VEHICLE OCCUPANTS NOT WEARING A SEAT BELT

An analysis of fatalities and traffic offences in New Zealand

FINAL REPORT

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Authorship: This document was written by Lily Hirsch (Mackie Research), Gerald Waters (RIDNZ), Richard Scott (Mackie Research), Hamish Mackie (Mackie Research) and John de Pont (TERNZ). For further information, please contact Hamish Mackie using the contact details below.

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Physical address
Level 2 Princes Court
2 Princes Street
Auckland 1010

Postal address
PO Box 106525
Auckland City
Auckland 1143

Contact
Hamish Mackie
MB 021 067 0337
Email: hamish@mackieresearch.co.nz

www.mackieresearch.co.nz

EXECUTIVE SUMMARY

There is an increased risk of death or serious injury for occupants who did not wear a seat belt in a crash (Høye 2016). Recent studies have also identified a number of risk factors associated with vehicle occupants who did not wear a seat belt and were killed, which include: vehicle factors; time of day; age; gender; ethnicity; education; and a history of previous offences (see Figure 4 and Appendix A).

In New Zealand, seat-belt wearing rates are high, yet non-seat belt fatalities accounted for 19-30% of overall motor vehicle occupant road deaths between 2006 and 2016. Over this period, the proportion has fluctuated but in 2015 and 2016 non-seat belt fatalities accounted for 29-30% of overall motor vehicle occupant road deaths (CAS query 2017). Note that this is likely to be an under-estimate of the true figures as there are a number of "unknown" cases for seat belt wearing.

The fact that these potentially preventable deaths are not decreasing is an issue worthy of investigation. It is important to better understand the contextual factors associated with crashes where seat belts are not worn, so that more relevant and effective road safety interventions can be designed and implemented.

Study aims

The aim of this research was to determine profiles for seat belt non-users who were killed in motor vehicle crashes, and to better understand trends in seat belt non-use offences. Related to this aim, the following research questions were examined:

- Over the past 5-10 years, how have the levels of people fatally or seriously injured while not wearing a seat belt changed?
- Are there any obvious patterns to crashes including geographic? Seasonal? Temporal?
- Are there any demographic patterns that can be established including age, gender, or any others that the data can reveal?
- What other factors are commonly associated with crashes where seat belts are not being worn such as speed, alcohol or drugs, distraction, vehicle type, drivers vs passengers?

Method

Following a review of the academic and non-academic literature (see Figure 4 and Appendix A), the method involved four key parts:

1. Crash Factors Analysis: In-depth Analysis of 200 Non-Seat Belt Fatalities: 200 fatalities from 2011-2015 were analysed in depth, using a Safe System framework, using Traffic Crash Reports and Serious Crash Unit reports;
2. Non-Seat Belt and Traffic Offence History Analysis
    a) Detected Non-Seat Belt Offenders 2012-2016: An analysis of NZ Police data to understand seat belt infringements, demographic analysis (age, sex);
    b) Non-Seat Belt Offences 2017, and the Offender's Traffic Offence History: Traffic offence history for those issued with a notice for not wearing a seat belt between January and March 2017;

c) **Deceased Vehicle Occupant Traffic Offence History 2012-2016:** Traffic offence history for fatally injured occupants who were not wearing seat belts;

3. **Integration of Findings:** To get a richer understanding of those killed in crashes where seat belts weren't used, data were matched, where possible, from the *Crash Factors Analysis* and the *Deceased Vehicle Occupant Traffic Offence History* data.
4. **Cluster Analysis and Profile Development:** A cluster analysis was applied to the crash factors to identify occupant profiles for those killed while not wearing seat belts.

Summary of findings

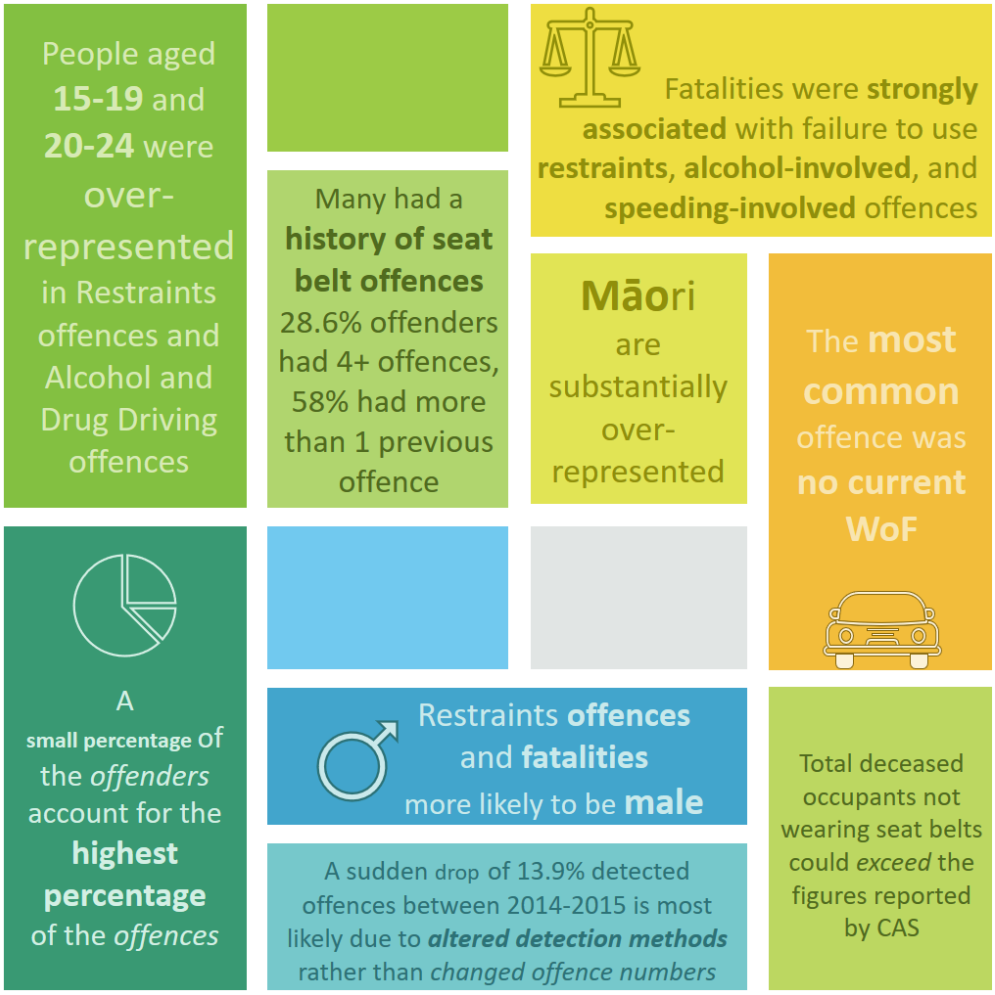
Crash Factors Analysis

A summary of the key findings from the in-depth analysis of 200 fatal crashes where seat belts were not worn are presented below.

The findings from the *Crash Factors Analysis* generally support previous literature in that alcohol and younger males are clearly associated with non-seatbelt wearing fatalities. However, there are a range of other people and contexts also associated. Note that this analysis does not compare the deceased non-seat belt wearing cohort with those who do not wear seatbelts but who have not died. However, the analysis may reflect those who are alive and at most risk.

Non-seat belt and traffic offences analysis

A summary of key findings from the analysis of traffic offence data from the *Non-Seat Belt and Traffic Offence History Analysis* are displayed below.



The high prevalence of young males and risky driving behaviours was consistent with the literature and *Crash Factors Analysis*. Furthermore, a disproportionately small group of people seem to account for a relatively large share of offences. However, there were limitations in the personal and contextual information available for offending data.

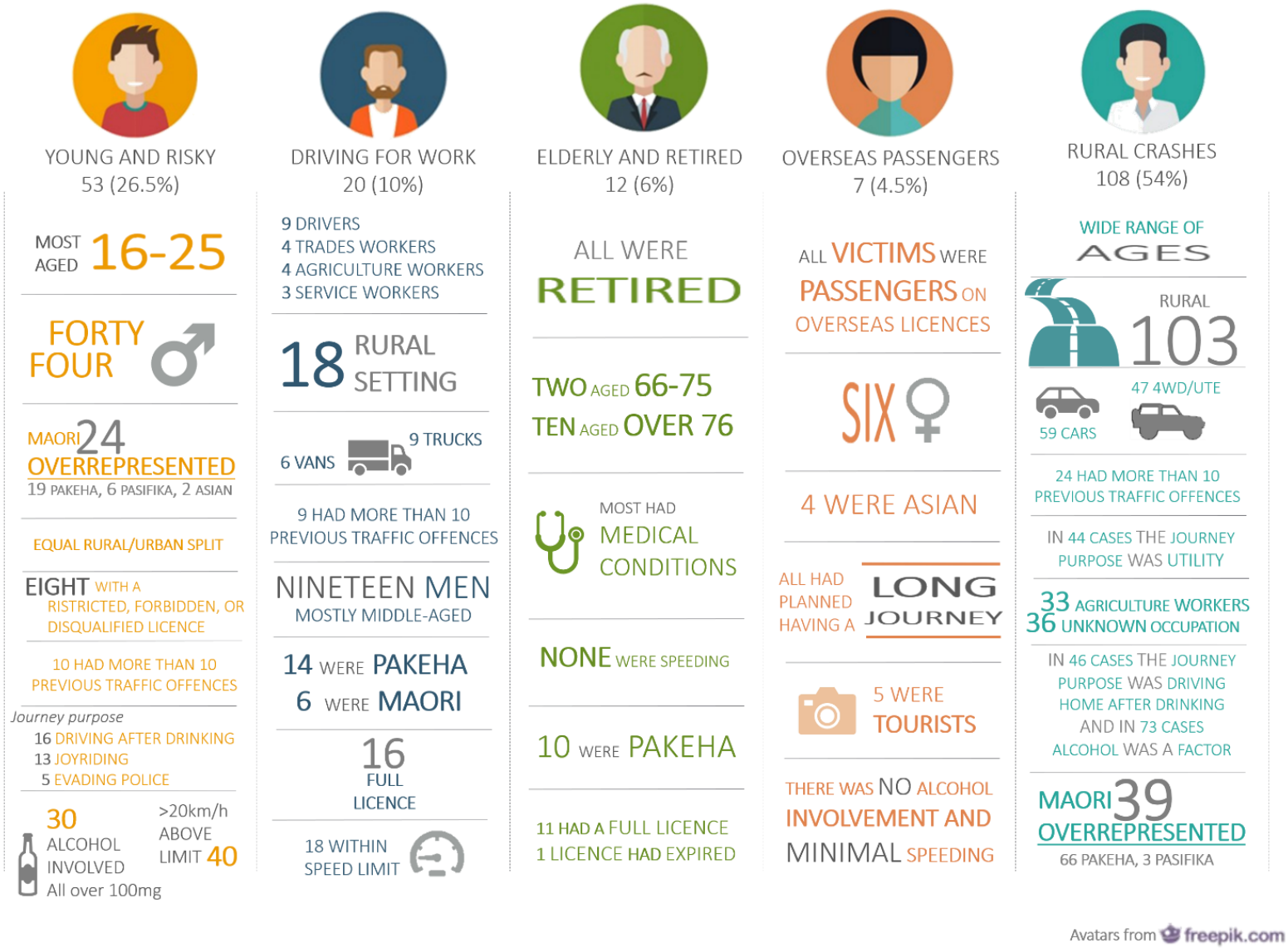
Given that Vehicle registration/WoF offences was one of the most common categories, care is needed to differentiate these lower level offences with higher-risk offences when drawing conclusions.

There are differences in the number of non-seatbelt wearing fatalities, between the CAS database and NZ Police-held data, most likely due to different parameters applied to each database. This may have implications for understanding trends in the data.

Cluster Analysis of Occupant Profiles

Using the earlier *Crash Factors Analysis* of 200 fatalities, five profiles of people who were fatally injured in crashes and who were not wearing a seat belt emerged from the cluster analysis (Figure 1). Six cases were influenced by a data integration exercise using the *Deceased Vehicle Occupant Traffic Offence History 2012-2016 data.*

Figure 1: Occupant Profiles



While young risky males were clearly an important group, a range of people and contexts for those killed in non-seat belt crashes emerged from the cluster analysis. This has implications for road safety interventions, as a variety of motivations and influences are likely to be at play, depending on the people involved. For the subset of data matched between the *Crash Factors Analysis* and *Non-Seat Belt and Traffic Offences Analysis*, traffic offending was spread relatively evenly across four of the five profiles, although those driving for work in particular, appeared to have a high number of repeat offenders.

Discussion

A concerningly high number of people are still being killed in crashes where seat belts are not being worn and hence urgency to address this issue is warranted. If it is assumed that those most at risk of being killed in non-seat belt crashes match the profiles developed in this study, then a range of approaches may be needed for effective intervention, depending on the people and contexts involved.

Based on the findings from this study, the following actions are recommended:

- Understanding if differences exist between the offence (traffic and non-traffic) history of people who do and do not wear seat belts and who die in crashes. This may give more insight into the profiles that have been developed in this report.
- Based from the profiles developed in this report, it is suggested that a next step is to understand *why* occupants do not use seat belts. This would require a different research approach, focussing on the system factors that influence people's actions.
- Following this deeper understanding of *why* people do not use seat belts, more tailored and evidence-based road safety initiatives can be designed and more efficiently and effectively targeted.

CONTENTS

GLOSSARY AND ABBREVIATIONS

ACC .....Accident Compensation Cooperation

APNR.....Automatic Number Plate Recognition

BST.....Breath Screening Tests

CAS..... Crash Analysis System

GDLS ..... Graduated Driver Licence System

ION.....Infringement Offence Notice

LDP..... Licensed Driving Population

MoT .....Ministry of Transport

NIA ..... National Intelligence Application

NZTA .....New Zealand Transport Agency

PIB.....Police Infringement Bureau

PIPS.....Police Infringement Processing System

RC .....Regional Council

SCU ..... Serious Crash Unit

TCR.....Traffic Crash Report

WoF .....Warrant of Fitness

BACKGROUND AND AIM

Seat belt use and fatalities in New Zealand

It has been well-established that seat belts substantially reduce the likelihood of injury or death in a crash. Indeed, by wearing a seat belt during a crash, an occupant's chances of survivability are increased by 60% in the front seats, and 44% in the rear seats (Høye 2016).

In New Zealand, with some exemptions[1], it is an offence to drive, or be an occupant of a motor vehicle without wearing a seat belt or restraint. However, vehicle occupant surveys suggest that whilst there is generally a high level of compliance with seat belt laws in New Zealand (Ministry of Transport 2014, Ministry of Transport 2016a)[2], the rate of seat belt use has plateaued or reduced slightly since 2014. In addition, the number of fatally injured motor vehicle occupants (excluding buses and tractors) increased by 10% from 2011 to 2016 (CAS query 2017). These changes may impact non-seat belt fatalities in the coming years.

On average, since 2006, excluding buses and tractors, 63 people in road crashes who did not wear a seat belt died in New Zealand each year (Figure 2). In addition, non-seat belt fatalities accounted for an average of 26% of overall motor vehicle occupant road deaths (excluding buses and tractors) between 2006 and 2016 (Table 1). Over this period, the proportion has fluctuated but in 2015 and 2016 non-seat belt fatalities accounted for 29-30% of overall motor vehicle occupant road deaths (CAS query 2017). Note that this is likely to be an under-estimate of the true figures as there are a number of "unknown" cases for seat belt wearing.

[1] Exemptions include: medical reasons; occupations that involve frequent vehicle stops; and vehicles that do not have restraint equipment fitted. For more information see (New Zealand Transport Agency, 2016).

[2] Wearing rates are measured by the Ministry of Transport in an annual survey (front seat) and biannual survey (rear seat). The surveys are conducted between November and December in over 100 locations around New Zealand. Surveys are held between 2pm and 4pm on Sundays during the school term. Only adults in window positions are included in the surveys.

Figure 2: Seat belt usage rates and road fatalities in New Zealand 2006-2016 (CAS query 2017, see Appendix D)

