Age related annual crash incidence rate ratios in professional drivers of heavy goods vehicles

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\begin{abstract}
\textbf{Objectives:} Evidence concerning crash risk for older heavy vehicle drivers is sparse, making it difficult to assess if it is prudent to encourage older drivers to remain in the workforce in a climate of labour shortages. The objective of this study was to estimate annual crash rate ratios of older male heavy vehicle drivers relative to their middle aged peers.

\textbf{Methods:} Data utilized in this study includes all crashes meeting inclusion criteria involving heavy goods vehicles, categorised as rigid trucks and articulated trucks; this data was recorded by the New South Wales Roads and Traffic Authority. The exposure to the risk of a crash was represented by distance travelled for each vehicle type and year, by age of driver, as estimated by the Australian Survey of Motor Vehicle Use. Negative binomial regression modelling was applied to estimate annual crash incidence rate ratios for male drivers in various age groups.

\textbf{Results:} A total of 26,146 crashes occurred in New South Wales during 1999–2006, involving a total of 54,191 vehicles; removing observations that did not meet the inclusion criteria, 19,736 observations remained representing 12,501 crashes. For rigid trucks, the incidence rate ratio for drivers aged 65+ years, compared to 45–54 year olds, was 0.74 (95\% CI 0.51, 0.98). For articulated trucks, the annual crash incidence rate ratio for drivers aged 65+ years compared to 45–54 year olds was 1.4 (95\% CI 0.96, 1.9), and that for drivers aged 55–64 years compared to 45–54 year olds was 1.1 (95\% CI 0.83, 1.3).

\textbf{Conclusions:} Older male professional drivers of heavy goods vehicles have lower risk of crashes in rigid vehicles, possibly due to accrued driving experience and self-selection of healthy individuals remaining in the workforce. Thus, encouraging these drivers to remain in the workforce is appropriate in the climate of labour shortages, as this study provides evidence that to do so would not endanger road safety.

\end{abstract}

\section{Introduction}
Increased life expectancy and reduced birth rate in developed countries over the past few decades has resulted in the proportion of older adults growing considerably faster than the population as a whole. In nations such as Australia, ageing populations and declining birth rates impact the size of the workforce. It is expected that across all industries, including the transport industry, recruitment challenges are likely in the near future (Department of Employment and Workplace...
The transport and storage industry plays a significant role in a nation’s economy; in Australia it contributes approximately 5.6% to gross domestic product and employs almost 5% of the workforce (National Road Transport Commission, 2003).

Whilst the ageing process affects individuals differently, even healthy older adults are likely to experience some level of functional decline in sensory, cognitive and physical areas (Anstey et al., 2005). Given that numerous functional abilities are important for safe and competent driving, it would be natural to suspect ageing to affect driving and lead to an over-involvement in crashes. However, evidence of relationships between declines in specific abilities and increased crash risk is sparse (Duke et al., 2010). This is particularly the case for heavy goods vehicle drivers’ (also known as road transport drivers) crash risk for those over 60 years of age. This contrasts starkly with the large volume of literature on the well-known increased risk of crashes for younger drivers of heavy goods vehicles (Mooren et al., 2014).

Estimating crash rates is one of the most common ways to assess the risk of drivers. Rate calculation requires division of crash counts (i.e. crash frequency) by some measure of exposure (e.g. vehicle distance travelled) (Huggins, 2013; Islam and Mannering, 2006). As has been previously suggested, such normalisation equalizes for differences in intensity of use, making comparisons more meaningful, and it helps identify differences between different populations’ characteristic crashes rates as a clue to causal factors (Hauer, 1995).

This is a limitation seen in studies of older drivers where the failure to include some measure of exposure. A question brought up by several researchers (Chipman et al., 1992, 1993; Hakamies-Blomqvist, 1998; Hauer, 1995; Kweon and Kockelman, 2003; Langford et al., 2005; Lord and Mannering, 2010; Tin Tin et al., 2010) is what measure of exposure is most appropriate in road safety research relating to risk and driver age? Five denominators of most often used:

1. per capita;
2. per number of licenced holders;
3. per distance travelled;
4. time spent driving; and
5. Household travel surveys to assess travel times.

Older professional drivers may be driving long distances, so the assumption that exposure is related to the number of licenced drivers or the proportion of the population in that age group, could lead to an inflated crash risk assessment for these drivers.

