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932012

NZQA
NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

QUALIFY FOR THE FUTURE WORLD
KIA NOHO TAKATŪ KI TŌ ĀMUA AO!

Scholarship 2017
Statistics

2.00 p.m. Tuesday 21 November 2017
Time allowed: Three hours
Total marks: 40

QUESTION BOOKLET

There are FIVE questions in this booklet. Answer ALL questions.

Pull out Formulae and Tables Booklet S–STATF from the centre of this booklet.

Write your answers in Answer Booklet 93201A.

Show ALL working. Start your answer to each question on a new page. Carefully number each question.

Check that this booklet has pages 2–11 in the correct order and that none of these pages is blank.

YOU MAY KEEP THIS BOOKLET AT THE END OF THE EXAMINATION.

QUESTION ONE

A study was carried out of all drivers who had been drinking. As part of this study, a random sample of 50 drivers who had been drinking was selected. The blood alcohol level (BAL) in mg / 100 mL was measured and the age recorded for each driver.

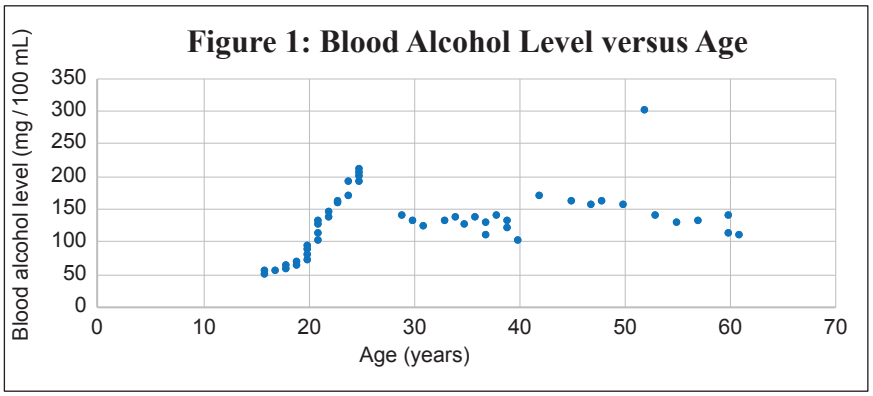
The following data were obtained:

Age Years	BAL mg / 100 mL
16	50
16	55
17	55
18	58
18	63
19	62
19	67
20	70
20	79
20	87
20	93
21	100
21	112
21	124
21	130
22	137
22	145

Age Years	BAL mg / 100 mL
23	159
23	160
24	170
24	190
25	191
25	200
25	205
25	210
29	140
30	130
31	122
33	131
34	136
35	126
36	136
37	109
37	129

Age Years	BAL mg / 100 mL
38	140
39	120
39	130
40	102
42	170
45	162
47	156
48	160
50	155
52	300
53	140
55	127
57	132
60	111
60	140
61	108

(a) A scatterplot of blood alcohol level versus age (Figure 1) was constructed.



(i) Describe the relationship between age and blood alcohol levels.

(ii) The regression line BAL = 89.85 + 1.235*age was fitted to these data.

Predict the blood alcohol level for a 27-year-old who had been drinking before driving.

Discuss any reservation(s) you have about using your prediction.

(iii) Suggest two further variables that would possibly influence blood alcohol levels.

Describe the expected relationship between each of your chosen variables and the blood alcohol level.

