DRIVER LICENSING REVIEW

LITERATURE REVIEW OF HEAVY VEHICLE SAFETY

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EXECUTIVE SUMMARY

This literature review has been prepared to support a review of New Zealand's heavy vehicle licensing system. It focusses on the factors that affect heavy-vehicle safety, in particular those that are relevant to the heavy vehicle licensing regime.

The following are key findings of the review:

1. Heavy vehicles make a disproportionate contribution to road fatalities. Information from overseas jurisdictions shows that trucks are between 1.3 and 3 times more likely to be involved in a fatal accident than light passenger vehicles, per kilometre driven. Approximately 80% of the fatalities in truck-involved accidents are *other road users*.

2. The main reason for this is the greater mass and structural differences of trucks relative to other road users. Overall, trucks are not more likely to be involved in an accident than light passenger vehicles, but this is countered by the greater harm when they are involved.

3. Truck drivers are less likely than other drivers to be judged responsible in a multiple-vehicle accident in which they are involved. Data from New Zealand and overseas shows that truck drivers are judged to have some responsibility in 20-30% of fatal accidents in which they are involved.

4. Critical risk factors for light vehicle drivers such as alcohol and night driving are less important for truck drivers because they are less likely to consume alcohol and drive. Despite a significant amount of research on the subject, the role of fatigue in truck driver accident risk remains unclear. Night driving and fatigue are prevalent factors in single-vehicle truck accidents, while impairment of other-vehicle drivers is a factor in multiple-vehicle, truck-involved accidents. In multiple-vehicle accidents where truck drivers are found responsible, the most prevalent factors are inattention, poor observation, inappropriate speed and violation of road rules.

5. There has been less research on the influence of age and experience on driver safety for trucks than for light passenger vehicles. However, available investigations indicate a significantly higher accident risk for younger, less experienced drivers, as much as four to six times higher for drivers under 21 than for all drivers. In addition, data from across different international jurisdictions show younger drivers to be more likely to be judged responsible for accidents in which they are involved. While no study has rigorously separated the effects of age from experience, study authors conclude that findings are suggestive of a role for judgement and maturity in accident risk.

6. Safety based studies of different heavy vehicle types and configurations suggest that larger combination vehicles have a slightly higher rate of fatal accident involvement than smaller rigid trucks. This suggests that the greater vehicle mass of large combination vehicles counteracts other factors such as being driven by more experienced drivers and on safer roads.

7. International jurisdictions take broadly consistent approaches to heavy vehicle driver licensing, with most establishing different vehicle classes based on truck and trailer weight and configuration. A distinction between commercial and non-commercial driving is also made in Europe and North America. There are differences in the extent to which licencing requirements emphasize age, experience, driving skill, training and education. New Zealand and Australia are unique in having established a graduated driver licensing system (GDLS) for trucks, although in other jurisdictions different age and experience requirements for different licence classes establish a 'quasi' GDLS.

8. No systematic evaluation has been found of heavy vehicle driver licensing systems, either across jurisdictions or 'before and after' evaluations following policy changes. There is a current worldwide trend to propose exchanging age and experience requirements for more intensive training and education and enhanced skill tests, in order to allow earlier entry to the driving workforce. This approach is unproven and is not supported by evidence from car-specific research, which suggests that where experience provides safety benefits, it cannot usually be substituted by intensive training. An overall conclusion is that licensing approaches which restrict access to the largest combination vehicles to older, more experienced drivers continue to be largely justified in terms of safety.

INTRODUCTION

This literature review has been prepared to support a review of New Zealand's heavy vehicle licensing system. It focusses on the factors that affect heavy-vehicle safety, in particular those that can be addressed by a heavy vehicle licensing regime. [1]