In addressing the increasing labour shortage, the question is raised as to whether it is wise to encourage older professional heavy vehicle drivers to remain in the transport sector for longer, particularly those of heavy goods vehicles. Whilst a more feasible solution to the predicted skills shortage in the transport industry is to recruit drivers of a younger age, this may not be viewed as a palatable solution with the public, regulators and insurance companies. Given the extensive media focus on the driving skills and attitudes of young drivers, any organisation suggesting encouragement of younger drivers into the transport industry needs to be sure that this does not present a risk to public safety.

1.1. Study aims and objectives

The aim of this study was to provide empirical evidence that would have capacity to both demonstrate the effect of age on driver performance and safety in professional heavy vehicle drivers and to assist in the formulation of strategies to meet the looming shortage of skilled professional heavy vehicle drivers in Australia. This was achieved by estimating and comparing annual crash incidence rate ratios of older heavy vehicle drivers relative to middle age drivers.

2. Materials and methods

This study utilised a retrospective cohort study design to analyse all crashes involving heavy goods vehicles between 1999 and 2006. Crash data from the New South Wales (NSW) Roads and Traffic Authority Traffic Accident Database System was used, together with distance travelled estimates from the Australian Bureau of Statistics Survey of Motor Vehicle Usage.

2.1. NSW roads and traffic authority traffic accident database

In Australia, all road and traffic crashes, involving the towing away of a damaged vehicle, person(s) requiring medical attention or fatality, are reported to police. In the state NSW, police reports are forwarded to the Road Safety Statistics Unit of the Roads and Traffic Authority where information from the reports is coded in accordance with the Traffic Accident Database System Coding System and entered into the Traffic Accident Database System database. It could be said that the crashes contained in this database are the more severe crashes. For this study, vehicle types were re-categorized as:

1. Rigid trucks exceeding 4.5 tonnes gross vehicle mass, constructed with a load carrying area, includes light rigid, medium rigid and heavy rigid trucks; and
2. Articulated trucks constructed primarily for load carrying, consisting of a prime mover and turntable device which is linked to semi-trailer; includes heavy and multiple combination vehicles (e.g. road train, B double).
Crashes can involve more than one vehicle and the Traffic Accident Database System identifies one vehicle per crash as the key (i.e. at-fault) vehicle. A priori we defined inclusion and exclusion criteria. To be included in this study a crash needed to meet the following criteria:

1. A vehicle was towed away, or an injury or fatality occurred;
2. The crash was recorded between 1999 and 2006;
3. A rigid or articulated truck was involved in the crash;
4. Age and gender of the driver were known; and
5. The key driver was licenced and aged 18 or over for rigid trucks, or aged 21 or over for articulated trucks.

Crashes were excluded from the analysis if the key driver of the vehicle was not in control of the vehicle or the action of the driver was not the reason for the crash. The three main reasons were:

1. The key vehicle in the crash was unoccupied;
2. Crash involved a stolen motor vehicle;
3. Crash error factor was identified as relating to a pedestrian, an animal or object being thrown at a vehicle.

Due to the low number of female heavy vehicle drivers \( n = 52 \), an additional exclusion criterion was that the key driver was a female driver of a heavy vehicle. The Traffic Accident Database System dataset also contained the year of crash and age of driver, which was recorded to age categories of 18–20 years, 21–25 years, 26–34 years, 35–44 years, 45–54 years, 55–64 years, and 65+ years.

2.2. Survey of motor vehicle usage dataset

In this study the measure of exposure used was total distance travelled (measured in kilometres) by vehicle type and age and gender of driver. This data is routinely estimated by the Australian Bureau of Statistics via the Survey of Motor Vehicle Usage (SMVU) (Australian Bureau of Statistics, 2008). This quarterly survey are of a stratified sample of registered owners each year and comprise all vehicles that were registered with a motor vehicle authority for road use at some stage during the twelve months ending 31 October each surveyed year. By way of an example, for the 2006 SMVU, a stratified sample of 16,000 vehicles was selected to report on vehicle use over a three-month period within the reference year of 1 November 2005 to 31 October 2006. This method accounted for the practice by some trucking companies of having a vehicle shared by two or more drivers at any time. Therefore, the data collected by the SMVU has sufficient detail to provide a fair estimate of driver age, gender and vehicle type by distance travel distribution in kilometres (km). Distances travelled by year during 1999–2006, age and gender of driver and vehicle type for New South Wales was provided by the Australian Bureau of Statistics in driver age groups: 18–20, 21–25, 26–34, 35–44, 45–54, 55–64 and 65+.