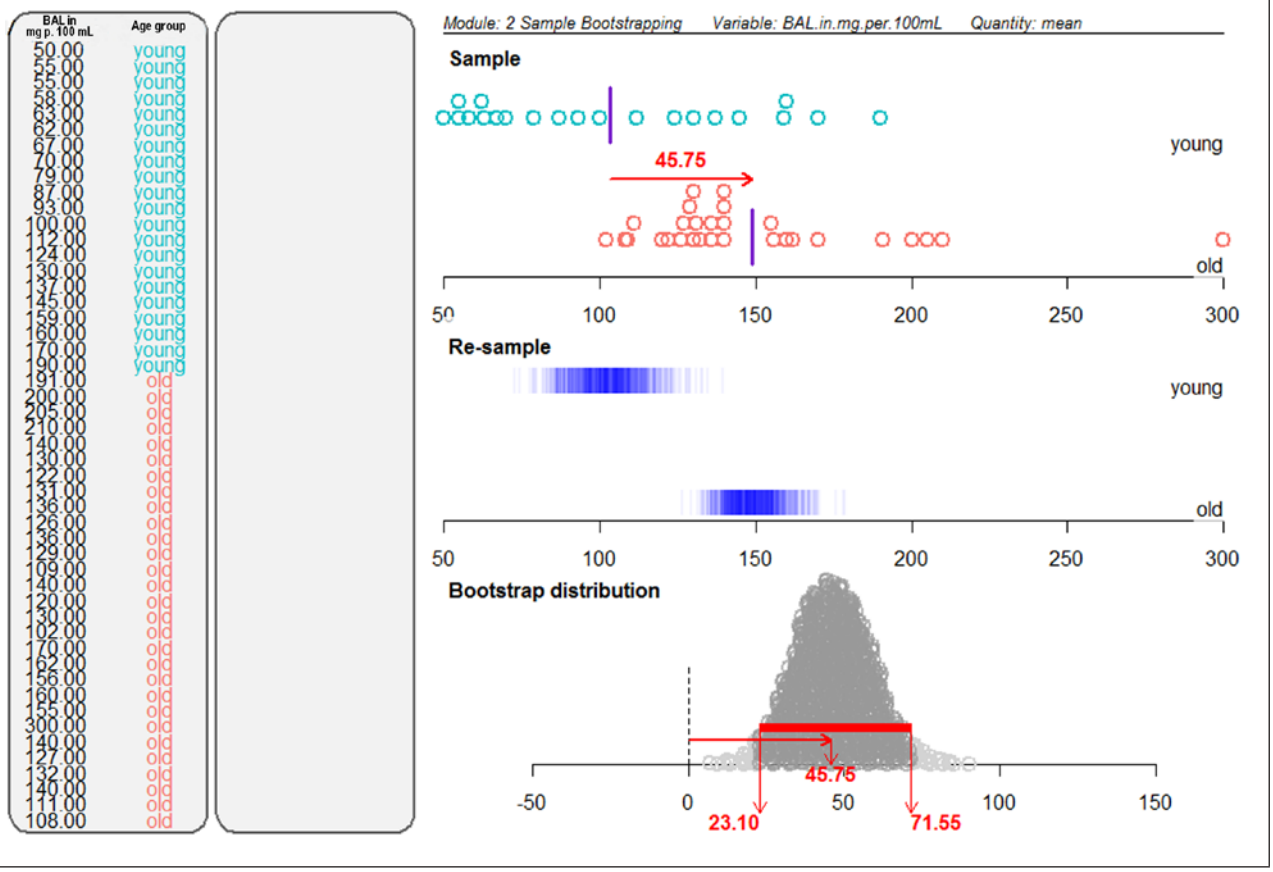
(b) A comparative analysis was carried out on the difference in blood alcohol levels between those drivers who were under 25 (young) and those who were aged 25 and over (old).

Figure 2 gives a summary of the blood alcohol levels of these two age groupings and the bootstrap distribution of the difference between the means of the BAL of the two groups.

What can be concluded from this output?

Justify your answer.

Figure 2



QUESTION TWO

Figures 3, 4, and 5 below present some information about road crashes in New Zealand that resulted in death, and where alcohol or drugs were involved.

Figure 3 shows the annual mean number of such crashes during four-hour periods for each day of the week (the first period is 0000 hours – 0359 hours, the second period is 0400 hours – 0759 hours, and so on) for the years 2013 – 2015. It also shows the number of such crashes as a percentage of **all** fatal crashes, whether or not alcohol or drugs were involved.