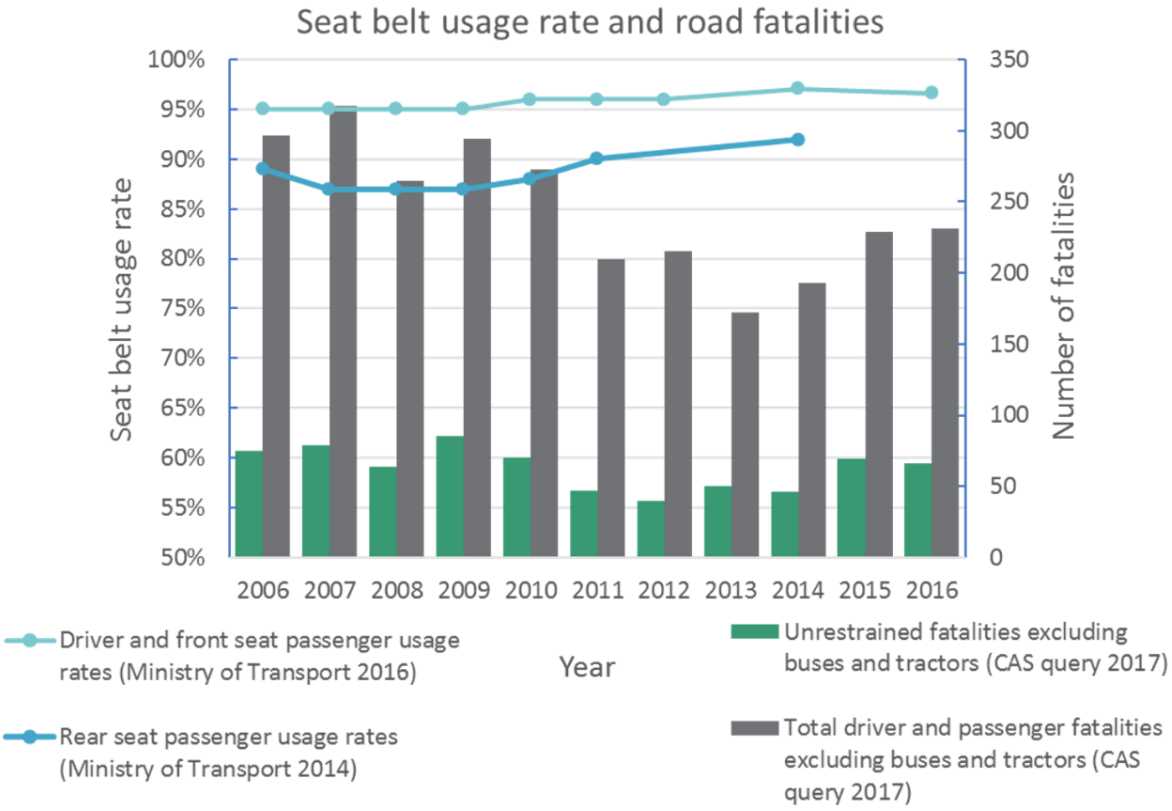


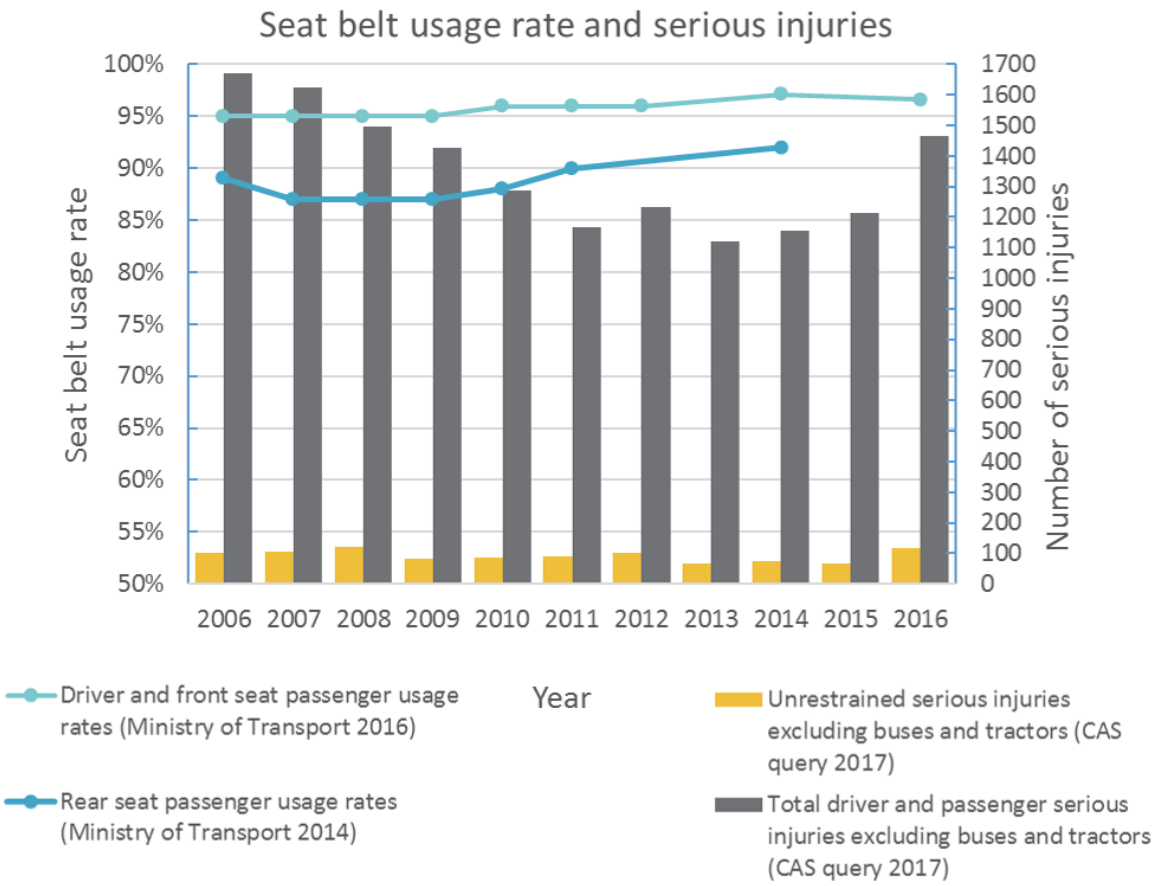
Table 1: Non-seat belt fatalities as a proportion of motor vehicle occupant deaths (excluding buses and tractors) (CAS query 2017)

Year	Non-seat belt fatalities as a proportion of motor vehicle occupant deaths
2006	25%
2007	25%
2008	24%
2009	29%
2010	26%
2011	22%
2012	19%
2013	29%
2014	24%
2015	30%
2016	29%

Please note that the numbers for non-seat belt fatalities reported in Figure 2 varies from numbers reported elsewhere (New Zealand Police 2017, NZ Transport Agency 2017a). This may be due to the variety of search parameters available in CAS, or because of the stages of reporting between the Fatal Traffic Notification database and CAS. This issue is explained in more detail in the discussion section under 'differences in data-sets'.

When examining serious injury outcomes as opposed to fatal, the proportions significantly differ. On average, since 2006, excluding buses and tractors, 92 people not wearing seat belts were seriously injured in road crashes in New Zealand each year (Figure 3). However, between 2006-2016, in only 6.8% of all motor vehicle serious injury cases (excluding buses and tractors) were seat belts not worn[3]. These lower proportions are unsurprising and reflect the higher likelihood of a fatal outcome in cases where a seat belt is not worn due to the physics involved in crash forces.

Figure 3: Seat belt usage rates and road serious injuries in New Zealand 2006-2016 (CAS query 2017, see Appendix D)



[3] Note that this is likely to be an under-estimate of the true figures as there are a number of "unknown" cases for seat belt wearing.

Table 2: Non-seat belt serious injuries as a proportion of motor vehicle occupant serious injuries (excluding buses and tractors) (CAS query 2017)

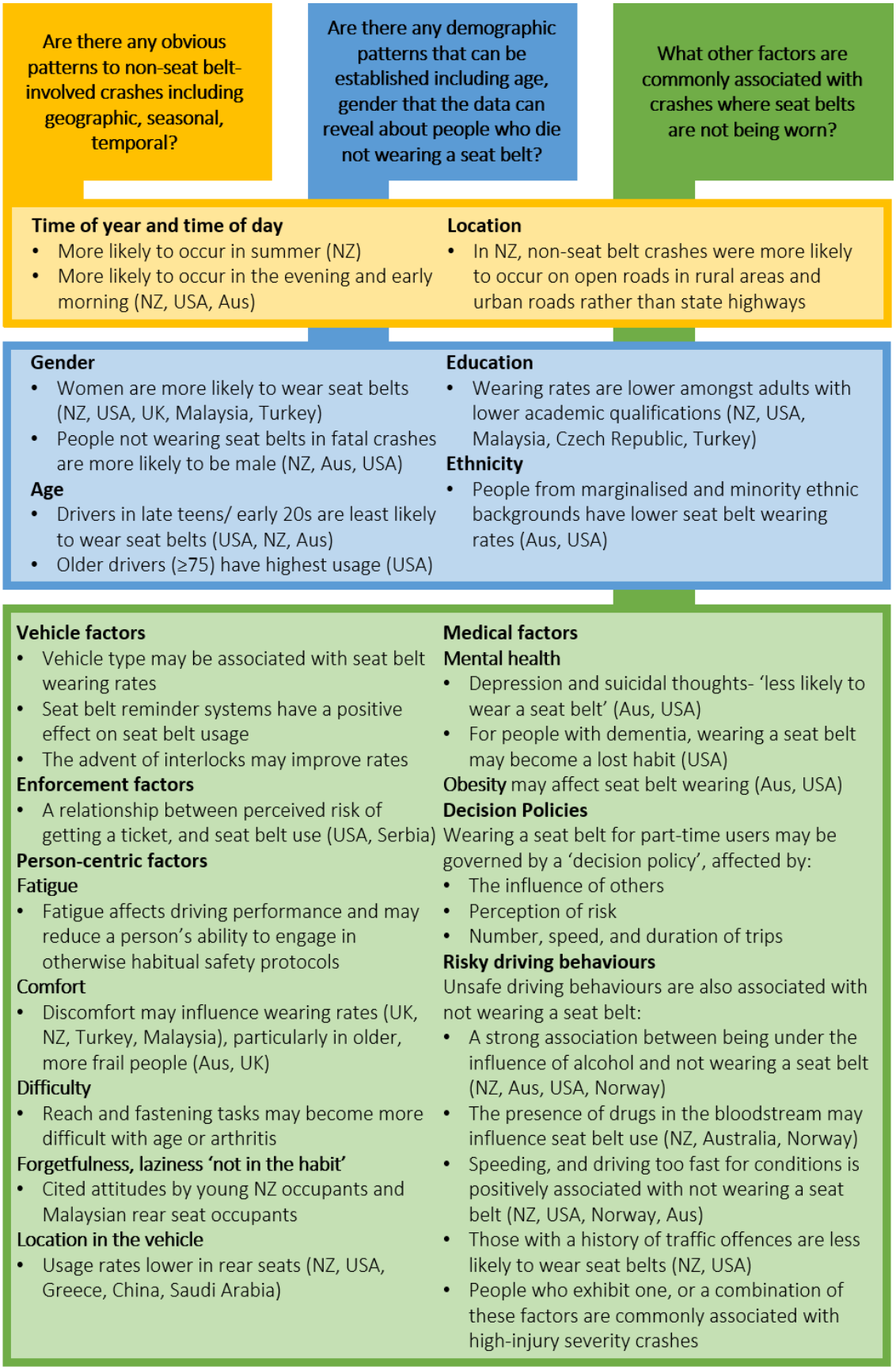
Year	Non-seat belt serious injuries as a proportion of total serious injuries (excluding buses and tractors)
2006	6.0%
2007	6.5%
2008	8.0%
2009	5.8%
2010	6.6%
2011	7.6%
2012	8.3%
2013	6.1%
2014	6.6%
2015	5.5%
2016	8.0%

The fact that these preventable deaths and serious injuries are not decreasing is an issue. It is therefore important to better understand the contextual factors associated with the non-use of seat belts so that more relevant and effective road safety interventions can be designed and implemented.

Factors commonly associated with non-seat belt use

A literature review was conducted to better understand the patterns of factors surrounding seat belt non-use, both in New Zealand and abroad. The review focused on seat belt use for people aged fifteen years and over. It did not include information about child restraints as this was beyond the scope of the project. In this section we present a summary of the review's findings (Figure 4). For the detailed review with citations, please refer to Appendix A.

Figure 4: Overview of factors associated with non-seat belt use



Knowledge gaps

As demonstrated in Figure 4, a sound understanding of the variables associated with non-seat belt use, both in New Zealand and internationally exists. In addition, there is a wealth of information relating to the non-use of seat belts as a traffic offence. However, what is less well understood is how those factors combine to reflect the various 'profiles' of people who did not wear seat belts and who were killed in road crashes.

By better understanding 'who' does not wear seat belts, future research may more efficiently focus on 'why' particular user groups do not wear seat belts. This richer understanding can then inform better and more targeted interventions. Figure 5 shows the logic of moving from current knowledge in this area to better road safety initiatives (and ultimately fewer deaths and serious injuries related to seat belt non-compliance). The new understanding provided by this work is represented by the second box.

Figure 5: Where this research sits in the wider context

Aim

The aim of this research is to determine profiles for seat belt non-users who were killed in road crashes, and to better understand historical traffic offence trends of seat belt offenders. By investigating crash data as well as traffic offence data, this research aims to fill the knowledge gap by better understanding the combination of factors in various contexts that are more strongly associated with non-seat belt fatalities.

The following research questions were examined:

1. Over the past 5-10 years, how have the levels of people fatally or seriously injured while not wearing a seat belt changed?
2. Are there any obvious patterns to crashes including geographic? Seasonal? Temporal?
3. Are there any demographic patterns that can be established including age, gender, or any others that the data can reveal?
4. What other factors are commonly associated with crashes where seat belts are not being worn such as speed, alcohol or drugs, distraction, vehicle type, drivers vs passengers?

To some extent, aspects of these questions have already been addressed by the studies outlined in the literature review. However, to better understand the combination and pattern of factors (or victim profiles) associated with non-seat belt fatalities in New Zealand, more in-depth descriptions of seat belt-non-users will be determined from the Crash Analysis System (CAS) SCU data and NZ Police data.

Structure of this report

For ease of comprehension, this report is structured through four self-contained sections. Each is organised in the same structure: aim; method; findings; and discussion. The four parts to the research are as follows:

1. Crash Factors Analysis: In-depth analysis of 200 non-seat belt fatalities 2011-2015
2. Non-Seat Belt and Traffic Offence History Analysis
    a) Detected Non-Seat Belt Offenders 2012-2016
    b) Non-Seat Belt Offences 2017, and the Offender's Traffic Offence History
    c) Deceased Vehicle Occupant Traffic Offence History 2012-2016
3. Integration of Findings
4. Cluster Analysis of Occupant Profiles

A discussion of the overall findings, study limitations, and recommendations is presented at the end of this report.

Throughout this report, people who did not wear seat belts and who died in road crashes are described. For simplicity, they will be referred to as 'non-seat belt fatalities'.

1. CRASH FACTORS ANALYSIS: IN-DEPTH ANALYSIS OF 200 NON-SEAT BELT FATALITIES

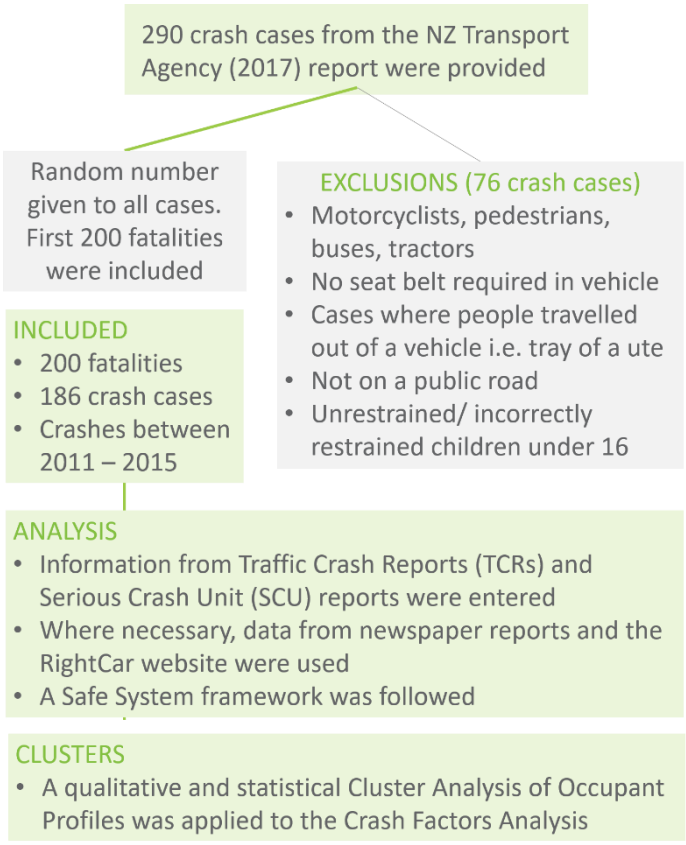
1.1 Aim

The aim of the study was to better understand the factors which are associated with fatal crashes in New Zealand where a seat belt was not worn. This section was designed to feed directly into the *Cluster Analysis of Occupant Profiles* which provides an understanding of the pattern of factors associated with non-seat belt crashes and subsequently the profiles of those involved.

1.2 Method

The 290 crash cases between 2011-2015 used in the NZ Transport Agency (2017b) report were provided to form the sample for this analysis. From the 290 cases, 76 were excluded as they did not fit within the parameters of this research (Figure 6). Each eligible crash case was assigned a randomly generated number, and crash cases were analysed until 200 fatalities were reached. In total, 186 crash cases were analysed for this research.

Figure 6: Summary of Method (Crash Factors Analysis)



The goal for the analysis was to understand the full context relating to fatalities where seat belts had not been worn. To achieve this, information from the Crash Analysis System (CAS) in the form of Traffic Crash Reports (TCRs) and Serious Crash Unit (SCU) reports were coded following a Safe System (Larsson and Tingvall 2013, New Zealand Government and National Road Safety Committee 2016) framework.

In some cases, where information (such as ethnicity and occupation) was missing from the CAS data, this was sourced from newspaper reports as they often report on coroner's findings. This was particularly useful for passenger details, as SCU information is generally focused on drivers.

The coding framework examined factors relating to: speed; roads and roadsides; vehicles; and users. As the aim of the research was ultimately to understand user behaviour in relation to seat belt use, the user category was investigated in-depth, whereas the other categories were more superficially explored. An outline of the coding framework is presented in Figure 7.

One analyst was engaged to code the CAS data into a spreadsheet. Each fatality was assigned a separate row. To ensure coding rigour, ten 'test' cases were initially coded by the analyst. Two authors of this report familiarised themselves with the TCR and SCU reports from the ten cases and cross-checked these with the entered data. There was a strong level of agreement between all three parties that the test coding was accurate, which is understandable given that this exercise mostly involved identifying data, rather than subjective coding. Furthermore, any queries were discussed among the team, prior to any summary analysis.

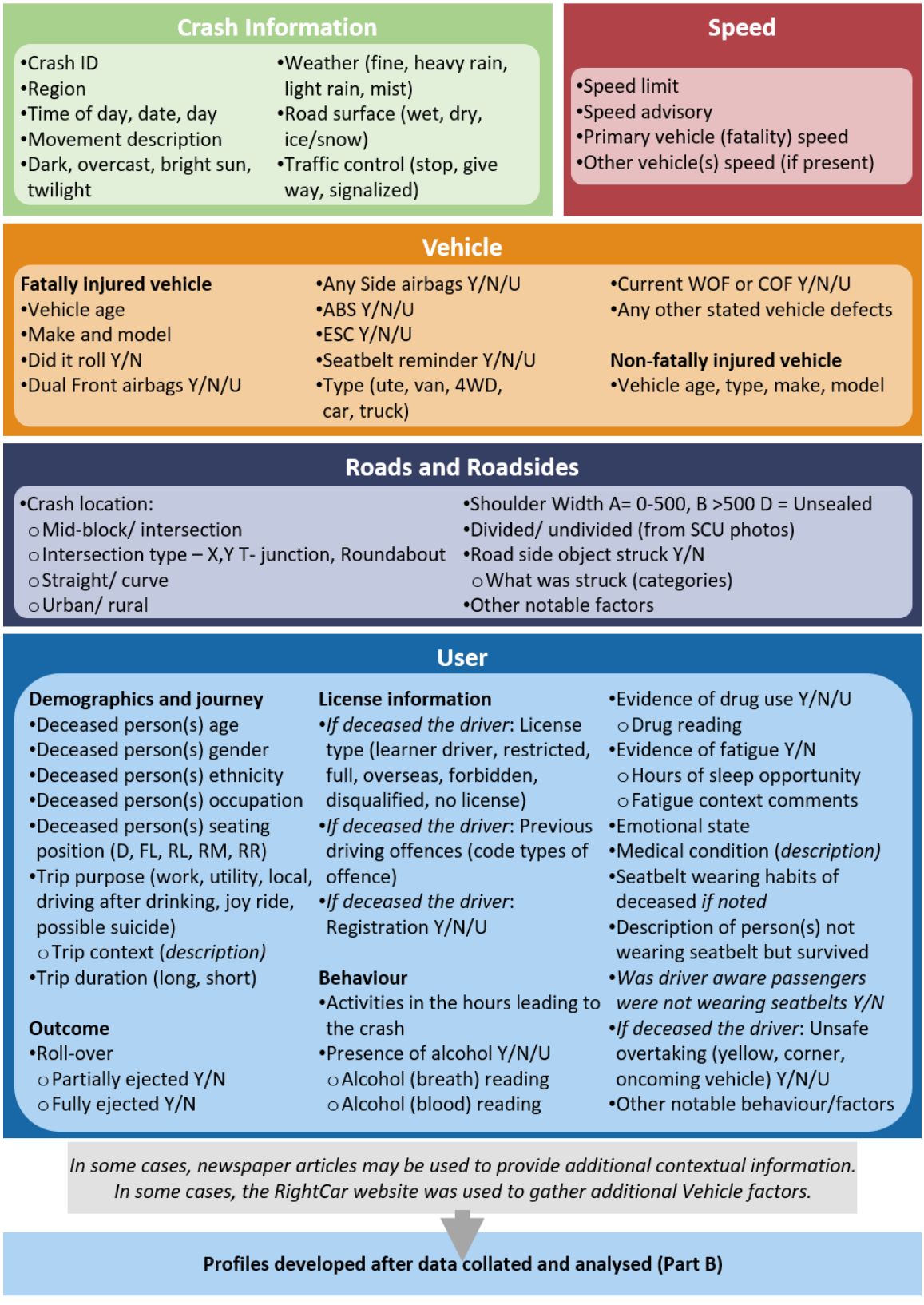
The outcome from this analysis was a description of factors associated with crashes. These were used in the creation of profiles (as described *Section 4: Cluster Analysis of Occupant Profiles*).

