

# **Evaluation of changes to mandatory fitness to drive reporting requirements**

CASR268

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## **Centre for Automotive Safety Research**



# Report documentation

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## Title

Evaluation of changes to mandatory fitness to drive reporting requirements

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## Abstract

This study investigated the impact of changes to the mandatory fitness to drive reporting requirements for South Australian drivers aged 70 years and over. Historically, drivers in South Australia were required to undertake an annual medical assessment of fitness to drive from age 70. This requirement was removed in 2014 and replaced in 2015 by a self-assessment form for drivers aged 75 or more. Trends in licensing, population and crash data for the years 1997 to 2023 were examined for those aged 18-59, 60-69 and 70-100. The removal of mandatory age-based fitness to drive assessments for older drivers in South Australia was found not to have resulted in any road safety disbenefits. The rate of licence suspensions on medical grounds for older drivers has actually increased since the policy change. Furthermore, there have been declines in casualty crash involvement rates for older drivers and no evidence of increases in older pedestrian casualties. These outcomes can be taken as supportive of changes to the medical fitness to drive policies and processes in South Australia that were made in 2014-15.

## Keywords

Fitness to drive, medical conditions, licensing, older drivers

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# Summary

This study investigated the impact of changes to the mandatory fitness to drive reporting requirements for South Australian drivers aged 70 years and over. Historically, drivers in South Australia were required to undertake an annual medical assessment of fitness to drive from age 70. This requirement was removed in 2014 and replaced in 2015 by a self-assessment form for drivers aged 75 or more. Previous CASR research predicted that this would result in an increase in the licensing rates for older drivers in South Australia and a small increase in crash rates. This study was designed to assess whether this had eventuated.

The study used licensing, population and crash data for the years 1997 to 2023 and examined trends in these for those aged 18-59, 60-69 and 70-100, to achieve the following project objectives:

- To assess changes in licensing rates for people in age groups affected by the changes to licensing requirements.
- To assess changes in crash numbers and crash rates for drivers in age groups affected by the changes to licensing requirements.
- To assess changes in crash numbers and crash rates for pedestrians in age groups affected by the changes to licensing requirements.

The key outcomes of the analyses include the following:

- The number of licensed drivers aged over 70 in South Australia is growing and has recently reached equivalence with the number of licensed drivers aged 60 to 69.
- There has been a higher rate of licence suspensions on medical grounds among those aged over 70 since the policy change in 2015.
- Post policy change, there has been a decrease in the average annual number of injury crashes among drivers in all age groups, including those aged over 70.
- There have also been decreases in the rate of injury crashes per licensed driver for all age groups. The injury crash rates are similar for those aged over 70 and those aged 60 to 69, and are lower than the rate for those aged 18 to 59.
- There is no indication of a change in the average annual number of pedestrian injury crashes among those aged over 70 since the policy change. The rate of pedestrian injury crashes per head of population has decreased for those aged over 70 since the policy change, with the magnitude of the decrease being similar to those for other age groups.

The removal of mandatory age-based fitness to drive assessments for older drivers in South Australia has not been found to have resulted in any road safety disbenefits. The rate of licence suspensions on medical grounds for older drivers has actually increased since the policy change. Furthermore, there have been declines in casualty crash involvement rates for older drivers and no evidence of increases in older pedestrian casualties. These outcomes can be taken as supportive of changes to the medical fitness to drive policies and processes in South Australia that were made in 2014-15.

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# 1. Introduction

Older drivers are often identified as having a higher rate of crash involvement than drivers in younger age groups, especially on a per distance travelled basis. However, such findings are usually based on casualty crash or fatal crash data, and so will be affected by differences between age groups in the likelihood of being injured in a crash. Numerous studies have found that older drivers are at an increased risk of being seriously or fatally injured when involved in a crash (Brand et al., 2012; Evans, 2000, 2001; Hanrahan et al., 2009; Kahane, 2013; Langford & Koppel, 2006; Meulenens et al., 2006; Newgard, 2008; OECD, 2001; Rakotonirainy et al., 2012; Thompson et al., 2010). This greater 'fragility' is a more significant road safety issue for older adults than the likelihood of crashing. Furthermore, studies of crash rates per head of population or per licensed driver have also found lower crash rates for older drivers than those in younger age groups (Baldock & McLean, 2005; Lyman et al., 2002; Mitchell, 2013; Thompson et al., 2010).

Although older drivers, as a group, do not exhibit higher crash rates than other age groups, there may be sub-groups of older drivers with a higher risk. For example, there may be sub-groups of older drivers with particular medical conditions that put them at greater risk of crash involvement.

As people age, they experience age-related decline in a variety of functional abilities (e.g., visual, cognitive) that are important for driving (Baldock, Thompson, Dutschke, Kloeden, Lindsay & Woolley, 2016). Furthermore, they are more likely to develop a medical condition that will impair their ability to drive safely. Baldock and Raftery (2024), in an analysis of 1,934 active road users admitted to hospital after a road crash in South Australia, found that road users in older age groups (e.g., over 70) were more likely than those in younger age groups to have been involved in a crash that could be attributed to a medical condition.

Historically, South Australia required all drivers to have their fitness to drive assessed by their doctor each year from the age of 70 onwards. However, from 1 September 2014, this requirement was removed in South Australia for car drivers. Instead, a compulsory annual self-assessment form for car drivers aged 75 or more was introduced in 2015.

Analysis of historical data in South Australia has shown that mandatory doctor-based fitness testing for drivers aged over 70 resulted in an apparent sharp increase in the number of drivers being refused a driver's licence on medical grounds at age 70 and above compared to the background rates before this age. The removal of the requirement for mandatory fitness testing of car drivers from the age of 70 on 1 September 2014 was expected to result in many fewer drivers over 70 being refused a licence on medical grounds. This could lead to a larger number of older drivers on the road, which, in turn, could have resulted in a larger rate of older driver crashes in South Australia.

Previous research by CASR suggested that, from 2019, there would likely be a 1.8% increase in older driver crashes and a 0.06% increase in all crashes. Although these figures are approximate, they indicate the small order of magnitude expected of the likely crash increases. Now that nine years have elapsed since the change in policy, it is timely to review actual crash data to assess whether the removal of the mandatory fitness to drive assessment affected crash rates. In addition to looking at driver crash rates, it is important to look at changes in pedestrian crash rates. Research has previously suggested that more demanding age-based testing for licences can prompt older drivers to give up their licences and lead to increased casualty pedestrian crashes (Hakamies-Blomqvist, Johansson & Lundberg, 1996).

The aims of this project are, therefore:

- To assess changes in licensing rates for people in age groups affected by the changes to licensing requirements.
- To assess changes in crash numbers and crash rates for drivers in age groups affected by the changes to licensing requirements.
- To assess changes in crash numbers and crash rates for pedestrians in age groups affected by the changes to licensing requirements.

## 2. Methodology

The following section outlines the methodology used for the extraction and analysis of all data.

### 2.1. Licensing data

Data were extracted from the South Australian vehicle and registration licensing system, the Transport Regulation User Management Processing System (TRUMPS). TRUMPS was updated in 1995 and 1997 and not all previous transactions were carried forward into the new systems. The extracted data included: licence number, date of birth, date of death, medical conditions, medical suspensions, refusals, refusal date and disqualifications for each driver.

Licensing data from TRUMPS were extracted for drivers who would have held a licence at any time during the years of 1997 to 2023. Three driver age groups were used for analyses in this report: 18-59, 60-69 and 70-100.

Only licensing data pertaining to those with a C class licence were included in the data analysis reported here. All other licence classes (e.g., motorbike (R), light rigid (LR) classes etc.) were excluded from analysis.

### 2.2. Identifying medical suspensions

Medical suspensions were extracted from TRUMPS, with only suspensions occurring between 1997 and 2023 and cases in which the licence holder was aged between 60-100 years of age being included in this analysis.

Medical suspensions were recorded in two categories: suspensions or refusals. Within the suspensions category, there were further sub-categories under which medical suspensions were classified: a) medical suspensions, b) medical not returned or c) self-assessment not returned. The first category refers to cases in which drivers were deemed not to be medically fit to drive. The other two categories, respectively, refer to failure to return a medical form from an annual review or failure to return a self-assessment form following the policy change in 2015. Refusals refer to cases in which the driver's licence was unable to be returned at the end of a suspension for other reasons (e.g., licence disqualification for offences).

To investigate if there were differences in the duration of medical suspensions based on medical suspensions type (e.g., medical not returned or medical suspension), the mean number of days for which a licence holder was suspended on medical grounds was calculated. The mean number of days by medical suspensions type was only calculated for those over 70 years of age, and where there was an end-date on a medical suspension. All other existing or continuing suspensions, or where death occurred during a medical suspension, were not included in the calculation of mean suspension duration.

To understand the patterns and trends of medical suspensions pre-policy change and post-policy change, it was important to look at the distribution of medical conditions contributing to medical suspensions. The recorded reason for a medical suspension was extracted from the licensing data and was aggregated into 10 subcategories: cardiovascular, neurological, diabetes, epilepsy, hearing, musculoskeletal, psychiatric conditions, vision, sleep disorders and stroke. A full table of which

medical conditions fall under each of the 10 categories can be found in Appendix B. It is important to note that multiple medical conditions could be recorded for a single medical suspension.

## **2.3. Identifying injury crashes and fatalities**

All injury crashes experienced by drivers in the identified age groups were extracted from the South Australian Traffic Accident Reporting System (TARS). Injury crash extraction was isolated to the years 1997 to 2023 to match the available licensing data.

In addition to injury crashes, fatalities involving drivers between aged 18 and 100 were also extracted from TARS and rates for different age groups were calculated per 10,000 licence holders. Fatalities were explored independently to investigate if the severity of crashes had changed over time, particularly in the context of the change to mandatory fitness requirements.

In order to understand the potential holistic impact of changes to mandatory fitness to drive requirements for drivers over 70 years of age, pedestrian crashes involving injury and gopher/mobility scooter crashes were also extracted from TARS. Pedestrian and gopher/mobility scooter crashes were selected for analysis as these forms of transportation may be alternative options for older people when or if their licence is suspended on medical grounds.

## **2.4. Population data**

In order to calculate the percentage of South Australians injured as a pedestrian, population data were acquired from the National, State and Territories population database available from the Australian Bureau of Statistics. The population data pertaining to all South Australians from 1997 to 2023 were downloaded and filtered to only include adults aged 18 to 100 years between 1997 and 2023. Controlling for population age trends is particularly important given South Australia's ageing population.

## **2.5. Forms of comparisons**

This report explores the impact of changes in the mandatory medical testing of drivers focusing on the following comparisons:

- By age group (3 categories; 18-59, 60-69 and 70-100 years of age)
- By pre and post policy change (pre policy 1997-2014; and post policy 2015-2023)

Comparisons between age groups and by pre and post policy change were also further explored:

- Per licence holder (all South Australian registered drivers within each age group)
- Per population (pedestrian injuries)
- In terms of the percentage of total crashes (for injury crashes and fatalities)

## **2.6. Statistical analyses**

Data normalcy and skewness were tested with the Wilk-Shapiro test and, where assumptions were not met, a log transformation (log10) was performed. As the distribution of the analysed data was

positively skewed in a number of cases, this process of data correction was important for producing valid results.

T-tests were performed to understand the extent of any changes between measures pre and post policy change. Independent t-tests using Welch's statistic to test significance were performed on road fatality data, as fatality data in the two time periods are independent. The Welch's t-test was chosen due to its ability to perform well when comparing means from two groups with unequal sample sizes. The unequal sample size of the current data was due to the differences in duration for the pre-policy and post-policy categories. Pre-policy spanned 18 years (1997-2014) compared to the post-policy change period, which spanned 9 years (2015-2023).

For data relating to medical suspensions, injury crashes, pedestrian injuries and gopher/mobility scooter injuries across the pre and policy dates of interest, statistical significance was assessed using a paired samples t-test and Welch's statistic. A paired t-test was performed on suspensions, injury crash, pedestrian injuries and gopher injuries as these data may have included an overlap of licence holders across the two time periods of pre and post policy change used for comparison. For both the independent t-tests and paired t-test, statistical significance was set at  $p \leq 0.05$ .

To account for underlying trends in the rate of medical suspensions and injury crashes, a piecewise regression model was performed. A piecewise regression model, also known as a segmented regression model, is a statistical method to test if a significant change has occurred at, or after, a particular point in time (referred to as a break point). This method was chosen to model the pre-policy change and post-policy change segments to determine if there was a significant change in trends after the policy change (2014), or if changes were a potential continuation of underlying trends. To ensure a reliable comparison between trend lines pre- and post-policy change, a 9-year period on either side of the breakpoint (the 2014 policy change) was selected, as balanced timeframes improve the model's validity and comparability. Model significance was set at  $p \leq 0.05$ .

## 2.7. Limitations

There are a number of limitations which need to be considered when interpreting the results presented in this report.

Considerable effort was made to identify all cases in which a licence was suspended on medical grounds across all potential categories but there may be cases of medical suspension having been missed due to changes in licensing systems.

The mean number of days for which a driver is suspended, based on each subcategory of medical suspension, is reported here. However, it is important to note that only medical suspensions with reported 'end-dates' have been included for this analysis. Therefore, there may be cases in which a licensed driver was still under a medical suspension before their death, which has not been included in the analysis of mean duration of medical suspension by sub-category.

When comparing the pre and post policy change periods, the potential impact of Covid-19 on drivers aged 70 and above needs to be recognised. Older adults were disproportionately impacted by Covid-19 and so the increase in medical suspensions from 2021 onwards in South Australia may in part reflect the effects of medical complications experienced post-Covid-19 by older adults.

Additionally, it is also important to note the potential impact of Covid-19 when interpreting the injury crash, fatality and pedestrian injury results. During 2020 and 2021, South Australia

experienced statewide lockdowns and stay-at-home orders, which significantly limited pedestrian and traffic movement from previous years, which may have contributed to the decrease in injury crashes, fatalities and pedestrian injuries.

Finally, the sample size available for the post-policy change period was considerably smaller than the comparison data available for the pre-policy change period. Across both the pre-policy and post-policy change periods of analysis, the sample size was moderately small when comparing impact on population samples (percentage of population and per 10,000 licence holder). Effort was made to mitigate the impact of unequal and small sample sizes with statistical testing appropriate for unequal sampling. As noted above, comparable time periods pre- and post-policy change were chosen for the piecewise regression modelling.

## 3. Results

### 3.1. South Australian population growth

The following figure (3.1) shows the population trends over time by the age groups of interest (18-59, 60-69 and 70-100). The average annual population growth rate for South Australia between 1997 and 2023 was 1.7%. The average annual growth rate was highest for the two older age groups: 2.3% for the 70–100-year-old age group and 2.2% for the 60-69 age group. In comparison, the annual growth rate was lower for the 18-59 age group (0.6%).