Figure 4 shows the annual mean number of drivers affected by alcohol or drugs involved in crashes that resulted in death, for the years 2013 – 2015 in various age groups. It also shows the percentage of such drivers taken over all fatal crashes, where alcohol or drugs were involved.

Figure 5 shows the annual total number of deaths from road crashes where at least one driver was affected by alcohol or drugs, for the years 1990 – 2015.

[The information is sourced from the New Zealand Ministry of Transport.]

Figure 3: Fatal crashes with driver alcohol/drugs as a factor by time of day and day of week (annual mean 2013–2015)

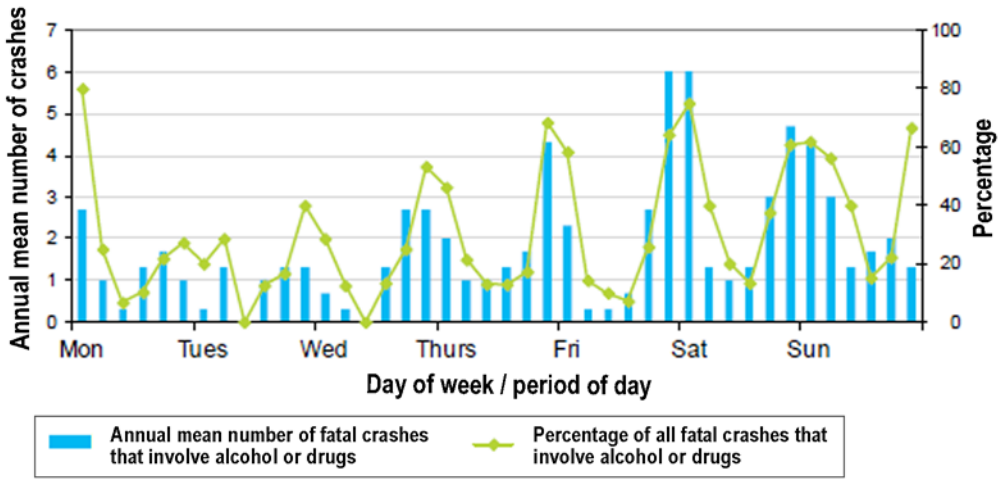


Figure 4: Fatal crashes with driver affected by alcohol or drugs by driver age group (annual mean 2013–2015)