2.3. Statistical analysis

The total number of crashes by year of occurrence, age group of vehicle driver and vehicle type are described as is total distance travelled. Annual crash incidence rate ratios were estimated using negative binomial regression modelling (Abdel-Aty and Radwan, 2000; Poch and Mannering, 1996), with the number of crashes by at-fault drivers of heavy goods vehicles per year as the response variable, and with explanatory variables of vehicle type and age group of the driver. The interaction of these two explanatory variables was included to allow the model to estimate the incidence rate for each age and vehicle type combination. Total distance travelled by that age group for the crash year was used as the exposure variable. Standard errors for incidence rates and incidence rate ratios were calculated using the delta method (Oehlert, 1992). Significance is determined at the 5% level. All analysis was done in STATA MP 12.2 (StataCorp LP, 2012).

3. Results

During the period 1st January, 1999 and 31st December 2006 a total of 395,740 crashes were recorded in the Traffic Accident Database System for the Australian state of New South Wales (Centre for Road Safety, 2013). Data for 26,146 crashes involving heavy rigid and articulated trucks were available for analysis. Of these, 18,923 crashes involved a rigid or articulated truck. Restricting data to crashes in which there was an at-fault driver, resulted in 12,553 remaining crashes. Of these, 52 (0.4%) were female drivers. Since no meaningful statistical comparison could be made on these 52, and since it is not reasonable to assume that there is no difference between female and male drivers, these 52 observations were excluded, leaving 12,501 crashes to be studied. Table 1 summarises the number of crashes by age of driver, vehicle type and year. Rigid trucks constituted 46.5% and articulated trucks in 53.5% of crashes.

The total distance travelled, as estimated by the Australian Bureau of Statistics in the Survey of Motor Vehicle Usage, by vehicle type and age of the driver between 1999 and 2006 is shown in Table 2. There were large differences in the distances
### Table 1
Number of crashes in New South Wales for at-fault male drivers of heavy goods vehicles, between 1999 and 2006.

<table>
<thead>
<tr>
<th>Age</th>
<th>1999</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rigid trucks</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18–20</td>
<td>15</td>
<td>21</td>
<td>12</td>
<td>8</td>
<td>12</td>
<td>11</td>
<td>4</td>
<td>7</td>
<td>90</td>
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<tr>
<td>21–25</td>
<td>85</td>
<td>76</td>
<td>61</td>
<td>60</td>
<td>52</td>
<td>69</td>
<td>52</td>
<td>62</td>
<td>517</td>
</tr>
<tr>
<td>26–34</td>
<td>235</td>
<td>247</td>
<td>218</td>
<td>209</td>
<td>211</td>
<td>242</td>
<td>228</td>
<td>177</td>
<td>1556</td>
</tr>
<tr>
<td>35–44</td>
<td>191</td>
<td>225</td>
<td>193</td>
<td>210</td>
<td>233</td>
<td>242</td>
<td>228</td>
<td>167</td>
<td>1689</td>
</tr>
<tr>
<td>45–54</td>
<td>138</td>
<td>153</td>
<td>138</td>
<td>157</td>
<td>185</td>
<td>151</td>
<td>133</td>
<td>148</td>
<td>1203</td>
</tr>
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<td>55–64</td>
<td>62</td>
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<td>66</td>
<td>68</td>
<td>73</td>
<td>99</td>
<td>76</td>
<td>86</td>
<td>593</td>
</tr>
<tr>
<td>65+</td>
<td>7</td>
<td>7</td>
<td>12</td>
<td>6</td>
<td>9</td>
<td>9</td>
<td>8</td>
<td>11</td>
<td>69</td>
</tr>
<tr>
<td>Total</td>
<td>733</td>
<td>792</td>
<td>700</td>
<td>718</td>
<td>775</td>
<td>785</td>
<td>678</td>
<td>636</td>
<td>5817</td>
</tr>
<tr>
<td><strong>Articulated trucks</strong></td>
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<td></td>
<td></td>
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<td></td>
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<tr>
<td>21–25</td>
<td>60</td>
<td>64</td>
<td>46</td>
<td>48</td>
<td>40</td>
<td>35</td>
<td>41</td>
<td>30</td>
<td>364</td>
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<tr>
<td>26–34</td>
<td>311</td>
<td>308</td>
<td>258</td>
<td>269</td>
<td>245</td>
<td>254</td>
<td>221</td>
<td>212</td>
<td>2038</td>
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<tr>
<td>35–44</td>
<td>261</td>
<td>264</td>
<td>218</td>
<td>209</td>
<td>211</td>
<td>204</td>
<td>177</td>
<td>155</td>
<td>1656</td>
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<tr>
<td>45–54</td>
<td>168</td>
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<td>66</td>
<td>72</td>
<td>88</td>
<td>94</td>
<td>92</td>
<td>602</td>
</tr>
<tr>
<td>65+</td>
<td>4</td>
<td>8</td>
<td>10</td>
<td>5</td>
<td>8</td>
<td>11</td>
<td>8</td>
<td>14</td>
<td>68</td>
</tr>
<tr>
<td>Total</td>
<td>866</td>
<td>902</td>
<td>851</td>
<td>819</td>
<td>818</td>
<td>860</td>
<td>820</td>
<td>728</td>
<td>6684</td>
</tr>
<tr>
<td><strong>Grand total</strong></td>
<td>1599</td>
<td>1694</td>
<td>1551</td>
<td>1557</td>
<td>1593</td>
<td>1645</td>
<td>1498</td>
<td>1364</td>
<td>12,501</td>
</tr>
</tbody>
</table>