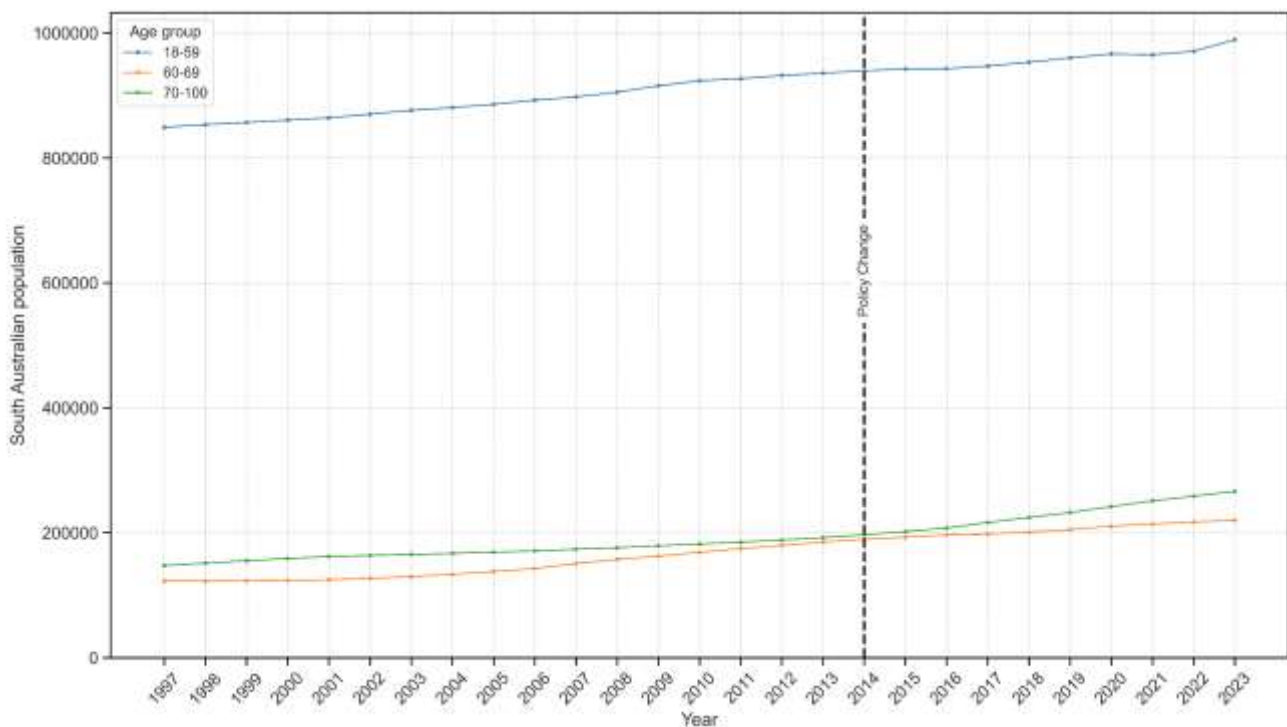


Figure 3.1: The South Australian population by age group (18-59, 60-69 and 70-100) across the years of 1997-2023.

### 3.2. South Australian licence holders

The following figures (3.2 – 3.3) represent data relating to the number of licence holders in South Australia (1997-2023). Figure 3.2 shows the number of licence holders for the age group of most interest (70 years of age and older), with the age group 60-69 as a comparison group and the remainder (16-59) to show overall licensing trends. The number of licence holders has increased over time for all three age groups, with the number of licence holders in the oldest age group increasing to be level with the number of licence holders in the 60-69 age group, potentially reflecting the ageing population. Data for Figure 3.2 are shown in Table A1 in Appendix A.

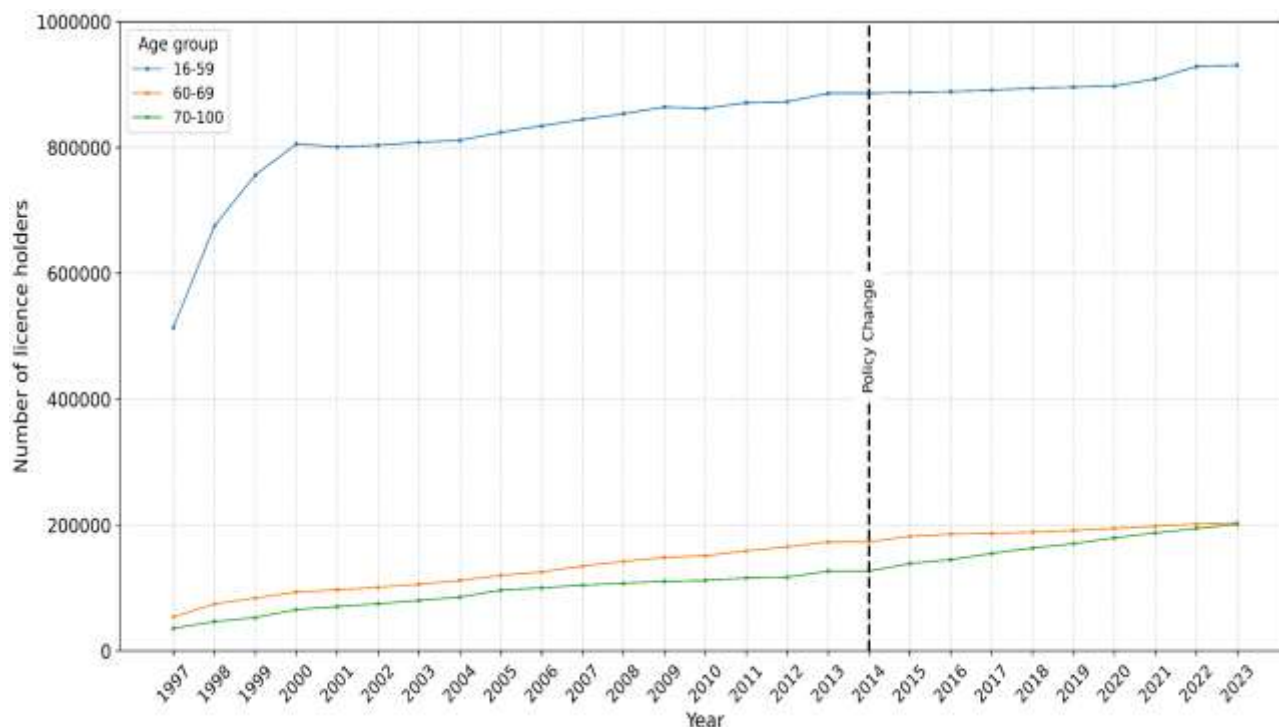


Figure 3.2: The number of South Australian licence holders per year, by age group (16-59, 60-69 and 70-100).

Figure 3.3 shows the same data represented in Figure 3.2, but with a focus on the two older age groups, more clearly demonstrating the distinct upwards trend of licence holders for these groups.

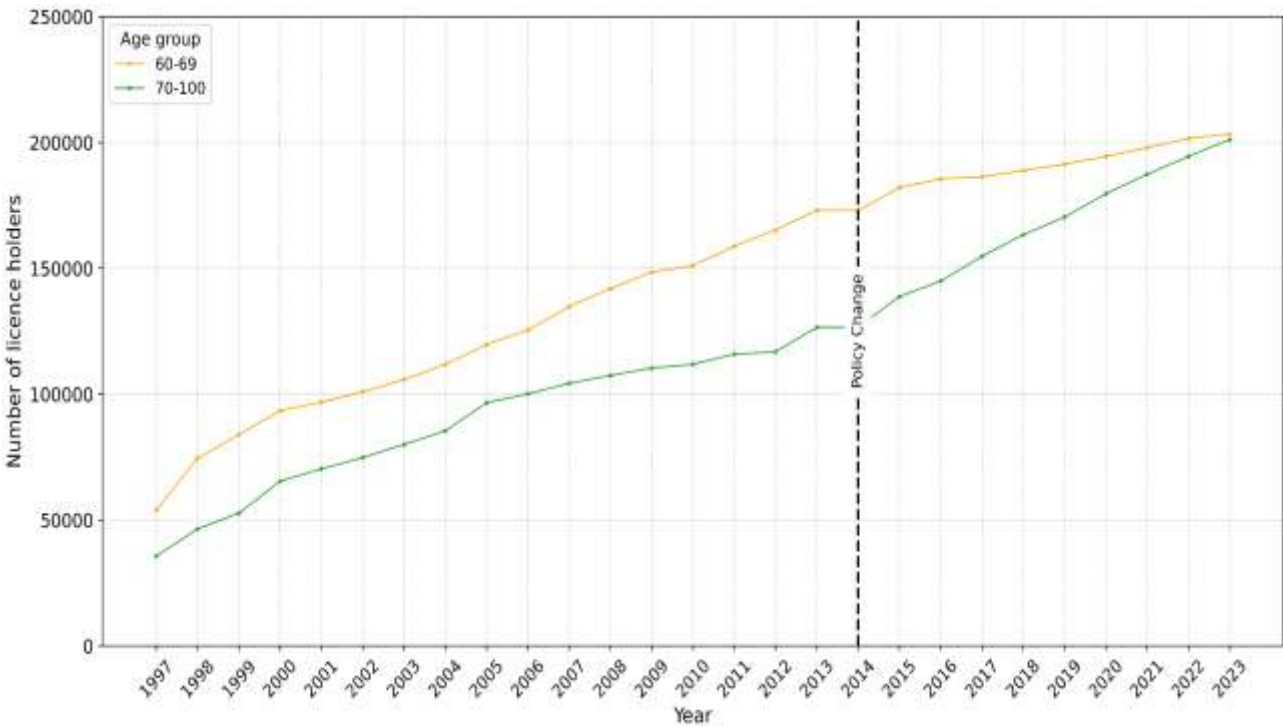


Figure 3.3: The number of South Australian licence holders per year, by age group (60-69 and 70-100).

### 3.3. Suspensions on medical grounds

The number of medical suspensions on medical grounds (across all applicable categories) by year (1997-2023) is shown in Figure 3.4. There appears to be an increase over time in the annual number of licence suspensions on medical grounds. Data for Figure 3.4 are shown in Table A2 in Appendix A. To account for the growth in the ageing population, medical suspensions were calculated as a percentage of the licensed population by age group (60-69 and 70-100), as seen in Figure 3.5. There was an increase in the mean annual percentage of drivers suspended on medical grounds aged 70-100 post-policy change ( $M=4.19\%$ ,  $SD=1.03\%$ ) when compared to pre-policy ( $M=2.41\%$ ,  $SD=0.82\%$ ), which a Welch's test found to be a statistically significant increase ( $t_{(13,2)} = -4.49$ ,  $p < 0.001$ ). Data for Figure 3.5 are shown in Table A3 in Appendix A.

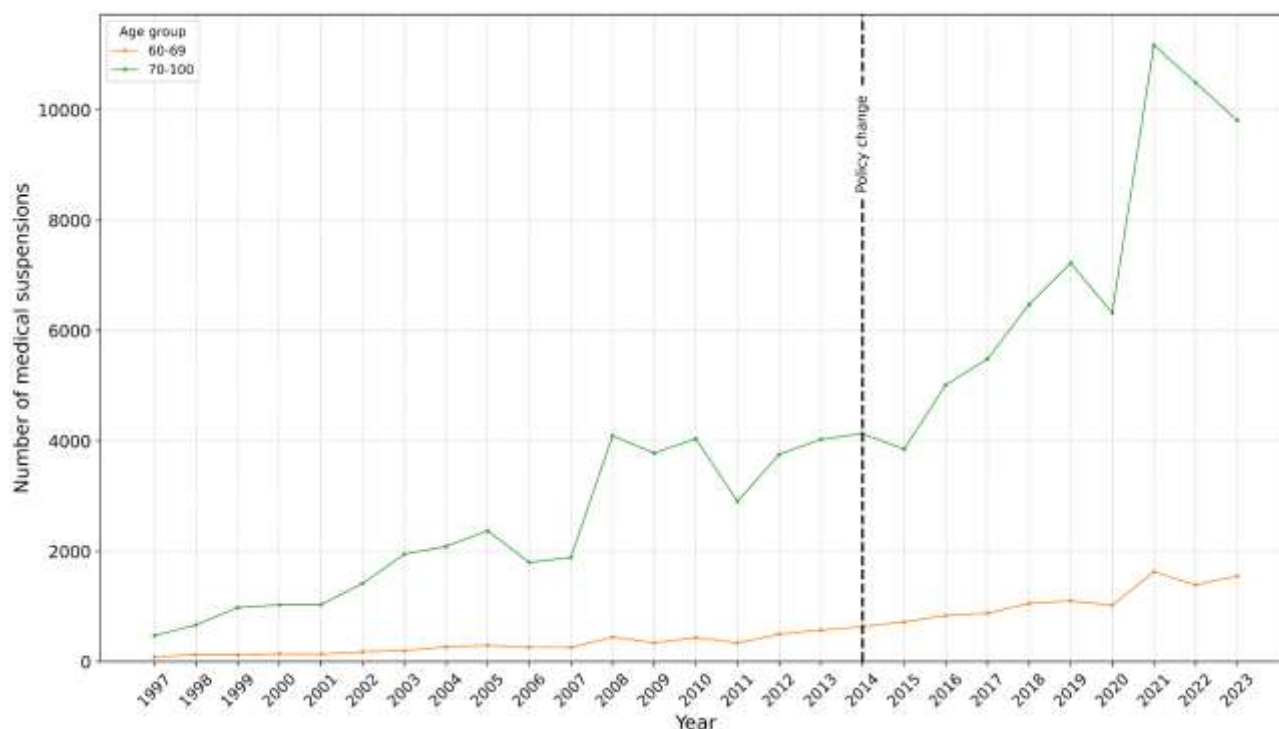


Figure 3.4: The number of medical licence suspensions by age group (60-69 years and 70-100 years) over time.

