohol in their blood and 22 of the drivers had an alcohol level of more than 30 mg/100 mL. The age of these surviving drivers is not known therefore the youth alcohol limit was selected as a threshold. Only seven of these drivers were tested for evidence of drug use and all seven tested were found to have used drugs prior to the crash.

The culpability analyses have shown that 70% of the deceased drivers who were killed in a multiple vehicle crash, were at fault for their crash. Therefore approximately 70% of the surviving drivers were not at fault for the crash. It is likely that it would often be clear to the attending police who was at fault and they may do no more than a breath alcohol test on a surviving driver who is not at fault.

There were 159 drivers who died in a crash, through no fault of their own, that involved two or more vehicles. 26 of these crashes also resulted in the death of the culpable driver. Therefore as determined using the Responsibility Analysis Guidelines there are 133 drivers, at fault, who survived the crash. Blood samples were received at ESR, for alcohol analysis, from 53 (40%) of these drivers.

The blood taken from 32 of the surviving drivers contained no alcohol, while 17 drivers had alcohol levels greater than 30mg/100 mL. Only six of these samples were tested for drug use, and all of those 6 drivers had used drugs.

Although this study has given some indication of drug use in the driving population, the population is small and biased. Determination of the full impact that drug use has on crashes will require a more complete study of the drivers involved.

Appendix 9: Profile of drivers with respect to drug use

During the course of this study a large amount of data on deceased drivers has been collected. Will this data give any information regarding the type of driver who will use alcohol or other drugs then drive? The following is a comparison of the 'drug using deceased drivers' with the 'non-drug using deceased drivers', made with the understanding that this is a selective and potentially biased portion of the driving population.

Gender

76% of the deceased drivers in this study are male (Table 34). The ratio of male: female deceased drivers is approximately 3: 1. Deviation from this ratio will indicate that a particular drug is used more by one group than the other.

For example, in the category of 'some other combination of drugs' there are three times more males than females. This category does not exclude cannabis or alcohol use, but includes any other drug use that has been covered in the main discussion document. If the numbers of the deceased were taken alone, the data could be misrepresented, saying males are 3 times more likely to use drugs. But because there are also three times more males in the deceased driver population, this indicates that drug use within this category is just as common in the female population as in the male population.

Table 34 - Gender comparison of deceased drivers using drugs

Gender	Unimpaired by alcohol or drugs (%)	Alcohol only (%)	THC only (%)	Alcohol and THC only (%)	Some other combination of drugs (%)	Total (%)
Male	385 (71)	115 (85)	81 (84)	121 (85)	95 (75)	797 (76)
Female	161 (29)	20 (15)	15 (16)	21 (15)	32 (25)	249 (24)
Total	**546**	**135**	**96**	**142**	**127**	**1,046**

Males are more likely to have used alcohol or cannabis, or both, with 84% to 85% of the deceased drivers in these categories being male (Table 34). This over-representation of males in alcohol and cannabis use categories, results in a higher

proportion of females in the unimpaired category (29%), compared with 24% females in the overall deceased driver population.

Males are also over-represented when driving under the influence of stimulants. 83% of the deceased drivers who had used stimulants were male (Table 35). Females appear more likely to drive with sedatives (33%) or some other drug that is not cannabis or alcohol (41%) in their blood. The drugs used by a higher proportion of females are those that could be considered legally obtained prescription medication.

Table 35 - Gender comparison of deceased drivers using drugs other than cannabis or alcohol

Gender	Opioids (%)	Sedatives (%)	Stimulants (%)	Impairing drug but no alcohol or THC (%)
Male	21 (72)	26 (67)	45 (83)	17 (59)
Female	8 (28)	13 (33)	9 (17)	12 (41)
Total	**29**	**39**	**54**	**29**

Ethnicity

The ethnicity of the deceased drivers was obtained from both the POL 565 Fatal Crash Report and the POL47 Report to Coroner form. The POL 565 Report defines the ethnicity categories for deceased drivers and separates Samoan and Tongan from a general Pacific Island group. However, because of the relatively low numbers involved, in the following tables Samoan and Tongan drivers have been combined within Pacific Island. Also because there are so few deceased drivers in the ethnic groups, other than European and NZ Maori, a comparison of drug use by these other ethnic groups is not useful. European and NZ Maori make up 89% of deceased drivers at a ratio of 2.6 to 1. Therefore this comparison will discuss only the comparative drug use of the European and NZ Maori deceased drivers.