1.2.1 Coding notes:

- 'Utility trips' included trips from one town or city to another, trips to or from work, trips to shops, or to visit friends etc.;
- Tourists were classified as undertaking utility trips, but were identified as tourists from details in the SCU report. They were coded as tourists under 'trip context';
- A 'joy ride' included young teenage men in stolen cars, or driving at speed back and forth along the same stretch of road;
- If the SCU report indicated that the most likely explanation for the crash was the driver falling asleep, fatigue was coded as a factor. In addition, consideration was given to the time that the crash occurred, and how long the driver had been awake (if mentioned). Fatigue crashes often involved a gradual drifting off the road to the left or right. Therefore, fatigue was not implicated in cases where there was clear evidence of steering input prior to the crash, or if the driver had started the trip within 30minutes of the crash occurring;
- The legal alcohol limits changed during the timeframe that the study covered:
    - Prior to 1/12/2014, the legal blood alcohol limit for people over 20 years of age was 80mg per 100ml (0.08).
    - After 1/12/2014, the legal blood limit for people over 20 years of age was 50mg per 100ml (0.05).
    - For drivers under 20 years of age, a zero-limit existed for both time periods;
- For this report, the definition of rural versus urban was based on photographs from the crash scene that were displayed in the SCU reports. An urban area was classified as having a high density of buildings, and urban motorways were also included. A rural area included farmland, forest, and/or a low density of buildings. Speed was not used to

identify a rural versus urban location as the measurement is too crude (complicating factors can include urban motorways and temporary speed restrictions on rural roads), but a rural road context did contribute to this assessment.

Figure 7: Method followed for in-depth analysis using SCU and CAS data

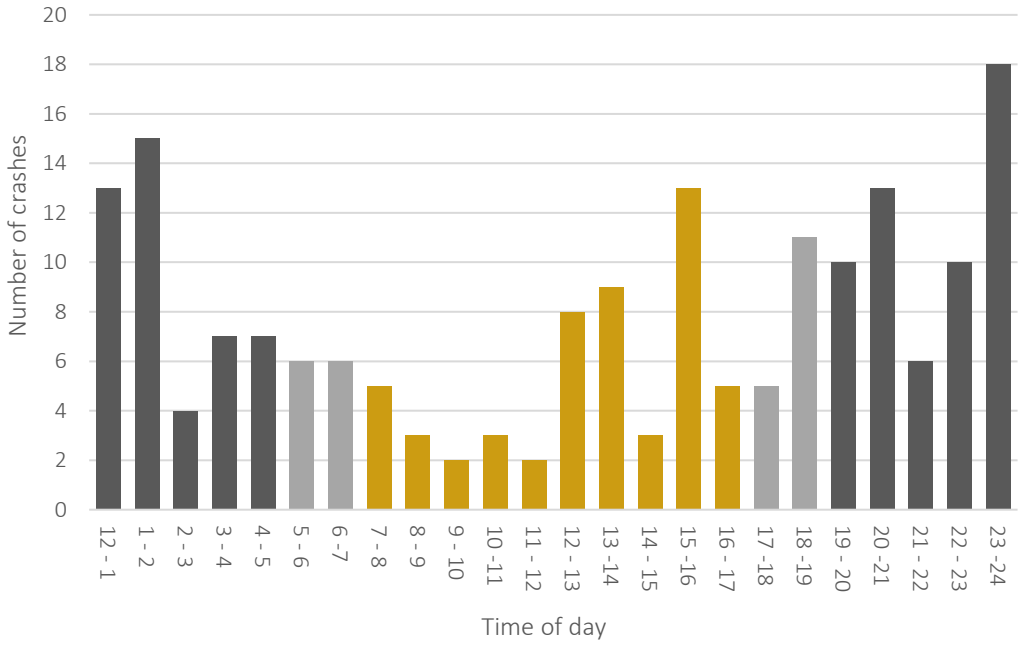


1.3 Findings

1.3.1 Are there any obvious patterns to crashes including geographic, seasonal, temporal?

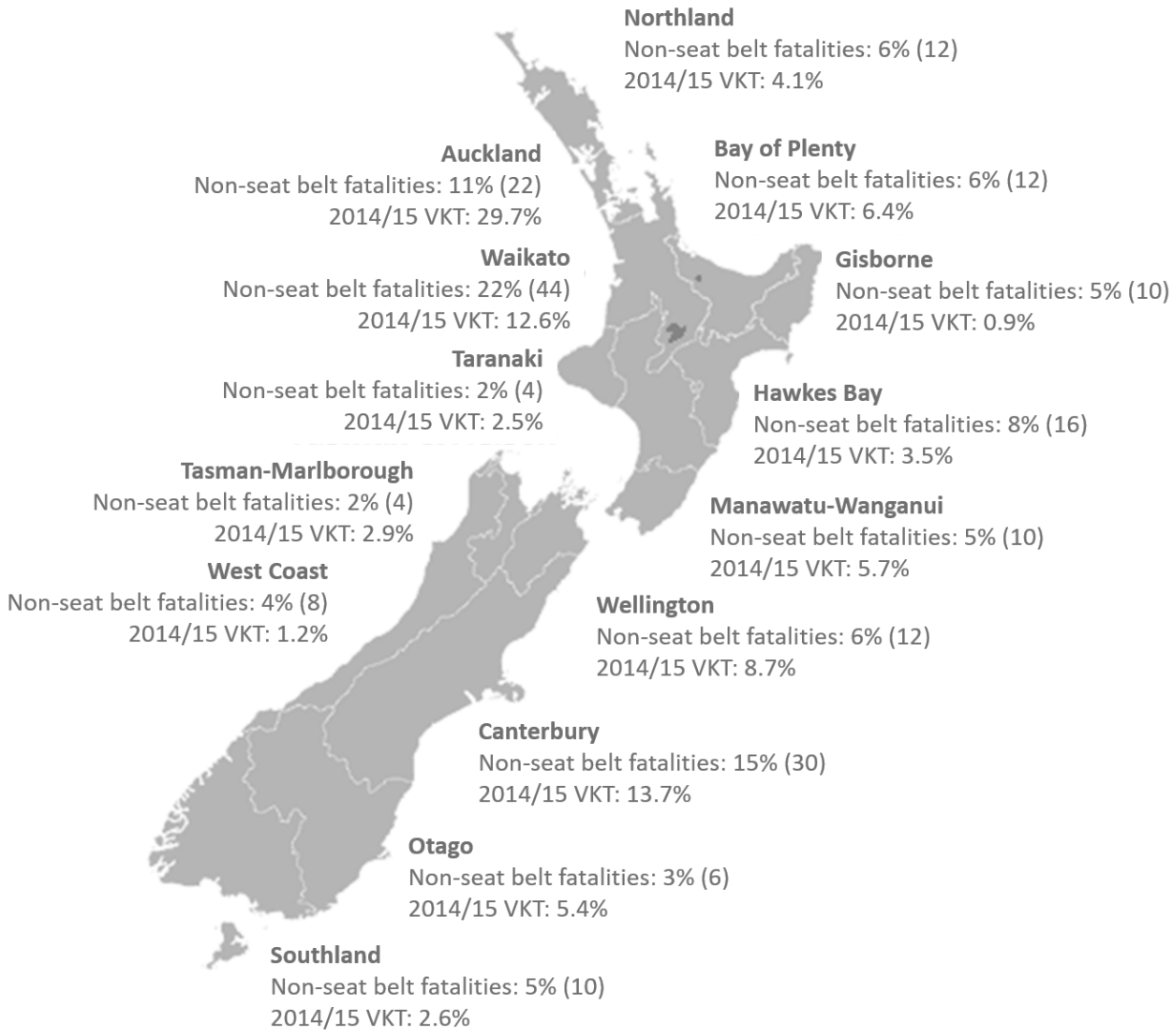
Most non-seat belt wearing fatal crashes occurred after dark, particularly during the early hours of the morning, with 24.7% crashes occurring between 11pm and 2am. This pattern is counter to normal travel patterns which have a peak demand in the morning and afternoon. Only 4.3% of the crashes happened during the regular commuting hours of 8-9am and 5-6pm (Figure 8). Note, the colours in Figure 8 represent daylight (orange), dusk (light grey), and night-time (dark grey).

Figure 8: Crashes by time of day



The geographic regions of non-seat belt wearing fatalities are shown in Figure 9 alongside the 2014/15 percentage share of road vehicle kilometres travelled (VKT) for those regions (Ministry of Transport 2017b). Note that this map shows the number and percentage of fatalities, not the number of crashes.

Figure 9: Fatalities by geographic region



Although the fatality sample size is relatively small, these data nevertheless give a sense of exposure versus outcome. For example, Gisborne experienced the highest, and most significant rate (5.5 times) of non-seat belt fatalities versus VKT. This was followed by the West Coast (3.3 times) and Hawkes Bay (2.3 times). Conversely, Auckland Region experienced the lowest rate (0.37 times) of non-seat belt fatalities versus VKT and this rate was 0.55 times in Otago and 0.7 times in Tasman-Marlborough.

Most of the fatalities (83.5%) occurred on rural roads, with Regions displaying a range of rural fatality rates. This difference may be affected by the presence of motorways or large urban areas. For example, Auckland Region had 55% fatalities on rural roads, whereas Southland and Tasman-Marlborough had 100%[4].In terms of the weather and road conditions, most fatalities

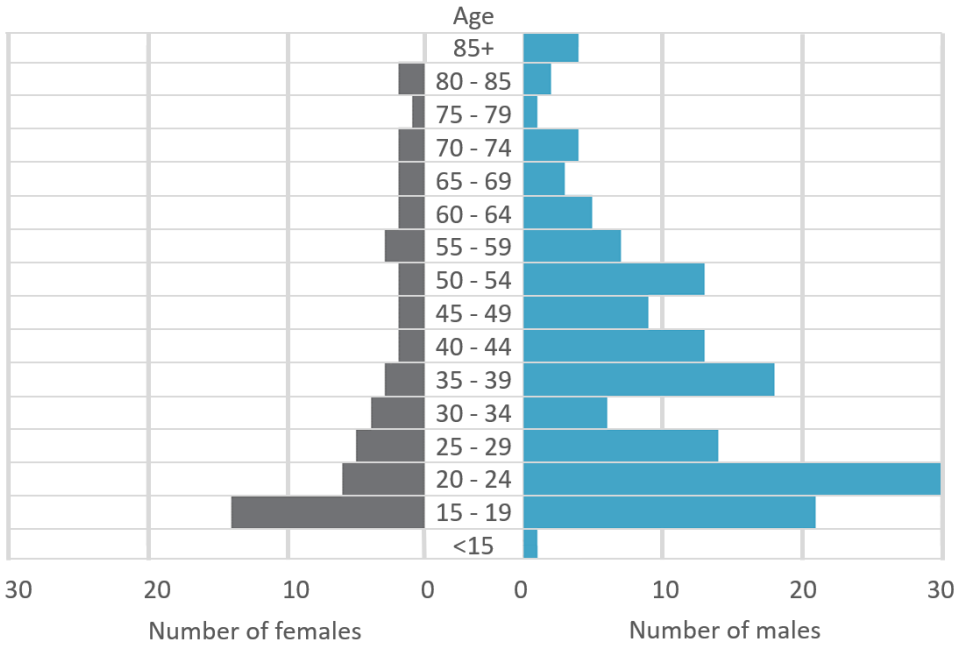
[4] The full breakdown of rural fatalities by region: Northland 75%; Auckland 55%; Waikato 83%; Bay of Plenty 83%; Gisborne 98%; Taranaki 100%; Hawkes Bay 93%; Manawatu-Wanganui 78%; Wellington 100%; Tasman-Marlborough 100%; West Coast 86%; Canterbury 75%; Otago 80%; and Southland 100%.

occurred in fine weather (77%). Lower crash numbers in wet conditions (27%) may be due to drivers being more careful during these times. Only 2% of crashes occurred in icy conditions, though this may be due to a lower exposure due to the lower frequency of icy conditions.

1.3.2 Are there any demographic patterns that can be established including age, gender, or any others that the data can reveal?

Figure 10 shows that the fatally injured non-seat belt wearing victims were skewed towards males (75%). For both males and females, the younger age groups aged 15-25 are over-represented 35.5%. However, this trend is stronger for males.

Figure 10: Age and gender profile



Māori were overrepresented in non-seat belt wearing fatalities (35%), compared to their proportion of the New Zealand population (15%). Pakeha were under-represented (54%) by non-seat belt wearing fatalities compared to their proportion of the population (74%) (Statistics New Zealand 2013a). In addition, 5% were Pasifika, and 4% were Asian or Indian.

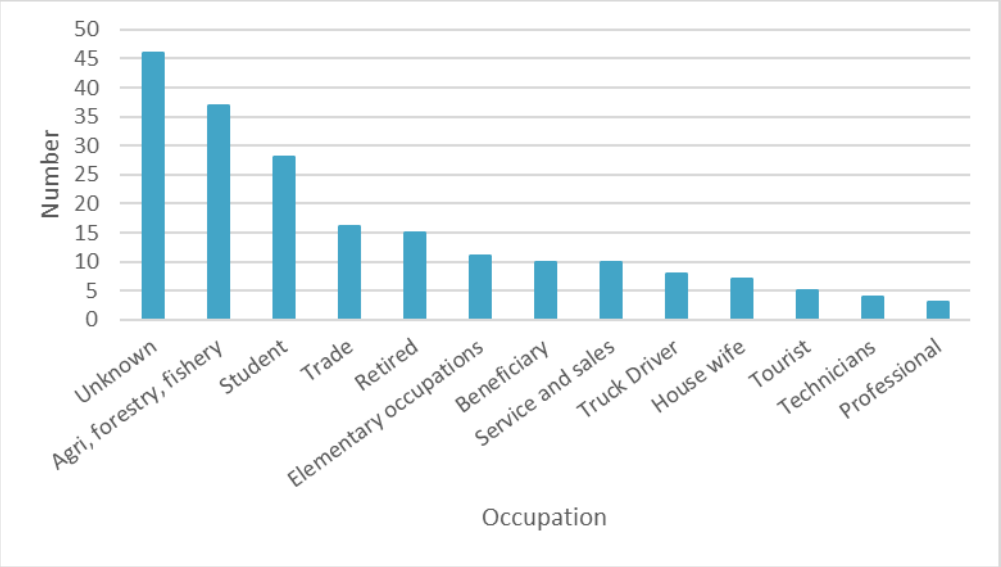
Victims' occupations are depicted in Figure 11. Where possible, they have been matched to the major occupational groups listed in the 2013 census data (Statistics New Zealand 2013b). Note that the occupation for 23% of the victims was unknown. 'Elementary occupations' and 'agriculture, forestry, and fishery workers' made up 5.5% and 18.5% of the fatalities respectively. Combined, these are similar to the 'labourers' category in the 2013 New Zealand census, which represented 11% of the population. However, in the fatality dataset, this category is over-represented 2.2 times. This may be due in part to the locational nature of these jobs, occurring more predominantly in rural areas, where there was a higher fatality exposure than in urban areas. Note that this is an estimated comparison only and that some workers within the 'agriculture, forestry, and fishery' group would be classified as skilled trades.

The second most populated category was students (14%). This included high school students and university students, and is consistent with the age breakdown depicted in Figure 10. In the fatality data presented in this report, the occupation of 4% of the victims was 'truck driver'. This category is over-represented in the fatality dataset in comparison to the 2013 New Zealand

census, where truck drivers[5] comprised 1.2% of the working population. This may be in part due to their higher VKT exposure. Finally, there was very low representation from people with occupations that are typically associated with higher education, such as 'professionals' (1.5%), whereas this category represented 23% of the occupational groups in the 2013 census data. These patterns are reflected in the literature (Begg and Langley 2000, Chaudhary, Solomon et al. 2004).

Situational factors, such as poor role modelling or peer-pressure not to wear a seat belt was also anecdotally apparent in some SCU reports. These findings are reflected in the literature with regards to decision policies and the influence of others (McCartt and Northrup 2004, Alattar, Yates et al. 2016, Han 2017).

Figure 11: Occupations of deceased



1.3.3 What other factors are commonly associated with crashes where seat belts are not being worn?

Vehicle factors

The majority of vehicles represented in non-seat belt wearing fatalities were cars (including rental) (59%) and 4x4/SUV/Utes (24%). This high rate of passenger vehicles is reflected in the New Zealand vehicle fleet composition from December 2014 where 77.8% of the fleet were light passenger vehicles (Ministry of Transport 2016b). These data demonstrate a consistency with the high level of exposure of passenger vehicles on New Zealand's roads.

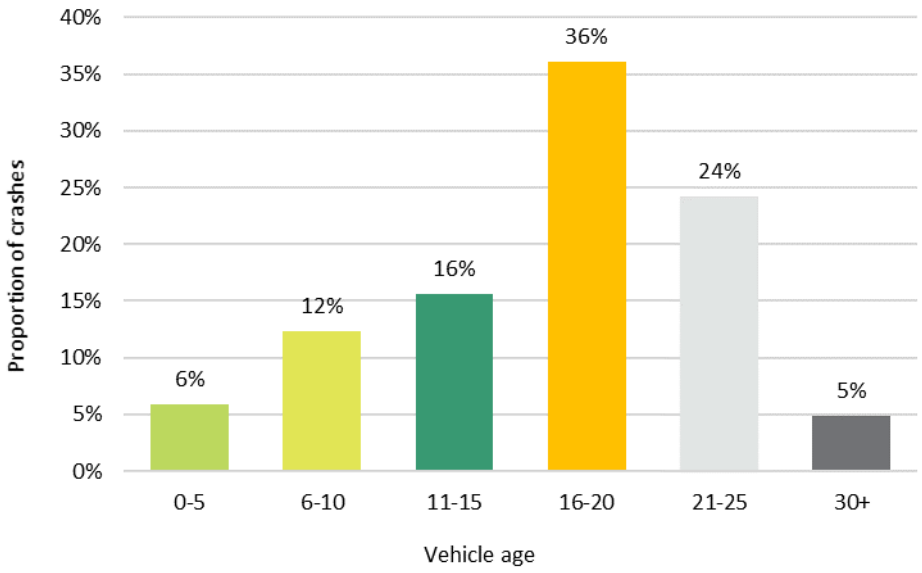
Trucks were represented in 5% of the non-seat belt fatally injured vehicle occupants. As with the light vehicles, this figure is similar to the representation of heavy goods vehicles that were present on New Zealand's roads in December 2014 (Ministry of Transport 2016b).