### Table 2
Total distance travelled, in millions of km, in New South Wales by male drivers of heavy goods vehicles, by vehicle type, between 1999 and 2006.

<table>
<thead>
<tr>
<th>Age</th>
<th>1999</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rigid trucks</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18–20</td>
<td>19.9</td>
<td>7.37</td>
<td>8.01</td>
<td>7.82</td>
<td>25.77</td>
<td>4.48</td>
<td>11.37</td>
<td>5.2</td>
<td>89.94</td>
</tr>
<tr>
<td>21–25</td>
<td>95.37</td>
<td>122.2</td>
<td>68.03</td>
<td>95.4</td>
<td>121.9</td>
<td>78.25</td>
<td>160.1</td>
<td>77.23</td>
<td>818.5</td>
</tr>
<tr>
<td>26–34</td>
<td>380</td>
<td>415.8</td>
<td>499.8</td>
<td>409.9</td>
<td>563.4</td>
<td>420.5</td>
<td>285.7</td>
<td>581</td>
<td>3430</td>
</tr>
<tr>
<td>35–44</td>
<td>785.5</td>
<td>539.2</td>
<td>630.7</td>
<td>665.3</td>
<td>875</td>
<td>846</td>
<td>761.8</td>
<td>581</td>
<td>5685</td>
</tr>
<tr>
<td>45–54</td>
<td>446.6</td>
<td>613.5</td>
<td>571.2</td>
<td>688.2</td>
<td>619.9</td>
<td>561.7</td>
<td>569.6</td>
<td>695.6</td>
<td>4766</td>
</tr>
<tr>
<td>55–64</td>
<td>202.6</td>
<td>237.4</td>
<td>262.2</td>
<td>237.8</td>
<td>259.5</td>
<td>202</td>
<td>196</td>
<td>178</td>
<td>1491</td>
</tr>
<tr>
<td>65+</td>
<td>29.08</td>
<td>31.41</td>
<td>40.17</td>
<td>48.36</td>
<td>72.11</td>
<td>60.05</td>
<td>61.04</td>
<td>728</td>
<td>6684</td>
</tr>
<tr>
<td>Total</td>
<td>1959</td>
<td>1967</td>
<td>2080</td>
<td>2133</td>
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<td>2260</td>
<td>2108</td>
<td>2115</td>
<td>17,052</td>
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<tr>
<td><strong>Articulated trucks</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26–34</td>
<td>256.8</td>
<td>227.1</td>
<td>195</td>
<td>217.6</td>
<td>239.5</td>
<td>209.8</td>
<td>183.6</td>
<td>183.9</td>
<td>1713</td>
</tr>
<tr>
<td>35–44</td>
<td>441.5</td>
<td>431.4</td>
<td>385.4</td>
<td>405.4</td>
<td>445.9</td>
<td>374.8</td>
<td>422.1</td>
<td>436.1</td>
<td>3342</td>
</tr>
<tr>
<td>45–54</td>
<td>106.4</td>
<td>156.4</td>
<td>132.5</td>
<td>107.3</td>
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<td>122.4</td>
<td>231.4</td>
<td>147.6</td>
<td>1123</td>
</tr>
<tr>
<td>55–64</td>
<td>0.29</td>
<td>22.11</td>
<td>10.4</td>
<td>8.8</td>
<td>3.57</td>
<td>23.82</td>
<td>18.6</td>
<td>13.05</td>
<td>100.6</td>
</tr>
<tr>
<td>65+</td>
<td>3112</td>
<td>3166</td>
<td>3228</td>
<td>3242</td>
<td>3614</td>
<td>3433</td>
<td>3341</td>
<td>3274</td>
<td>26,411</td>
</tr>
<tr>
<td><strong>Grand total</strong></td>
<td>3112</td>
<td>3166</td>
<td>3228</td>
<td>3242</td>
<td>3614</td>
<td>3433</td>
<td>3341</td>
<td>3274</td>
<td>26,411</td>
</tr>
</tbody>
</table>