Table 36 - Ethnicity comparison of deceased drivers using drugs

Ethnicity	Unimpaired by alcohol or drugs (%)	Alcohol only (%)	THC only (%)	Alcohol and THC only (%)	Some other combination of drugs (%)	Total (%)
European	396 (73)	75 (56)	51 (53)	65 (46)	87 (68)	674 (64)
NZ Maori	89 (16)	44 (33)	35 (36)	66 (46)	28 (22)	262 (25)
Indian	10 (2)	2 (1)	0	0	2 (2)	14 (1.3)
Asian	15 (3)	0	0	1 (1)	3 (2)	19 (1.8)
Pacific Island	15 (3)	10 (7)	5 (5)	6 (4)	3 (2)	39 (3.7)
Unknown	15 (3)	4 (3)	4 (4)	4 (3)	4 (3)	31 (3.2)
Other	6 (1)	0	1 (1)	0	0	7 (0.8)
Total	**546**	**135**	**96**	**142**	**127**	**1,046**

If drug or alcohol use is more prevalent in either population this will be shown by a deviation from the ratio 2.6: 1 (European: NZ Maori). The ratio for the unimpaired driver category is 4.4: 1 indicating drivers classed as European are less likely to be killed in a crash while under the influence of drugs. The ratio for alcohol only is 1.7 : 1, for cannabis only it is 1.5 : 1, and for the combined use of alcohol and cannabis it is 1 : 1, indicating that although far fewer drivers classified as NZ Maori are deceased drivers, they are more likely to have used alcohol or cannabis prior to driving (Table 36).

When drug use other than cannabis and alcohol are considered the difference is not so marked (Table 37). The ratio of European to NZ Maori when looking at use of sedatives is 2.9: 1, not much different to the deceased driver population ratio of 2.6: 1. A similar ratio of 2.8: 1 is found for use of stimulant type drugs.

Table 37 - Ethnicity comparison of deceased drivers using drugs other than cannabis or alcohol

Ethnicity	Opioids (%)	Sedatives (%)	Stimulants (%)	Impairing drug but no alcohol or THC (%)
European	24 (83)	26 (67)	36 (67)	20 (69)
NZ Maori	4 (14)	9 (23)	13 (24)	4 (14)
Indian	0	0	0	1
Asian	0	2	2	1
Samoan	0	0	0	0
Tongan	0	0	0	0
Pacific Island	0	0	1	1
Unknown	1	2	2	2
Other	0	0	0	0
Total	**29**	**39**	**54**	**29**

The ratio of European drivers using opioids or some other impairing drug, then driving, is higher, 6: 1 and 5: 1 respectively, than the overall deceased driver population. But the sample groups involving drugs other than cannabis or alcohol are small in number and it is difficult to determine any significance.

Age Group

The common perception is that drivers killed in crashes are young, that is under 25, and male. Without some knowledge of age distribution of drivers using NZ roads, it is not possible to properly assess the significance of the distribution of ages of deceased drivers.

Table 38 shows that 28% of the 1046 deceased drivers whose blood was analysed are under 25 years old. However, the fatal crash reports covering the five years showed that blood samples from 131 deceased drivers were not received. If all of the 1,177 deceased drivers were considered, 26% were under 25 years old.

Table 38 - Age comparison of deceased drivers using drugs

Age group	Unimpaired by alcohol or drugs (%)	Alcohol only (%)	THC only (%)	Alcohol and THC only (%)	Some other combination of drugs (%)	Total (%)
<15	2 (0.4)	0	1 (1)	0	0	3 (0.3)
15-19	77 (14)	12 (8.8)	22 (23)	22 (15)	4 (3.1)	137 (13)
20-24	55 (10)	27 (20)	23 (24)	35 (25)	13 (10)	153 (15)
25-29	30 (5.5)	17 (13)	10 (10)	19 (13)	12 (9.4)	88 (8.4)
30-34	36 (6.6)	17 (13)	8 (8.3)	22 (15)	22 (17)	105 (10)
35-39	29 (5.3)	13 (9.6)	10 (10)	15 (10)	19 (15)	86 (8.2)
40-44	53 (9.8)	8 (5.9)	11 (11)	17 (12)	18 (14)	107 (10)
45-49	57 (10)	12 (8.9)	6 (6.3)	7 (4.9)	16 (13)	98 (9.4)
50-54	46 (8.4)	8 (5.9)	4 (4.2)	5 (3.5)	6 (4.7)	69 (6.6)
55-59	39 (7.1)	7 (5.2)	1 (1)	0	5 (3.9)	52 (5.0)
60-64	27 (4.9)	5 (3.7)	0	0	6 (4.7)	38 (3.6)
65-69	30 (5.5)	5 (3.7)	0	0	3 (2.4)	38 (3.6)
70-74	11 (2.0)	2 (1.5)	0	0	1 (0.8)	14 (1.3)
75-79	24 (4.4)	0	0	0	2 (1.6)	26 (2.5)
>=80	30 (5.5)	2 (1.5)	0	0	0	32 (3.1)
Total	**546**	**135**	**96**	**142**	**127**	**1,046**