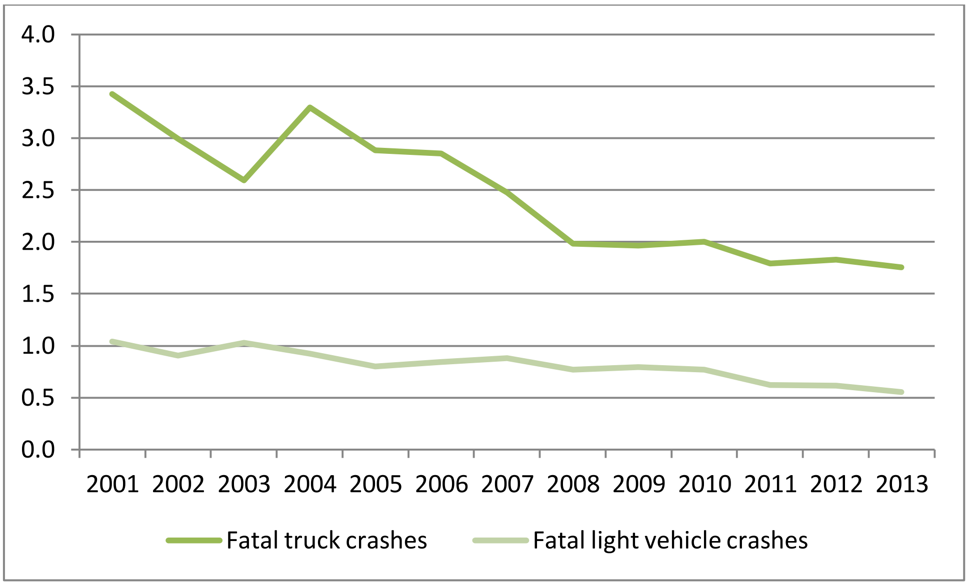
The review is broadly divided into three parts. The first part takes a general look at heavy vehicle safety and the factors involved in heavy vehicle accidents, including the extent to which these differ from traffic accidents in general. The second part looks at driver-specific factors relevant to heavy vehicle safety. Particular emphasis is placed on summarising available evidence on the relationship of driver age and experience to accident risk. This section also covers the relative risks of different vehicle configurations and looks at emerging technologies to address accident risk. Finally, the third section discusses and evaluates the different approaches taken to heavy vehicle driver licensing internationally.

[1] Not all factors contributing to heavy vehicle safety can be influenced by driver licensing. For example, factors such as road configuration and vehicle design relate to other parts of a safe systems approach, while others such as operator responsibility can be influenced by other regulatory tools apart from licensing.

Why is heavy vehicle safety important?

Accidents involving heavy vehicles are acknowledged to account for a disproportionate percentage of fatalities among road users. The Ministry of Transport reports that in 2012, trucks were involved in 17 percent of road fatalities and 6 percent of reported injuries on New Zealand roads although they accounted for just 6 percent of the total distance travelled (MoT, 2013). Fatalities involving trucks have dropped to about a third of what they were in the early 1990s but their proportion of the total road toll has remained relatively stable. The rate of fatal crashes involving trucks per million kilometres driven is around three times the rate for light vehicles (see Figure 1). Road users other than truck drivers account for 80 percent of fatalities.

Figure 1: Fatal crashes in trucks and light vehicles in New Zealand, per million vehicle kilometres travelled, 2001-13

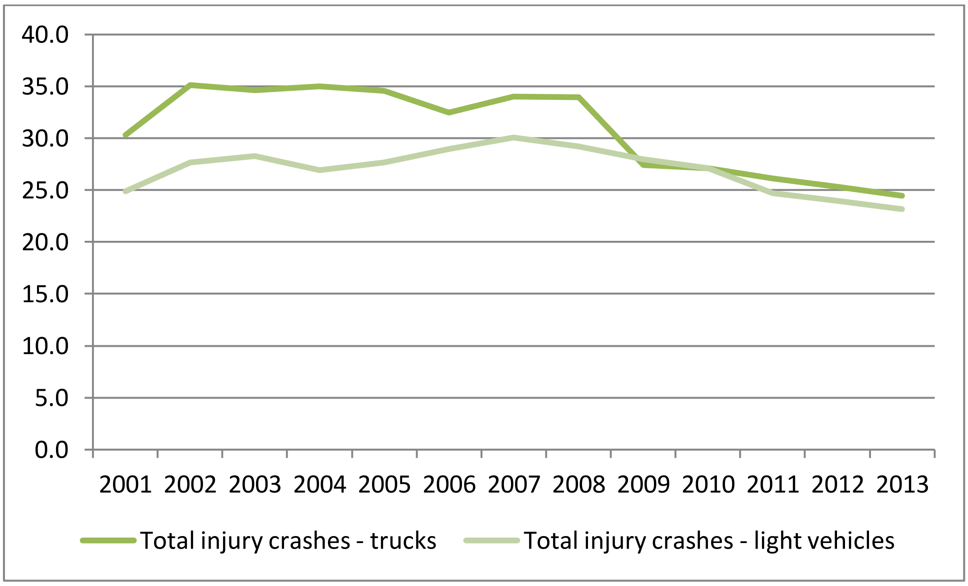


Source: NZTA elaboration from data extract provided by Ministry of Transport, June 2015