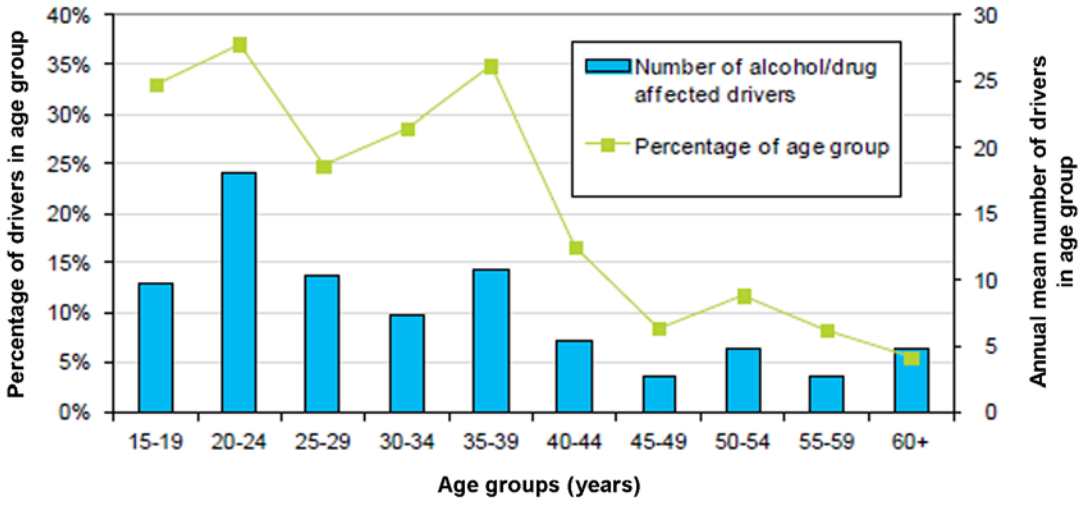
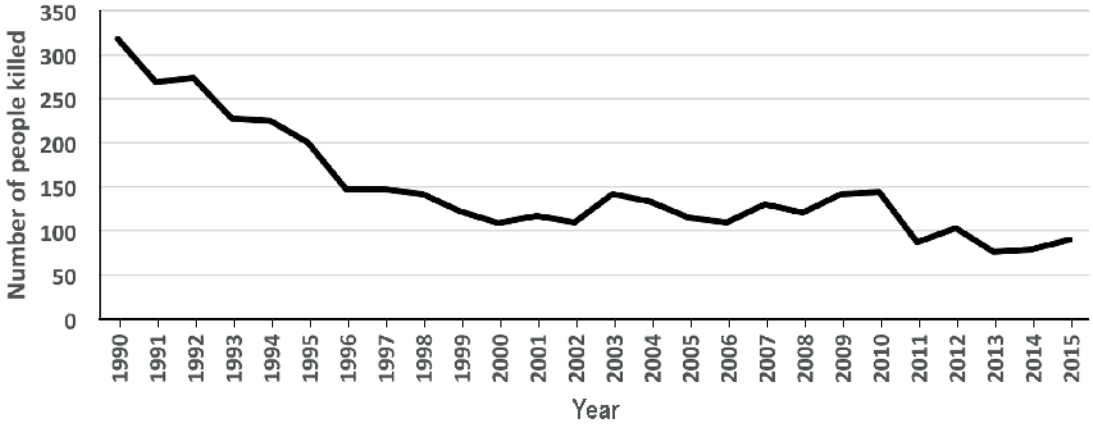


Figure 5: Annual total number of deaths from road crashes where at least one driver was affected by alcohol or drugs



(a) Sam belongs to SADD (Students against Driving Drunk) at her school and is to give a talk to the senior assembly.

From each of Figures 3, 4, and 5, write two statistical points that Sam could make in her talk about deaths from road crashes in New Zealand between 2013 and 2015, where alcohol or drugs were a factor.

Number each point clearly.

(b) Using the information in Figure 3, compare the annual mean number of fatal road crashes on a Saturday, and the annual mean number of fatal road crashes on a Sunday that DO NOT involve alcohol as a factor, for the time period 4 p.m. to 8 p.m.

(c) Give two further pieces of information that could help in understanding the trend observed in Figure 5, and explain how that information might affect this trend.

(d) Using the information in Figure 3, estimate a seasonal effect for the number of fatal crashes involving a driver affected by alcohol or drugs, for Tuesdays.

Justify your answer.

QUESTION THREE

(a) A large sample of road crashes where alcohol was a contributing factor, was selected from the records. It was noted that, for a given number of occupants in the car:

- Fifty per cent of car crashes occurred with a single occupant, and 36 per cent of car crashes occurred with two or three occupants.
- The road crashes were classified in 95 cases as being fatal, in 455 as being serious, and in 1500 as being minor.
- Forty per cent of all serious crashes occurred with only a single occupant.
- Forty-three per cent of all minor crashes occurred with two or three occupants.
- Three per cent of all minor crashes occurred with four or more occupants.
- There were a total of 195 crashes classified as serious with four or more occupants.

Use this information to answer the following where alcohol was a contributing factor.

(i) How many of these crashes were classified as fatal where there was only one occupant in the car?

(ii) Estimate the probability of the following events:

1. A crash was classified as minor and had two or three occupants in the car.
2. A serious crash had four or more occupants in the car.