Cannabis use is higher in the 15 to 25 year old age group than in the older age groups. 47% of the cannabis only drivers and 40% of the combined alcohol and cannabis drivers are under 25 years old. But cannabis use was found, with and without alcohol, in drivers over 50 years old (Table 38).

The proportion of drivers in the age group of 15 to 19, using alcohol and driving, is low relative to the older age groups, up to 40 years old. This contrasts with the high proportion using cannabis and driving.

Alcohol use was found through all age groups, but cannabis use did not appear to occur in the over 55 year olds to any extent.

Relative to alcohol and cannabis use, very few drivers used opioids, sedatives, stimulants or other potentially impairing drugs. The age groups using stimulants is centred in the 20 to 45 year olds but the use of the other types of drugs is spread over just about all age groups (Table 39).

Table 39 - Age comparison of deceased drivers using drugs other than cannabis or alcohol

Age group	Opioids	Sedatives	Stimulants	Impairing drug but no alcohol or THC
<15	0	0	0	0
15-19	1	0	2	0
20-24	1	2	9	1
25-29	2	1	7	0
30-34	4	4	12	4
35-39	3	8	8	6
40-44	4	9	9	5
45-49	5	7	5	1
50-54	2	2	2	2
55-59	2	0	0	1
60-64	2	3	0	3
65-69	0	3	0	3
70-74	2	0	0	1
75-79	1	0	0	2
>=80	0	0	0	0
Total	**29**	**39**	**54**	**29**

Licence status

The licence status of the deceased drivers was obtained from the Fatal Crash Report . Information concerning licence status was not always obtained, with 8% of the deceased drivers having an unknown status. 23% of deceased drivers had not yet obtained a full licence, and were in the categories of learner, restricted or never licensed drivers (Table 40).

Table 40 - Licence status comparison of deceased drivers using drugs

Licence status	Unimpaired by alcohol or drugs (%)	Alcohol only (%)	THC only (%)	Alcohol and THC only (%)	Some other combination of drugs (%)	Total (%)
Disqualified	7 (1.3)	8 (5.9)	1 (1)	11 (7.7)	10 (7.9)	37 (3.5)
Expired	6 (1.1)	4 (3.0)	2 (2)	3 (2.1)	2 (1.6)	17 (1.6)
Forbidden	2 (0.3)	2 (1.5)	1 (1)	4 (2.8)	4 (3.1)	13 (1.2)
Full	364 (67)	73 (54)	39 (41)	54 (38)	75 (59)	605 (58)
Learner	30 (5.5)	9 (6.7)	16 (17)	22 (15)	10 (7.9)	87 (8.3)
Never	8 (1.5)	7 (5.2)	7 (7)	7 (4.9)	2 (1.6)	31 (3.0)
Overseas	29 (5.3)	1 (0.7)	2 (2)	2 (1.4)	0	34 (3.3)
Restricted	61 (11)	17 (13)	15 (16)	18 (13)	13 (10)	124 (12)
Unknown	37 (6.8)	11 (8.1)	10 (10)	17 (12)	10 (7.9)	85 (8.1)
Wrong class	2 (0.4)	3 (2.2)	3 (3)	4 (2.8)	1 (0.8)	13 (1.2)
Total	**546**	**135**	**96**	**142**	**127**	**1,046**

The proportion of deceased drivers with a full licence was 58%. Table 40 shows that of the deceased drivers who had not used a potentially impairing drug, 67% had a full licence. This indicates that drivers with full licences appear to be less likely to use drugs or alcohol and drive. This is also shown by the proportions of alcohol and cannabis using deceased drivers with full licences - 54% used alcohol only, 41% used cannabis only and 38% of drivers who used the combination of cannabis and alcohol - all less than the 58% of all deceased drivers who had a current full licence.