### Table 3
Annual crash incidence rate (crashes per million km travelled) and annual crash incidence rate ratio for at-fault male drivers in heavy goods vehicles in New South Wales, with reference group category 45–54 years of age, and 95% confidence intervals (CI).

<table>
<thead>
<tr>
<th>Age group (years)</th>
<th>Incidence rate</th>
<th>95% CI</th>
<th>Incidence rate ratio</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rigid trucks</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18–20</td>
<td>1.12</td>
<td>0.82  1.41</td>
<td>4.38**</td>
<td>3.06  5.71</td>
</tr>
<tr>
<td>21–25</td>
<td>0.67</td>
<td>0.56  0.78</td>
<td>2.63**</td>
<td>2.04  3.23</td>
</tr>
<tr>
<td>26–34</td>
<td>0.5</td>
<td>0.42  0.57</td>
<td>1.95**</td>
<td>1.53  2.36</td>
</tr>
<tr>
<td>35–44</td>
<td>0.3</td>
<td>0.26  0.35</td>
<td>1.19</td>
<td>0.93  1.44</td>
</tr>
<tr>
<td>45–54</td>
<td>0.25</td>
<td>0.22  0.29</td>
<td>1</td>
<td>0.22  0.45</td>
</tr>
<tr>
<td>55–64</td>
<td>0.32</td>
<td>0.26  0.37</td>
<td>1.24</td>
<td>0.96  1.52</td>
</tr>
<tr>
<td>65+</td>
<td>0.19</td>
<td>0.14  0.24</td>
<td>0.74*</td>
<td>0.51  0.98</td>
</tr>
<tr>
<td><strong>Articulated trucks</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21–25</td>
<td>2.25</td>
<td>1.85  2.65</td>
<td>4.35**</td>
<td>3.34  5.37</td>
</tr>
<tr>
<td>26–34</td>
<td>1.19</td>
<td>1.01  1.36</td>
<td>2.30**</td>
<td>1.82  2.79</td>
</tr>
<tr>
<td>35–44</td>
<td>0.63</td>
<td>0.54  0.72</td>
<td>1.22</td>
<td>0.96  1.47</td>
</tr>
<tr>
<td>45–54</td>
<td>0.52</td>
<td>0.44  0.59</td>
<td>1</td>
<td>0.44  0.68</td>
</tr>
<tr>
<td>55–64</td>
<td>0.55</td>
<td>0.46  0.64</td>
<td>1.07</td>
<td>0.83  1.3</td>
</tr>
<tr>
<td>65+</td>
<td>0.74</td>
<td>0.52  0.95</td>
<td>1.43</td>
<td>0.96  1.89</td>
</tr>
</tbody>
</table>

* Significantly different to 1 at the 5% level.
** Significantly different to 1 at the 1% level.
travelled by vehicle types and age groups. For both rigid and articulated trucks the two younger age groups- and the oldest age group travelled far less distance than the two middle aged groups.

Negative binomial modelling was used to estimate rates and standard errors. The likelihood ratio test for over-dispersion found significant evidence of over-dispersion \( (p < 0.01) \), confirming that a Poisson model was not appropriate \((\text{Lord and Mannering, 2010})\). In a model including age, vehicle type and crash year as main effects, the year of the crash was not

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**Fig. 1.** Annual crash incidence rate per million km travelled for at-fault male drivers in heavy goods vehicles by age group in New South Wales, with 95% confidence intervals.