(iii) Are the events "fatal crash classification" and "one occupant in the crashed car" statistically independent or not?

Justify your answer.

(iv) How many more times as likely is a car with a single occupant to be in a minor crash, compared to a single occupant in a fatal crash?

(b) Suppose data on the number of crashes classified as serious per quarter were collected over the last 50 quarters, giving rise to the following distribution.

Number of Serious Crashes per Quarter	**Frequency**
90 – 109	2
110 – 129	4
130 – 149	8
150 – 169	10
170 – 189	12
190 – 209	8
210 – 229	5
230 – 249	1

(i) Investigate whether a normal distribution with a mean of 170 and a standard deviation of 33 would be a suitable model for these data. Justify your answer.

(ii) Calculate an estimate for the probability that, in the next year, fewer than 160 crashes occur in each quarter.

What assumption(s) do you have to make?

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The examination continues on the following page.

QUESTION FOUR

[Adapted from: 'Driver risk from blood alcohol levels between 50 mg / 100 mL and 80 mg / 100 mL' December 2013; S.G Charlton and N J Starkey; Traffic and Road Safety Research Group, University of Waikato.]

In an experiment to test the effect of consuming alcohol on driving, 61 participants (33 male, 28 female) were recruited. All participants were experienced drivers.

The participants were randomly assigned to one of three groups (classified as "none", "medium dose", or "high dose"), with the groups being approximately the same size.

Each participant in the "none" group was given no alcohol.

Each participant in the "medium dose" group was given a dose of alcohol that resulted in their having a maximum alcohol level of 40 – 60 mg / 100 mL of blood.

Each participant in the "high dose" group was given a dose of alcohol that resulted in their having a maximum alcohol level of 70 – 90 mg / 100 mL of blood.

Each participant was then tested on a driving simulator for an 11 km standardised road test. The test scenario involved a two-lane rural highway with the centre line and road edges marked. Sections of the road had different speed limits, and hazards such as opposing traffic and traffic at intersections were included so that drivers had to react to these situations.

Some of the variables recorded were:

- blood alcohol level
- the number of times the participants steered across the centre line of the simulated road
- the number of seconds the participants spent with their wheels across the centre line of the road
- the number of times the participants steered across the left edge line of the simulated road
- the number of seconds the participants spent with their wheels across the left edge line of the road.

Each participant was tested five times, once at the start of the experiment before the alcohol was administered, and at four different times after the "medium dose" and "high dose" groups had consumed the alcohol. These five times are referred to as "test blocks". The second test was conducted 15 minutes after drinking alcohol, the third 10 minutes later, and the fourth after a gap of 30 minutes. Between the fourth and fifth test, the participants had some snacks to eat, and the last test was conducted almost an hour after the fourth.

Figure 6: Average blood alcohol levels and driving performance across five test blocks for each alcohol test group.