In the same way drug and alcohol use by drivers who were not yet fully licensed may be considered. 23% (242 of 1046) deceased drivers had a licence status of learner, restricted and never licensed. However, only 18% (99 of 546) of the drivers who had not used a potentially impairing drug are represented by these licence categories. These deceased drivers, who had not got a full licence, accounted for 25% of the drivers using alcohol alone, 40% of those using cannabis by itself and 33% of the drivers who had used cannabis and alcohol together.

There are too few drivers who have used drugs other than alcohol and cannabis, spread over too many licence categories, to determine anything significant from drug

use and licence status (Table 41). No licence status appears to be over-represented in the use of stimulants, opioids, sedatives or other potentially impairing drugs.

Table 41 - Licence status comparison of deceased drivers using drugs other than cannabis or alcohol

Licence status	Opioids	Sedatives	Stimulants	Impairing drug but no alcohol or THC
Disqualified	3	3	6	0
Expired	0	1	1	0
Forbidden	1	4	0	1
Full	17	25	27	24
Learner	1	1	6	1
Never	0	0	1	0
Overseas	0	0	0	0
Restricted	5	2	7	2
Unknown	2	3	5	1
Wrong class	0	0	1	0
Total	**29**	**39**	**54**	**29**

There appears to be minimal drug use by tourists. For the purposes of this study a deceased driver was identified as a tourist either by the documentation accompanying the samples or by the deceased holding an overseas licence.

Summary

This Appendix has attempted to profile the drivers who have been involved in fatal driver crashes. If numbers alone are considered, the type of driver most often killed in a crash is male, under 25 years old, European and fully licensed.

However the profile changes if drug use by a deceased driver is considered. Drug use other than alcohol and cannabis is not high so in profiling the deceased driver, only these drugs are considered. If it is accepted that use of these drugs will increase the risk of death in a motor vehicle crash, the 'at risk' category associated with drug use is male, under 25 years old, Maori, and not fully licensed.

Appendix 10: Profile of crash with respect to drug use

In the same way as the driver has been profiled with respect to drug use, so can the types of crashes in which these drivers are involved. The drug use with respect to single vehicle and multiple vehicle crashes has already been discussed (Appendix six). What follows is a brief examination of some other aspects of the crashes including the Police district in which the crash occurred, the type of road (state highway, rural or urban) and the time of day of the crash.

District

Consideration of the variation of the type of drug use in the 12 Police districts needs to include consideration of a number of factors including the proportion of crashes, with respect to the estimated population, for each of these districts as discussed in Appendix four. It is also possible to consider the proportion of crashes that do, or do not, involve alcohol or other drugs within each district. Table 42 gives the proportion of deceased drivers in each district who had not used alcohol or drugs (as defined earlier). The overall percentage of unimpaired drivers was 52%.

Table 42 - Police district comparison of deceased drivers with no alcohol or drugs

District	Number unimpaired by alcohol or drugs	Total	Percentage unimpaired
Auckland	3	17	18
Bay of Plenty	78	159	49
Canterbury	72	118	61
Central	80	142	56
Counties Manukau	35	79	44
Eastern	25	56	45
Northland	31	73	42
Southern	44	75	59
Tasman	29	51	57
Waikato	82	151	54
Waitematä	41	82	50
Wellington	26	43	60
Total	**546**	**1,046**	**52**

Auckland has a very high proportion of drivers using alcohol and other drugs, but very few fatal driver crashes occur in this district. As seen in Appendix four the number of crashes per head of population for the Auckland district is significantly lower than other districts. It should be noted that the numbers of deceased drivers in the above table differ from those in Appendix four because Appendix four includes all deceased drivers, not just those who had been analysed for drugs.

Counties Manukau, Northland and Eastern districts have higher than average drug use with the percentages of unimpaired drivers being 44%, 42% and 45% respectively. Canterbury, Wellington and Southern districts all have lower than average drug use, with about 60% unimpaired drivers.

Table 43 gives the numbers and percentages of deceased drivers using alcohol and/or cannabis, or some other drug combination, in each of the districts. If drug use is over-represented in a particular district then the percentage drug use for that district will be greater than the percentage calculated in the Total column.