These figures are comparable to those from other jurisdictions. For example, in the US, heavy vehicles have been reported as being involved in approximately 12 percent of fatal accidents while representing 3 percent of registered vehicles and 7 percent of kilometres driven (Bezwada and Dissanayake, 2010). In Australia, Fabre and Christie (1999) estimated that there were approximately three times as many fatalities per million kilometres driven by trucks compared to passenger vehicles or buses. The main reason for the over-representation of heavy vehicles in fatal accidents is most likely their greater mass and structural differences relative to other road users (such as cars and pedestrians), which makes death more likely in any given accident.

In New Zealand from 2009-2013, trucks were involved in injury accidents at about the same rate as light vehicles, per kilometre driven (see Figure 2). In the United States, the FCMSA (2014) reports that in 2012, trucks were about half as likely to be involved in an injury or property damage-only accident as passenger vehicles.[2] Therefore, it is the consequence of the accidents that do occur which makes heavy vehicle safety such a critical issue.

Figure 2: All injury accidents involving trucks and light vehicles in New Zealand, per million vehicle kilometres travelled, 2001-13



Source: NZTA elaboration from data extract provided by Ministry of Transport, June 2015

Which factors affect heavy vehicle accident risk?

There is quite a wide range of international studies on the factors involved in heavy vehicle accident risk, many of which are based on official data sets drawn from accident investigations. These data sets vary according to their purpose, scope, and the level of information collected.

In New Zealand, the Crash Analysis System (CAS) collates data on all road traffic accidents involving injury and thus provides a routinely updated source from which information on heavy vehicle accidents can be extracted. Within CAS, responsibility for the accident may be assigned to one or more drivers, where this is identified.

In the United States, the Fatal Accident Reporting System (FARS) collects accident report data on all fatal road traffic accidents, from which the University of Michigan Transport Research Institute (UMTRI) extracts data on accidents involving heavy vehicles and undertakes additional follow up to form the Trucks in Fatal Accidents (TIFA) database. FARS does not assign responsibility but ‘associated factors’ judged to have contributed to the crash are coded, including driver, vehicle, roadway and environment factors.

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[2] In the United States, the rate of fatal truck crashes per kilometre driven is only about 1.4 times that of light vehicles. The large distances driven on divided roads with their much lower accident rate (Campbell et al, 1988) is likely to be a factor here.

In addition, a considerable amount of data has been made available through the Large Truck Crash Causation Study (LTCSS) a research study using more detailed data collected on a sample of accidents over three years (2000-2003) and weighted to form a nationally representative dataset (Blower et al, 2007; Starnes, 2006). The LTCSS includes up to 1,000 factors associated with each accident, and a 'critical reason' for each accident is defined (although this is not synonymous with responsibility).

Other countries have implemented similar accident reporting systems. For example, in Finland a multidisciplinary team follows up on all fatal accidents and collects data on up to 300 variables (Hakkanen and Summala, 2001). This includes determination of the action that led to the accident and assignation of the 'primary originator', which can be interpreted as implying driver responsibility.

More recently, naturalistic driving studies have been undertaken which record safety-related critical errors (SCEs) during real driving situations. While these studies provide rich detail on the actual driving practices of truck drivers and the errors they make, there are problems with extrapolating from them to draw conclusions about accident risk, since they capture the "real world" but not "real harm" (Knipling, 2011, p.4).

Type of accident and where they occur

The NZ Ministry of Transport reports that for 2013, 80% of fatal accidents and 57% of injury accidents involving heavy vehicles occurred on open roads. A data extract from the NZTA covering the period 2008-14 indicates that 79% of fatal accidents, 66% of serious injury accidents and 57% of minor injury accidents happened on the open road (speed limit of 80 km/h or higher).