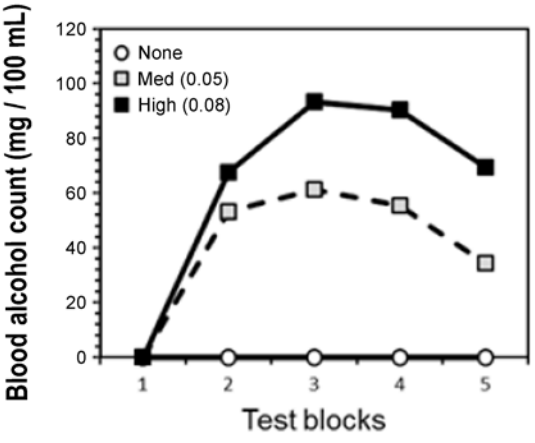
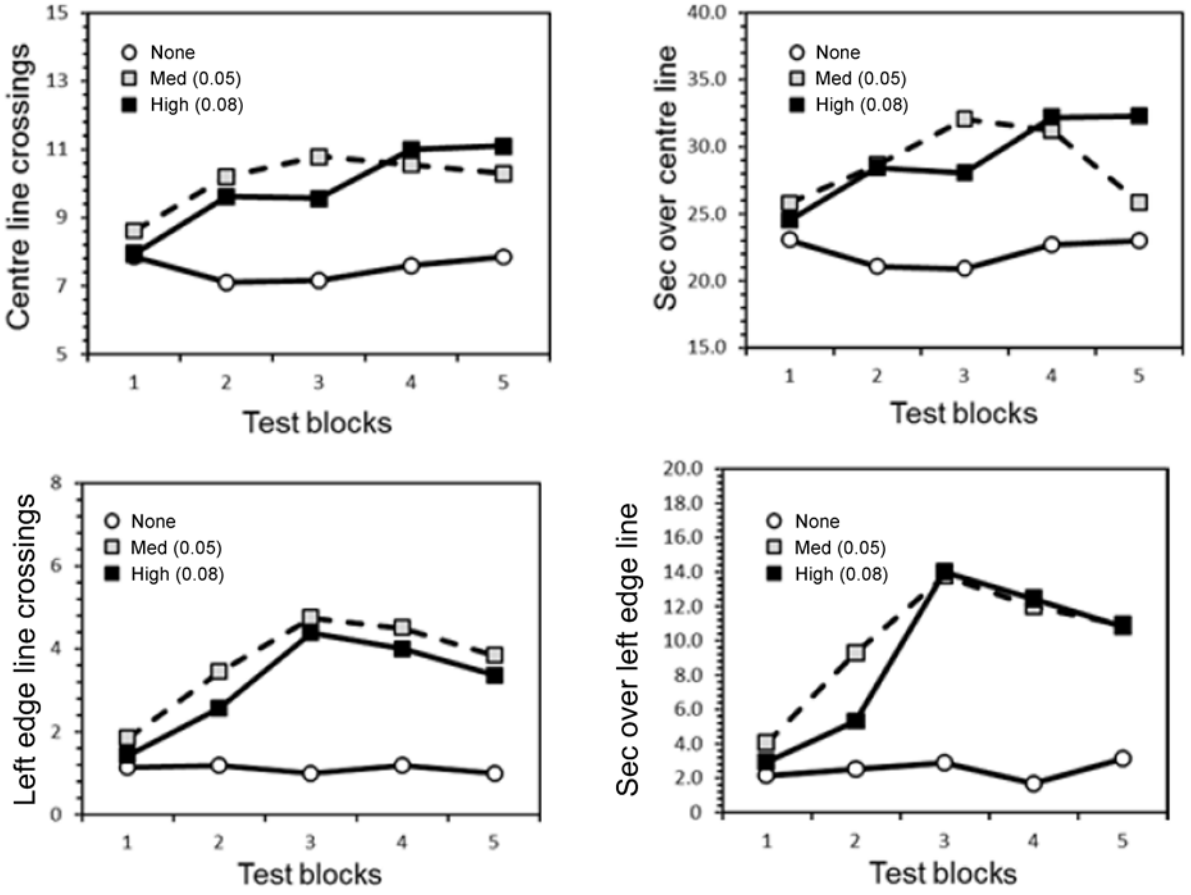


Figure 6: (continued)



(a) Explain why one group was not given an alcohol dose in this experiment.

(b) Explain why the different blood alcohol levels (40 – 60 mg alcohol / 100 mL blood, and 70 – 90 mg alcohol / 100 mL blood) would have been used in this experiment.

(c) Explain why the participants were tested repeatedly.

(d) Give a possible reason why drivers who had had no alcohol crossed the centre line.

(e) Compare the number of centre line crossings and left edge line crossings for these groups of participants.

(f) Name and describe a statistical test that could be performed to investigate the claim that drivers who had consumed alcohol had a greater number of centre line crossings than drivers who had not consumed any alcohol.