Table 43 - Police district comparison for crashes involving drug use

District	Unimpaired by alcohol or drugs (%)	Alcohol only (%)	THC only (%)	Alcohol and THC only (%)	Some other combination (%)	Total (%)
Auckland	3	2 (1.4)	2 (2.1)	8 (5.6)	2 (1.6)	17 (1.6)
Bay of Plenty	78 (14)	21 (16)	17 (18)	28 (20)	15 (12)	159 (15)
Canterbury	72 (13)	16 (12)	9 (9.4)	11 (7.7)	10 (7.9)	118 (11)
Central	80 (15)	14 (10)	14 (15)	20 (14)	14 (11)	142 (14)
Counties /Manukau	35 (6.4)	13 (10)	9 (9.4)	6 (4.2)	16 (13)	79 (7.6)
Eastern	25 (4.6)	8 (5.9)	3 (3.1)	10 (7.0)	10 (7.9)	56 (5.4)
Northland	31 (5.7)	10 (7.4)	6 (6.3)	13 (9.2)	13 (10)	73 (7.0)
Southern	44 (8.0)	13 (10)	5 (5.2)	8 (5.6)	5 (3.9)	75 (7.2)
Tasman	29 (5.3)	5 (3.7)	7 (7.3)	4 (2.8)	6 (4.7)	51 (4.9)
Waikato	82 (15)	15 (11)	17 (18)	21 (15)	16 (13)	151 (14)
Waitematä	41 (7.5)	12 (9)	3 (3.1)	11 (7.7)	15 (12)	82 (7.8)
Wellington	26 (4.8)	6 (4.4)	4 (4.2)	2 (1.4)	5 (3.9)	43 (4.1)
Total	**546**	**135**	**96**	**142**	**127**	**1,046**

If the percentage of crashes involving cannabis only is considered Bay of Plenty and Waikato Central districts, with values of 18%, show higher than average use. If the combined use of cannabis and alcohol is considered, Bay of Plenty district, with 20%, is higher than average. However, not only the high percentages should be examined. For example in the Tasman district drug use in general in deceased drivers is lower than average. However, the proportion of deceased drivers from that District using cannabis by itself is high when compared with those using either alcohol, or cannabis and alcohol together.

Table 44 gives the numbers of crashes involving drug types other than alcohol or cannabis. The numbers involved are small so percentages have not been calculated for each drug type and district. Use of opioids appears to be spread around the country.

The number of deceased drivers using sedative type drugs is high in the Northland district.

Stimulant use in the Bay of Plenty is not high (11%) relative to the proportion of crashes in that district (15%), but Counties-Manukau (17%), Waikato (22%) and Waitemata (13%) are all higher than expected if the distribution was even.

Table 44 - Police district comparison of crashes involving drug use other than alcohol and cannabis

District	Opioids	Sedatives	Stimulants	Impairing drug but no alcohol or THC
Auckland	1	1	1	0
Bay of Plenty	2	3	6	3
Canterbury	3	4	3	1
Central	3	5	5	3
Counties Manukau	4	3	9	5
Eastern	2	2	4	1
Northland	5	8	4	5
Southern	2	4	0	1
Tasman	3	2	2	2
Waikato	2	2	12	2
Waitematä	1	4	7	6
Wellington	1	1	1	0
Total	**29**	**39**	**54**	**29**

A more detailed analysis of these numbers is required to determine the significance of the differences, if any, of drug use and their involvement in fatal crashes, within the Police districts.

Time of day at which crash occurs

Crashes occur throughout the day, but the characteristics of the driving population are likely to vary over this time. In this study it was found that most fatal crashes occur between midday and six pm (Table 45). This may be a reflection of a greater number of vehicles on the road over this time period. The following section looks at the variation of drug use throughout the day.

Table 45 -Time of day comparison of crashes involving drug use

Time of day	Unimpaired by alcohol or drugs (%)	Alcohol only (%)	THC only (%)	Alcohol and THC only (%)	Some other combination (%)	Total (%)
0000 - 0600	45 (8.2)	50 (37)	9 (9.4)	59 (42)	23 (18)	186 (18)
0600 - 1200	152 (28)	17 (13)	25 (26)	11 (7.7)	34 (27)	239 (23)
1200 - 1800	250 (46)	19 (14)	35 (36)	22 (15)	39 (31)	365 (35)
1800 - 2400	96 (18)	45 (33)	26 (27)	50 (35)	31 (24)	248 (24)
unknown	3	4	1	0	0	8
Total	**546**	**135**	**96**	**142**	**127**	**1,046**

In 52% of all crashes the deceased drivers showed no evidence of using a potentially impairing drug. But between the hours of midnight and six am only 24% of deceased drivers (45 of 186) had not used alcohol or other drugs. Between the hours of six am and six pm, drivers are less likely to have used an impairing substance. 67% of the drivers killed in a crash within this time period (402 of 604) had not used alcohol or other drugs.