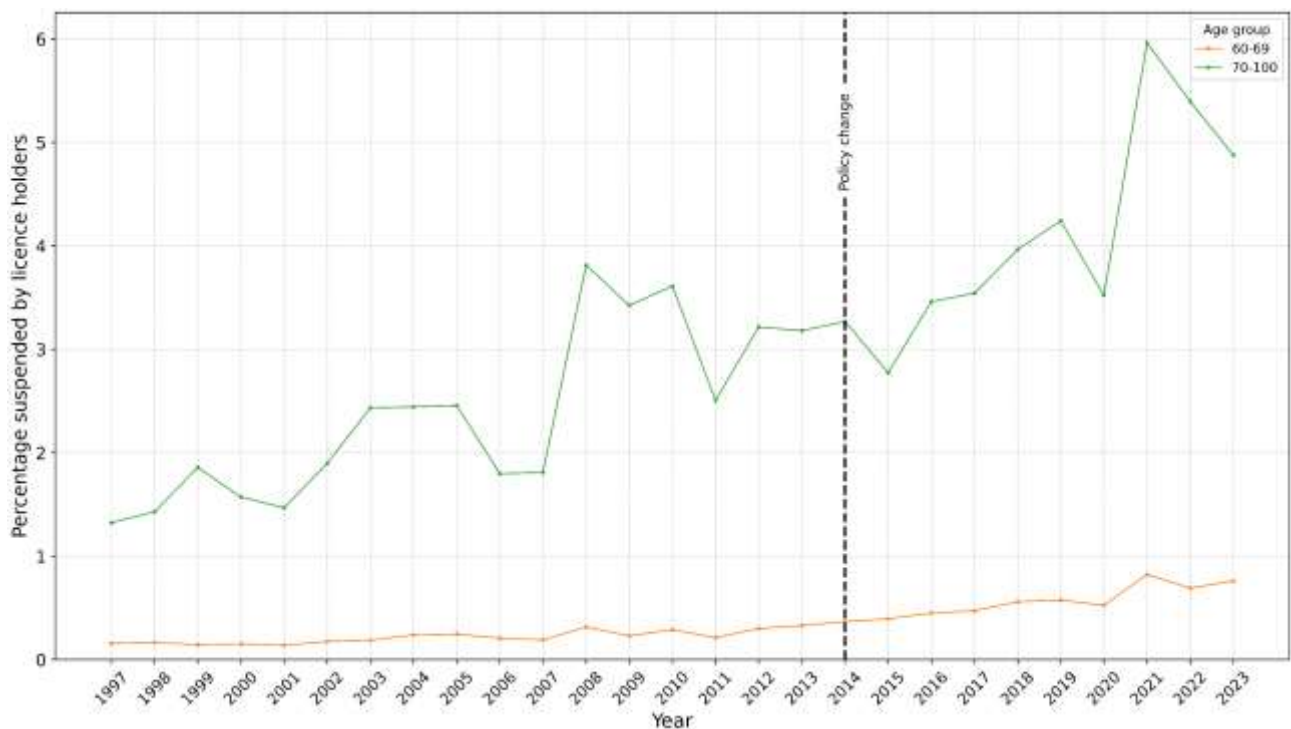


Figure 3.5: The percentage of licensed drivers by age group (60-69 and 70-100 years) suspended on medical grounds by year.

It is possible that the increasing rates of licence suspensions in the oldest age group is still due to an ageing population. It could be that the 70+ age group has increasing numbers of ‘very old’ drivers, which results in increasing licence suspensions for the group. To investigate this possibility, Figure 3.6 shows the mean age at which older drivers aged 70 to 100 years first incurred a licence suspension. There appears to have been a slight trend upward in the mean age at which licence suspensions were occurring from 1997 to 2007 but little change since 2008.

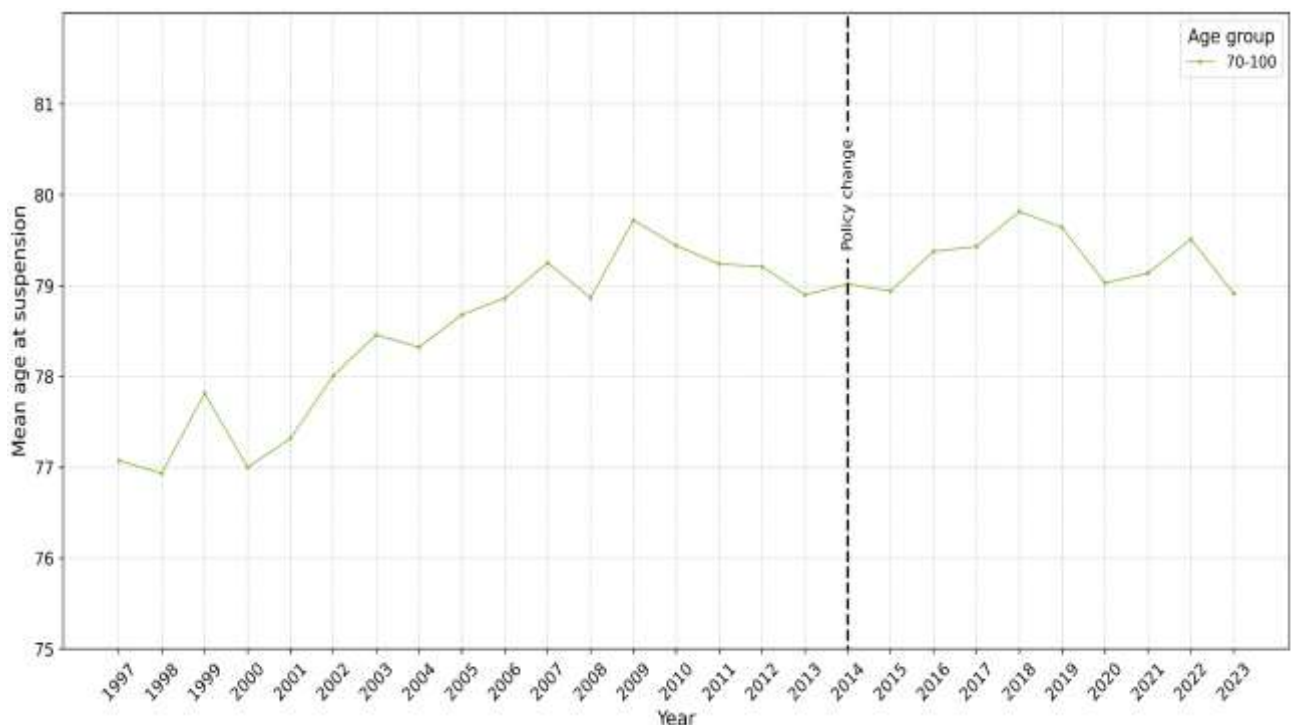


Figure 3.6: The mean age at which licences were first suspended for those aged 70 to 100, over time.

A piecewise regression analysis examined whether the trend of medical suspensions per 10,000 licence holders (for the 70–100-year-old age group) followed a similar upward trend for the post-policy period when compared to the pre-policy period. Results of the regression model explained a substantial proportion of the variance of medical suspensions per 10,000 licence holders (Adjusted  $R^2 = 0.66$ ) and is shown in figure 3.7.

The model showed no statistically significant change in trend from the break point (the 2014 policy change represented by the red dashed line) of medical suspensions post-policy change compared to pre-policy change. The trend post-policy change remained consistent and was not significantly different when compared to the trend pre-policy change ( $\beta = 13.01$ ,  $p = 0.14$ ). Additional piecewise regression models for drivers aged 60–69 can be found in figure D1, Appendix D.

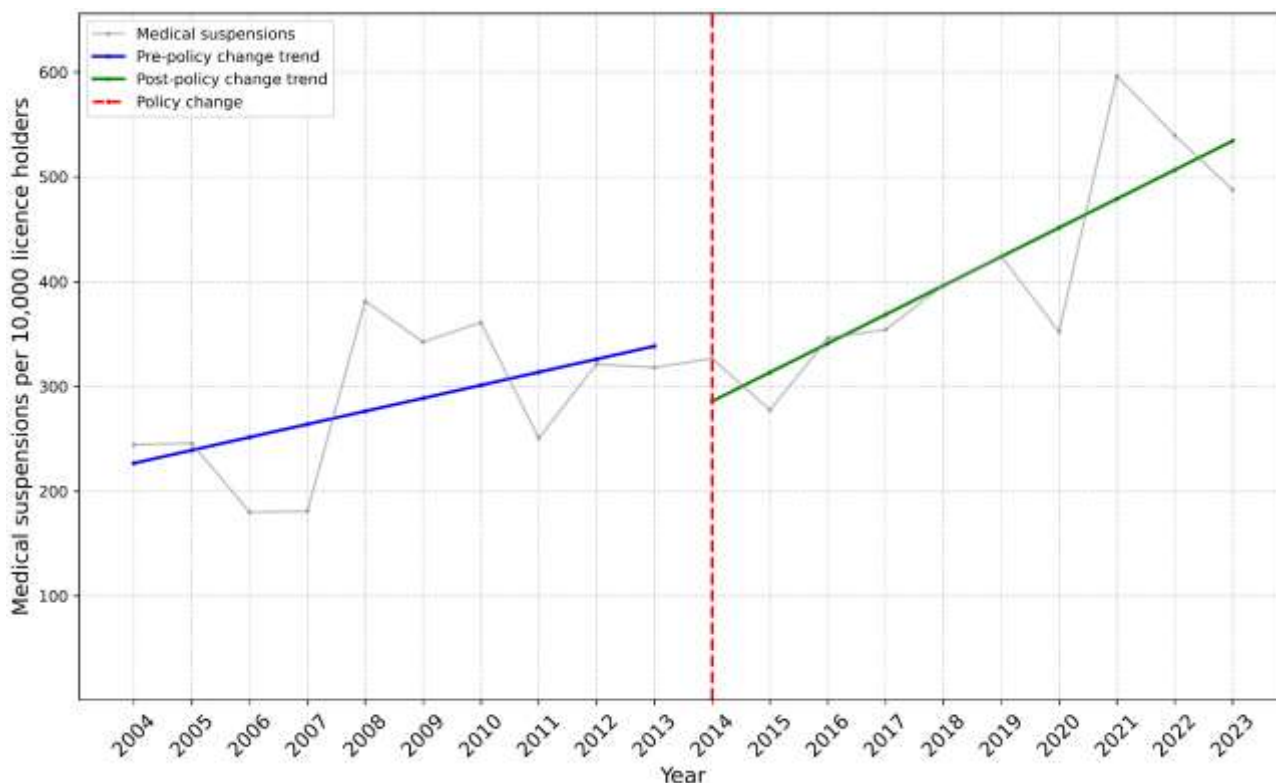


Figure 3.7: Piecewise regression model for medical suspensions showing the model of best fit for the pre-policy change (blue line) and post-policy change (green line) separated by the policy change which occurred at 2014 (dashed red vertical line).

Figures 3.8 and 3.9 present the distribution of medical suspensions across the three different suspension types: medical grounds, medical not returned and self-assessment not returned. Figure 3.8 shows the change in distribution over time in medical suspension types for drivers aged 70-100 years only; no other age groups are included in this figure. As seen in Figure 3.8, a majority of suspensions are on medical grounds (mostly 60-80%), with smaller numbers for ‘administrative’ reasons: failure to return the medical form or self-assessment form. Non-return of self-assessment forms only appear in the dataset from 2016, while non-return of medical forms does not appear until 2008. The latter is most likely due to non-differentiation of the reason for medical licence suspensions in the database prior to 2008.

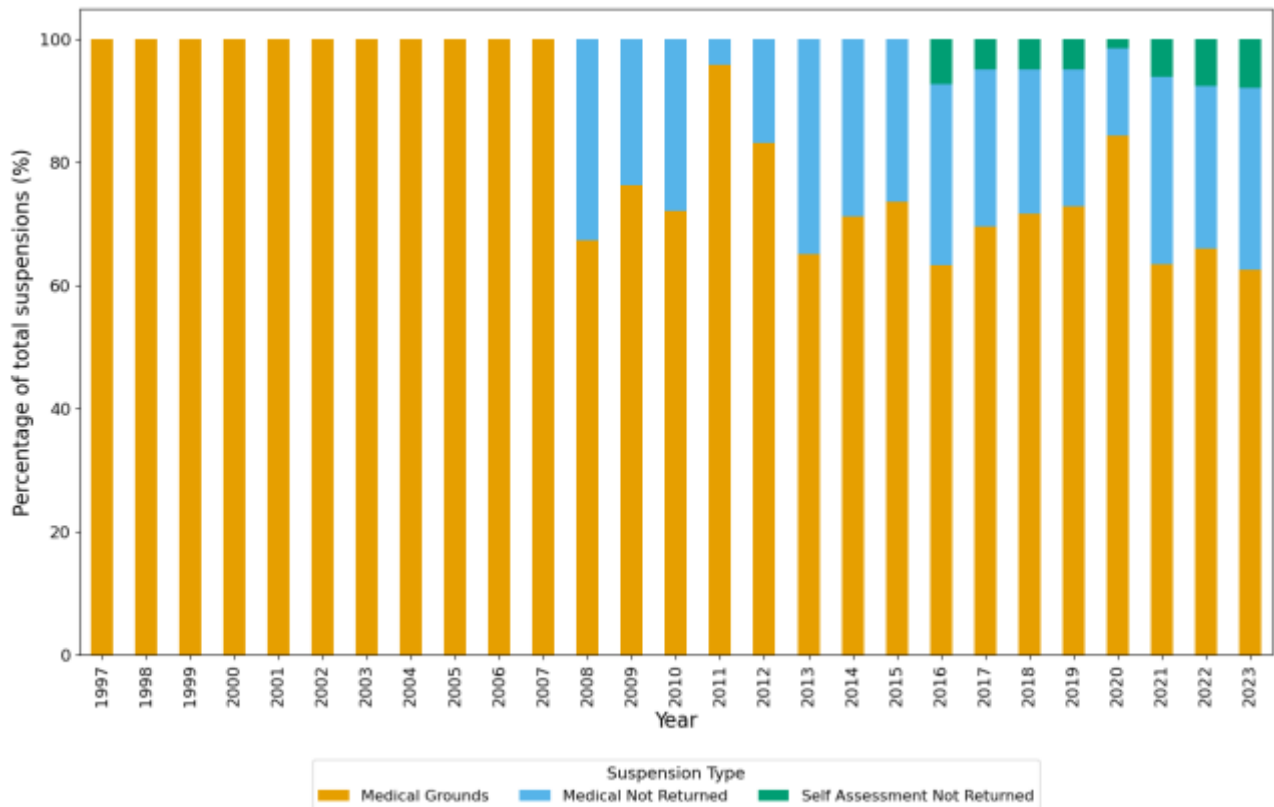


Figure 3.8: The distribution of suspension types, as a percentage of all medical suspensions, over time for the 70-100 age group.

Figure 3.9 shows a comparison between numbers of different types of medical suspensions per year for the 60-69 and 70-100 age groups. Interestingly, in Figure 3.9, the numbers of all types of medical suspensions have increased in recent years, showing a fairly similar pattern. This pattern is also similar for both age groups, although failure to return self-assessments are not seen for those aged 60-69, as this age group is not required to fill them out. Figure 3.9 further highlights the increase across all sub-categories of medical suspensions for drivers aged 70-100 after the policy change in 2014.