Non-seat belt fatalities were more likely (66%) to occur in vehicles aged 16 years or over than in those aged under 16 years (Figure 12). The representation of older vehicles in non-seat belt fatality crashes was disproportionate (1.7 times higher) to the number of vehicles aged 16 years

[5] Truck drivers include tanker drivers, tow truck drivers, and truck driver's offsiders

and over in the New Zealand fleet as of November 2015 (NZ Transport Agency 2017c). The higher proportion of older cars in the dataset may be reflective of the lower-income occupations of crash-involved victims as shown in Figure 11.

Figure 12: Vehicle age



Data regarding the safety aspects of crash-involved vehicles were recorded from the SCU reports and the RightCar website (Figure 13). However, for some vehicle features (e.g. seat belt reminder system, anti-lock braking system (ABS), and electronic stability control (ESC)), there was limited information about their presence in the vehicles.

In most cases, there was a low presence of dual front airbags (31%) and side airbags (6%) and this is likely to be reflected by the older age of the vehicles. However, the data are not definitive as the presence of airbags was not known for all vehicles.

Of those vehicles that rolled (Figure 13), 40.5% were 4x4/Ute/SUVs. This may be due to their higher centre of gravity and the greater likelihood for them to roll, generally resulting in poorer injury outcomes for their occupants.

Figure 13: Vehicle safety features

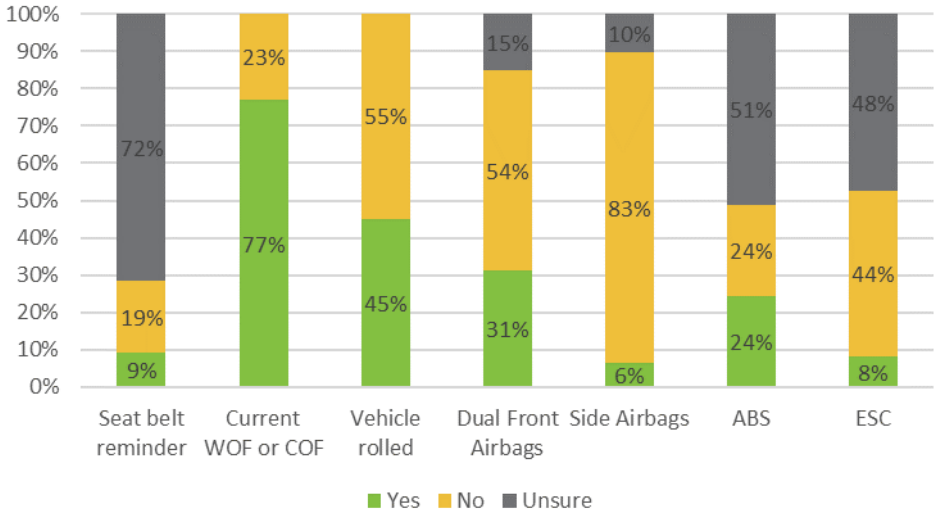
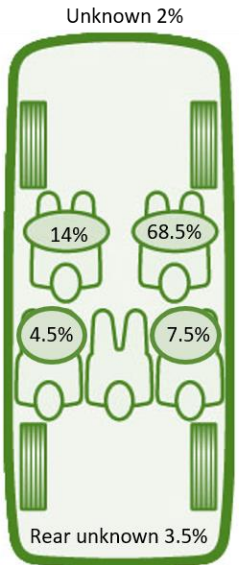


Figure 14: Seating position of non-restrained fatalities



The seating position of fatally injured victims was examined (Figure 14). The most prevalent fatality location in the vehicle was the driver's seat which is consistent with 73.7% of the fatalities occurring in a single occupancy crash. Likewise, 14% of the fatalities were in the front passenger seat, and this is likely due to a higher level of exposure due to this seat being a common locational choice for a vehicle's sole adult passenger. The rear seats made up 15.5% of the total fatalities. However, in some cases, where multiple occupants were ejected from the vehicle, or where there may have been vehicle occupant overloading, their initial location in the vehicle could not be established.

User behaviour

Journey purpose

Nine categories were created to encompass the journey purpose of the crash-involved victims. Although these categories could be further simplified, they have been left reasonably detailed to allow for more nuanced cluster analysis (see *Section 4: Cluster Analysis of Occupant Profiles*). The categories, and the number of victims in these categories are as follows in Table 3.

Table 3: Journey purpose of fatally injured victims

Journey purpose	Number of fatalities
Utility trip (e.g. going to the shops, driving to get somewhere, driving to work)	78
Driving home after drinking (e.g. private party, birthday, wedding, Tangi)	38
Driving home from the pub after drinking	28
Driving for work	20
Joy Ride	14
Suicide (please note, ambiguous cases are not included in this category)	8
Recreation (e.g. 4x4 adventure trip, tourists, Sunday drive)	8
Evading police	4
Unknown	2

Alcohol involvement

There is a fundamental difference between drinking alcohol and driving, and the non-wearing of seat belts. Not wearing a seat belt does not, in general, have any effect on the occurrence of a crash. Its primary effect is on the severity of the outcome. The consumption of alcohol on the other hand, has a significant effect on the risk of having a crash and possibly the severity of the outcome (Traynor 2005). This makes it difficult to compare the two factors.

In fatal crashes, there can sometimes be a delay of hours or days before the victims are found, or before blood is taken for testing, so in some cases, the degree of alcohol-involvement may be uncertain. Overall, 53.5% (107) of the fatalities were alcohol-involved. Of those, 90 cases (84%) were over the legal driving limit of 50mg, and 36 cases (33.6%) were over 200mg. Alcohol-involved crashes were typified by high levels of intoxication, rather than people being slightly over the legal limit.

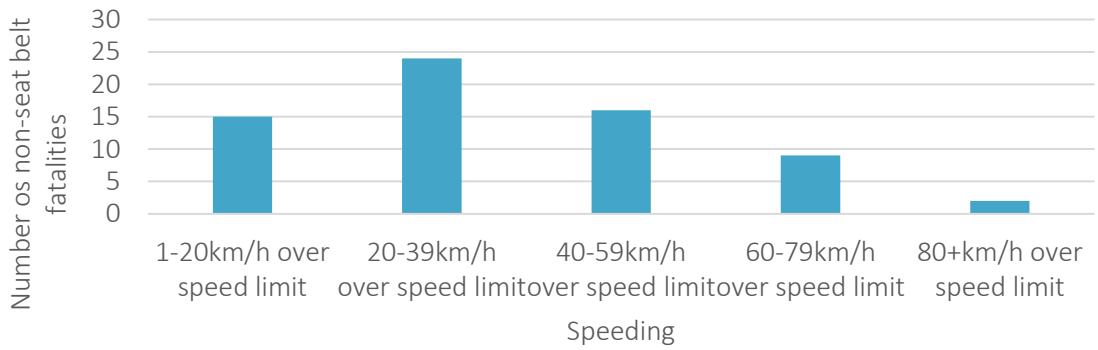
The journey purpose for 62 cases (58%) had been driving home after drinking. Please note that the journey purpose for a further 42% of alcohol-involved fatalities were categorised differently.

Speed

Roads with a speed limit of 100km/h were associated with more fatal non-seat belt wearing crashes (135) than roads with lower speed limits (65). This is likely due to the lower incidence of survivability in high-speed crashes, as demonstrated by Mackie, Gulliver et al. (2017).

User behaviour in the form of travelling over the speed limit was also a contributing factor in the outcome of crashes. Indeed, as Figure 15 shows, 66 of the fatalities had 'speeding' as a contributing factor.

Figure 15: In-excess of the speed limit



Fatigue

In 73 cases (36.5%), the SCU reports suggested that fatigue may have been a factor in the cause of the crash. Fatigue may affect an occupant in forgetting to wear a seat belt, or may be implicit in the decision not to wear a seat belt to allow for comfort whilst sleeping (if not driving). Indeed, in a few cases, passengers were asleep lying across the back seats.

Emotional state

In 33 (16.5%) of the cases, the SCU report noted that at the time of the crash, the victim was likely to have an emotional state which may have affected their driving. In some cases, their emotional state may have affected their ability to remember to wear a seat belt. This would particularly affect people who were part-time, rather than habitual seat belt users.

1.4. Discussion

In general, these data show that the factors associated with fatal non-seat belt crashes from New Zealand (e.g. time of day, gender, age, alcohol-involved) are closely aligned to the international literature. However, the data also give an indication of some New Zealand-specific

factors. For example, it highlights that specific 'at risk' regions for non-seat belt fatalities exist, particularly in Gisborne, the West Coast, and Hawkes Bay.

The factors presented in this section will be more deeply analysed in *Section 4: Cluster Analysis of Occupant Profiles* to better understand the pattern of factors that are more commonly associated with fatal non-seat belt wearing crashes in New Zealand.

The data presented in this section pertain only to people who did not wear a seat belt and died. Therefore, it is likely that there is a far broader cohort of people who do not wear seat belts and who are alive. Given that we do not have in-depth information about these people, the data presented here cannot be extrapolated into that wider population. However, these data may be similar to those still living who are at most risk, especially if other risky behaviours are exhibited by those still living.

2. NON-SEAT BELT AND TRAFFIC OFFENCE HISTORY ANALYSIS

Aim

To better understand trends surrounding seat belt non-use offences. By investigating crash data as well as traffic offence data, this research aims to fill the knowledge gap by better understanding the combination of factors that are more strongly associated with non-seat belt fatalities. The information provided in this section is a summary of a deeper analysis of these data (Waters 2017a).

Structure

Non-Seat Belt and Traffic Offence History Analysis

2.1. **Detected non -seat belt offenders 2012-2016**: An analysis of NZ Police data to understand seat belt infringements, demographic analysis (age, sex);

2.2. **Non-seat belt offences 2017 and the offender's traffic offence history:** Traffic offence history for those issued with a notice for not wearing a seat belt between January and March 2017;

2.3. **Traffic offence history of deceased occupants who had not worn a seat belt 2012-2016:** Traffic offence history for fatally injured occupants who were not wearing seat belts;

Method

Data were provided by NZ Police (Table 4).

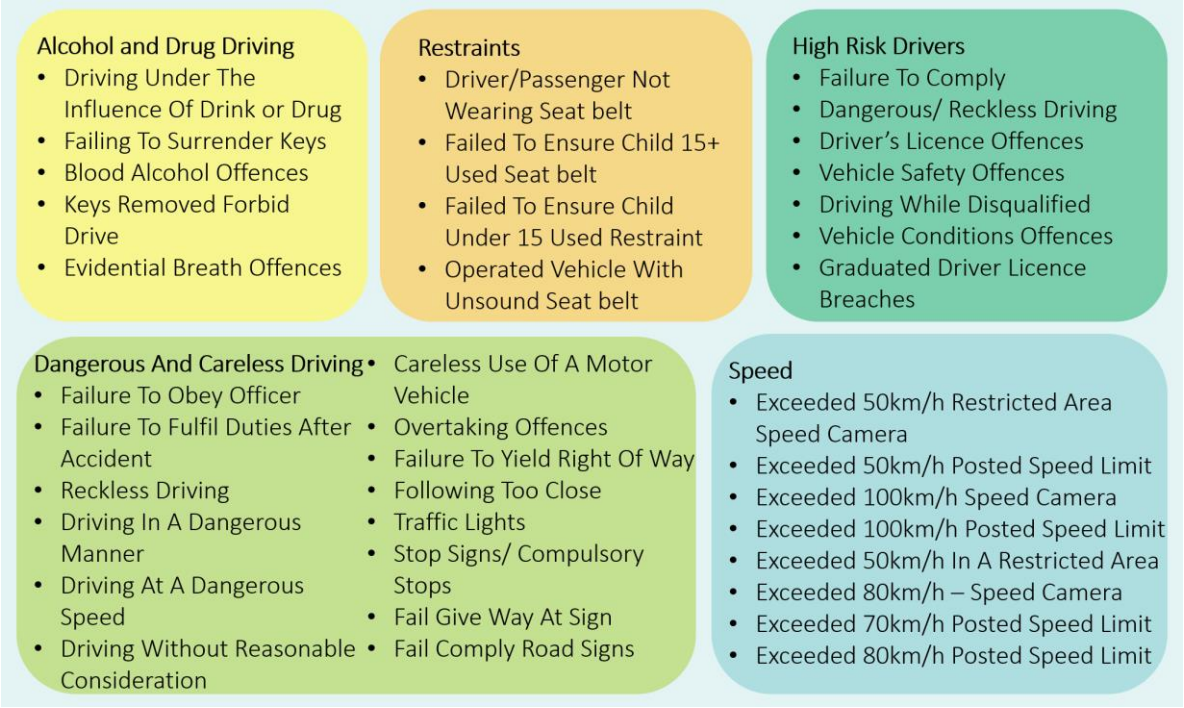
Table 4: Data used for this study

Section	Data source	Description	Number of cases	Timeframe
2.1	NZ Police	Detected driver or passenger not wearing a seat belt	271,688	2012-2016
2.2	NZ Police	Detected occupant for the offence: *'Driver or Passenger not wearing seat belt'*	12,000 offenders. 311,000 historic offences	January - March 2017
2.3	Crash Analysis System (CAS). Included TCRs and SCUs	Exclusions: • Children, tourists • No restraint available • No restraint required in the vehicle	317	2012-2016
	NZ Police	Detected traffic offence history for the above cohort	217 occupants and 3,750 offences	2012-2016

To reduce complexity, and to provide easy to understand groupings, the data from Sections 2.2 and 2.3 were recoded into 'Fatal Five' (NZ Police 2010) and 'Other' categories (Table 5). The 'Other' category captures all traffic offences not included under a 'Fatal Five' category. The majority of 'Other' offences related to Warrant of Fitness (WoF) and vehicle registration offences.

This recoding allowed a more comprehensive understanding of the categories. They were reviewed and compiled for offence numbers, mean averages, and demographic information.

Table 5: 'Fatal Five' offence categories



2.1. DETECTED NON-SEAT BELT OFFENDERS 2012-2016

2.1.1. Aim

To understand the demographic patterns of seat belt non-use offences between 2012-2016.

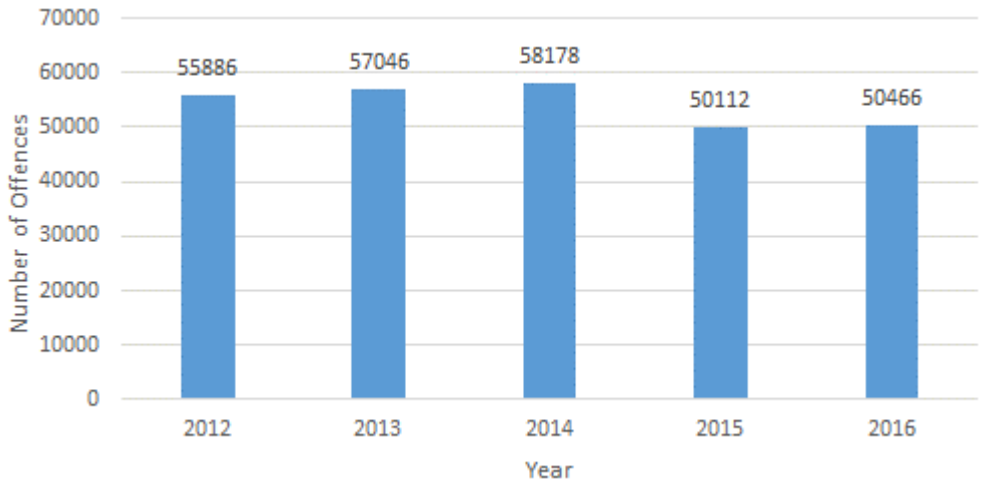
2.1.2. Method

The NZ Police provided data on detected '*Driver or Passenger not wearing seat belt'* offences for the calendar years 2012-2016. These data were reviewed and compiled for offence numbers and demographic information. Ministry of Transport data on Licenced Driving Populations (LDP) were also reviewed and included for comparative purposes.

2.1.3. Findings

There were a total of 271,688 recorded *'Driver or Passenger not wearing seat belt'* offences for the calendar years 2012-2016 (Figure 16). Following a slight increase between 2012-2014, there was a 13.9% decrease in detected offences from 2014-2015.

Figure 16: National 'Driver or passenger not wearing seat belt' offences 2012-2016



As shown in Figure 17, 20-24-year-olds accounted for the highest number of non-seat belt offences (23.2%). This was particularly evident for males in that category. Indeed, when compared to the licenced driving population (LDP) age groups, 20-24-year olds are the most over-represented group in the offence count, representing 17.2% of the LDP in 2016. The 15-19 age group[6] (is also over-represented, as is the 25-29 age group.

[6] Please note that 15-year-olds only comprised 2.4% (640 individuals) of this age grouping. This is due to the increase in learner driver licensing age to 16 years.

Figure 17: 'Driver or passenger not wearing a seat belt' offences 2012-2016, by age groups[7]

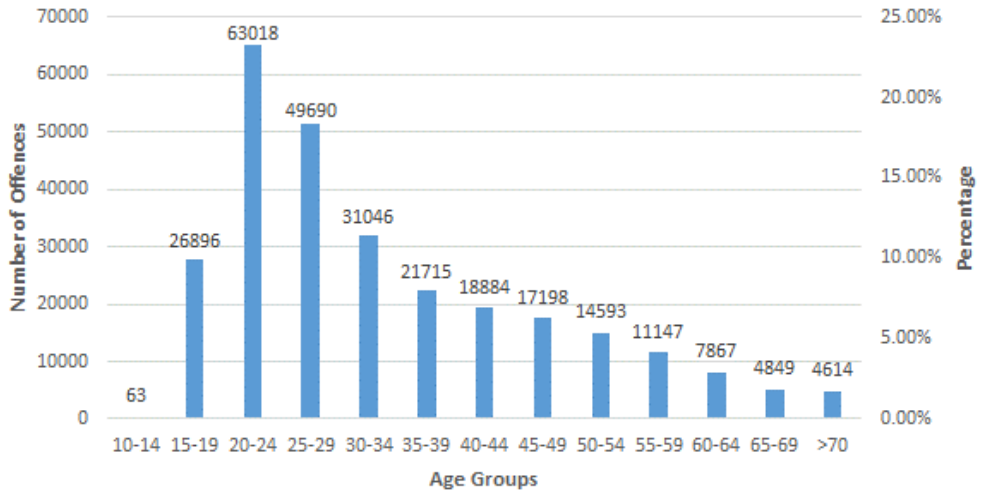
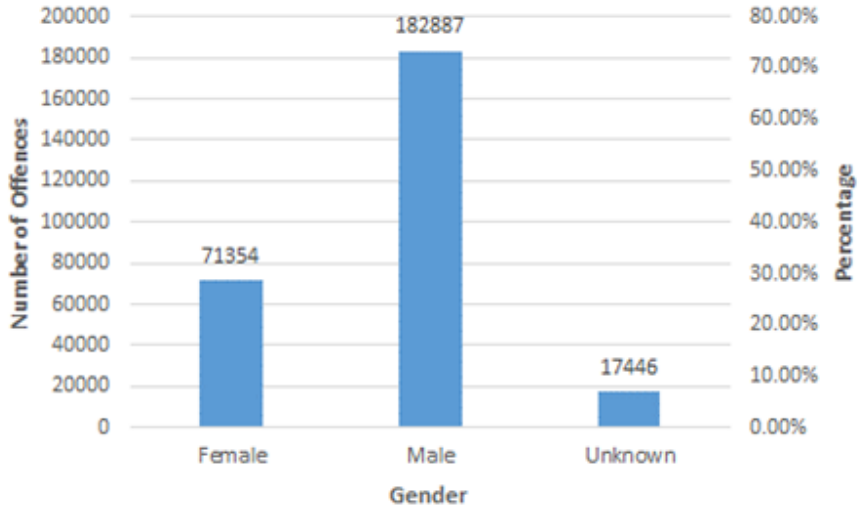


Figure 18 shows that males accounted for most non-seat belt offences (71.9%). Males are over-represented as they account for 51% of the LDP, since 2001.