QUESTION FIVE

Read the following abridged article from the 2016 Public Attitudes to Road Safety Survey.

2016 Public Attitudes to Road Safety Survey Results

Alcohol-impaired driving. Most people recognise that drink-driving is risky, with only 8 per cent saying there is not much chance of an accident when driving after drinking if you are careful. Most of the drink-driving indicators have either slowly improved, or remained fairly static over the last decade.

Method

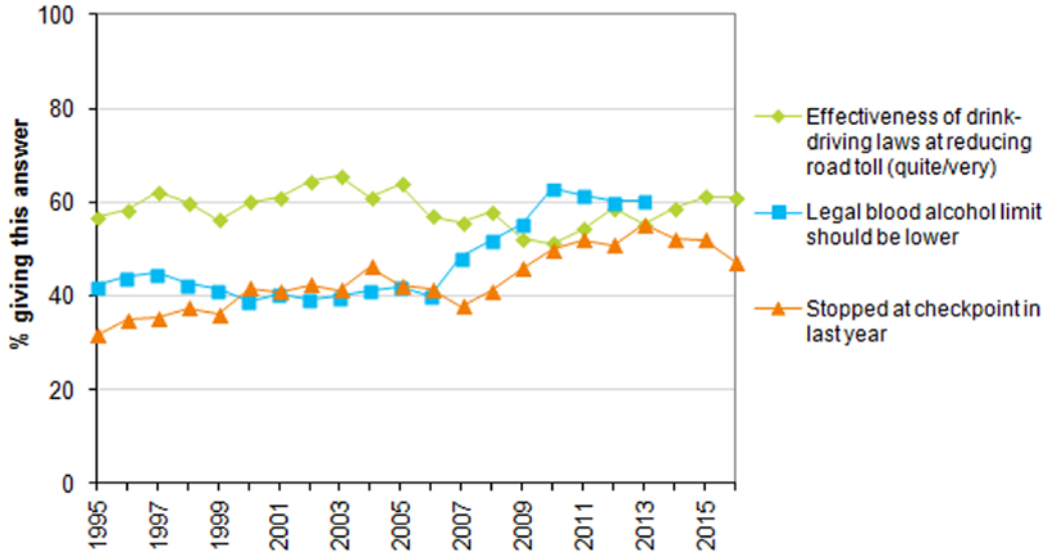
The fieldwork for the survey is carried out by an independent survey company, TNS New Zealand. Surveys are carried out in May and June of each year by trained interviewers who conduct face-to-face interviews in the respondents' homes.

The sample is chosen to be representative of the New Zealand adult population, and includes men and women aged 15 and over from towns, cities, and rural areas throughout New Zealand. In 2016, 1 666 people were interviewed, 1527 of whom held a driver licence.

Alcohol-impaired driving

Figure 7 and Figure 8 show some key attitudinal measures related to drink-driving.

Figure 7: Attitudes to alcohol (*increasing* trend reflects improvement in safety attitudes)