Alcohol alone, or alcohol with cannabis, are more commonly found to have been used by drivers killed in a crash at night, between six pm and six am. When cannabis is used by itself the fatal crashes do not occur so frequently between midnight and six am, but are fairly evenly distributed over the rest of the day.

Table 46 shows that crashes involving prescription drugs, sedatives and opioids, are more common from six am to six pm.

Table 46 - Time of day comparison of crashes involving drug use other than alcohol and cannabis

Time of day	Opioids (%)	Sedatives (%)	Stimulants (%)	Impairing drug but no alcohol or THC (%)
0000 - 0600	3 (10)	3 (7.7)	9 (17)	3 (10)
0600 - 1200	7 (24)	12 (31)	14 (26)	9 (31)
1200 - 1800	14 (48)	14 (36)	14 (26)	13 (45)
1800 - 2400	5 (17)	10 (26)	17 (31)	4 (14)
Unknown	0	0	0	0
Total	**29**	**39**	**54**	**29**

The proportion of drivers using opioids (which include methadone), killed in a crash between midday and six pm, is at 48%, much higher than the proportion killed at other times of the day. Similarly a higher proportion of the drivers using sedatives are killed between midday and six pm but the difference with the other times of day is not as great. More drivers using stimulants are killed on the roads between six pm and midnight but these drivers' crashes are more evenly spread during daylight hours. The numbers of deceased drivers using drugs other than alcohol and cannabis is small and too much should not be read into these differences.

Road type

The types of roads on which crashes occur are generally defined as either urban or rural. The differentiation between urban and rural driving appears to be based on the speed limit on the road. A urban road is defined as one with a speed limit below 70 km/hr. A high proportion of fatal crashes occur on roads that are designated as state highways. These roads would be in better condition that a truly rural road and more frequently used. Therefore, for the following discussion the road type involved has been defined as urban, rural or state highway. A rural road is defined as a road with a speed limit of greater than 70 km/hr but is not a state highway.

Table 47 indicates that the proportion of fatal crashes analysed in this study that occurred on state highways was 54%, higher than the proportion on urban roads (16%) and rural roads (30%). This difference in proportions may be explained by the amount of traffic on these roads and the speeds involved.

Table 47 - Road type comparison of crashes involving drug use

Road type	Unimpaired by alcohol or drugs (%)	Alcohol only (%)	THC only (%)	Alcohol and THC only (%)	Some other combination (%)	Total (%)
Rural	157 (29)	58 (43)	27 (28)	41 (29)	34 (27)	317 (30)
State highway	330 (60)	56 (41)	53 (55)	61 (43)	64 (50)	564 (54)
Urban	59 (11)	21(16)	16 (17)	40 (28)	29 (23)	165 (16)
Total	**546**	**135**	**96**	**142**	**127**	**1,046**

Table 47 shows that of the 135 crashes that involved alcohol use only, 43% were on a rural road, higher than the proportion for all drivers killed on rural roads. The proportions of fatal crashes involving only cannabis use are similar to the proportions of all road deaths in this study. However, when considering fatal crashes on the urban roads, the combined use of alcohol and cannabis is more common that use of these drugs by themselves.

Because there are so few crashes that involve drugs other than cannabis and alcohol the significance of any differences are doubtful. Also, as discussed earlier, use of these drugs was often combined with alcohol and/or cannabis. The proportions of stimulant or opioid use on the different types of roads were similar to the proportions found for all of the road deaths (Table 48). However, where the driver had been using sedatives or the other impairing drugs, a higher proportion of these crashes occurred on state highways.

Table 48 - Road type comparison of crashes involving drug use other than alcohol and cannabis

Road type	Opioids (%)	Sedatives (%)	Stimulants (%)	Impairing drug but no alcohol or THC (%)
Rural	7 (24)	8 (21)	15 (28)	5 (17)
State highway	16 (55)	27 (69)	28 (52)	20 (69)
Urban	6 (21)	4 (10)	11 (20)	4 (14)
Total	**29**	**39**	**54**	**29**

Motorbikes and trains

There were 174 fatal crashes in which the deceased was riding a motorbike, 17% of all the crashes considered in this study. 55% of the motorbike riders (95 of 174) had no alcohol or other drugs in their blood. This is slightly higher than the proportion of all unimpaired drivers in this study (Table 49). In the 18 fatal crashes involving trains, only three had used a possibly impairing drug.