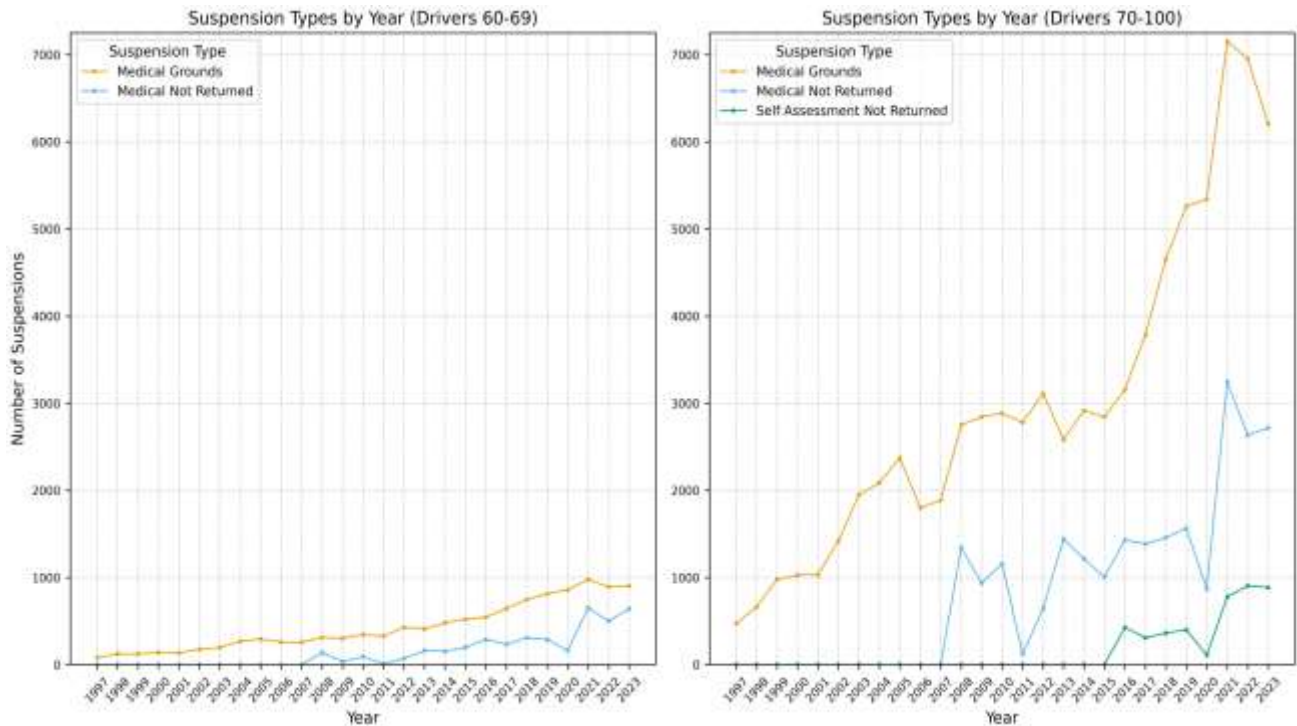


Figure 3.9: The distribution of suspension types by year, with a side-by-side comparison of the two age groups of interest: 60-69 year old drivers presented on the left hand graph and 70-100 year old drivers presented on the right hand graph.

Table 3.1 shows the mean duration in days a medical suspension was applied to a licence holder by subcategory (e.g., medical grounds, medical not returned or self-assessment not returned) for both pre-policy and post-policy change time periods. Table 3.1 only shows the data where a suspension came to an end and so suspensions which are still ongoing have not been included in these results. The medical grounds sub-category had the longest average duration of suspension being applied to the licence holder. There was a large variation in the duration of time for which medical suspensions were applied to licence holders, which can be seen by the large standard deviations, relative to the means, shown in Table 3.1.

Table 3.1: Mean number of days for which a driver was suspended on medical grounds, by medical grounds type (medical grounds, medical not returned and self-assessment not returned). Mean and standard deviation presented in the duration column.

| Medical suspension category  | Mean duration of suspension in days |
|------------------------------|-------------------------------------|
| Medical Grounds              | 464 (SD 690)                        |
| Medical Not Returned         | 426 (SD 635)                        |
| Self-Assessment Not returned | 315 (SD 445)                        |

Given the increase in the number and rates of medical suspensions for older drivers, as seen in Figures 3.4 and 3.5, despite less stringent mandatory age-based medical assessment, it was necessary to investigate potential contributors to this. One potential contributor was that SA Police were becoming more active in recent years in referring older drivers for a medical assessment (after a crash or traffic offence, for example). Table 3.2 shows rates of SA Police medical referrals which resulted in a medical suspension or refusal of a licensed driver, as a percentage of the total medical suspensions for each age group (60-69 and 70-100) for the years 2019 to 2023. It can be seen that the proportion of licence suspensions that follow a police referral are only a small proportion of the total. Any contribution to increased medical suspensions from police activity would therefore be small.

Table 3.2: The percentage of medical suspensions that were referred by SA Police by age group (60-69 and 70-100 years of age) and year.

| Year | Age group |        |
|------|-----------|--------|
|      | 60-69     | 70-100 |
| 2019 | 1.18%     | 0.75%  |
| 2020 | 2.15%     | 3.94%  |
| 2021 | 1.66%     | 2.52%  |
| 2022 | 1.51%     | 2.37%  |
| 2023 | 2.64%     | 2.77%  |

Figure 3.10 shows the medical reasons provided for medical suspensions as a percentage of total medical suspensions by each year for drivers aged 70-100 years of age. The percentages were calculated as the total of all medical conditions attributed to a medical suspension, noting that multiple medical reasons could be attributed to a single medical suspension. In the early to mid-2010s, a majority of medical reasons for a medical suspension were attributed to cardiovascular,

diabetes or musculoskeletal conditions. After that point, there is an increase in the incidence of medical condition categories such as neurological, vision and psychiatric conditions. Appendices B and C provide additional information on how the medical conditions were grouped into each sub-category and further information on percentages per medical condition.

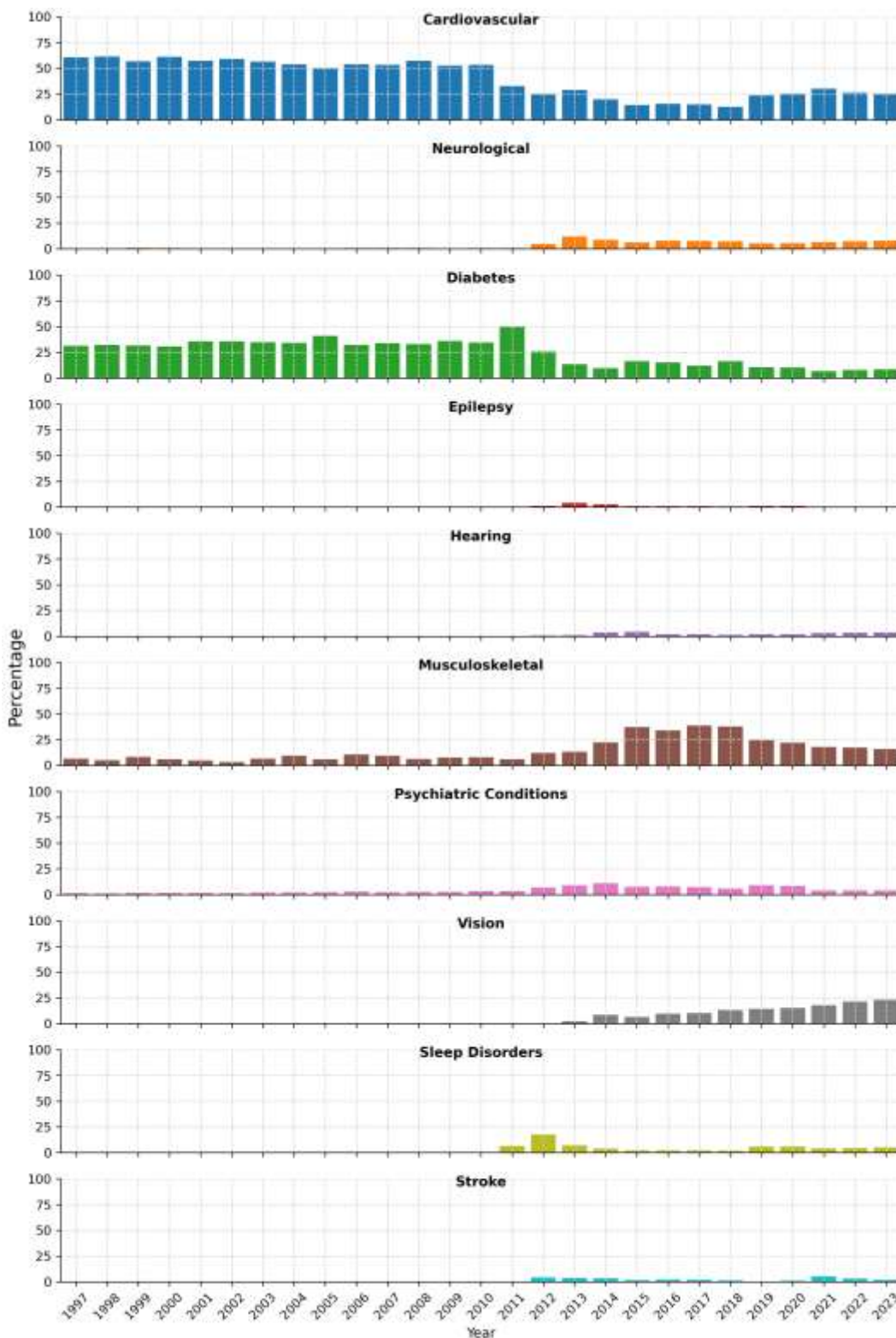


Figure 3.10: The percentage of medical condition types attributed as the reason for medical suspensions issued by year (1997-2023) for drivers aged 70-100. The medical condition (10 sub-categories) is presented at the top of each sub-graph.

Table 3.3 shows the percentage of medical suspension attributed to each medical condition category during the pre-policy and post-policy change periods for drivers aged 70 to 100. Pre-policy change, cardiovascular conditions (M= 49.6%, SD=12.9) and diabetes (M=32.0%, SD 8.7) were the top two reasons for a medical suspension being issued, making up 81% of overall suspensions. The most common in the post-policy change period were musculoskeletal conditions (M= 27.3%, SD= 9.1) and cardiovascular conditions (M=20.8%, SD= 6.2%), making up 48% of reasons for a medical suspension. Post-policy change there was a decrease in the percentage of medical suspensions attributed to cardiovascular conditions and diabetes but an increase post-policy change for all other medical conditions categories.

Table 3.3: The percentage of medical suspensions for drivers aged 70-100 suspended due to each medical condition category by pre-policy (1997-2014) and post-policy change periods (2015-2023), and the direction of change in frequency post policy-change.

| Medical condition category |      | Pre-policy change % | Post-policy change % | Direction of change post-policy |
|----------------------------|------|---------------------|----------------------|---------------------------------|
| Cardiovascular             | Mean | 49.6                | 20.8                 | Decrease                        |
|                            | SD   | 12.9                | 6.2                  |                                 |
| Diabetes                   | Mean | 32.0                | 11.5                 | Decrease                        |
|                            | SD   | 8.7                 | 3.5                  |                                 |
| Epilepsy                   | Mean | 0.5                 | 0.7                  | Increase                        |
|                            | SD   | 1.1                 | 0.4                  |                                 |
| Hearing                    | Mean | 0.3                 | 2.6                  | Increase                        |
|                            | SD   | 0.9                 | 1.0                  |                                 |
| Musculoskeletal            | Mean | 8.4                 | 27.3                 | Increase                        |
|                            | SD   | 4.2                 | 9.1                  |                                 |
| Neurological               | Mean | 1.9                 | 6.9                  | Increase                        |
|                            | SD   | 3.3                 | 0.9                  |                                 |
| Other                      | Mean | 0.7                 | 3.1                  | Increase                        |
|                            | SD   | 1.8                 | 0.8                  |                                 |
| Psychiatric Conditions     | Mean | 3.2                 | 6.4                  | Increase                        |
|                            | SD   | 2.7                 | 1.9                  |                                 |
| Sleep Disorders            | Mean | 2.0                 | 3.8                  | Increase                        |
|                            | SD   | 4.5                 | 1.6                  |                                 |
| Stroke                     | Mean | 0.7                 | 2.2                  | Increase                        |
|                            | SD   | 1.5                 | 1.3                  |                                 |
| Vision                     | Mean | 0.8                 | 14.6                 | Increase                        |
|                            | SD   | 1.9                 | 5.2                  |                                 |

### 3.4. Injury and fatal crashes

The following figures (3.11 - 3.14) present the injury crash data by age group and year. Figure 3.11a shows an overall decline in injury crashes over time, with declines for the two older age groups notable from around 2011. Data for Figure 3.11a are shown in Table A4 in Appendix A. Figure 3.11b shows the crash injury numbers by year and age for just the two older licence groups (60-69 and 70-100).

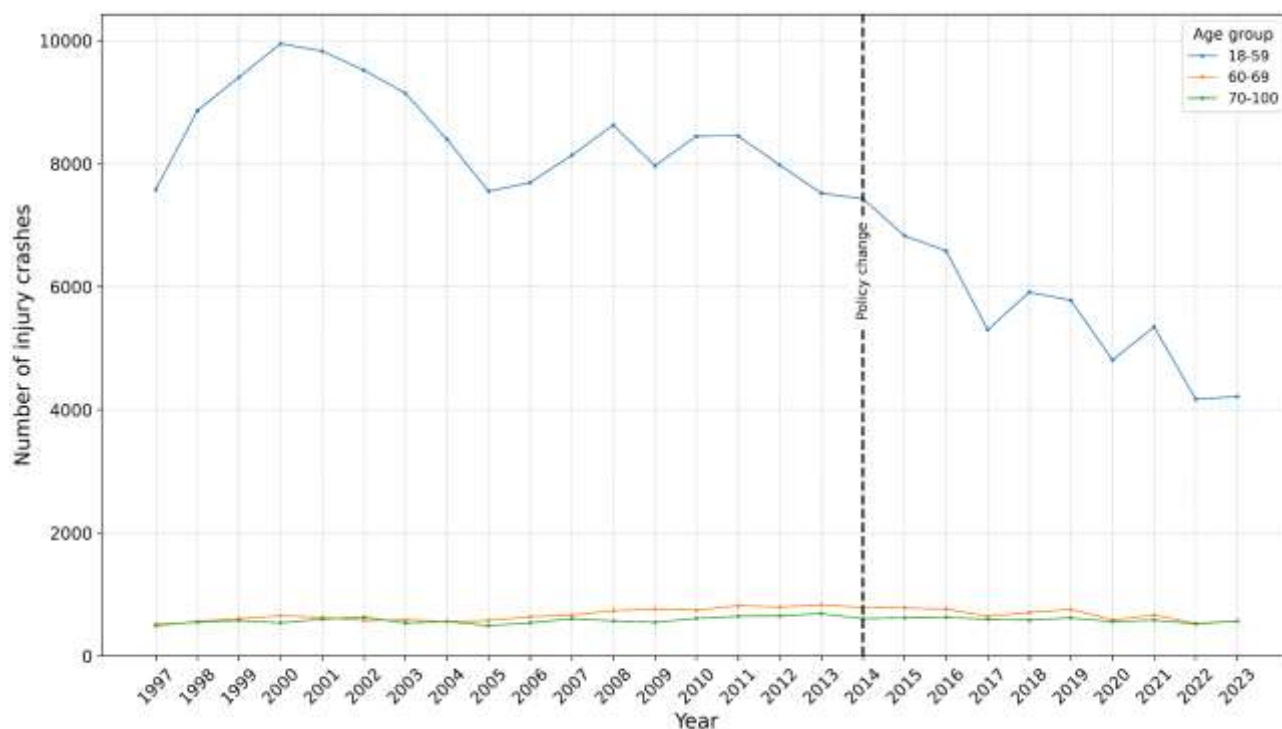


Figure 3.11a: The number of injury crashes by age group (<59, 60-69 and 70-100) and year (1997-2023).