Figure 18: 'Driver or passenger not wearing seat belt' offences 2012-2016, by gender[8]



2.1.4. Discussion

The high prevalence of males as seat belt offenders is consistent with young males being over-represented in risky driving behaviour and crashes in New Zealand (Ministry of Transport 2017a). The extent to which other risky behaviours are associated with non-seat belt offences is explored elsewhere in the Non-Seat Belt and Traffic Offence History Analysis.

The reduction in detected offences, by 13.9% from 2014-2015, with only slight rise in 2016, is indicative of either some form of intervention or reduction in detection resource. For example, NZ Police Breath Screening Tests have fallen by at least 15% since 2014. Any reductions in road Policing resource may have an impact on detected traffic offending.

[7] Where the age was identified. There were 108 inaccurate ages recorded.

[8] Where gender was identified. 6.4% of the gender data were missing.

2.2. NON-SEAT BELT OFFENCES 2017 AND THE OFFENDER'S TRAFFIC OFFENCE HISTORY

2.2.1. Aim

To understand the demographics and traffic offence history of people who were detected for a non-seat belt offence between January and March 2017.

2.2.2. Method

The NZ Police provided the traffic offence history for a sample group (n= 11,989) of vehicle occupants who had been detected for the offence *'Driver or Passenger not wearing seat belt'* between January 2017 and March 2017. These data were recoded into the 'Fatal Five' and 'Other' categories.

2.2.3. Findings

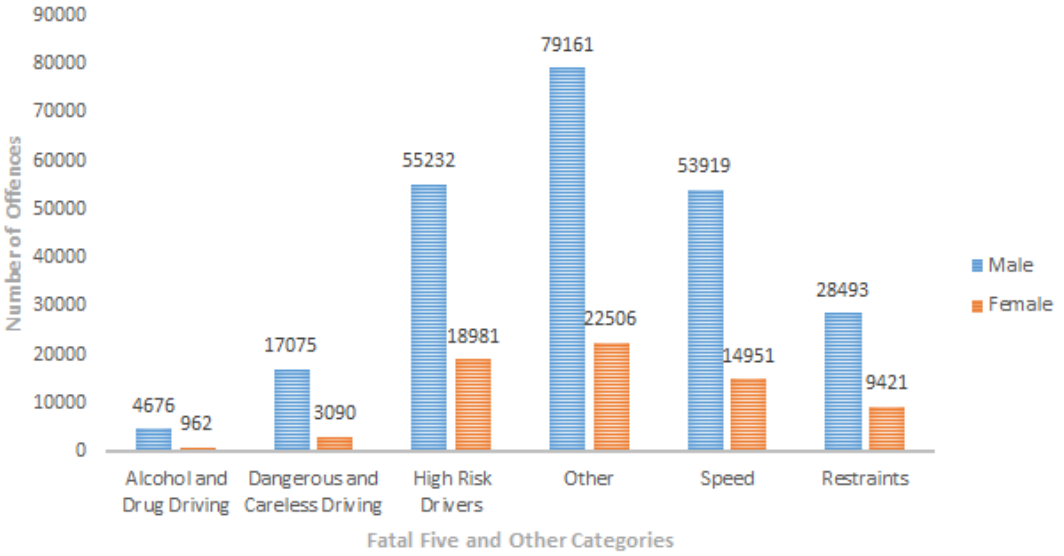
Offences

From the sample group of 11,989, a total of 310,988 offences[9] were recorded. The mean number of offences for this group was 25.9 and the median was 16, reflecting the skewed nature of the offence distribution.

Figure 19 depicts the offences by gender under the 'Fatal Five' and 'Other' categories. Gender data were unavailable for 0.8% of cases and those cases are not recorded below. The highest number of offences were in the 'Other' category, followed by 'High-Risk Drivers' and 'Speed'. Please note that most offences in the 'Other' category were attributable to vehicle registration and WoF offences. In addition, most offences within the 'High-Risk Drivers' category were GDLS offences for Learner and Restricted licence holders. For a more detailed break-down of the offence types within each category, see Waters (2017a). Amongst those with 'Alcohol and Drug Driving' offences, 45% were repeat offenders and young vehicle occupants represented the greatest proportion of these offence types.

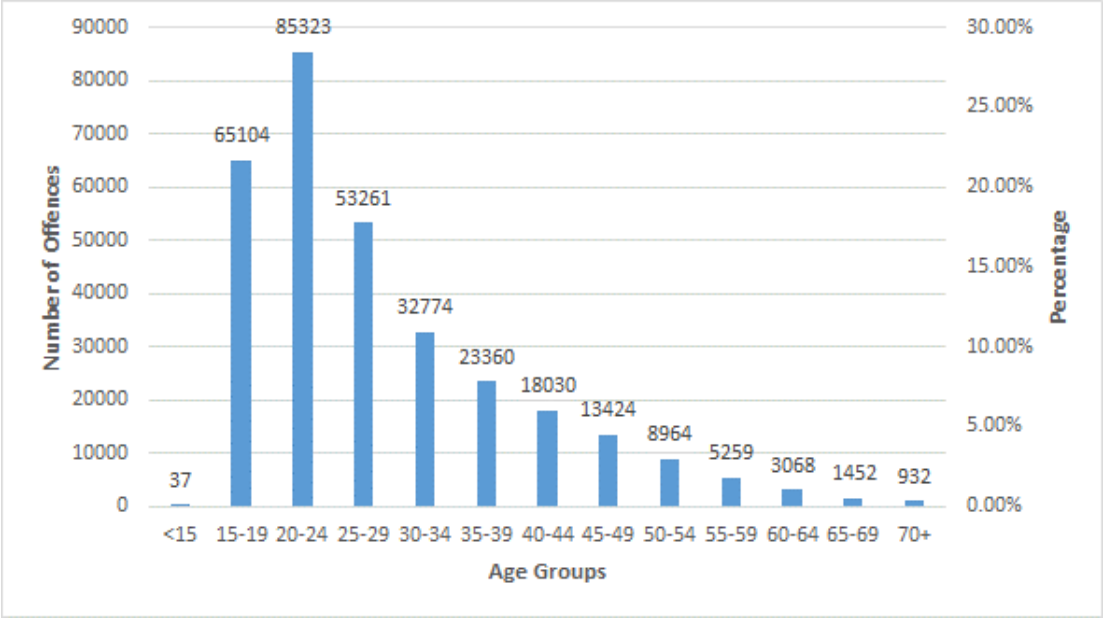
[9] Including the most recent 'Restraints' offences that identified the sample group. Individual offenders may be represented many times in the offences count.

Figure 19: Seat belt offenders 2017 by offence type and gender



As shown in Figure 20, a strong pattern pertaining to offenders' age was apparent with 20-24-year-olds, accounting for the highest number of offences. This is consistent with the previous section's results. Not shown in Figure 20 is that, where gender could be identified, 77.3% of all offences were committed by males. This is consistent with the previous section's gender data.

Figure 20: Total offences by age group at offence date

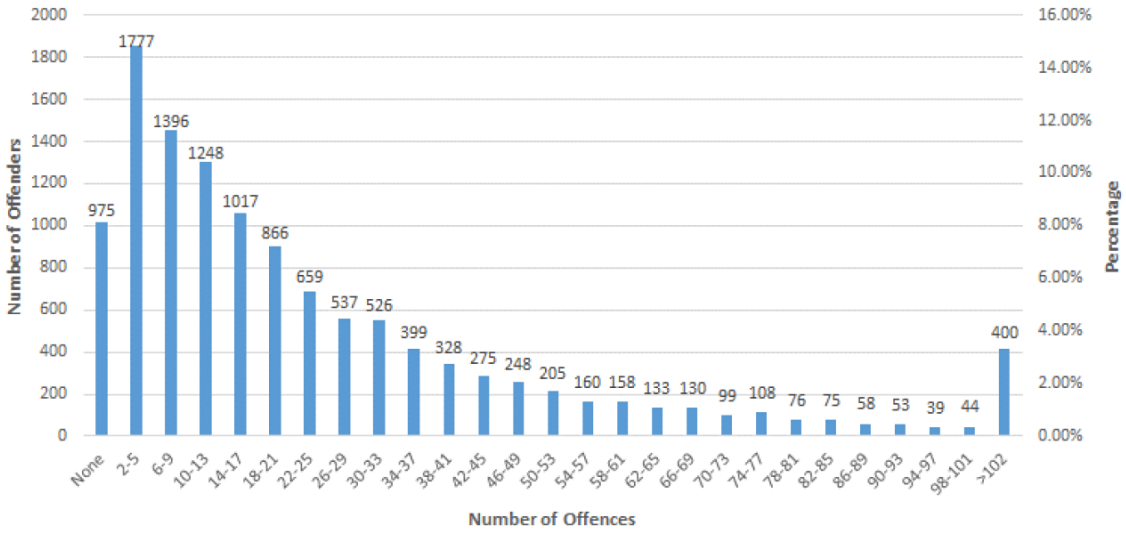


Offenders

Of the 11,989 seat belt offenders identified in the sample group, 11,014 (91.9%) had incurred a previous traffic offence (Figure 21). Of the sample group, 26.5% had fewer than 10 previous offences and 8% had more than 70 offences each. Males accounted for the highest proportion (74.5%) of the total offenders, consistent with the gender data for the seat belt offenders in the previous section.

Of the total seat belt offenders, 58% were repeat seat belt offenders (mean 3.3), suggesting an underlying habitual non-seat belt wearing cohort.

Figure 21: Previous traffic offences by number of offenders



As Figure 21 demonstrates, a relatively small proportion of individuals (1,250, 10.4%) were responsible for a disproportionate number 120,235 (38.7%) of offences (averaging 98 offences each). The pattern presented in Figure 21 suggests that the *Pareto Principle* may be applied to these data in that "… a few people do commit the most crimes, and among offenders, a relatively small group are responsible for the most crimes" (Martinez, Lee et al. 2017; p.23). It is interesting to take these high-level offenders into account and to examine their patterns separately from the wider population, as they are more likely to represent high-risk, recidivist behaviours and may require different interventions. An analysis of the Top Ten offenders from this sample (0.1% of the total offenders, with an average of 440 offences each) is presented in Appendix B.

While this report does not focus on the incorrect use of child restraints, it is useful to understand the magnitude of this problem compared with drivers or passengers not wearing seat belts Table 6 shows that 86% of offences were for '*Driver or passenger not wearing seat belt',* which means that 14% of restraint offences related to the incorrect restraint or seat belt use of children.

Table 6: Ten most common restraint offences

'Restraints' Offence Description	Number of Offences
Driver or passenger not wearing seat belt	33,461
Failed to ensure child under 7 years in approved child restraint	1,929
Child under 5 years not in approved child restraint	1,732
Failed to ensure child 8 to 14 years used seat belt	508
Passenger of or over 15 years not wearing seat belt	452
Failed to ensure child aged 7 years used restraint or seat belt	338
Failed ensure child over 5 & under 8 years used restraint or seat belt	186
Permitted child under 15 in front seat not restrained	147
Ineffective child restraint	111
Fails to ensure child under 8 years uses restraint/seat belt	47

2.2.4. Discussion

Offences

Among those who had 'Alcohol and Drug Driving' offences, 45% were repeat offenders, which is consistent with New Zealand-based literature (Waters 2013). Young vehicle occupants represented the greater percentage for 'Alcohol and Drug Driving' offences, and this is consistent with international literature (Shults, Haegerich et al. 2016).

The most common offences for the category 'Other' - accounting for a significant proportion of the total offences - were vehicle registration and WoF offences. These have been previously reported as the most common offences for 14-19-year-old offenders (Waters 2015).

The 'High-Risk Drivers' category was dominated by GDLS offences for Learner and Restricted drivers, and this is supported by previous research (Waters 2015, Waters 2016).

A small percentage of the offenders account for the highest percentage of offences. That 40% of the offences were created by 10% of the offenders is consistent with the *Pareto Principle*, or the '80/20' principle – where 80% of effects or consequences come from 20% of the causes (Eck, Clarke et al. 2007, Martinez, Lee et al. 2017).

Offenders

The seat belt offenders sample have the same demographics regarding age and gender as those from the cohort presented in section 2.1. Young males were the predominant offender cohort, and this is mirrored in other traffic offence areas, as shown by the trends in the offence histories and by previous literature (Begg and Langley 2000, Litt, Lewis et al. 2014, Waters 2017b).

2.3. DECEASED VEHICLE OCCUPANT TRAFFIC OFFENCE HISTORY 2012-2016

2.3.1. Aim

To understand the demographic and previous traffic offence history of people who were not wearing a seat belt and who died in crashes between 2012-2016.

2.3.2. Method

This section reviews the traffic offending history of those deceased occupants not wearing a seat belt for the calendar years 2012-2016. This cohort shall be referred to as the 'deceased occupants' (unless otherwise stated) and as 'offenders' when referring to traffic offences. Historical records of offence data date back to 1998 for non-camera offences, and to 2004 for camera offences. Therefore, the historical records of some offenders may pre-date the record-keeping.

The data in this section were obtained by identifying deceased occupants by their driver licence information, found in the SCU reports and TCR which are embedded in the CAS interface. These data were provided to the NZ Police to provide previous traffic offence history, hence providing a traffic offence history for deceased vehicle occupants. Table 7 describes the exclusion process that was undertaken to arrive at the final sample of 196 deceased vehicle occupants who had an offending history that could be matched to them.

Table 7: Method of refining the study sample

	Occupants removed from sample	Total in sample
Number of Deceased Occupants not wearing seat belts or restraints, or 'uncertain' 2012-2016 as indicated in CAS		362
Cases that were not relevant to this study were removed. These included children, tourists, those not lawfully required to wear a seat belt, or where seat belts were not required (e.g. bus drivers, tractor operators)	45	317[10]
Cases where NZ Police data and CAS data could not be matched due to unavailable license information	100	217
Number with no previous traffic offence history	21	196
Deceased occupants with a traffic offence history for this review		196

[10] Please note, in this section, the analysis used both TCR and SCU report information and hence the number 317 presented here is not consistent with the number 271 as presented in Figure 2. These limitations are discussed in more detail at the end of the report.

To reduce complexity, these data were also recoded into 'Fatal Five' and 'Other' categories and then compiled for offence numbers, averages, and demographic information. Information on the most common individual offences is also provided as well as data on the highest offenders by number of offences, NZ Police district, and other demographic information.

Please note that a limitation of this stage of the research was that there was no previous traffic offence history for deceased vehicle occupants who were wearing a seat belt at the time of the crash to be used for comparative purposes.

2.3.3. Findings

Offences

In total, 3,754 offences[11] were recorded for the 196 deceased occupants who had an available traffic offence history. The mean number of offences was 19.2 and the median was 11, which is lower than the mean number for the seat belt offenders 2017 (25.9). As is shown in Figure 22, the number of traffic offences by 'Fatal Five' and 'Other' categories are similar and consistent to those of the seat belt offenders 2017 cohort (Figure 19). Please note that as with the previous section, the 'Other' category was predominantly comprised of vehicle licencing and WOF offences.

Figure 22: Deceased occupants 2012-2016 by offence type and gender

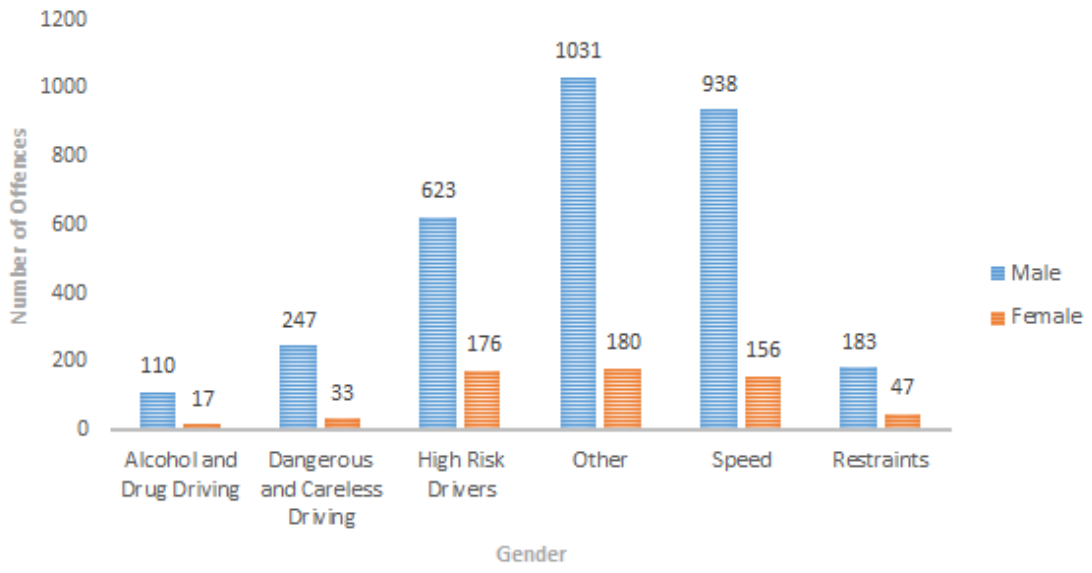
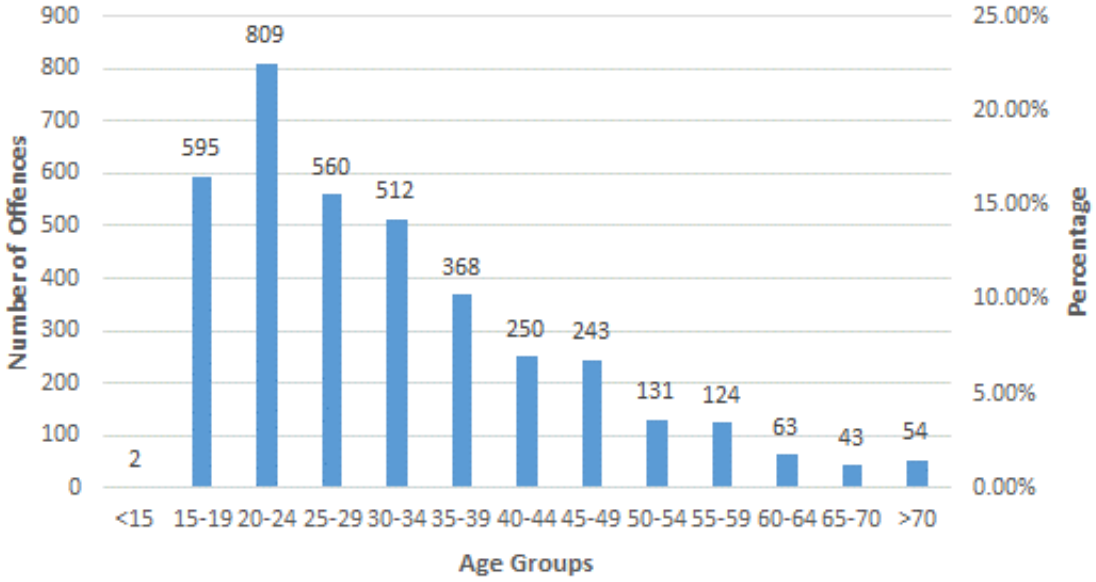


Figure 23 shows the total offences by age at the date of the offence. As the graph is by 'offence', not 'offender', an individual may be recorded several times across different age groupings. Figure 23 shows that 20-24-year-olds accounted for the highest number of offences (21.6%), which is consistent with both the seat belt offenders 2012-2016 and the seat belt offenders 2017 data described earlier. The mean age at the time of the offences was 32. This is slightly higher than the mean age of 28 for seat belt offenders 2017. Please note that where gender could be identified, males accounted for the highest percentage (83.7%) of offences.