**Fig. 2.** Annual crash incidence rate ratios for at-fault male drivers in heavy goods vehicles by age group in New South Wales compared to reference group 45–54 years of age, with 95% confidence intervals.
significant ($p = 0.11$), confirming that a model containing driver age and vehicle type, with interaction is suitable for this data.

Annual crash incidence rates per million km travelled with 95% confidence intervals (CI), by age group and vehicle type are listed in Table 3 and displayed in Fig. 1. The rate for drivers aged 65+ years of articulated trucks was 0.74 crashes per million km travelled (95% CI 0.52, 0.95). For drivers in the next age group 55–64 years of articulated trucks, the rate was 0.55 crashes per million km travelled (95% CI 0.46, 0.64). For drivers of rigid trucks in the oldest age group 65+ was 0.19 crashes per million km travelled (95% CI 0.14, 0.24). Rates for drivers in the age group 45–54 years were lowest for both rigid and articulated trucks (0.25, 95% CI 0.22, 0.29 for rigid, and 0.52, 95% CI 0.44, 0.59 for articulated), so this group was selected as the reference group for the annual incidence rate ratio calculation.

Forming the ratio of two rates is recommended when comparing crash rates between age groups, as any ratio significantly different from one shows a significant difference in rates (Hauer, 1995; Huggins, 2013; Lord and Mannering, 2010). Table 3 lists annual crash incidence rate ratios, some of which are also displayed in Fig. 2. Ratios for 65+ drivers were 1.43 (95% CI 0.96, 1.89) for articulated trucks and 0.74 (95% CI 0.51, 0.98) for rigid trucks. Thus, 65+ aged drivers of rigid trucks are safer than their younger peers and, for articulated trucks; there is no evidence of a difference in crash rate between the 65+ group and their younger peers. For the next age group 55–64, the rate ratios are not significantly different from one, indicating no difference in crash rates between them and their younger peers aged 45–54 years.

4. Discussion

The aim of this study was to examine the effect of age on driver performance and safety in professional heavy vehicle drivers and to assist in the formulation of strategies to meet the looming shortage of skilled professional heavy vehicle drivers in Australia. This was achieved by estimating and comparing annual crash incidence rate ratios of older heavy vehicle drivers relative to middle age drivers using data from New South Wales, Australia for the period 1999–2006 for crashes requiring a vehicle to be towed away or where vehicle occupants were injured or died.

The modelling of incidence rate ratios involving male drivers of rigid trucks showed that, compared to 45–44 year olds, older drivers 65 years of age and older were significantly less likely to have a crash. For drivers in the 55–64 age group there was no difference between their crash rate and their younger peers. For articulated trucks, incidence rate ratio showed that, compared to 45–54 year olds, drivers aged over 64 years were not more likely to cause a crash, and the same was true for the 55–64 year old drivers.

There is a wealth of literature on the factors affecting functional ability in older drivers (Anstey et al., 2005; Wood et al., 2009). An example is macular degeneration related to age that affects visual acuity, which has been shown to effect driving ability (Owsley and McGwin, 2010). However, self-selection (the healthy survivor effect) among professional drivers has been reported: in Taiwan, bus drivers self-report having health better than their peers (Chung and Wong, 2011). This may explain why an increase in crashes does not follow directly from the loss of visual acuity with age.

The slowing of sensory and cognitive function with age can affect driving ability (Mathias and Lucas, 2009). However, in a US study of drivers over the age of 55 who had previously been involved in a crash, Roenker et al. (2003) found that drivers were very cautious and avoided situations that demanded high cognitive processing speeds, such as making gap selections in order to make turns across oncoming traffic. Similarly, a Danish study found that the older drivers who recognised problems with cognitive functions, displayed good self-assessment of changes in their driving skills and that this may be a contributing to safer driving performance among older Danish drivers (Meng and Siren, 2012).

There is a well-documented benefit to continued activity levels during old age (Kokkinos et al., 2010). A recent randomized control trial found that participation in a weekly exercise class improved movement and response time as well as cognitive processing speed (as measure by useful field-of-view) (Marmeleira et al., 2009). This may also contribute to continued safe driving among older professional drivers, as remaining in the work force is linked to higher activity levels (Van Domelen et al., 2011).

While the decline in ability for older drivers is easily understood, more subtle is that this may be offset by the value of increased experience. In support of this notion, it has been found that older drivers self-select, meaning that those with the largest declines in driving ability choose to avoid driving, that frequent drivers have faster reaction times than their peers who drive less frequently, and that older drivers can compensate for slowing sensory and cognitive abilities (Lerner, 1994).