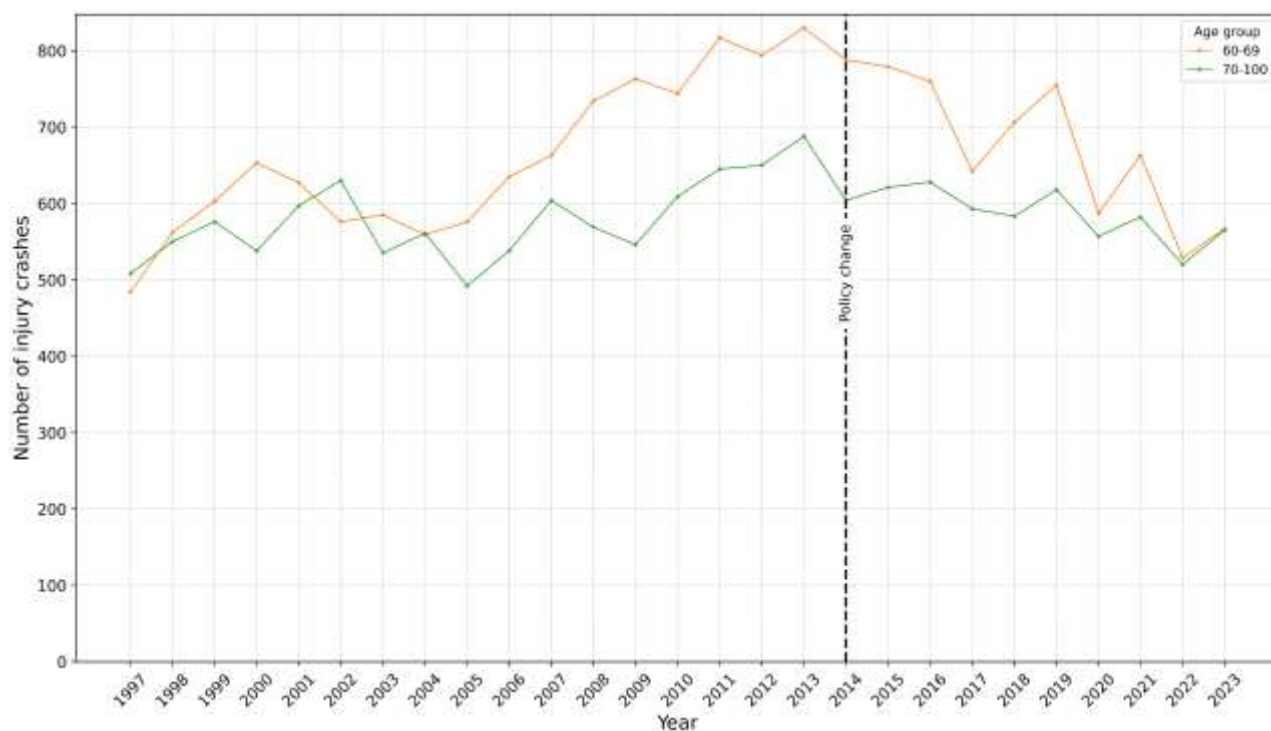


Figure 3.11b: The number of injury crashes by year and age for drivers over 60 years of age. This graph shows the same data represented in Figure 3.11a, but with a focus on the two older age groups.

To account for population changes over time, the percentage of licensed drivers per age group (18-59, 60-69 and 70-100) involved in an injury crash was calculated and is shown in Figure 3.11. When accounting for numbers of licensed drivers by age, there was a mean decrease in the rate of injury crashes involving drivers aged 70-100 post policy change ( $M= 0.35\%$ ,  $SD= 0.06$ ) when compared to pre-policy change ( $M= 0.71\%$ ,  $SD= 0.27$ ), which a Welch's  $t$ -test found to be a statistically significant change ( $t_{(20.4)}= 5.39$ ,  $p<0.001$ ). Data for Figure 3.11 are shown in Table A5 in Appendix A.

There was also a mean decrease in the rate of injury crashes involving drivers aged 18-59 post policy change ( $M= 0.62\%$ ,  $SD= 0.11$ ), when compared to pre-policy ( $M= 1.07\%$ ,  $SD= 0.15$ ), which was statistically significant using a Welch's  $t$ -test ( $t_{(20.9)}= 8.25$ ,  $p<0.001$ ). For drivers aged 60-69 there was also a mean decrease in the rate of injury crashes by percentage of licence holders post-policy change ( $M= 0.34\%$ ,  $SD= 0.05$ ), when compared to pre-policy change ( $M= 0.57\%$ ,  $SD=0.12$ ), which was statistically significant using a Welch's  $t$ -test ( $t_{(25.0)}= 6.41$ ,  $p<0.001$ ).

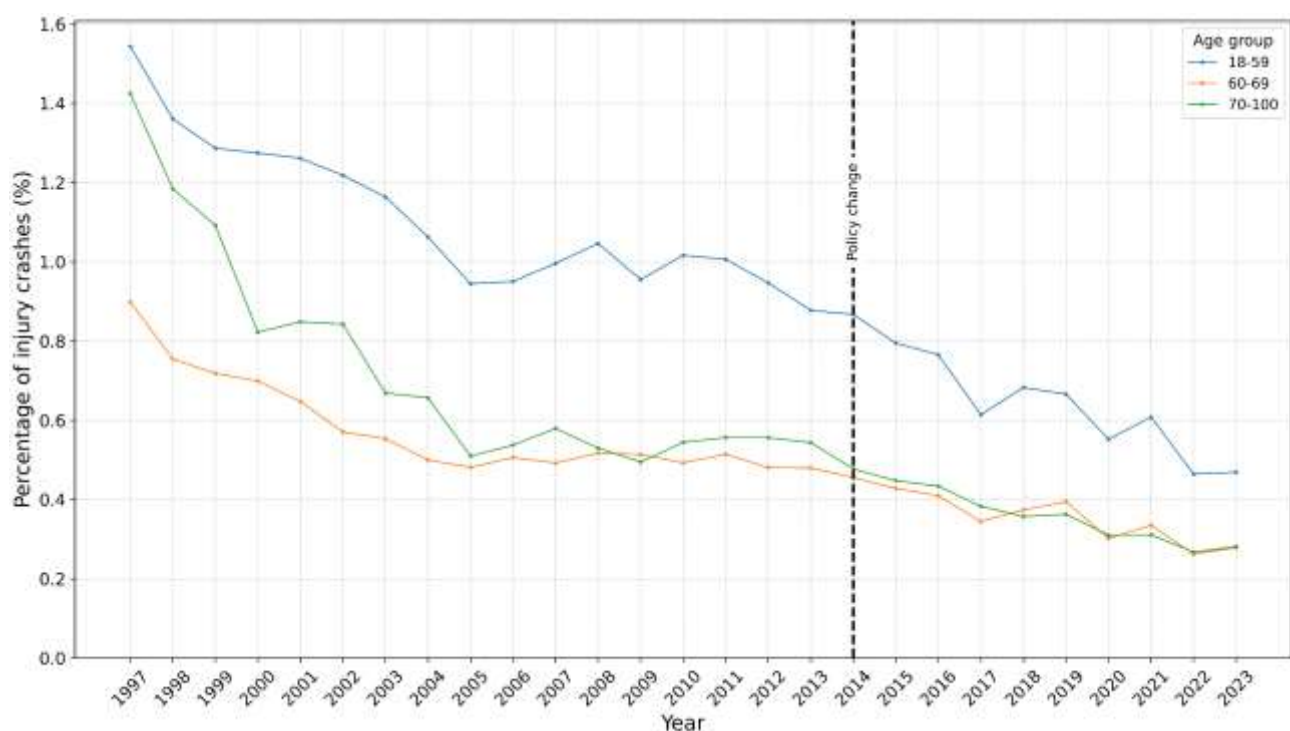


Figure 3.12: The injury crash rates per licensed driver over time presented as a percentage for the three age groups (18-59, 60-69 and 70-100).

A piecewise regression analysis examined whether the trend in injury crashes per 10,000 license holders (drivers aged over 70 years) was following a downward trend, or if there was a marked difference in trend post-policy change. The regression model explained a large proportion of the variance in injury crash rates per 10,000 licence holders (Adjusted  $R^2=0.84$ ) and is shown in Figure 3.13.

There was a statistically significant change in the trend of injury crashes post-policy change compared to pre-policy change. The interaction trend, which tests whether the slope changed post-policy change, was significant ( $\beta = -1.90, p>0.0001$ ), indicating that the rate of decline in injury crashes was occurring at a different rate when compared to the pre-policy change period. It is apparent in Figure 3.13 that the crash rate for older drivers declined more rapidly after the policy change. Additional piecewise regression models for drivers aged 60-69 can be found in figure D2, Appendix D.

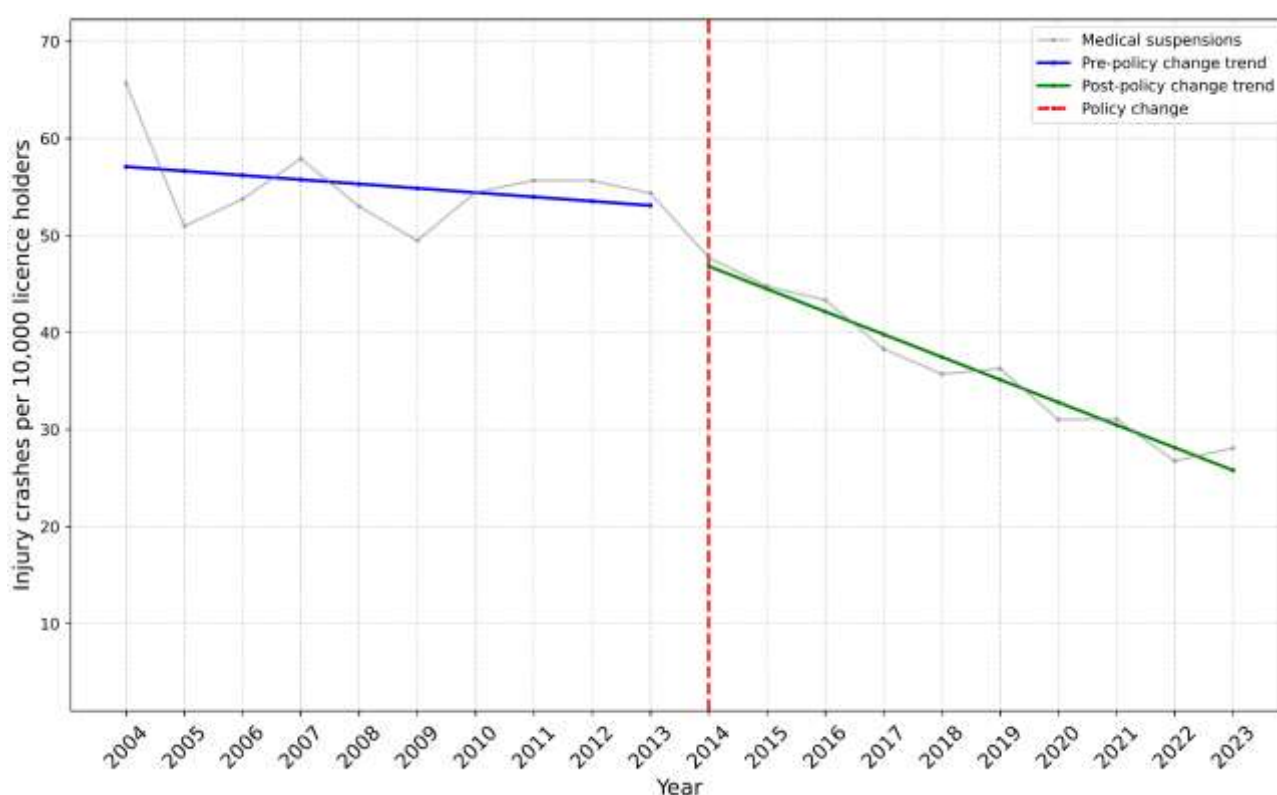


Figure 3.13: Piecewise regression model for injury crashes per 10,000 licence holders showing the model of best fit for the pre-policy change (blue line) and post-policy change (green line) separated by the policy change which occurred at 2014 (dashed red vertical line).

To understand if fatality rates were impacted by the policy change, the mean number of fatalities per 10,000 licence holders for each age group was calculated and is shown in Figure 3.14. There was a mean decrease in the annual rate of fatalities per 10,000 licence holders for drivers aged 70-100 post-policy change ( $M=0.97$ ,  $SD=0.38$ ) when compared to pre-policy change ( $M=1.90$ ,  $SD=1.23$ ). This decrease was found to be statistically significant using a Welch's test ( $t_{(21.2)}= 3.01$ ,  $p < 0.05$ ).

For the other age groups, there was a decrease in fatalities seen for younger drivers aged 18-59 ( $M=0.59$ ,  $SD=0.28$ ), as well as an overall decrease in fatalities for drivers aged 60-69 ( $M=0.36$ ,  $SD=0.31$ ) over the period of interest (1997-2023).

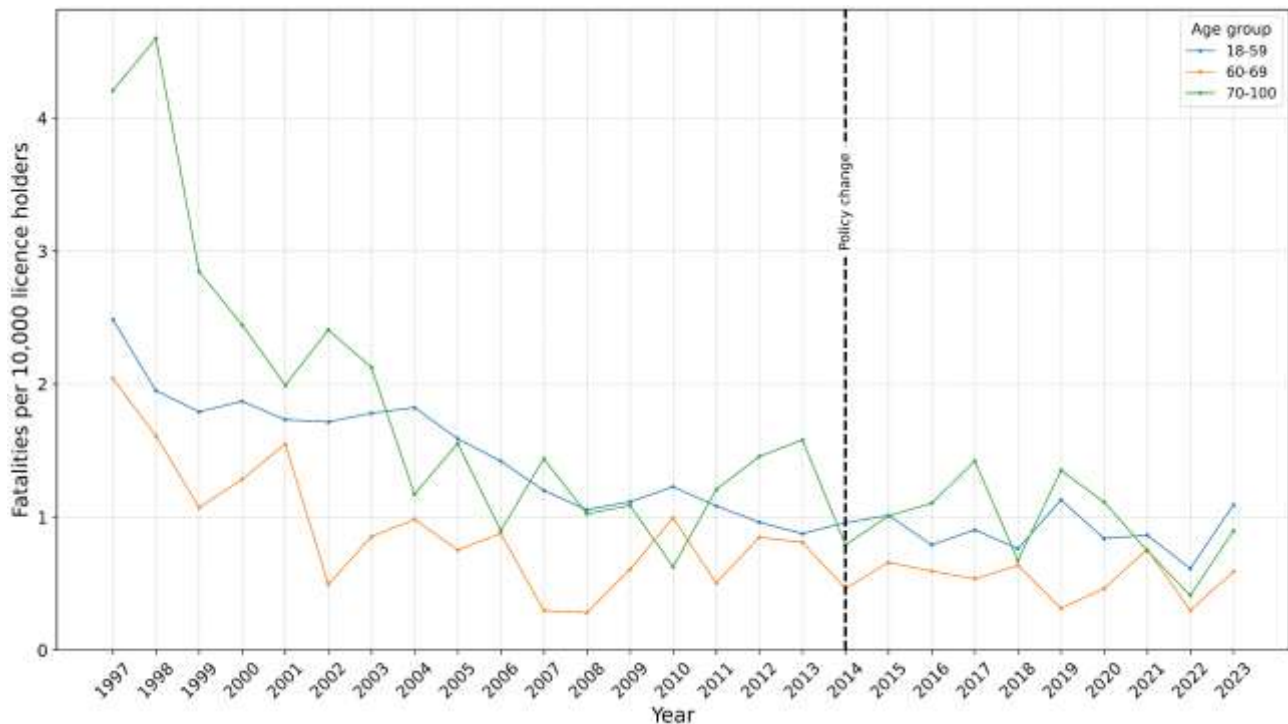


Fig 3.14: Mean number of fatalities each year per 10,000 licence holders, calculated for each age group (18-59, 60-69 and 70-100).