[11] Individual offenders may be represented many times in the offences count.

Figure 23: Total offences by age at date of offence

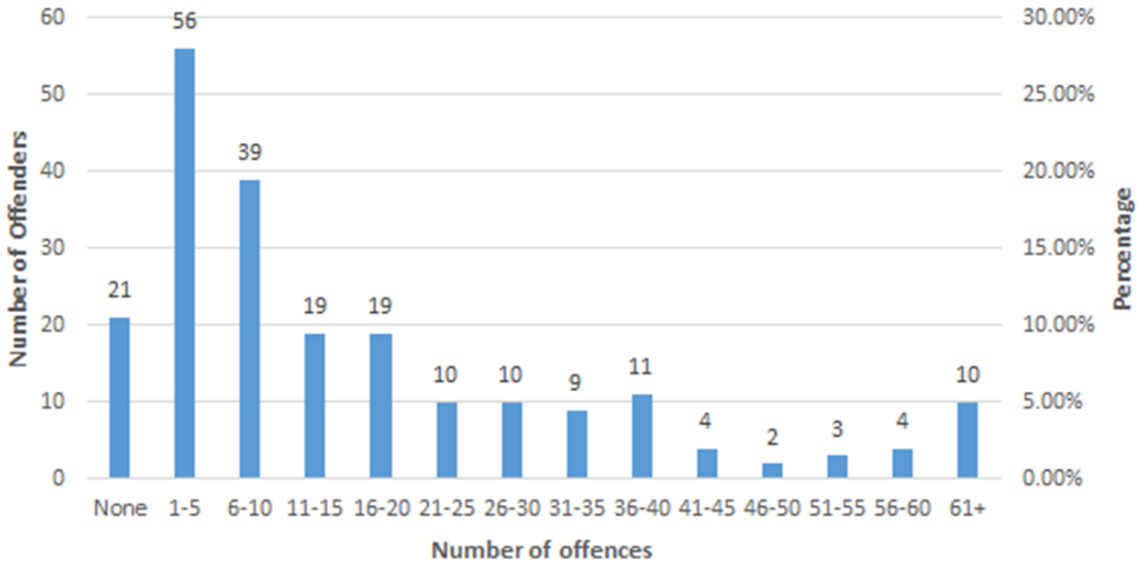


Offenders

Of the 217 deceased occupants, 21 (10.1%) had no traffic offence history (Figure 24), which is consistent with the subjects of the *Seat Belt Offenders 2017*. Twenty offenders (10.2%) were responsible for 1,347 (35.9%) of the total offences and this is consistent with similar findings in the previous two sections with the *Pareto Principle* (Martinez, Lee et al. 2017).

Males accounted for 79.1% of the total offenders, which is consistent with the same data for the seat belt offenders 2012-2016 and the 2017 offenders.

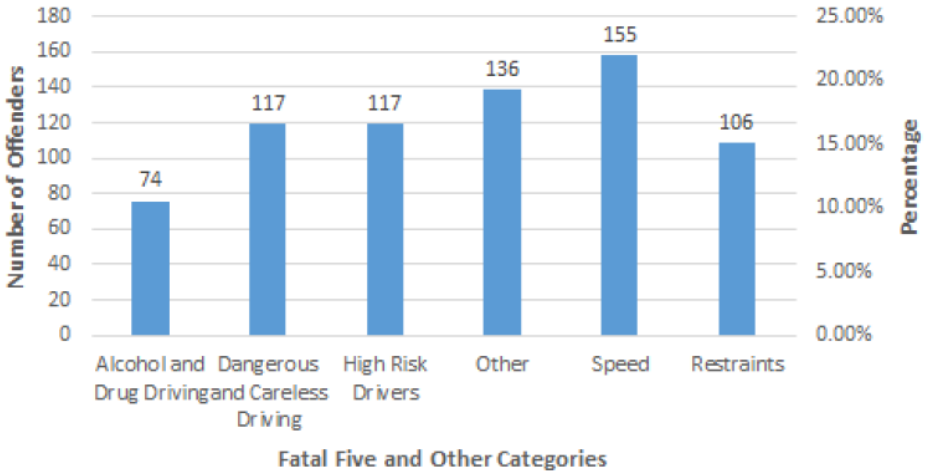
Figure 24: Offences by number of offenders



As noted in section 2.2, it is worth taking the offending history of the high-level offenders into account and to examine their patterns separately from the wider population, as they are more likely to represent high-risk, recidivist behaviours and may require different interventions. The Top Ten offenders from this sample (5.1% of the total offenders) accounted for 813 (21.7%) of the total offences. An analysis of these offenders is presented in Appendix B.

Of the 196 occupants with an offence history (Figure 25) shows that 155 (79%) had a previous recorded offence for the 'Fatal Five' category 'Speed'. 'Speed' offences were also the most common of the 'Fatal Five' offences in the previous section. However, compared with the previous section, this section had a higher percentage (42.3% higher) of 'Alcohol and Drug Driving' offences recorded, and a lower percentage (8.4% lower) of 'High-Risk Drivers' offences. 'High-Risk Driving' offences were predominantly comprised of GDLS-type offences. The age group 20-24 accounted for the greatest number of offenders. This age group data was consistent throughout the majority of the offences except for the Fatal Five category 'Speed'. For a more detailed break-down of the offence type categories, and the involvement of age and gender please refer to (Waters 2017a).

Figure 25: Number of offenders by 'Fatal Five' and 'Other' categories



Ethnicity data were gathered for the deceased occupants from CAS, and this is shown in Figure 26. The majority of deceased occupants (53.9%) were European and 31.8% were Māori. Māori were significantly over-represented in these data compared to their proportion of the population (15%) (Statistics New Zealand 2013a).

Figure 26: Deceased occupants by ethnicity

2.3.4. Discussion

Offences

As with section 2.2, the sample in this section comprised a high percentage (44.6%) of repeat 'Alcohol and Drug Driving' offenders, although they represented a much higher percentage (42.3%) of 'Alcohol and Drug Driving' offences. Both the samples represented in this section, and in the previous section, had similar proportions of repeat offenders in the 'Speed' category. 'High-Risk Drivers' offences were predominantly represented by 15-19-year-olds and 20-24-year-olds and were dominated, by GDLS-type offences (as they were in section 2.2). The top offence in the 'Other' category, which also accounted for the highest number of all total offences, was no WoF. This is reflected in the findings from the previous section.

Males accounted for the greatest percentage of all offences. Likewise, for all offence types, people aged 20-24 were the most represented.

The links between failure to use seat belts, the use of alcohol, and involvement in speeding are reflected in the literature (Bogstrand, Larsson et al. 2015). The present study strongly supports that these behaviours are also strongly associated with fatalities. This study suggests similarities between the seat belt offenders and the deceased occupants regarding demographics and traffic offence history.

Offenders

Males accounted for the greatest percentage of all offenders (79%). Likewise, Māori were over-represented in comparison to their proportion of the New Zealand population.

Of the individual offenders, 10.1% had no history of traffic offences, whilst 10.2% collectively had 35.9% of all offences. This is in line with the *Pareto Principal* (Martinez, Lee et al. 2017) as discussed elsewhere.

In terms of the Fatal Five categories, a higher proportion of offenders were charged with 'Speed' offences than in section 2.2, but a lower proportion had 'High-Risk Driving' offences.

3. INTEGRATION OF FINDINGS

3.1. Aim

The aim of this section was to integrate the data between *Section 1: Crash Factors Analysis* and *Section 2.3: Deceased Vehicle Occupant Traffic Offence History*. In doing so, the goal is to determine if it is possible to gather more insight about some victims with relation to their previous crash offences. By matching these data, we may better inform the profiles that are developed in *Section 4: Cluster Analysis of Occupant Profiles*, thereby getting a more accurate picture of the factors within the user groups who were fatally injured in crashes between 2011-2015 in New Zealand whilst not wearing a seat belt.

3.2. Method

In *Section 1: Crash Factors Analysis*, 200 fatalities from 2011-2015 were examined from SCU reports. In *Section 2.3: Deceased Vehicle Occupant Traffic Offence History*, 217 cases from 2012-2016 where people were not wearing a seat belt and were fatally injured in crashes were examined and matched to their traffic offence history.

Using the Crash ID from CAS, and the licence number from the offence data, 85 cases between the two studies were matched. Therefore, for 42.5% of the *Crash Factors Analysis* cohort, there is a better understanding not only the detailed factors pertaining to the crash, but also more contextual information relating to the victim's traffic offence history.

Please note that the match rate was affected by:

- The *Crash Factors Analysis* used data from 2011-2015. For that section, there were benefits in using a sample of randomly selected cases from the NZ Transport Agency (2017b) data so that a greater combined understanding of non-seat belt wearing fatalities could be achieved. In addition, the CAS data changes as information becomes available over time, so having data that ended at 2015 ensured stability in the data;
- Data from the *Deceased Vehicle Occupant Traffic Offence History* were from 2012 to 2016. For this section, it was more important to have up to date information.

The findings from this section are presented as part of the *Section 4: Cluster Analysis of Occupant Profiles*, because they strongly relate to each other.

4. CLUSTER ANALYSIS OF OCCUPANT PROFILES

4.1. Aim

The aim of this analysis was to determine profiles for people killed in road crashes where seat belts were not worn.

4.2. Method

Using the 200 fatalities, as described earlier in *Section1: Crash Analysis Factors*, vehicle occupant profiles were determined. Basing these profiles on individual fatalities rather than crashes does mean that the characteristics of crashes with multiple victims will appear in the analysis multiple times and thus will carry more weight. However, as those crashes had more severe outcomes this is reasonable.

The profiles were determined by carrying out a cluster analysis on the 200 fatalities using the R statistics programme using the FactomineR add-in package. The software applied a Multiple Correspondence Analysis[12] (MCA) and then performed clustering to group the results into individuals with similar characteristics. The procedure automatically arrived at five vehicle occupant clusters and these clusters then become our vehicle occupant profiles. For further detail of how the variables were categorised in the MCA, and the MCA output, please see Appendix C. Once the MCA analysis was complete, the characteristics of these groups were determined qualitatively and described.

Every one of the 200 individuals is part of one and only one occupant profile, and some individuals will fit the profile better than others. However, all individuals will fit their allocated occupant profile more strongly than any other profile.

The variables that were used in the MCA were:

- Vehicle age bands
- Vehicle type
- WoF/CoF
- Seat belt reminder
- Speeding level
- Urban/Rural
- Victim age bands
- Gender
- Ethnicity
- Occupational group
- Driver/Passenger
- Journey purpose/type
- Intended journey length
- Licence
- Previous offences
- Alcohol
- Drugs
- Fatigue
- Emotional
- Medical

Note that previous offences from the SCU reports were included in this analysis but this information was highly variable. As described earlier in *Section 3: Integration of Findings*, a sub-

[12] A detailed explanation of this method can be found at http://www.sthda.com/english/wiki/correspondence-analysis-in-r-the-ultimate-guide-for-the-analysis-the-visualization-and-the-interpretation-r-software-and-data-mining

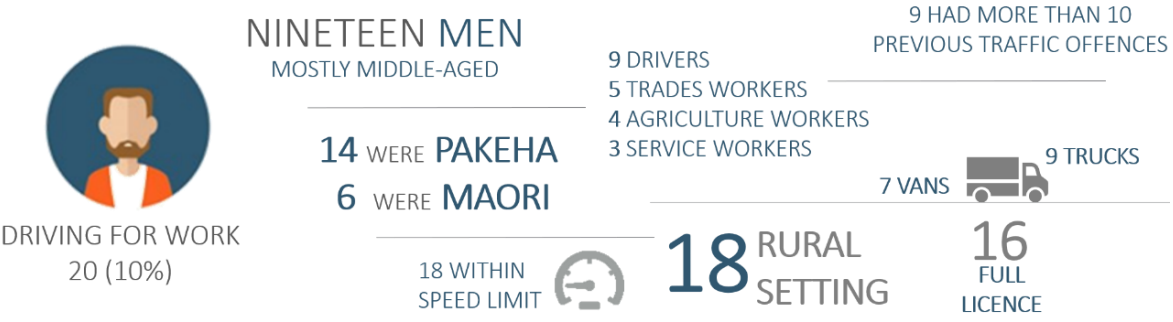
set of matched data from the in-depth fatalities and the offence analysis were used to provide a richer understanding of the traffic offence patterns of each of the occupant profiles. The findings from the data integration are presented in Section 4.4.

In parallel with the MCA, a manual sort of the in-depth fatality data was also carried out to explore what categories made sense. This served as a 'sense check' to validate the MCA and ensure that illogical results were not somehow resulting from the MCA.

4.3. Cluster analysis findings

There was strong agreement between the statistically and manually derived profiles that were determined and so the profiles that have emerged seem reasonable. Nevertheless, there are clearly limitations to this process and the boundaries of the profiles are never going to be perfect. However, if the overall goal is to create a more enhanced understanding of the combination of factors that are associated with non-seat belt fatalities (profiles) for the future purpose of obtaining a deeper understanding regarding why seat belts are not worn - with road safety activities designed accordingly - then we feel that these profiles are robust and useful.

The MCA analysis revealed five profiles of people who did not wear seat belts and who were fatally injured in crashes between 2011-2015. These are illustrated below.



4.4. Data integration findings

From the data integration between the *Crash Factors Analysis 2011-2015* and the *Deceased Vehicle Occupant Traffic Offence History 2012-2016*, 85 cases out of 200 were able to be matched. This matching slightly influenced the placement of 6 occupants between the profiles. The profiles presented above reflect this.

Of those, some clear patterns emerged:

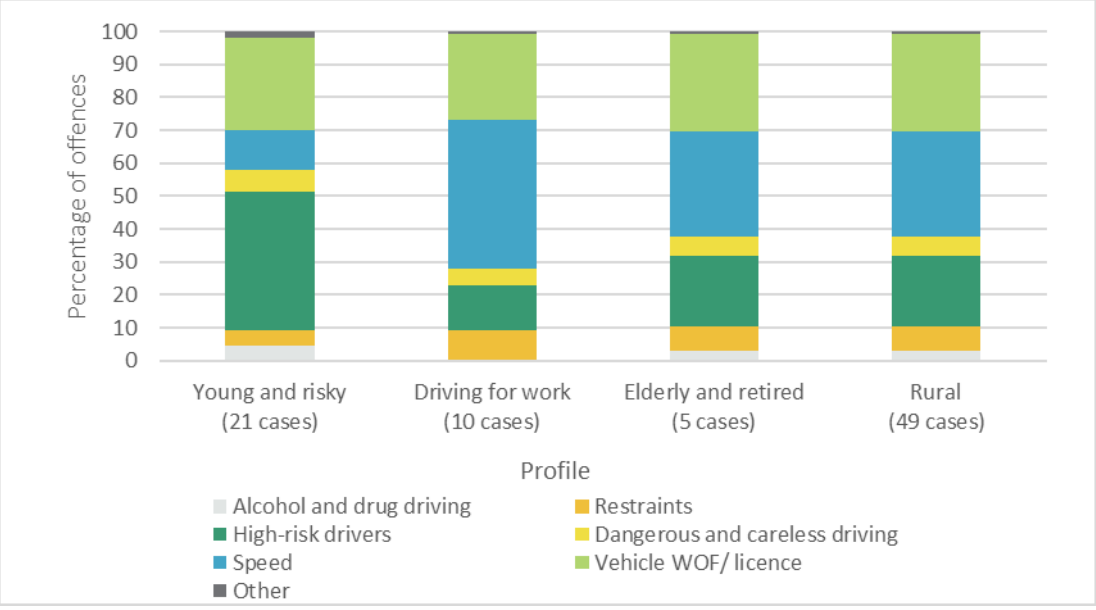
- Of the 85 cases, 27 victims were recorded as having a traffic offence history in both datasets. This highlights the value of examining both data sets together. It demonstrates that information is not consistently available between sources. For example, in the SCU reports, it may be unnecessary to mention a history of traffic offending if the history is unremarkable (i.e. vehicle registrations). However, in some cases, a victim had a significant history (i.e. 'High-Risk' and 'Dangerous Driving') and in some SCU reports this was noted, but in others it was omitted;
- Victims with 10 or fewer traffic offences accounted for 40 of the 85 cases. Therefore, 53% of the cases had a noteworthy prior traffic offending history, and 5 cases had a significant history, with 50 or more recorded offences; and
- Of the 85 cases, 8 victims had no prior traffic offending history. This means that the majority of victims had some level of traffic offending. The extent of each profile's traffic offending history is displayed in Table 8. However, the significance of the victims' offending history did not affect the cluster. This is due to the lack of sensitivity in the 'previous offence history' trigger due to the limited information available in SCU reports. The *Deceased Vehicle Occupant Traffic Offence History* was able to provide this nuance, but with no information about 115 cases, these details could not be incorporated into the overall profile creation.