In New Zealand in 2013, 43.5% of fatal accidents involving trucks were head-on (including lane change and overtaking). Injury accidents were distributed relatively evenly across different types of manoeuvre. In the study in Finland by Hakkanen and Summala (2001), 69.8% of all fatal accidents involving truck-trailer combinations were head-on crashes.

In the United States, the FHMCSA (2012) reports that in 2012, 63% of fatal truck-involved crashes happened on rural roads and in total 76.4% happened on roads with a speed limit of 50 mph or above. The collision point was the front of the truck in 58.6% of fatal accidents as opposed to 45.2% of injury accidents and 36.1% of property damage-only accidents.

Data from the United States indicate that divided roadways such as motorways (referred to as 'limited-access roads') greatly reduce the chances of trucks being involved in a fatal accident. Campbell et al (1988) found that the fatal accident rate for heavy vehicles driving on limited access roads was one half to one quarter the rate on all other roads.

Driver responsibility

In New Zealand, the Ministry of Transport (2013) reports that during 2009-13 truck drivers had primary responsibility for 34% of fatal crashes and 57% of minor injury crashes. Single vehicle truck crashes accounted for 13% of fatal crashes and 20% of injury crashes. In multiple vehicle accidents, truck drivers had primary responsibility in 22% of fatal and 43% percent of injury accidents.[3]

[3] Trucks drivers had primary or partial responsibility in 32% of fatal and 48% of injury accidents, in other words, they had some responsibility in 46% of all multiple-vehicle accidents.

In the United States, Rogers and Knipling (2007) report that of serious large-truck crashes in the LTCCS (including both single- and multivehicle crashes), 48% had a "critical reason" (CR) assigned to the driver of the large truck.[4] In crashes involving a truck and a passenger vehicle, 44% had a CR assigned to the truck driver and 56% to the driver of the other vehicle. In fatal car-truck crashes, the truck driver was assigned the CR in 23% of cases.

This is consistent with the findings of Blower (1998), who reviewed the Trucks in Fatal Accidents (TIFA) database and found that factors associated with the truck driver were coded in just 26.5% of cases while factors associated with drivers of light passenger vehicles were recorded in over 80% of cases (in around 10% of cases factors associated with both drivers were coded).

In Finland, Hakkanen and Summala (2001) studied 337 two-vehicle fatal accidents in which truck-trailer combinations were involved during 1991-97. They found that the truck driver was assessed as being the "primary originator" of the accident in 17% of cases, while the driver of the other vehicle was the originator in 83% of cases.

In Australia, the National Centre for Truck Accident Research (Driscoll, 2009) reports that in 2007, 75.4% of serious truck crashes (defined as those causing damage in excess of $50,000) involved a single vehicle, but where more than one vehicle was involved, the truck driver was assigned responsibility in 46% of cases. The profile of these accidents is rather different from the studies cited above, as the bulk of them are property-damage only.

These results are largely consistent and suggest that some responsibility can be attributed to truck drivers in somewhat less than half of the accidents in which they are involved, while data from New Zealand, the United States and Finland suggests that the more serious the accident, the less likely the truck driver is to be assigned responsibility. In fatal, multiple-vehicle accidents involving a truck, the truck driver is assigned some responsibility in 20-30% of cases.

Accident factors

Knipling (2011a), using data from the LTCSS, found important differences between single-vehicle (SV) truck crashes and multiple-vehicle (MV) truck crashes in which the critical reason (CR) was assigned to the truck driver. Overall, MV crashes with truck driver CR were more similar to MV crashes with other vehicle CR than to SV crashes.

In SV truck crashes, speed (too fast for conditions), fatigue (asleep-at-the-wheel), vehicle failure and inattention were the most important factors; whereas in MV crashes inattention, inadequate surveillance, speed and illegal manoeuvre were most important. Speed, fatigue, vehicle failure and physical impairment of the driver were much more important in SV crashes, whereas inadequate surveillance, illegal manoeuvre, following too close or misjudgement of another road user's actions were much more important in MV crashes with truck driver responsibility. The author sums this up by noting that SV crashes result from speeding or "catastrophic failure of the driver or vehicle" whereas MV crashes are more often due to recognition failures or decision errors in relation to another vehicle.

[4] Critical reason does not necessarily imply fault or culpability.