### 3.5. Pedestrian crashes

In order to get a holistic view of the effect of the change in mandatory fitness to drive reporting requirements, it was necessary to examine trends in pedestrian injuries among the different age groups, shown in Figure 3.15. There does not appear to be any indication of increasing pedestrian crash involvement for adults aged over 70 since the policy change.

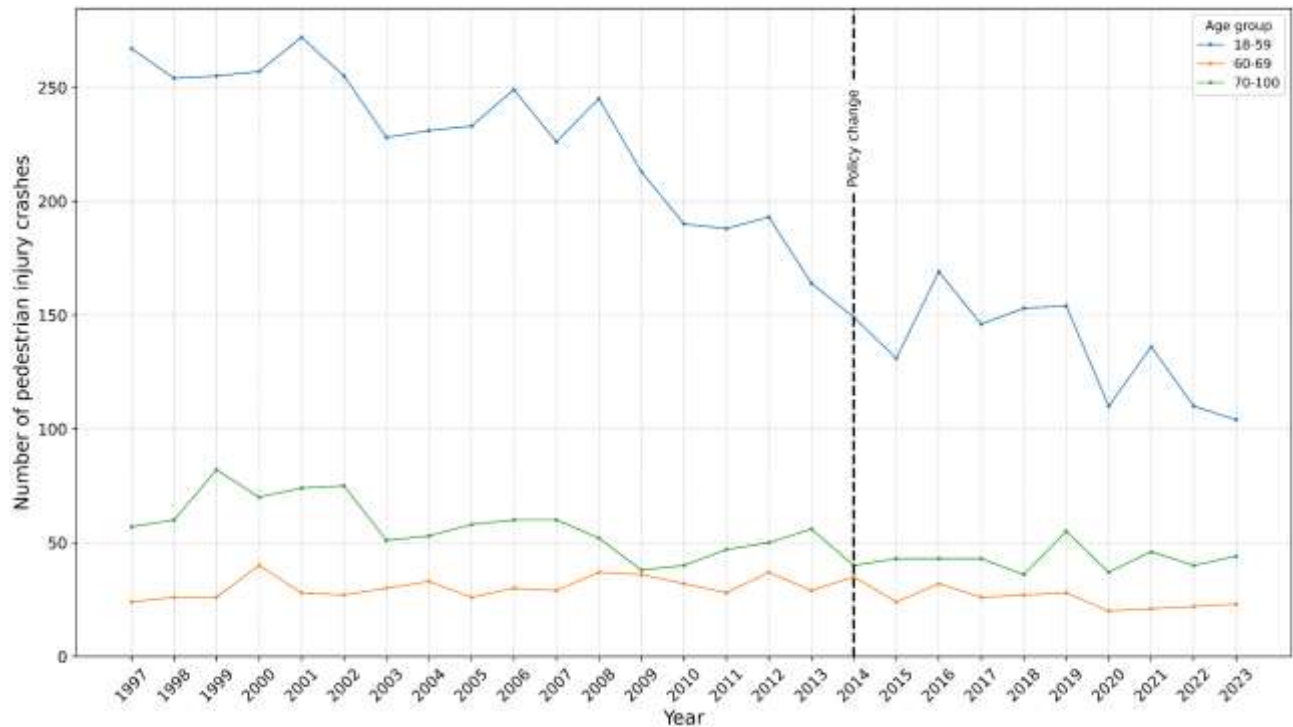


Figure 3.15: The number of pedestrian injuries by age group (18-59, 60-69 and 70-100 years of age) for the years 1997 to 2023.

By percentage of population (see Figure 3.16), pedestrians aged between 70-100 year had a decrease in the annual rate of pedestrian injuries per 10,000 population post-policy change ( $M= 1.88$ ,  $SD= 0.82$ ), when compared to pre-policy change ( $M= 3.37$ ,  $SD= 0.92$ ), which was statistically significant using a Welch's test ( $t_{(22.7)}= 6.31$ ,  $p<0.001$ ).

There was also a mean decrease in the rate of pedestrian injuries for those aged 18-59 post-policy ( $M=1.41$ ,  $SD= 0.25$ ) when compared to pre-policy change ( $M= 2.54$ ,  $SD= 0.47$ ), which was statistically significant using a Welch's test ( $t_{(23.5)}= 8.05$ ,  $p<0.001$ ). A mean decrease in pedestrian injuries was also seen for those aged 60-69 post-policy change ( $M= 1.21$ ,  $SD= 0.22$ ) when compared to pre-policy change ( $M= 2.11$ ,  $SD= 0.37$ ) which was statistically significant using a Welch's test ( $t_{(25.0)}= 6.41$ ,  $p<0.001$ ).

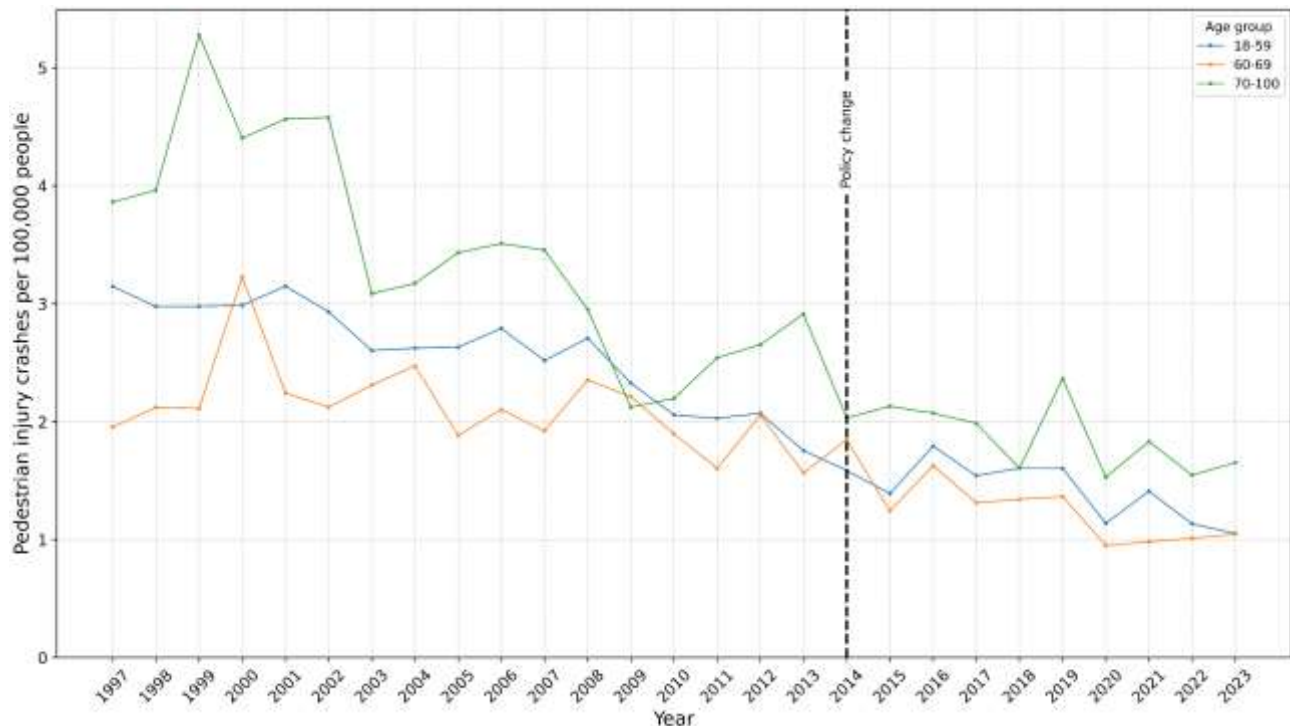


Figure 3.16: The rate of pedestrian injury crashes per 10,000 people for each age group (18-159, 60-69 and 70-100), for the years 1997 to 2023.

### 3.6. Gopher and mobility scooter injury crashes

Figure 3.17 show the injury rates of gopher/mobility scooter riders across the three age group categories (18-59, 60-69 and 70-100 years of age) over time (2000 to 2023). Note that the year 2000 is the earliest year in which gopher and mobility scooter injuries were recorded. The number of gopher/mobility scooter crashes each year is quite low so there is no indication of any effect of the policy change on these crashes. The difference in the number of injury crashes involving gophers or mobility scooters for users aged 70-100 pre-policy change ( $M = 5.79$ ,  $SD = 2.83$ ) when compared to post policy change ( $M = 5.11$ ,  $SD = 2.93$ ) was not statistically significant using Welch's test ( $t(16.9) = 0.55$ ,  $p = 0.593$ ).

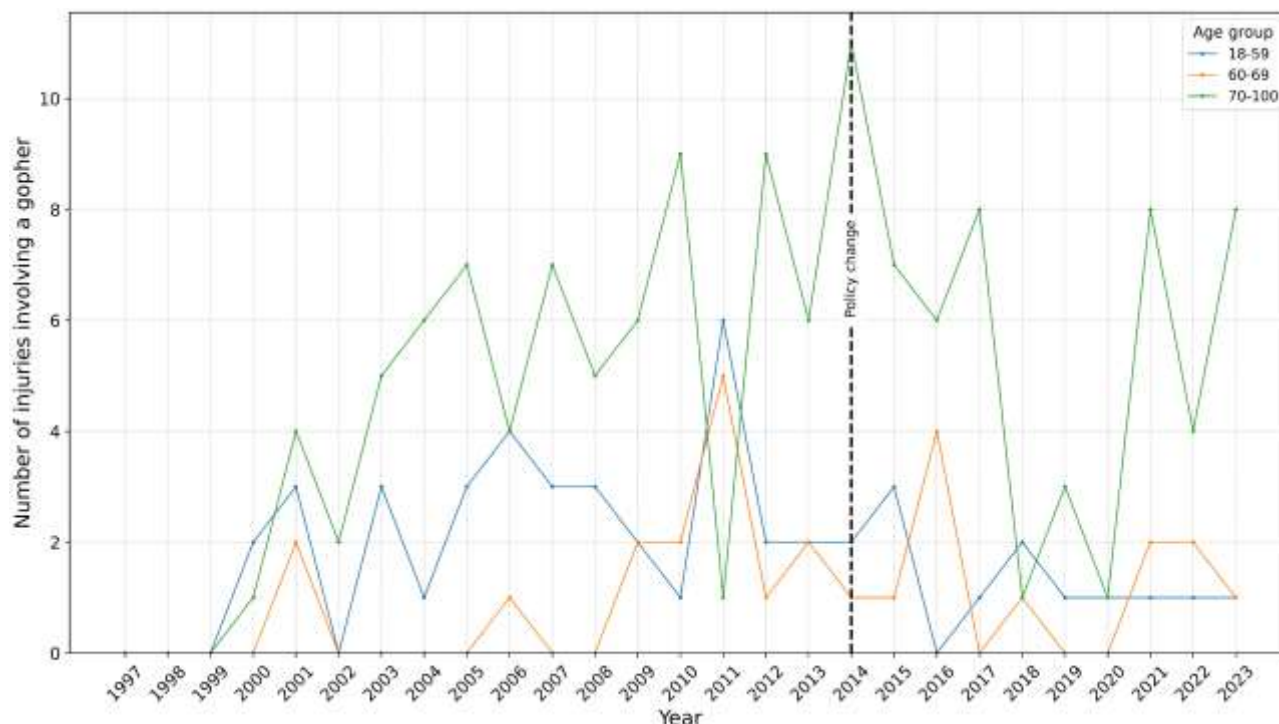


Figure 3.17: The number of injury crashes involving a gopher or mobility scooter per year by age group (<59, 60-69 and 70-100).

## 4. Discussion

### 4.1. Introduction and summary of findings

This study investigated the impact of changes to the mandatory fitness to drive reporting requirements for South Australian drivers aged 70 years and over. Historically, drivers in South Australia were required to undertake an annual medical assessment of fitness to drive from age 70. This requirement was removed in 2015 and replaced by a self-assessment form for drivers aged 75 or more. Previous CASR research predicted that this would result in an increase in the licensing rates for older drivers in South Australia and a small increase in crash rates. This study was designed to assess whether this had eventuated.

The outcomes of the analyses can be summarised as follows:

- The number of licensed drivers aged over 70 in South Australia is growing and has recently reached equivalence with the number of licensed drivers aged 60 to 69. This is being driven by an ageing population but is also likely to be due to cohort differences in licensing rates among older adults (e.g., more women driving and fewer people who have never driven).
- There has been a higher rate of licence suspensions on medical grounds among those aged over 70 since the policy change in 2015.
- This higher rate of licence suspensions post-policy change appears to be a continuation of an upward trend in suspensions that commenced before the policy change.
- There has been little change in the average age of medically suspended drivers aged over 70 since the policy change.
- The vast majority of medical suspensions are made on medical, rather than administrative, grounds.
- Medical licence suspensions based on referrals by SA Police tend to account for between 1 and 3 per cent of all medical licence suspensions.
- Common medical conditions resulting in licence suspensions include musculoskeletal conditions, cardiovascular conditions and diabetes. Musculoskeletal conditions have increased as a proportion of medical suspensions in more recent years, as have vision and psychiatric conditions.
- Post policy change, there has been a decrease in the average annual number of injury crashes among drivers in all age groups, including those aged over 70. Crash rates are declining at a faster rate post-policy change than they were in the pre-policy change period.
- There have also been decreases in the rate of injury crashes per licensed driver for all age groups. The injury crash rates are similar for those aged over 70 and those aged 60 to 69, both of which are lower than the rate for those aged 18 to 59.
- The fatality rate per licensed driver for those aged over 70 has decreased since the policy change.
- There is no indication of a change in the average annual number of pedestrian injury crashes among those aged over 70 since the policy change. The rate of pedestrian injury crashes per head of population has decreased for those aged over 70 since the policy change, with the magnitude of the decrease being similar to those for other age groups.

## 4.2. Interpretation of the findings

The two key findings of this study are that there was an increase in the rate of medical licence suspensions after the policy change and a decrease in the crash rate. These findings were counter to expectations but indicate that the change in policy has not had any negative effects: medically unfit drivers are still being identified and road safety outcomes for the affected age group have improved. It appears that that higher average rate of suspensions in the post-policy change period is a continuation of an upward trend that began prior to the policy change.