Table 49 - Drug use in motorbike and train crashes

	Unimpaired by alcohol or drugs (%)	Alcohol only (%)	THC only (%)	Alcohol and THC only (%)	Some other combination (%)	Total
All crashes	546 (52)	135 (13)	96 (9.2)	142 (14)	127 (12)	**1,046**
Motorbike	95 (55)	14 (8)	23 (13)	21 (12)	21 (12)	**174**
Train	15 (83)	0	1	1	1	**18**

The proportion of those on motorbikes who had used cannabis and alcohol together or some other combination of drugs, was not greatly different from the proportion for all drivers. Alcohol was not used as much by the motorbike riders (8%), compared with alcohol use by all of the deceased drivers (13%). Cannabis was used more often by those riding motorbikes (13% compared with 9.2% for all drivers in this study who used only cannabis). The ratio of all crashes to motorbike crashes is 6: 1.

Table 50 gives the number of crashes involving motorbikes and trains where the drivers have used drugs other than alcohol or cannabis. The ratio for opioid use crashes is 4.8: 1 indicating a higher proportion of opioid use in motorbike riders. A

similar ratio (4.9: 1) was obtained for motorbike riders using stimulants. The ratio for crashes involving sedative use was 7.8: 1, indicating a lower proportion of sedative use (Table 50).

Table 50 - Drug use not including cannabis or alcohol in motorbike and train crashes

	Opioids	Sedatives	Stimulants	Impairing drug but no alcohol or THC
All crashes	29	39	54	29
Motorbike	6	5	11	3
Train	0	0	1	0

Summary

The significance of the involvement of drug use in relation to fatal crashes in the different Police districts will need a more detailed analysis than is possible with the data available in this study.

If the time of day of the crash, or the type of road on which a crash occurs, are considered, there is a variation in the proportion of drivers using alcohol and other drugs compared with all deceased drivers. Alcohol use, with or without other drugs is more prevalent at night time (six pm to six am). Cannabis use alone and use of other potentially impairing drugs is found in a higher proportion of drivers killed during day time (six am to six pm). Alcohol use only is found in a higher proportion of drivers killed on state highways and other rural roads.

Drug use other than alcohol or cannabis is minimal and little significance can be placed on the proportional differences observed when other drugs are used.

Appendix 11: Occupation - driver

An Australian study found that a higher proportion of deceased drivers whose occupation was a 'driver' had used methamphetamine, when compared with the overall deceased driver population [13]. The following considers evidence of drug use found in NZ deceased drivers whose occupation was documented as 'driver'.

Occupation - driver

Some people drive for a living, putting them on the road for a greater proportion of the time compared with those who do not. In the population of deceased drivers there were 66 drivers whose occupation was documented as a driver. There were a considerable number of deceased drivers whose occupation was unknown (281 of 1,046, 27%) so there could have been more drivers. Where the deceased driver has the occupation of driver, it is not known if the deceased was working at the time of the crash.

Table 51 - Drug use in deceased drivers – occupation driver

Occupation	Unimpaired by alcohol or drugs (%)	Alcohol only (%)	THC only (%)	Alcohol and THC only (%)	Some other combination of drugs (%)	Total (%)
Driver	49 (74)	4 (6.1)	5 (7.5)	3 (4.5)	5 (7.5)	**66**
Total	546 (52)	135 (13)	96 (9.2)	142 (14)	127 (12)	**1,046**

Table 51 shows that 6% of deceased drivers (66 of 1,046) had the occupation of driver. Alcohol and other drug use was lower in this 'occupation-driver' subset of the deceased driver population when compared with the overall population. It must be acknowledged that this may not be representative of the 'driver' driving population particularly if it is considered that a driver in a big truck is more likely to survive a crash than a driver in a car. In this study there were 175 crashes that involved trucks as the other vehicle.

None of the 66 deceased 'drivers' had used opioids or sedatives. Stimulants are anecdotally considered a concern with those who drive for a living, particularly those driving long distances. In this study three of the 66 (4.5%) deceased, whose occupation was driver, had stimulants in their blood. This can be compared with

stimulant use in 54 of the 1,046 (5.1%) deceased drivers in the whole of the deceased driver population studied.

Of the 1,999 uninjured drivers whose blood was taken and tested for evidence of drug use, 67 had given their occupation as some type of driver. Again, it is not known if the samples were taken while the driver was working or not. These were uninjured drivers who would generally be screened by a breath alcohol device, so there should be no zero alcohol results. The blood alcohol levels found in these drivers is given in Table 52.