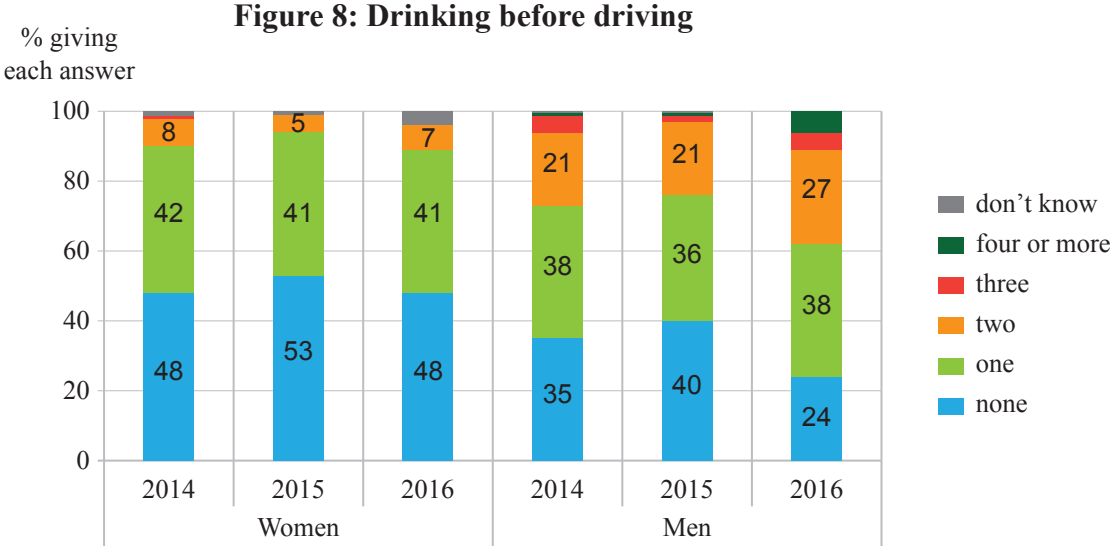


Blood alcohol limit. In 2013, 60 per cent of New Zealanders favoured a lower legal blood-alcohol limit for driving. This increased significantly from 40 per cent in 2006 to 63 percent in 2010. There were **no statistically significant changes** from 2010 to 2013 (see Figure 7). This question has not been asked from 2014 when the blood alcohol limit for drivers aged 20 years and over was lowered from 80 to 50 mg / 100 mL of blood.

Behaviour and attitudes. A new question was introduced in 2014, asking how much people would be drinking after the alcohol limit was lowered from 80 to 50 mg / 100 mL. Fifty-two per cent said they never drink before driving, 25 per cent said they will drink less, 22 per cent said they will drink about the same, 0 per cent said they will drink more, and 1 per cent didn't know.

In 2015 the question was rephrased to reflect the fact that the limit had been lowered to 50 mg / 100 mL. Figure 8 shows the results. From 2014 to 2015, there was an increase in the percentage of people who said they would be comfortable driving if they had limited themselves to one or no drinks during the previous hour. In 2016, this percentage dropped again, back to the 2014 level for women and to below the 2014 level for men.

Figure 8: Drinking before driving



Social influences. Peer pressure and social drinking remain strong influences. Among people who admitted to having driven while slightly intoxicated, 49 per cent thought they would be comfortable to drive having had one or no drinks, a further 37 per cent having had two drinks, and 13 per cent said three or more drinks. For other people, 83 per cent said they would be comfortable with one or no drinks, 12 per cent said two drinks, and 2 per cent said three or more drinks.

Self-reported driving while 'slightly intoxicated'. The percentage of drivers who said they had driven while slightly intoxicated during the 12 months before the survey was unchanged from the previous year. In 2016, 18 per cent of drivers, 25 per cent of male drivers, and 23 per cent of 20–24-year-old drivers said they had driven while slightly intoxicated during the last year. ('Slightly intoxicated' was as self-reported by the driver.)

(a) (i) What percentage of those interviewed held a driver licence?

(ii) Compare the attitudes, as shown by the graphs, of men and women to driving after having had one or no drinks in the previous hour.

(iii) Describe how the information on social influences could be presented graphically.

(iv) Describe any changes in attitude shown in Figure 7.

(b) (i) In the paragraph titled blood alcohol limit, suggest what was meant by the expression "no statistically significant changes".

(ii) From Figure 7, for each year 1995 to 2013 inclusive, suppose the percentage of drivers who were stopped at checkpoints during the previous year was plotted as a scatterplot against the percentage who said that the legal blood limits should be lower.

Describe the relationship you would expect to find.

Suggest a possible reason for your answer.

(iii) Using data for 2016, estimate the percentage that had admitted driving while slightly intoxicated, given that they felt comfortable driving when they had had only one or no drinks.

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