### 4.2.1. Licensing

In 2015, the policy in South Australia changed from requiring an age-based medical assessment for older drivers to one requiring only self-reporting of conditions to the licensing authority and commencing at a later age (75 rather than 70). Given that this is a less 'strict' policy, it was hypothesised that there would be a lower rate of licence suspensions on medical grounds for those aged over 70, which would result in increasing numbers of active, licensed older drivers.

The number of licensed drivers aged 70 or more did indeed increase post-policy change, increasing from around 125,000 in 2014 to around 200,000 in 2023. Those number of licensed drivers aged between 60 and 69 increased from around 175,000 in 2014 to around 200,000 in 2023. Such increases in licensing numbers in older age groups are expected given the ageing population and also cohort differences, with more recent birth cohorts being more likely to be drivers.

In order to assess the policy outcomes from a licensing perspective, the key outcome variable is the rate of licence suspensions on medical grounds for older drivers. This is best expressed as the percentage of licensed drivers aged over 70 who incur a medically based licensing suspension each year. As noted above, this rate increased after the policy change. This means that the policy change did not have the hypothesised outcome of reducing the rate of detection of medically unfit older drivers. This is an interesting finding that was the opposite of expectations.

Data related to the source of referrals for medical licence suspensions were examined to assess whether there had been an increase in referrals from SA Police, following traffic offences or crashes. Although available data only extended back to 2019, it was apparent that licence suspensions for medical reasons resulting from referrals by the Police only account for between 1 and 3 per cent of medical licence suspensions. This proportion of cases could not possibly account for the substantial increases in licence suspensions since the policy change.

Data related to the medical conditions associated with licence suspensions were also examined to assess whether changes in patterns of medical conditions were responsible for the study results. In more recent years, there has been a higher rate of musculoskeletal conditions and also increases in vision and psychiatric conditions. It is unclear whether some changes are due to changes over time in the coding of referrals but, nonetheless, it is possible that drivers are being referred for a wide range of conditions than previously, which may be leading to a higher rate of referrals.

That the higher rate of suspensions post-policy change appears to be a continuation of an existing upward trend suggests the need to look for an explanation of the increase that is unrelated to the policy change. One possible explanation is the release in 2012 of an updated Austroads guide for Assessing Fitness to Drive for commercial and private vehicle drivers (Austroads, 2012). Beran (2013) reported that this updated guide, 'while defining driver and licensing authorities' responsibilities,' affirmed that, 'health professionals remain pivotal for evaluation, with

professionals expected to report at-risk drivers and vigorously apply the guidelines' (Beran, 2013, p853). It could be that the new guidelines prompted a stricter application of guidelines and a consequent greater rate of licence suspensions. There appears to be, however, no relationship between the updated contents of the guide related to specific conditions and changes in referral numbers for those conditions.

There are other possible reasons for increased medical suspensions of drivers arising from medical review, although most of the proposed reasons rest on anecdotal evidence at this stage. It has been suggested that the new cohort of doctors, in contrast to previous cohorts, place greater emphasis on application of the fitness to drive guidelines than safeguarding the doctor-patient relationship, resulting in a greater willingness to refer drivers for fitness to drive assessments. There is also said to have been more training provided to doctors in this time period in regard to fitness to drive requirements and greater awareness of issues related to cognitive decline. Furthermore, increased availability of beds for rehabilitation has resulted in older patients being seen for a longer time period, which has increased detection of issues that could affect fitness to drive.

#### **4.2.2. Crashes**

The key outcome for any policy change related to road safety is the effect on crash numbers or crash rates. Given the hypothesised reduction in the rate of identification of medically unfit drivers, it was hypothesised that there would be an increase in the rate of crashes involving older drivers. Instead, the crash-based analysis found that crash rates for older drivers had decreased markedly following the policy change. In fact, in the post policy change period, the crash rate per licensed driver, which was identified in an Austroads report as the appropriate measure for older driver crash rates (Baldock et al., 2016), was *half* of that during the pre-policy change period, for drivers aged 70 or more. There were also reductions during this timeframe in the crash rates for those in other age groups, of a somewhat lesser but still substantial magnitude. Although it is not possible to argue that the crash rate reductions for those aged over 70 were larger than those in other age groups to a meaningful degree, it is nonetheless evident that the policy change has not had a discernible safety disbenefit. Crash rates per licensed driver are declining across all age groups in South Australia, the result of other road safety-related improvements (e.g., improved infrastructure, speed management, vehicle safety technology) and those aged 70 or more are exhibiting a similar pattern.

The reductions in crash rates for those aged 70 or more could be due, in part, to the increased rate of removal of drivers for reasons of being medically unfit to drive. That is, the increased detection post-policy change in the rate of medical suspensions could be removing drivers with a higher than average crash risk. This means that the remaining drivers are more likely to have a medical fitness to drive profile more similar to those in the other age groups, which results in overall declines in the crash rates of the older drivers (70+) that match those in younger age groups.

### **4.3. Limitations**

As noted earlier in Section 2.2, there are a number of limitations which need to be considered when interpreting the results presented in this report.

Although considerable effort was made to identify all cases in which a licence was suspended on medical grounds across all potential categories, there may be cases of medical suspension having been missed due to changes in licensing systems.

When comparing the pre and post policy change periods, the potential impact of Covid-19 on drivers aged 70 and above needs to be recognised. Previous research has shown that Covid-19 disproportionately affected older adults, with one meta-analysis finding that patients over 70 years of age had a higher risk of developing severe Covid-19 and long-term health complications (Pijls, et al., 2021). Therefore, the increase in medical suspensions from 2021 onwards in South Australia may, in part, reflect the effects of medical complications experienced post-Covid-19 by older adults.

Additionally, it is also important to note the potential impact of Covid-19 when interpreting the injury crash, fatality and pedestrian injury results. During 2020 and 2021, South Australia experienced statewide lockdowns and stay-at-home orders, which significantly limited pedestrian and traffic movement from previous years, which may have contributed to the decrease in injury crashes, fatalities and pedestrian injuries.

Finally, the sample size available for the post-policy change period was considerably smaller than the comparison data available for the pre-policy change period. Across both the pre-policy and post-policy change periods of analysis, the sample size was moderately small when comparing impact on population samples (percentage of population and per 10,000 licence holder). Effort was made to mitigate the impact of unequal and small sample sizes with statistical testing appropriate for unequal sampling.

#### **4.4. Conclusion**

The removal of mandatory age-based fitness to drive assessments for older drivers in South Australia has not been found to have resulted in any road safety disbenefits. The rate of licence suspensions on medical grounds for older drivers has actually increased since the policy change. Furthermore, there have been declines in casualty crash involvement rates for older drivers and no evidence of increases in older pedestrian casualties. These outcomes can be taken as supportive of changes to the medical fitness to drive policies and processes in South Australia that were made in 2014-15.

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The views expressed in this report are those of the authors and do not necessarily represent those of the Adelaide University or the funding organisations.

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## Appendix A

Table A1: The number of licence holders by year (2000-2023) and by each age group of interest (18-59, 60-69 and 70>) (Data for Figure 3.1).

| Year | Age group |        |        |
|------|-----------|--------|--------|
|      | 18-59     | 60-69  | 70-100 |
| 2000 | 773028    | 93423  | 65430  |
| 2001 | 779272    | 96843  | 70333  |
| 2002 | 781320    | 100940 | 74779  |
| 2003 | 785912    | 105687 | 79998  |
| 2004 | 789699    | 111815 | 85422  |
| 2005 | 799307    | 119734 | 85422  |
| 2006 | 809456    | 125454 | 100128 |
| 2007 | 816942    | 134734 | 104302 |
| 2008 | 824435    | 141918 | 107392 |
| 2009 | 833919    | 148424 | 110382 |
| 2010 | 831060    | 151059 | 111887 |
| 2011 | 839693    | 159841 | 115892 |
| 2012 | 842643    | 165195 | 116825 |
| 2013 | 856865    | 173056 | 126567 |
| 2014 | 858333    | 177795 | 131785 |
| 2015 | 859006    | 182004 | 138758 |
| 2016 | 860046    | 185558 | 144906 |
| 2017 | 863281    | 186297 | 154767 |
| 2018 | 865950    | 188798 | 163293 |
| 2019 | 867997    | 191372 | 170329 |
| 2020 | 872084    | 194426 | 179579 |
| 2021 | 879455    | 197917 | 187365 |
| 2022 | 898285    | 201567 | 194451 |
| 2023 | 898569    | 203353 | 201170 |

Table A2: The number of medical suspensions by year (2000-2023) and by age group (60-69 and 70-100). (Data for Figure 3.3)

| Year | Age group |        |
|------|-----------|--------|
|      | 60-69     | 70-100 |
| 2000 | 142       | 1029   |
| 2001 | 135       | 1032   |
| 2002 | 177       | 1418   |
| 2003 | 197       | 1947   |
| 2004 | 268       | 2087   |
| 2005 | 295       | 2372   |
| 2006 | 259       | 1800   |
| 2007 | 256       | 1887   |
| 2008 | 448       | 4093   |
| 2009 | 341       | 3780   |
| 2010 | 437       | 4040   |
| 2011 | 338       | 2903   |
| 2012 | 497       | 3755   |
| 2013 | 571       | 4025   |
| 2014 | 634       | 4134   |
| 2015 | 719       | 3848   |
| 2016 | 836       | 5014   |
| 2017 | 878       | 5482   |
| 2018 | 1055      | 6474   |
| 2019 | 1101      | 7224   |
| 2020 | 1022      | 6323   |
| 2021 | 1628      | 11173  |
| 2022 | 1393      | 10493  |
| 2023 | 1548      | 9810   |

Table A3: The percentage of drivers suspended on medical grounds by year (2000-2023) and age group (60-69 and 70-100). (Data for Figure 3.4)

| Year | Age group |        |
|------|-----------|--------|
|      | 60-69     | 70-100 |
| 2000 | 0.15%     | 1.57%  |
| 2001 | 0.14%     | 1.46%  |
| 2002 | 0.17%     | 1.89%  |
| 2003 | 0.18%     | 2.43%  |
| 2004 | 0.23%     | 2.44%  |
| 2005 | 0.25%     | 2.45%  |
| 2006 | 0.21%     | 1.80%  |
| 2007 | 0.19%     | 1.81%  |
| 2008 | 0.31%     | 3.81%  |
| 2009 | 0.22%     | 3.42%  |
| 2010 | 0.29%     | 3.62%  |
| 2011 | 0.21%     | 2.51%  |
| 2012 | 0.30%     | 3.21%  |
| 2013 | 0.32%     | 3.28%  |
| 2014 | 0.36%     | 3.26%  |
| 2015 | 0.39%     | 2.77%  |
| 2016 | 0.41%     | 3.46%  |
| 2017 | 0.47%     | 3.52%  |
| 2018 | 0.55%     | 3.96%  |
| 2019 | 0.57%     | 4.24%  |
| 2020 | 0.52%     | 3.52%  |
| 2021 | 0.82%     | 5.96%  |
| 2022 | 0.69%     | 5.39%  |
| 2023 | 0.76%     | 4.87%  |

Table A4: The number of injury crashes per year (2000-2023) and by age group (18-59, 60-69 and 70-100). (Data for Figure 3.9a)

| Year | Age group |       |        |
|------|-----------|-------|--------|
|      | 18-59     | 60-69 | 70-100 |
| 2000 | 9949      | 653   | 538    |
| 2001 | 9829      | 627   | 597    |
| 2002 | 9519      | 576   | 630    |
| 2003 | 9144      | 585   | 535    |
| 2004 | 8391      | 559   | 561    |
| 2005 | 7550      | 576   | 492    |
| 2006 | 7692      | 635   | 538    |
| 2007 | 8137      | 663   | 604    |
| 2008 | 8626      | 734   | 569    |
| 2009 | 7964      | 763   | 546    |
| 2010 | 8446      | 744   | 609    |
| 2011 | 8449      | 817   | 645    |
| 2012 | 7978      | 794   | 650    |
| 2013 | 7518      | 830   | 688    |
| 2014 | 7431      | 788   | 604    |
| 2015 | 6827      | 779   | 621    |
| 2016 | 6582      | 760   | 628    |
| 2017 | 5301      | 642   | 593    |
| 2018 | 5913      | 706   | 583    |
| 2019 | 5778      | 755   | 618    |
| 2020 | 4807      | 587   | 557    |
| 2021 | 5347      | 663   | 582    |
| 2022 | 4172      | 529   | 520    |
| 2023 | 4214      | 567   | 565    |

Table A5: The percentage of injury crashes by licensed driver each year (2000-2023) for each age group (18-59, 60-69 and 70-100). (Data for Figure 3.10)

| Year | Age group |       |        |
|------|-----------|-------|--------|
|      | 18-59     | 60-69 | 70-100 |
| 2000 | 1.27%     | 0.69% | 0.82%  |
| 2001 | 1.26%     | 0.64% | 0.85%  |
| 2002 | 1.22%     | 0.57% | 0.82%  |
| 2003 | 1.16%     | 0.55% | 0.66%  |
| 2004 | 1.16%     | 0.50% | 0.65%  |
| 2005 | 0.94%     | 0.48% | 0.51%  |
| 2006 | 0.95%     | 0.51% | 0.53%  |
| 2007 | 0.99%     | 0.50% | 0.58%  |
| 2008 | 1.04%     | 0.52% | 0.52%  |
| 2009 | 0.95%     | 0.51% | 0.49%  |
| 2010 | 1.01%     | 0.49% | 0.54%  |
| 2011 | 1.01%     | 0.51% | 0.55%  |
| 2012 | 0.94%     | 0.48% | 0.55%  |
| 2013 | 0.87%     | 0.47% | 0.54%  |
| 2014 | 0.86%     | 0.45% | 0.47%  |
| 2015 | 0.79%     | 0.43% | 0.44%  |
| 2016 | 0.76%     | 0.41% | 0.43%  |
| 2017 | 0.61%     | 0.34% | 0.38%  |
| 2018 | 0.68%     | 0.37% | 0.35%  |
| 2019 | 0.66%     | 0.39% | 0.36%  |
| 2020 | 0.55%     | 0.30% | 0.31%  |
| 2021 | 0.61%     | 0.33% | 0.31%  |
| 2022 | 0.46%     | 0.26% | 0.27%  |
| 2023 | 0.47%     | 0.28% | 0.28%  |

## Appendix B

Table B1: This table presents the list of medical conditions included in each of the medical condition categories included in this report. The list of medical conditions included in each category has been extracted from the information provided in the TRUMPS licensing database.