Table 52 - Blood alcohol levels in uninjured drivers – occupation driver

Blood alcohol levels	Number
<5	1
5 to 30	0
3 to 80	4
81 to 160	35
161 to 240	25
>240	2
Total	**67**

There was no indication of the use of methamphetamine or morphine by any of these drivers. One driver had indications of use of a benzodiazepine. There were indications of cannabis use in 28% (19 of 67) of the uninjured drivers whose occupation was a driver [7, 8].

Appendix 12: Alcohol in hospitalised drivers

The original study proposal included analysis of blood samples taken from drivers, hospitalised as a result of a crash, for evidence of drug use. This did not happen due to legislative restrictions on re-analysis of blood samples taken for prosecution purposes. The following discusses some of the issues that may arise if a study of hospitalised drivers is carried out.

Hospitalised drivers

An issue that needs to be considered when studying hospitalised drivers is the delay between the time of the crash and the time the sample of blood is obtained. This could be several hours during which alcohol and other drugs will be removed from the body by metabolism and excretion processes. This means that levels of alcohol or other drugs present at the time of the blood sampling may be much lower than the levels existing at the time of the crash. Furthermore administration of drugs by medical personnel, in particular opioids or benzodiazepines, could also mask the use of similar drugs by the driver.

Analysis of the blood taken from deceased drivers and from uninjured drunk drivers indicates that drug use is prevalent in both driving populations. The distribution of blood alcohol levels found in the deceased drivers, hospitalised drivers and uninjured drivers is shown in Graph four, in the alcohol analysis of deceased drivers section. This graph considers the proportion of drivers from each driving population when alcohol is detected. Both the deceased driver and hospitalised driver population have a number who have not used alcohol.

Table 53 shows the numbers of evidential blood samples received at ESR laboratories for analysis for the presence of alcohol, each year over the period covered by the deceased driver study. The numbers of samples submitted from hospitalised drivers has remained fairly steady while the total number of samples has increased.

Table 53 - Numbers of evidential blood samples received

Financial year starting	Number of blood samples received	Number of hospitalised drivers
1/7/04	5,698	1,636
1/7/05	5,571	1,575
1/7/06	6,222	1,676
1/7/07	6,679	1,682
1/7/08	7,298	1,676

It is unclear if the blood samples received at ESR are representative of the hospitalised driver population. It is possible that the blood samples taken from hospitalised drivers form a biased population. A driver who is suspected of alcohol use or is considered at fault for the crash may be more likely to have a blood sample taken than otherwise.

The fatal crash reports analysed as part of this study showed that, over the five years, there were 534 drivers who were involved in a fatal crash and survived. Not all of these drivers would have been seriously hurt and many may not have required hospitalisation. They may have passed a breath alcohol test. If so, no blood sample would have been taken. However, 131 of these drivers were documented as being seriously injured.

By examining the database of evidential blood samples received at ESR it was found that a blood sample was taken from 27% (145 of 534) of the surviving drivers. These had been sent to ESR to be tested for the presence of alcohol. Blood samples were received from 61% (80 of 131) of the drivers who were documented as being seriously injured.

Of the 145 surviving drivers who did have blood taken, 118 (81%) had a zero blood alcohol level. Only seven of these drivers were tested, on request by the investigating officer, for evidence of drugs use. All seven drivers tested were found to have used drugs prior to the crash.

Clearly evidential blood samples are not taken from all drivers involved in a road fatality. We have no idea of the proportion of injured drivers (not involved in a crash

fatality) that have evidential blood samples taken. While analysis of the blood samples taken from hospitalised drivers is now possible with the amendment made to the Land Transport Act in 2009, it would be acknowledged that the blood samples received at ESR from this driving population will be a biased group. Should a study of drug use in hospitalised drivers be carried out bias may be reduced by advertising the study or asking particular hospitals to take part. This may give an accurate picture for that catchment area.

Drug use by drivers hospitalised as a result of a crash would be an interesting part of the driving population to study. The population would be divided into those that have alcohol and those who do not. The drunk uninjured drivers already studied [7, 8] showed 35% of these drivers had possibly used cannabis as well as alcohol.

The alcohol levels found in the blood samples sent to ESR from hospitalised drivers over a period of six months are given in Table 54. Of the 785 blood samples received, 45% contained no alcohol.

Table 54 - Blood alcohol levels in hospitalised drivers from January 2009 to June 2009 inclusive

Alcohol level (mg/100 mL)	Number	%
0 [<5]	355	45
5 to 30	20	2
31 to 80	47	6
81 to 160	182	23
161 to 240	150	19
>240	31	4
Total	**785**	

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