NZ Transport Agency's report on heavy vehicle crashes from 2005-2009 (NZTA, 2010) summarises the factors involved in crashes where a truck was involved compared to all crashes and all crashes on state highways. For the large part, crashes involving heavy vehicles had a similar profile to other crashes. In urban areas, poor observation and failure to give way or stop were by far the dominant factors, while on rural roads poor handling overtook poor observation, followed by excessive speed and road factors. Factors significantly more likely to be implicated in heavy vehicle crashes included vehicle factors and failure to keep left (in both urban and rural areas), and poor observation, overtaking and pedestrian factors (in rural areas).

Heavy vehicle crashes were significantly less likely to involve excessive speed or alcohol in either rural or urban areas, or fatigue, road factors, poor handling, or poor judgement in rural areas. Most differences, though significant, were small, but vehicle factors were about twice as likely to be implicated in rural heavy vehicle vs all rural crashes (12% vs 6%) and alcohol was about half as likely to be implicated in heavy vehicle vs all crashes in both rural and urban areas (7% vs 15% and 5% vs 12% respectively). This study did not separate crashes into single- and multiple-vehicle, or according to whether the truck driver had responsibility for the crash or not, so it is unclear whether the heterogeneity between SV crashes and MV crashes with truck-driver responsibility discussed by Knipling (2011a) is also found here.

Night driving

Driving during the hours of darkness is recognised as a factor in accident risk for light vehicles. For heavy vehicles, Campbell (1991) found that night time accident risk was approximately double that of daytime driving, while Blower and Campbell (1998) reported that overall, night time fatal/casualty accident risk for truck-trailer combinations was also about double that of daytime. Night time accidents tended to be more severe, with about three times more fatalities per thousand crashes.[5]

By contrast, Hendrix (2002) found that the fatal crash rate of truck-trailer combinations was not substantially higher during midnight-6:00 am than at other hours of the day. This was in contrast to passenger vehicles and light trucks, which showed much higher crash risk per mile travelled during the overnight period than at other hours of the day.

Knipling (2010) argues that the relative risk of night driving for truck drivers has not been firmly established. In the LTCCS, only 28% of crashes occurred between 6:00 pm and 6:00 am – but because of lack of data on exposure, the accident risk could not be determined.[6] Single-vehicle (SV) and multiple-vehicle (MV) accidents with and without the CR assigned to the truck driver had different distributions by time of day: SV crashes peaked during the early hours of the morning (4:00-7:00 am), while the great majority of crashes involving another vehicle occurred daytime working hours. In New Zealand in 2011, 24% of fatal heavy vehicle crashes and 19% of injury crashes were between 6pm and 6am (MoT, 2013b).

Naturalistic studies of truck drivers show that a higher proportion of safety-related critical errors (SCEs) occur during morning and evening rush hour than during night time driving, but Knipling (2010) notes that this cannot be extrapolated to actual risk given that SCE data "rarely captures truly harmful events".

[5] Knipling (2010) notes that in the Blower and Campbell (1998) study, exposure was survey-based (this is also true of the Campbell (1991) study). However, this is true of most driving studies that attempt to evaluate driving exposure.
[6] http://rns.trb.org/dproject.asp?n=25339

Fatigue

Fatigue is one of the most widely-discussed and researched topics in relation to heavy vehicle safety, although conclusions about its role in accidents vary. Blower and Campbell (1998) suggest that fatigue is underestimated as a factor in accidents – studies report from a few percent to 40% - though they have mainly concentrated on the truck driver, when fatigue is also a factor in non-truck drivers. They report Fatal Accident Reporting System (FARS) data from 1993-95 showing that fatigue was identified as a factor in 9.7% of single vehicle truck crashes (reaching around 20% in accidents between midnight-6:00 am), but in multiple vehicle crashes it was 0.9% for truck drivers and 2.4% for non-truck drivers.

Knipling (2011a) analysed data from the LTCSS and found that truck driver fatigue was an associated factor in 30% of single-vehicle (SV) crashes, as opposed to 14% of multiple-vehicle (MV) crashes where critical reason was assigned to the truck driver and 3% where the critical reason was assigned to the other vehicle. In line with these findings, last sleep of less than 6 hours, early morning driving (4:00-7:00 am) and, to a lesser degree, consecutive hours awake, were much more important factors in SV than in MV crashes.