Another aspect of self-regulation among older drivers is the documented avoidance of risky situations. For example, Sullivan et al. (2011) found, in a study of drivers aged 65 and over in Queensland Australia, that older drivers seek to avoid driving in the rain at night and driving in peak hour. While professional drivers would not have the same flexibility as the general public, choices made within their time and route constraints as well as choosing employment with easier tasks and reduced night-time driving is most probably a mechanism used by older professional drivers to maintain employment in the sector.

While we cannot expect that self-regulation alone will ensure that those who are not capable of driving safely will refrain from driving, the system of fitness-to-drive medical assessments serves as a safety net. This topic has been discussed extensively in the research literature in relation to ageing drivers of motor vehicles (Fildes et al., 2008; Langford, 2008; Molnar and Eby, 2008; Soderstrom and Joyce, 2008; Wheatley and Di Stefano, 2008) and drivers with specific health issues such as poor eyesight, heart disease, diabetes, epilepsy and early stages of dementia (Adler and Silverstein, 2008; Bohensky et al., 2008; Marshall, 2008; Wheatley and Di Stefano, 2008). Little research today exists in relation to professional drivers. Fildes (2008)
makes the point in his discussion of the research needs relating to older drivers that while there is a body of knowledge relating to older drivers, what is still unclear and in need of future knowledge and intervention are issues related to crash epidemiology, licensing, medical fitness-to-drive, and the role of new safety technology.

The effect of driver age and vehicle type on crash occurrence has not previously been studied in heavy vehicle crashes in Australia. Internationally, a number of studies have been carried out using fatality data (Campbell, 1991; Driscoll et al., 2005; Häkkänen and Summala, 2001; Summala and Mikkola, 1994), workers compensation claim data (McCall and Horwitz, 2005), law enforcement data (Stein and Jones, 1988) and survey data (Braver et al., 1992). Therefore this study is the first examining the effect of driver age and vehicle type on crash rate by utilizing all crashes involving a heavy vehicle, where a vehicle was towed away, or a person was injured.

The more usual practice for studies of this nature is to analyse just fatality or work related traffic crashes data. Langford (2005) discussed the limitation of that method; it introduces frailty bias because once involved in a crash, older drivers are more likely to experience adverse outcomes due to their greater frailty. This increased vulnerability to injury, as distinct from increased crash propensity, can be reflected in different age groups relative likelihood of involvement in crashes of different severity.

This analysis has demonstrated the Australian Government initiative to diversify the working population to include experienced drivers aged 65 years and over maybe appropriate for the Australian heavy vehicle transport industry. This recommendation comes with a number of caveats including firstly, knowing that presently in all states of Australia, professional drivers of heavy goods vehicles are regularly assessed at age-specific intervals for their fitness to drive. Secondly, that at the time of diagnosis of certain medical conditions (e.g. Type I diabetes) the treating physician is required to advise the licensing authority.

A key strength of this study is the use of an estimate of distance driven by state, vehicle type, driver age and gender of the driver as a proxy for exposure. This approach had previously been used by Campbell et al. using U.S. data (Campbell, 1991), but not previously been applied in an Australian study. A further strength of this study is the use of eight years of objective state-wide administrative data. While administrative data of this nature are not collected specifically for the purposes of research, audit programs of the state-wide road traffic authority administrative data are undertaken routinely, and it is the best available crash data in New South Wales. Two limitations of this study are: firstly is that the distance travelled is only an approximation for actual crash risk exposure and thus implications of our results are limited by the extent to which this was a valid proxy. Secondly, the administrative crash dataset used contains only the more severe crashes.

5. Conclusion

This analysis has demonstrated the Australian Government initiative to diversify the working population to include experienced drivers aged 65 years and over maybe appropriate for the Australian heavy vehicle transport industry.

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Appendix A. Licensing rules in New South Wales

1. New South Wales law restricts driving articulated vehicles to those who have held a heavy rigid licence for 12 months. To obtain a heavy rigid you must have a full driver’s licence which at the earliest can only be obtained by age 20 Thus to hold a multiple combination licence a driver would be at least 21 years. Further information regarding getting a heavy vehicle licence in the Australian state of New South Wales can be obtained from: <http://www.rms.nsw.gov.au/licensing/downloads/getting_heavy-vehicle_licence_dl1.html>.


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