| Medical Condition Category | Medical conditions included in category                                                                                                                                                                                                                                                                                                                    |
|----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Cardiovascular             | Acute Myocardial Infarction (AMI), Angina, Angioplasty, Atrial Fibrillation, Cardiac Aneurysm, Cardiac Arrest, Cardiac Pacemaker, Cardiovascular - Other, Coronary Artery Bypass Grafting (CABG), Heart Failure, Hypertrophic Cardiomyopathy (HCM), Implantable Cardioverter Defibrillator (ICD), Ventricular Assist Device (VAD), Valvular Heart Disease' |
| Neurological               | Subarachnoid Haemorrhage, Blackouts, Brain Aneurysm, Alzheimer's Disease, Neurological/Neuromuscular - Other, Head Injury, Dementia, Parkinson's Disease, Huntington's Disease                                                                                                                                                                             |
| Diabetes                   | Diabetes controlled by tablet, Diabetes controlled by insulin                                                                                                                                                                                                                                                                                              |
| Epilepsy                   | Epilepsy                                                                                                                                                                                                                                                                                                                                                   |
| Hearing                    | Hearing loss                                                                                                                                                                                                                                                                                                                                               |
| Musculoskeletal            | Limb, arthritis, Musculoskeletal Conditions - Other, Neurological/Neuromuscular - Other, Multiple Sclerosis, Muscular Dystrophy                                                                                                                                                                                                                            |
| Psychiatric Conditions     | Chronic Depression, Chronic Anxiety, Post Traumatic Stress Disorder, Psychiatric Conditions - Other, Schizophrenia, Personality disorder                                                                                                                                                                                                                   |
| Vision                     | Glaucoma, Vision and Eye Disorders - Other, Visual Field Defect, Cataracts, Macular Degeneration, Monocular vision (one eye)                                                                                                                                                                                                                               |
| Sleep Disorders            | Sleep Apnoea, Sleep Disorders - Other, Narcolepsy                                                                                                                                                                                                                                                                                                          |
| Stroke                     | Stroke                                                                                                                                                                                                                                                                                                                                                     |

## Appendix C

Table C1: This table shows the medical condition provided as a reason a licence was suspended on medical grounds. The following table presents the percentage attributed to each medical reason calculated as a percentage of all categories of overall medical conditions.

| Medical Condition reason (%) |                 |          |          |         |                 |              |       |                        |                 |        |        |
|------------------------------|-----------------|----------|----------|---------|-----------------|--------------|-------|------------------------|-----------------|--------|--------|
| Year                         | Cardio-vascular | Diabetes | Epilepsy | Hearing | Musculoskeletal | Neurological | Other | Psychiatric Conditions | Sleep Disorders | Stroke | Vision |
| 1997                         | 60.60           | 31.13    | 0.00     | 0.00    | 6.36            | 0.40         | 0.00  | 1.19                   | 0.00            | 0.00   | 0.33   |
| 1998                         | 61.40           | 32.08    | 0.00     | 0.00    | 4.92            | 0.49         | 0.00  | 0.92                   | 0.00            | 0.00   | 0.18   |
| 1999                         | 56.85           | 31.65    | 0.00     | 0.00    | 8.32            | 1.06         | 0.00  | 1.71                   | 0.00            | 0.00   | 0.41   |
| 2000                         | 61.05           | 30.60    | 0.00     | 0.00    | 6.02            | 0.60         | 0.00  | 1.58                   | 0.00            | 0.00   | 0.15   |
| 2001                         | 57.42           | 35.63    | 0.00     | 0.00    | 4.81            | 0.31         | 0.00  | 1.65                   | 0.00            | 0.00   | 0.18   |
| 2002                         | 59.18           | 35.63    | 0.00     | 0.00    | 3.38            | 0.31         | 0.00  | 1.39                   | 0.00            | 0.00   | 0.10   |
| 2003                         | 56.40           | 34.79    | 0.00     | 0.00    | 6.48            | 0.23         | 0.00  | 1.87                   | 0.00            | 0.00   | 0.23   |
| 2004                         | 53.85           | 34.26    | 0.00     | 0.00    | 9.50            | 0.19         | 0.00  | 2.05                   | 0.00            | 0.00   | 0.15   |
| 2005                         | 50.18           | 40.98    | 0.00     | 0.05    | 5.91            | 0.47         | 0.00  | 2.30                   | 0.00            | 0.00   | 0.10   |
| 2006                         | 53.76           | 32.13    | 0.00     | 0.00    | 10.70           | 0.67         | 0.00  | 2.67                   | 0.00            | 0.00   | 0.08   |
| 2007                         | 53.31           | 33.97    | 0.06     | 0.00    | 9.45            | 0.69         | 0.00  | 2.09                   | 0.12            | 0.12   | 0.19   |
| 2008                         | 57.31           | 33.11    | 0.05     | 0.03    | 6.16            | 0.50         | 0.03  | 2.63                   | 0.03            | 0.00   | 0.18   |
| 2009                         | 52.68           | 36.00    | 0.14     | 0.00    | 7.60            | 0.43         | 0.00  | 2.44                   | 0.57            | 0.09   | 0.05   |
| 2010                         | 53.18           | 34.32    | 0.10     | 0.03    | 7.96            | 0.54         | 0.00  | 3.37                   | 0.21            | 0.08   | 0.21   |
| 2011                         | 32.78           | 50.32    | 0.12     | 0.04    | 5.74            | 0.70         | 0.02  | 3.50                   | 6.60            | 0.07   | 0.11   |
| 2012                         | 24.77           | 25.98    | 1.21     | 0.91    | 12.08           | 4.83         | 0.91  | 6.95                   | 17.82           | 4.23   | 0.30   |
| 2013                         | 28.84           | 13.30    | 4.12     | 0.94    | 13.30           | 12.17        | 4.68  | 8.99                   | 7.30            | 3.93   | 2.43   |
| 2014                         | 19.88           | 9.61     | 2.61     | 3.65    | 22.26           | 8.79         | 6.33  | 11.02                  | 3.87            | 3.50   | 8.49   |
| 2015                         | 14.15           | 16.33    | 0.81     | 4.38    | 37.27           | 6.25         | 3.15  | 7.49                   | 2.05            | 1.78   | 6.35   |
| 2016                         | 15.30           | 15.22    | 0.86     | 1.87    | 34.06           | 7.92         | 2.49  | 7.88                   | 2.26            | 2.38   | 9.77   |
| 2017                         | 14.92           | 11.93    | 0.82     | 1.86    | 38.77           | 7.62         | 2.35  | 7.12                   | 2.33            | 2.12   | 10.16  |
| 2018                         | 12.40           | 16.34    | 0.50     | 1.33    | 37.68           | 7.52         | 1.74  | 5.81                   | 1.96            | 1.46   | 13.27  |
| 2019                         | 23.61           | 10.31    | 1.18     | 1.85    | 25.03           | 5.42         | 2.87  | 9.08                   | 5.89            | 0.37   | 14.38  |
| 2020                         | 25.23           | 10.20    | 1.16     | 2.05    | 21.88           | 5.73         | 3.11  | 8.24                   | 6.12            | 1.06   | 15.22  |
| 2021                         | 30.19           | 6.70     | 0.23     | 3.19    | 17.82           | 6.41         | 3.98  | 4.02                   | 4.16            | 5.29   | 18.00  |
| 2022                         | 26.31           | 7.88     | 0.25     | 3.42    | 17.37           | 7.30         | 4.29  | 4.11                   | 4.61            | 3.11   | 21.35  |
| 2023                         | 25.15           | 8.37     | 0.25     | 3.78    | 15.75           | 8.17         | 4.18  | 4.1                    | 5.1             | 1.98   | 23.27  |

## Appendix D

A piecewise regression analysis examined whether the trend of medical suspensions per 10,000 licence holders (for the 60-69-year-old age group) followed a similar upward trend for the post-policy period when compared to pre-policy period. The results of the regression model explained a large proportion of the variance of medical suspensions per 10,000 license holders (Adjusted  $R^2 = 0.91$ ) and is shown in figure D1.

The trend line post-policy change was significantly different when compared to the trend line pre-policy change for drivers aged 60-69 ( $\beta = 3.77, p = 0.001$ ).

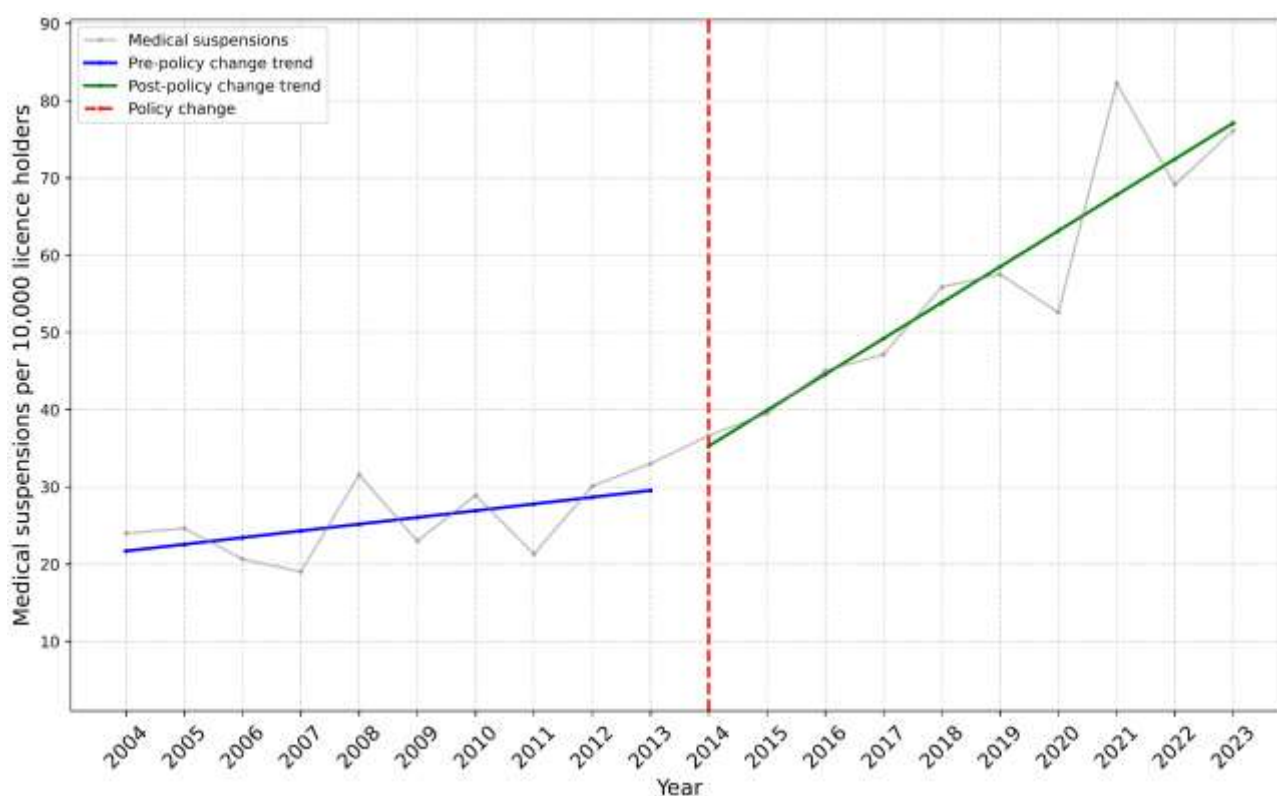


Figure D1: Piecewise regression model for medical suspensions per 10,000 licence holders showing the model of best fit for the pre-policy change (blue line) and post-policy change (red line) separated by the policy change which occurred at 2014 (dashed red vertical line).

An additional piecewise regression analysis examined whether the trend of injury crashes per 10,000 licence holders (for the 60-69-year-old age group) followed a similar trend for the post-policy period when compared to pre-policy period. The results of the regression model explained a large proportion of the variance of injury crashes per 10,000 license holders (Adjusted  $R^2 = 0.94$ ) and is shown in figure D2.

The trend post-policy change increased and was significantly different when compared to the trend pre-policy change for drivers aged 60-69 ( $\beta = -2.6$ ,  $p < 0.0001$ ).

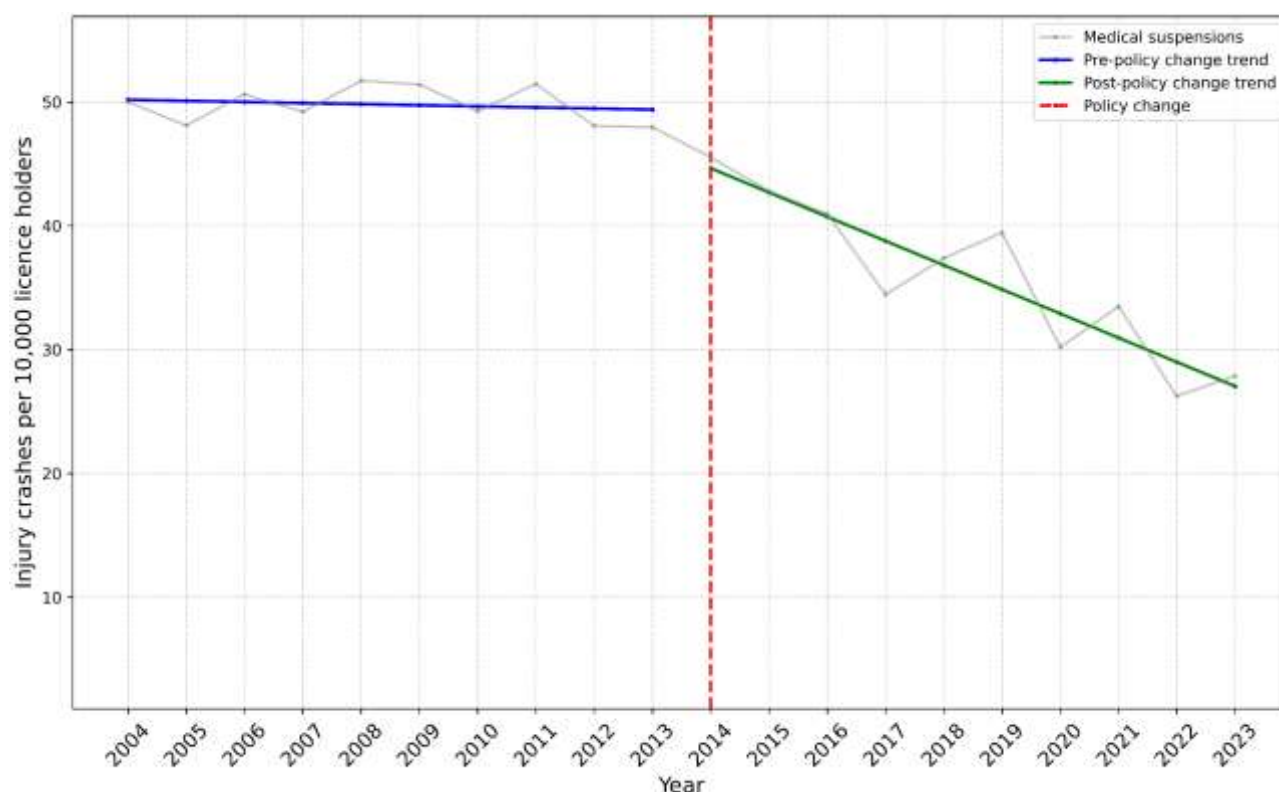


Figure D2: Piecewise regression model for injury crashes per 10,000 licence holders showing the model of best fit for the pre-policy change (blue line) and post-policy change (red line) separated by the policy change which occurred at 2014 (dashed red vertical line).