Table 8: Occupant profile and traffic offence matches

Occupant profile	Matches and match rate	Number of previous traffic offences								Previous seat belt offences
		0	1-5	6-10	11-20	21-30	31-50	51-100	100+	
YOUNG AND RISKY	21 cases 39.6%	2	5	4	5	0	4	0	1	7 cases
DRIVING FOR WORK	10 cases 50%	1	0	0	2	2	4	1	0	7 cases
ELDERLY AND RETIRED	5 cases 41.6%	1	2	0	1	1	0	0	0	1 case
OVERSEAS PASSENGERS	No matches									
RURAL CRASHES	49 cases 45.4%	4	11	10	7	7	7	2	1	19 cases

The traffic offending was spread heavily across four of the profiles, suggesting that most types of people who are killed in non-seat belt wearing crashes commonly have some minor level of traffic offence history. Figure 27 shows the break-down of offence types within each profile based on the available matched cases. The offence types are themed within the 'Fatal Five' categories, as well as vehicle offences (i.e. no current WOF/ unlicensed vehicle), and other (predominantly bicycle offences).

Figure 27: Break-down of offence type by Profile



For all profiles, there was a relatively consistent proportion of vehicle offences ranging from 26-29.5% of the total offences. Of note is the over-representation of the 'driving for work' profile in the Restraints and Speed categories and under-representation in Alcohol and drug driving. Conversely, in the 'young and risky' profile, speed did not feature strongly, which seems unusual. But alcohol and drug driving offences were over-represented as were high-risk driving offences, which were predominantly associated with driver licence offences.

It cannot be said, at this point, whether the level and break-down of offending shown in Table 8 and Figure 27 is representative of the New Zealand population of similar profiles, or to others who are killed in road crashes where seat belts were worn.

4.5. Discussion

As already suggested by the literature the fatality analysis, and the offence analysis, a profile that was expected to emerge was the 'young and risky' category. This category did emerge, yet it only represented 26.5% of the cohort. The development of the profiles therefore demonstrated that there are far more categories of people who did not wear seat belts and who died. This shows that a range of people not wearing seat belts are killed in various contexts in New Zealand. The range of contexts are likely to have implications for the approaches that need to be taken to address non-seat belt use. For example, we suggest that the profiles 'elderly and retired', 'driving for work', and 'overseas passengers' may benefit from targeted intervention, specifically addressing compliance with the seat belt requirements. The people in these profiles were generally law-abiding in most other respects. Conversely, profiles 'young and risky' and 'rural crashes' exhibit a range of other unsafe driving behaviours which probably should be targeted first. For these profiles, focusing interventions on seat belt wearing may be less successful, especially as they display low compliance around other road safety issues such as speed, alcohol, and licencing.

It is worth noting that the 'rural crashes' profile were predominantly comprised of crashes which occurred in a rural setting. However, the fatally injured people in this profile did not necessarily reside in rural locations. Residential data were not collected as part of this study, so the proportion of these cases is unclear.

DISCUSSION OF OVERALL FINDINGS, STUDY LIMITATIONS, AND RECOMMENDATIONS

Discussion of overall findings

The aim of this research was to determine trends and profiles for seat belt non-users who were killed in motor vehicle road crashes, and to better understand trends surrounding seat belt non-use offences. From all parts of this study, there are some key findings that are worthy of discussion, as outlined below.

Is the non-seat belt fatality problem escalating?

Our analysis (CAS query 2017) show that the number of fatalities where seat belts were not worn may have increased in more recent years. Furthermore, when expressed as a proportion of all motor vehicle occupant deaths (excluding tractors and buses), non-seat belt fatalities in 2015 and 2016 is higher than the long-term (2006-2016) average. However, depending on the stage of data management, and the query that is used for CAS, there can be differing views on the degree to which non-seat belt fatalities are worsening. This is discussed in more detail below.

However, regardless of the degree in which non-seat belt fatalities are worsening, they nevertheless represent an unacceptably high number of deaths. This is especially pertinent given that, in theory their use should be a simple, effective, and accessible safety measure; and given that for most people, wearing a seat belt is an automatic behaviour.

It would be useful to know whether seat-belt compliance in general is worsening, or whether other risky behaviours are accumulating with non-seat belt use to result in the relatively high numbers of deaths. The figures from the MoT seat belt surveys are based on roadside observations which are, in themselves limited[13]. Therefore, with this methodology the survey results are more likely to capture the wearing rate for profiles 'elderly and retired', 'driving for work', and 'overseas passengers', but they almost certainly will not capture the profiles 'young and risky' and 'rural crashes'. Thus, the actual seat belt wearing rates may be lower than the reported values, particularly for particular user groups, and possibly particular regions.

A range of people and contexts, with varying offending histories are not wearing seat belts and are being killed

This research provides a deeper understanding of the range of people and contexts related to fatalities where seat belts were not worn. As per previous research, young males with associated risky driving behaviours appear to be associated with non-seat belt fatalities. However, this research highlights that other profiles are also associated with these fatality types

[13] The surveys are conducted between November and December in over 100 locations around New Zealand. Surveys are held between 2pm and 4pm on Sundays during the school term. Only adults in window positions are included.

(e.g. middle-aged people driving home from rural pubs, people driving for work, and people carrying out a range of utility trips). Across the five identified profiles, there are also a range of offending histories, with some relatively compliant people, but many who have accumulated significant offence histories, ranging from WOF and vehicle licencing offences to more severe offences such as dangerous driving and speed-related. These findings suggest that, along with a range of offences, failure to use a seat belt may be in many cases habitual or normalised. Situational factors, such as vehicle occupant overloading or poor role modelling by others, were also identified in the analysis and may influence people's decision to not wear a seat belt. These pose challenges for interventions that seek to improve seat belt wearing behaviours.

Other risky behaviours

The research suggests that in many cases the non-wearing of seat belts is a symptom of risky driving behaviour not the cause. It is very unusual for not wearing a seat belt to be the cause of a crash, but it is likely to be a major factor in the outcome of a crash. Compared with the generally high rate of seat belt wearing in New Zealand (97% for front seat passengers, Figure 2), the number of fatalities for non-seat belt wearers as a proportion of the overall vehicle occupant fatalities (nearly one third) is remarkably high[14]. It is almost certain that many non-seat belt wearers are often also engaging in other unsafe driving behaviours. Merely getting vehicle occupants to wear their seat belt will not reduce their likelihood of crashing, but it would reduce their fatality rate substantially (Høye 2016). The drunk agricultural worker driving home from the pub or a party in a single vehicle accident (there are 17 of these) will still have the crash, but with a seat belt, their chance of surviving is higher. These findings do suggest that the non-seat belt fatality issue will not be solved by focussing on seat-belts alone - rather, it is part of a broader Safe Systems issue.

The next step: Why do some people use seat belts while others do not?

As outlined earlier, the next step towards meaningful road safety initiatives to improve seat belt compliance is to understand why the groups of people identified in this study do not wear seat belts. There are a range of possibilities, and if the mechanisms are more clearly defined for various contexts, then road safety initiatives can be better targeted to address these mechanisms, hence have a greater likelihood of success. As indicated by the findings, for some people, a general focus on risky driving is needed, or even support from outside of the transport system. For others, cultural norms and a focus on positive habits may be more relevant.

Study limitations

Who but not why

Overall, the available data has been sufficient to achieve the core goal of the project, which is to determine profiles of those not wearing seat belts who were killed in crashes. Between the CAS and NZ Police offending data, a picture of the people and contexts involved in these crashes seems clear enough. The data stops short of explaining why people do not wear seat belts and

[14] As discussed earlier, these wearing rates may not be representatively of the entire NZ population. However, they are the most comprehensive rates available.

so if this next step (as above) is to be taken, then other methods will be needed to determine this. Surveys, focus groups, or in-depth interviews with non-seat belt users are more likely to yield an understanding of the underlying reasons why people do not wear seat belts. Although this cannot be achieved for those who were killed, similar reasons may exist for those who do not wear seat belts and have not been involved in a fatal crash.

Differences in data-sets

Please note that the numbers for non-seat belt fatalities reported in Figure 2 varies from numbers reported elsewhere (New Zealand Police 2017, NZ Transport Agency 2017a). Within this report, CAS was used solely for the identification of non-seat belt wearing deceased vehicle occupants. Other data sources are also available in New Zealand, such as the Fatal Traffic Notification database. Due to the three reporting stages following a fatal crash, it may be that some crashes may be present in one database but not in another. The three reporting stages following a fatal crash are as follows:

1. A fatal notification is required within 24 hours and is included in the MoT fatal database;
2. The TCR is completed by the attending officer at the scene of the crash and forms part of the crash record in CAS; and
3. An SCU report is written by a trained crash-investigation Police Officer. This report is completed at a later stage, following in-depth investigation, scientific tests, and interviews. Data from the SCU are used to improve the earlier data from the crash record in CAS.

Given the nature of the data and the timelines associated with gleaning and reporting the data, there can be significant time delays between the publication of the three reports, especially if the crash is particularly complicated (e.g. involving multiple vehicles and/or multiple fatalities).

Presumably, part of the challenge with these data is determining an accurate assessment of seat belt use at various stages of crash scene investigations. For example, a police officer completing a TCR at the scene of a fatal crash – a situation that is complex and stressful – may not always be in a position to accurately determine whether seat belts were used or not. Sometime later, the SCU report will become available and it is more likely to yield a robust assessment of whether seat belts were worn or not. Sometimes this more thorough analysis can be used to adjust the CAS fields. If different databases use data at different stages of data management, then inconsistent outcomes may be possible. While this system may be difficult to change in the short-term, it may be useful to reach universal agreement on the data sources that should be used to report non-seat belt fatalities, for example, the queries that were used in Section 1 of this report can be viewed in Figure 29 and Figure 30, Appendix D. It may also be useful to estimate the potential for under-reporting. This would provide more confidence in any estimate of non-seat belt fatality numbers and trends in the future.

Limitations in offence data

The NZ Police traffic offence records are only available from1998. In addition, whilst there was some ethnicity data recorded by the NZ Police for traffic infringement offences, the available data was not complete and was deemed unreliable[15]. Finally, it was proposed to provide offence data by individual NZ Police district. However, due to the multiple caveats and variables involved with these data, they were excluded. The data reviewed did not analyse the offences by rural/urban locations.

For the offence data there were some variables that could not be readily distinguished, such as:

- Longer-term offence history (only went back to 1998);
- Distinguishing drivers vs passengers;
- Ethnicity; and
- Gender (on occasions).

Adults but not children

The study was deliberately limited to vehicle occupants who would normally wear seat belts. Therefore, it is still unknown to what extent children are killed or seriously injured due to responsible adults not using or incorrectly fitting child restraints. The offending data found that approximately 14% of restraint offences were related to incorrectly restrained children, but we are not sure, from this analysis, whether this proportion would also extend to those who are killed while not wearing seat belts.

Recommendations

For any future analyses, it is recommended that the following data issues should be investigated, or at the very least acknowledged:

- The representativeness of the driving population of non-seat belt wearing rate data;
- The variability in databases as to whether deceased occupants were wearing seat belts or not;
- The reason for a recent decrease in 'Restraints' offences;

With a better understanding of these data issues, steps can then be taken to achieve a greater level of confidence in seat belt non-wearing data.

There would be value in understanding if differences exist between the offence (traffic and non-traffic) history of people who do and do not wear seat belts and die in crashes. This may give more insight into the profiles that have been developed in this report.

There is now a good understanding of the profiles of people who are killed in crashes where seat belts are not used. A next step, as outlined earlier, is to understand *why* occupants do not

[15] Any mention to ethnicity in the body of this report is based on an analysis of SCU reports in the CAS system. No ethnicity information was determined from the NZ Police data.

use seat belts. This would require a different research approach, focussing more on the system factors that influence people's actions.

Following this deeper understanding of *why* people do not use seat belts, more targeted road safety initiatives can be designed. As indicated by the findings, for some people, a general focus on risky driving, or support with other areas of life, is needed. For others who are otherwise likely to be more law abiding, focussing on seat belt use through high quality road safety education and enforcement is likely to be relevant. Note that there is evidence for road safety initiatives that are likely to be more successful, and for those that are not, and an evidence based approach should always be taken.

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APPENDICIES

Appendix A: Review of the Literature

Background

This review focuses on seat belt use for, and by people aged fifteen and over. It does not include information about child restraints as this is beyond the scope of the project. By understanding the patterns of factors surrounding seat belt non-use, we are in a better place to start to comprehend occupants' reasons for not wearing seat belts and target these accordingly.

An initial step was to review academic and non-academic literature related to non-seat belt use and associated factors. A literature search was conducted using the databases PubMed, Tandfonline, Science Direct, Cochrane library, Researchgate, and Google Scholar. Key words in the search terms included "non-seat belt", "seat belt wearing patterns" "restraint", "safety belt", "deaths and serious injuries", "driver attitudes and behaviours", "teen", "offending", "traffic offence history", amongst others. Additional information was obtained through government websites, including the New Zealand Ministry of Transport, the Australian Federal Office of Road Safety, UK's Department for Transport, and the World Health Organization.

A key report drawn on for this review is the NZ Transport Agency (2017b) "Buckle and clip: Failure to wear restraints and helmets in fatal crashes" which is discusses the patterns behind 359 vehicle and motorcycle fatality crashes in New Zealand from 2011-2015. It will be referred to throughout this review as *Buckle and clip*.

It has been established that seat belts substantially reduce the likelihood of injury or death substantially in a crash (Fildes, Fitzharris et al. 2003, World Health Organization 2009, Road Safety Observatory 2013, de Pont 2016, Høye 2016, Han 2017). Indeed, Høye (2016) indicates that by wearing a seat belt in a crash, an occupant's chances of survivability are increased by 60% in the front seats, and 44% in the rear seats.

This literature review answers three of the four research questions that pertain to seat belt non-use and is structured to follow the questions:

1. Are there any obvious patterns to crashes including geographic? Seasonal? Temporal?
2. Are there any demographic patterns that can be established including age, gender, or any others that the data can reveal?
3. What other factors are commonly associated with crashes where seat belts are not being worn such as speed, alcohol or drugs, distraction, vehicle type, drivers versus passengers?

Are there any obvious patterns to crashes including geographic, seasonal, temporal?

Time of year and time of day

Buckle and clip found that that crashes involving non-seat belt use were more likely to occur in the summer months. In addition, these crash types were more likely to occur in the evening and early morning (NZ Transport Agency 2017b). Similar crash patterns are reflected in the literature from abroad, including the USA (McCartt and Northrup 2004, Chaudhary and Preusser 2006, Steinhardt and Watson 2007, Alattar, Yates et al. 2016) and Australia (Steinhardt and Watson 2007, Raftery and Wundersitz 2011).

Location

Buckle and clip showed that non-seat belt fatal crashes were more likely to occur on open roads in rural areas, and urban roads rather than on state highways. The most common regions for crash occurrence was in the Waikato and Bay of Plenty (NZ Transport Agency 2017b). In the USA and Australia, it has been shown seat belt

wearing rates may be lower in rural settings (Arup 1991, Steinhardt and Watson 2007, Knight, Harris et al. 2008, Raftery and Wundersitz 2011).

Are there any demographic patterns that can be established including age, gender, or any others that the data can reveal?

Gender

Evidence that women are more likely to wear seat belts than men has been demonstrated in studies around the world, including New Zealand (Fergusson, Swain-Campbell et al. 2003), USA (Eluru and Bhat 2007, Reagan, McClafferty et al. 2013), the United Kingdom (Richards, Hutchins et al. 2008), the Czech Republic (Gabrhe, Zamecnik et al. 2017), Malaysia (Ng, Hua Law et al. 2013), and Turkey (Alver, Demirel et al. 2014).

In addition, there is a common theme that those not wearing seat belts in fatal crashes are more likely to be male. This has been demonstrated in New Zealand (NZ Transport Agency 2017b), Australia (Palamara, Oxley et al. 2009, Raftery and Wundersitz 2011), and the USA (Romano and Voas 2011).

Age

A common theme throughout the literature is that an association between age and seat belt use exists. Drivers in their late teens and early 20s are least likely to wear seat belts (Eluru and Bhat 2007, Romano and Voas 2011, Alver, Demirel et al. 2014, Mackie, Gulliver et al. 2017). This trend is compounded for young males (McCartt and Northrup 2004, Raftery and Wundersitz 2011, Alattar, Yates et al. 2016). However, older drivers are more likely to wear seat belts, with the ≥75 age group representing the highest usage rates (Romano and Voas 2011, Bao, Xiong et al. 2015).

Education

Seat belt wearing rates have been shown to be lower amongst adults with lower academic qualifications. This has been observed in New Zealand (Begg and Langley 2000), the USA (Chaudhary, Solomon et al. 2004), Malaysia (Ng, Hua Law et al. 2013), the Czech Republic (Gabrhe, Zamecnik et al. 2017), and in Turkey (Demirer, Durat et al. 2012).

Ethnicity

There is an association between ethnicity and lower seat belt-wearing rates, particularly people from marginalised and minority ethnic backgrounds. In South Australia, seat belt use has been identified as an important issue for Indigenous Australians (Raftery and Wundersitz 2011). Likewise, in the USA, people from African American and Hispanic backgrounds have been reported to have lower rates of seat belt use (Shin, Hong et al. 1999, Shults, Haegerich et al. 2016).

What other factors are commonly associated with crashes where seat belts are not being worn?

Vehicle factors

There is recognition that the vehicle type may be associated with seat belt wearing rates, but there is no consensus on which vehicle type. *Buckle and clip* showed that fatal non-seat belt crashes were more likely to occur in cars/ taxis, and in particular in older vehicles (NZ Transport Agency 2017b). In an American study, SUV drivers were most likely to wear seat belts and those driving a 'pick up' were least likely to wear a seat belt (Eluru and Bhat 2007).

Vehicles with a seat belt reminder system have been shown to have a positive effect on seat belt usage rates (Lie, Kullgren et al. 2008, Demirer, Durat et al. 2012). Speculation about the likely improvement to seat belt wearing rates with the future advent of commonly available seat belt interlocks is described by Høye (2016).

In a South Australian analysis of crashes that occurred in 2008, more non-seat belt fatalities occurred in single vehicle crashes than those involving multiple vehicles (Raftery and Wundersitz 2011).

Enforcement factors

Findings from the United States, where there is a discrepancy of enforcement laws between states have shown that a relationship exists between people's perceived risk of getting a ticket, and their seat belt use – the actual risk being based on the strength of the law in a particular state (Chaudhary, Solomon et al. 2004, Shults, Elder et al. 2004, Eluru and Bhat 2007, Bhat, Beck et al. 2012).

Similar findings are reflected in a study of driving attitudes and behaviours between Northern Kosovo (little traffic enforcement) and Serbia (traffic enforcement). The study concluded that drivers in Northern Kosovo not only wore seat belts less than those from Serbia, but they also were more likely to be involved in other risky driving situations (Stanojević, Jovanović et al. 2013).

Person-centric factors

Fatigue

Although we have been unable to identify a paper that specifically correlates fatigue with forgetting to wear a seat belt, there is nevertheless strong evidence that fatigue affects cognitive function. In a study comparing the effect of wakefulness and blood alcohol concentration on cognitive performance, Dawson and Reid (1997) found that 17 hours of sustained wakefulness was equivalent to the performance impairment observed in people with a blood alcohol concentration of 0.05%. There is strong evidence that fatigue affects driving performance (Lal and Craig 2001, Philip, Sagaspe et al. 2005), and it may be that fatigue also reduces a person's ability to engage in otherwise habitual safety protocols, such as wearing a seat belt.

Comfort

Seat belt discomfort has been cited as a reason for people making a decision not to wear them. This is a particular issue for people aged over 75 (Acar, Feng et al. 2013, Harris, Waller et al. 2014, Fong, Keay et al. 2016), with females being 7.3 times more likely to cite comfort problems than males (Fong, Keay et al. 2016). However, comfort issues are not solely related to older people as described in the UK (Christmas, Young et al. 2008), New Zealand (Begg and Langley 2000), Turkey (Demirer, Durat et al. 2012), and Malaysia (Ng, Hua Law et al. 2013).

Difficulty

For some people, seat belts may be difficult to use. The reach and fastening tasks in particular may influence non-use in some cohorts. This has been observed in older car occupants (Acar, Feng et al. 2013, Harris, Waller et al. 2014) and in people who experience arthritis (Arie 1986).

Forgetfulness and laziness

In a survey of 21-year-old New Zealanders, 'forgetfulness', 'not in the habit' and 'laziness' were common reasons given for not wearing a seat belt (Begg and Langley 2000). Similar attitudes were reported in a Malaysian study of rear seat occupants (Ng, Hua Law et al. 2013).

Location in the vehicle

A common finding worldwide is that seat belt usage rates are lower in the rear seats than in the front seats. This has been reported in New Zealand (see Figure 2), the USA (Bhat, Beck et al. 2012, Bose, Arregui-Dalmases et al. 2013, Macy, Carter et al. 2014), Greece (Chliaoutakis, Gnardellis et al. 2000), Iran (Hatamabadi, Vafaee et al. 2012), China (Routley, Ozanne-Smith et al. 2007), and Saudi Arabia (Fildes, Stevenson et al. 2016).

Medical factors

Mental health

Depression, suicidal thoughts, and unhappiness have been cited as indicators for people to be less likely to wear seat belts. This has been noted in the USA (Barrios, Everett et al. 2000, Goudie, Mukerjee et al. 2014) and Australia (Pasculli and Harris 2016).

For people suffering from dementia, remembering to wear a seat belt may be one habit that is lost. In a US-based study, drivers with early stage dementia were less likely to wear a seat belt than the control group (Eby, Silverstein et al. 2012).

Obesity

People who are overweight or obese may be less likely to wear their seat belt. This has been observed in Australia (Fong, Keay et al. 2016), and in the USA. The effect of obesity on usage rates is likely to be significant, with one study in the US reporting that people with a normal BMI were 67% more likely to wear a seat belt than morbidly obese people (Jehle, Doshi et al. 2014).

'Decision policies'

Whilst wearing seat belts is a legal requirement, and whilst the majority of vehicle occupants in New Zealand habitually wear a seat belt every time they travel, some vehicle occupants disregard the law. For those who do not always wear a seat belt, it has been shown that this behaviour may be governed by numerous factors, resulting in a 'decision policy' (Alattar, Yates et al. 2016) for when they opt to wear their seat belt. This section outlines how some of those decisions may be made.

Influence of others

In his *Threshold Models of Collective Behaviour* Granovetter (1978) poses that individuals' behaviour is dependent on the number of other individuals already engaging in that behaviour. Importantly, each individual has a different threshold for up-taking that behaviour based on a variety of factors, such as the number of people already participating, socioeconomic status, age, education, gender, and personality. In addition, each individual calculates their cost and benefit from participating in the behaviour, thereby making thresholds situation-specific.

In the case of part-time seat belt users, the influence of other people in the vehicle has been shown to affect the decision policy of some user types in engaging in the collective behaviour of wearing, or not wearing a seat belt. In a US-based study, in cases where a driver wore a seat belt, passengers wore seat belts 92.6% of the times. However, if a driver did not wear a seat belt, only 19.1% of the passengers were observed to wear a seat belt (Han 2017, p.254). Similar results have been reported by McCartt and Northrup (2004), Catalano and Hawkins (1996), Litt, Lewis et al. (2014), Bingham, Simons-Morton et al. (2016), and Jaccard, Blanton et al. (2005).

Perception of risk

For those vehicle occupants employing a 'decision policy' to inform their seat belt wearing behaviour, the individual's low perception of risk about the trip may be a factor (Begg and Langley 2000).

Number, speed, and duration of trips

The number of planned trips in a day may affect the likelihood of seat belt use. In the USA, Reagan, McClafferty et al. (2013) found that regular seat belt users took fewer trips in a day than infrequent or occasional users.

An increase in average journey speed is positively associated with increased seat belt use amongst occasional drivers (Reagan, McClafferty et al. 2013, Alattar, Yates et al. 2016). This may indicate an increased perception of risk.

The intended duration of the journey may also influence seat belt use (Demirer, Durat et al. 2012, Alattar, Yates et al. 2016), whereby the 'decision policy' of part-time users may be triggered to use a seat belt for a long trip, but not for a short trip i.e. to the local shops.

Risky driving behaviours

Under the influence of alcohol

A strong association exists between people being under the influence of alcohol and not wearing a seat belt. This has been reported in New Zealand (Begg and Langley 2000, Mackie, Gulliver et al. 2017, NZ Transport Agency 2017b), Australia (Blackman, Veitch et al. 2007, Steinhardt and Watson 2007, Raftery and Wundersitz 2011, Scott-Parker, Watson et al. 2013), the United States (Eluru and Bhat 2007, Steinhardt and Watson 2007, Tsai, Anderson et al. 2010, Romano and Voas 2011, Shults, Haegerich et al. 2016), and Norway (Bogstrand, Larsson et al. 2015).

The presence of drugs in the system whilst driving

The presence of different classes of drugs in the bloodstream of a vehicle occupant has been shown to be associated with the non-use of seat belts:

- THC – A correlation between marijuana use and non-seat belt use has been demonstrated in New Zealand (Begg and Langley 2000, Blows, Ivers et al. 2005) and Australia (Raftery and Wundersitz 2011);
- MDMA – In fatal crashes in Australia, victims not wearing a seat belt were more likely to test positive to MDMA than those who had worn a seat belt (Raftery and Wundersitz 2011);
- Amphetamines – In a sample of 372 fatally injured drivers in Norway, a total of 146 had not been wearing a seat belt. Of those, 54.5% were impaired by amphetamines (concentration above 200mg/l) (Bogstrand, Larsson et al. 2015). This is reflected in fatal crashes in Australia where victims not wearing a seat belt were more likely to test positive to methamphetamine than those who had worn a seat belt (Raftery and Wundersitz 2011).

Speeding

Speeding, and driving too fast for the conditions has been reported as a factor positively associated with a tendency to not wear a seat belt. This has been observed in New Zealand (Mackie, Gulliver et al. 2017, NZ Transport Agency 2017b), Norway (Bogstrand, Larsson et al. 2015), the United States, and Australia (Steinhardt and Watson 2007).

History of traffic offences

The literature suggests that people with a history of traffic offences, such as multiple speeding convictions, drinking and driving, and texting whilst driving, are less likely to wear seat belts than people who do not have a history of traffic offences (Preusser, Williams et al. 1991, Begg and Langley 2000, Blackman, Veitch et al. 2007, Eluru and Bhat 2007, Steinhardt and Watson 2007, Simsekoglu and Lajunen 2009, Gray 2015).

Inherently unsafe people do not wear seat belts

Several studies suggest that people who exhibit one, or a combination of the factors described in the section above are likely to be 'inherently unsafe' drivers, and for this group, low seat belt usage is commonly exhibited, as are high-injury severity crashes (Shinar 1993, Janssen 1994, Evans 1996, Begg and Langley 2000, Petridou and Moustaki 2000, Fergusson, Swain-Campbell et al. 2003, Eluru and Bhat 2007, Wundersitz and Baldock 2011).

Appendix B: Analysis of Top Ten Offenders

Figure 28: New Zealand Police Districts (Source: CPNZ)

Top Ten offenders from Section 2.2 ('Restraint' offences 2017 and the offender's traffic offence history)

From the restraint offender sample, the Top Ten offenders (0.1% of the total offenders, with an average of 440 offences each) accounted for 4,400 (0.4%) of the total offences (Table 9). These are examples of the most serious offenders and give some indication about their cost to the community. All were male and the predominant NZ Police districts (Figure 28) of detection were: Wellington, Southern, and Central. Six of the offenders were under the age of 20 at the first detected offence. Offenders 5 and 10 had their first offence recorded in 1998, when the record keeping began, and in all likelihood (considering the pattern of yearly offending) started their offending at an earlier age. Offenders 2, 8, and possibly 1 also span the full record keeping period and are likely to have had additional offences prior to that. As previously noted, the same offenders can be responsible for many offences. As an example of this, offender 1 recorded 8 different offences in a single day (this was not an isolated incident for this offender or others). Note, the data presented in Table 9 do not represent all people who have restraint offences, rather they show the extreme end of high-level offenders.

Table 9: Top Ten offenders identified under the 'driver or passenger not wearing a seat belt'

Top Ten Offenders	Number of Offences	Gender	Predominant Area of Offence Detection by NZ Police District	Age at First Offence	Age at Last Offence
1	728	M	Southern	20	38
2	661	M	Wellington/Central	19	38
3	439	M	Southern	15	24
4	431	M	Wellington/Central	15	33
5	401	M	Central	41	60
6	380	M	Wellington	15	27
7	366	M	Wellington	15	27
8	362	M	Southern	22	41
9	322	M	Wellington	16	30
10	310	M	Wellington/Southern	34	54

Top Ten offenders from Section 2.3 (Deceased vehicle occupant traffic offence history 2012-2016)

The ten highest offenders from Section 2.3 (5.1% of the total offenders, Table 10) accounted for 813 (21.7%) of the total offences. All but two were male and the predominant NZ Police districts of detection were Counties Manukau, Central and Waitemata. Five of the Top Ten offenders were under the age of 20 at the first detected offence. Offenders 3, 5, and 9 had their first offence recorded in 1998, when the record keeping first began, and as with the Top Ten offenders in the previous section, they too may have started their offending at an earlier

age. Offenders 6, 10, and possibly 1 also span the full record keeping period and are likely to have additional offences prior to that.

Table 10: Top Ten offenders: 'deceased occupants not wearing a seat belt' 2012-2016

Top Ten Offenders	Number of Offences	Gender	Predominant Area of Offence Detection by NZ Police District	Age At First Offence	Age at Last Offence
1	150	F	Northland	17	34
2	107	M	Southern	15	22
3	82	M	Counties Manukau	43	60
4	78	M	Counties Manukau	18	32
5	74	M	Waitemata	39	54
6	68	M	Tasman/Canterbury	26	43
7	66	M	Central	17	21
8	64	M	Waitemata	16	29
9	62	M	Waikato	43	60
10	62	F	Central	25	40

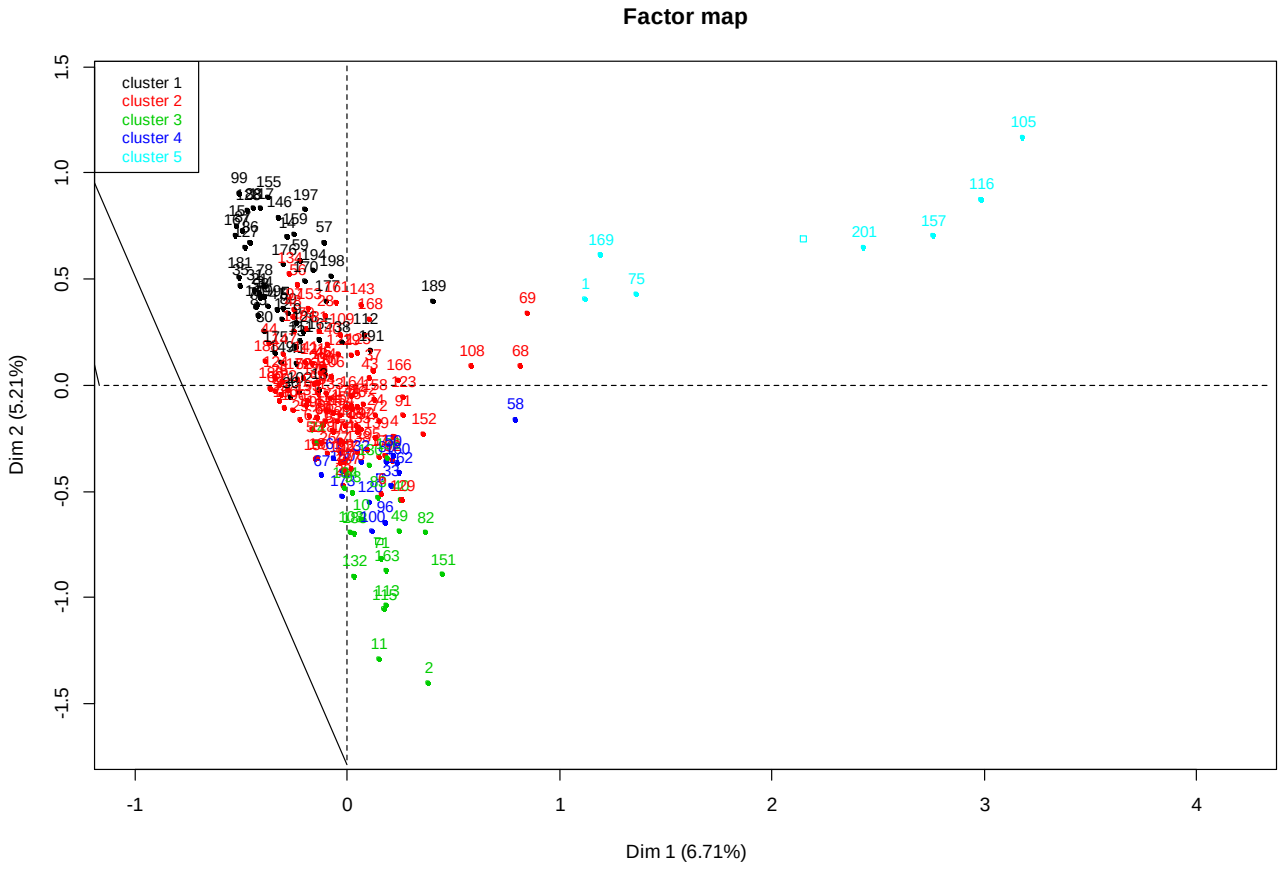
Appendix C: Supplementary Information from Cluster Analysis

Most of the variables in the database are nominal categorical variables. This means that variables can take one of a number of values and that there is no ranking of these values. For example, the vehicle type can be “car”, “truck”, “van”, “ute”, “SUV” etc. Some variables such as victim age were continuous numerical variables, but it is not clear that these correlate with risk in any linear way. Thus, these continuous variables were converted to category variables. For example, with victim age we created 10-year age bands and assigned the data accordingly. There is some categorical data which can be regarded as ordinal which means that there is a ranking of the categories, for example, vehicle age and speeding. These two variables were originally continuous but were converted into categories with bands. It is reasonable to consider that exceeding the speed limit by 30-40 km/h is worse than exceeding the speed limit by 20-30km/h which, in turn, is worse than 10-20 km/h which is worse than 0-10 km/h. The analysis did not consider the ordinal nature of these variables. All variables were treated as nominal categories.

In the analysis, each option in a categorical variable was converted to a 0/1 variable. So, for example, if the vehicle was a car, then it would be coded vehicle_type_car, with a value of 1. The other vehicle type variables; vehicle_type_truck, vehicle_type_van, vehicle_type_ute, vehicle_type_SUV etc. would then be zero. Thus, with more category options there will be more variables but most of them will be zero. With many variables it is much harder to find patterns and develop profiles. Thus, the category options were consolidated as much as possible.

The MCA analyses the correlations between the category variables and develops new composite variables which are combinations of the category variables and are independent of each other. The cluster analysis then identifies groups of individuals that are close to each other in terms of the composite variables.

The output from the MCA is shown in the plot below with the clusters being represented by the five colours:



Appendix D: Suggested CAS query for non-seat belt fatality search

The figures below are screen shots of the suggested CAS query for non-seat belt fatalities and serious injuries. The output from this search displays 'not available', 'not worn', 'uncertain', and 'worn'. For this study we only assessed those categorised as 'not worn' and 'worn'. The 'uncertain' cases were not included in the analysis.

Figure 29: Suggested CAS query for non-seat belt fatalities

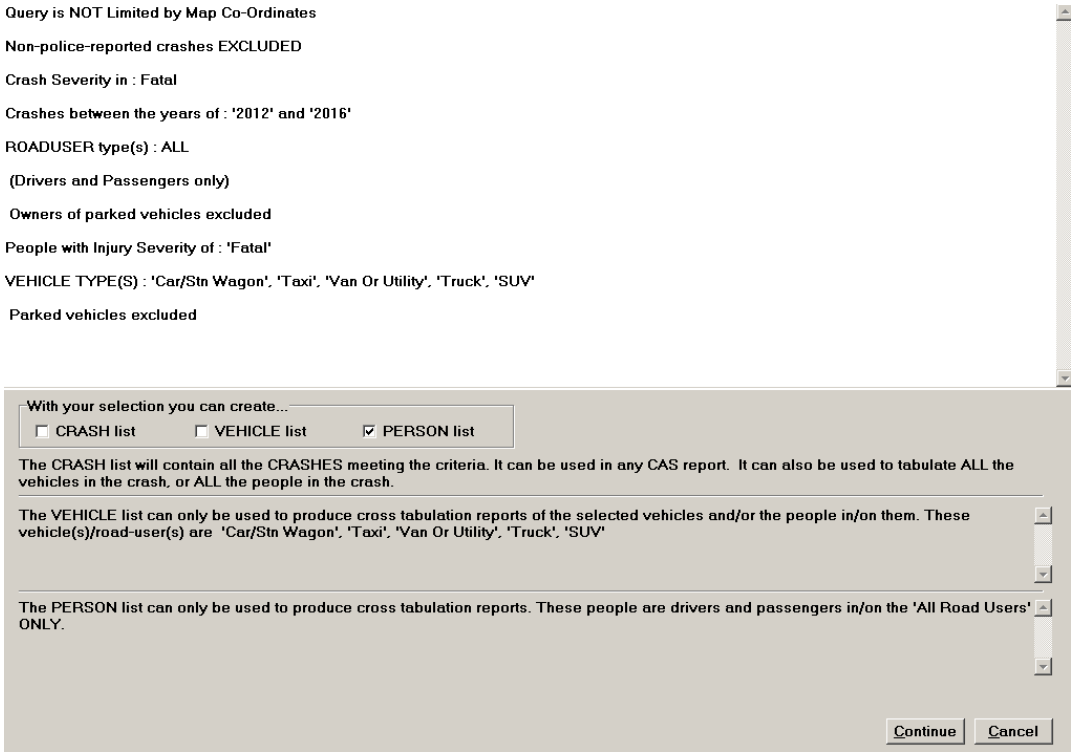


Figure 30: Suggested CAS query for non-seat belt serious injuries