Hakkanen and Summala (2001) found that fatigue was identified as a factor in just 4% of fatal two-vehicle accidents involving truck trailer units, though they note that determining what role, if any, fatigue has played in an accident can be difficult for accident investigators.[7]

In New Zealand, the NZTA (2010) reports fatigue as a factor in approximately 4% of urban accidents and 7% of rural accidents involving trucks during 2005-09. This report does not separately identify whether fatigue was a factor for the truck driver or another driver.[8]

Rogers and Knipling (2007) list a number of factors which may limit the identification of fatigue as a factor in truck crashes:

- truck drivers are the more likely to survive a multiple-vehicle accident and may have disincentive to report fatigue
- accident investigation is often superficial (in-depth police investigation is two to three times more likely to find fatigue as a factor than a routine police investigation)
- the role of fatigue in awake-type errors is hard to prove, and drivers may not be aware of the role that fatigue has played.

Knipling's (2011a) summary and critique of naturalistic driving studies cites Barr et al (2011) and Wiegard et al (2008) as finding that safety-critical errors (SCEs) were actually inversely related with driver fatigue. This was related to the important role of distraction in SCEs - the measures of distraction tended to be greater when drivers were alert and lower when they were drowsy. Knipling (2011a, p.5) notes that "fatigued drivers tended to narrow their working visual fields, whereas distracted drivers tended to widen them".

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[7] Sharwood et al (2011) undertook a systematic review of research on the relationship between fatigue, sleep disorders and commercial vehicle crashes, finding a total of 16 studies that met the review criteria.

[8] However, a review of fatal accidents recorded in CAS for 2013 and 2014 shows that there was just one fatal accident in which fatigue was coded to a truck driver.

Distraction

Inattention and/or poor observation are among the most common factors in the studies of truck crashes from different jurisdictions cited above. They also seem to be the most frequent contributing factors in multiple-vehicle crashes where the truck driver is judged to have some responsibility for the accident. Perrin et al (2007) suggest that distraction may be an underreported factor in crash databases and that further research is needed.

A study of naturalistic driving reported by Olson (2009) found that distraction by non-driving related "tertiary tasks" was a factor in 60% of safety-critical errors (SCEs). The highest risk was associated with texting on cell phones, followed by other complex tasks such as cleaning side mirrors, and interacting or looking at a dispatch advice. Talking on either a hand-held or hands-free phone was not associated with higher risk of a SCE.

Alcohol

Blower and Campbell's (1998) study of fatal accidents in the US found that in crashes between 12:00 am and 3:00 am, alcohol was a factor in 40% of non-truck drivers as compared to 2.7% of truck drivers. Overall, alcohol was a factor in 16% of non-truck drivers compared to 1.4% of non-truck drivers.

Rogers and Knipling (2007) reported that in the US 2002, only 2% of truck drivers involved in fatal crashes had a BAC above 0.08%, as opposed to 25% of non-truck drivers. Data reported by the US Federal Motor Carrier Safety Administration (FMCSA, 2014) shows that during 1992-2012, drivers of other vehicles in truck-involved fatal accidents were about ten times more likely to have a Blood Alcohol Content (BAC) over 0.08% than truck drivers.

In New Zealand, a summary of data on heavy vehicle crashes during 2005-2009 (NZTA, 2010) found that crashes involving a heavy vehicle were about half as likely to involve alcohol as all road accidents, although these did not differentiate according to whether alcohol had been consumed by the truck driver or another driver.

Summary

Fatal and serious injury truck crashes mostly occur in high speed-limit areas and head-on crashes are the most common fatal crash type. Truck drivers have some responsibility in less than half of all crashes, and less than a third of all fatal crashes. Divided roads greatly reduce the chances of a fatal crash involving a truck.

Critical risk factors that have been identified for car drivers are less important for truck drivers. Alcohol use is a less prevalent factor than for car drivers, and the increase in accident risk at night time seems to be less than for car drivers. Although the role of fatigue continues to be debated, studies to date suggest that it is most important in single-vehicle truck crashes and it has not been shown to be a very important factor in multiple-vehicle crashes where the truck driver has responsibility. Alcohol use, fatigue and night driving are more important factors for the drivers of *other vehicles* involved in truck crashes.

Data from both New Zealand and the United States suggest that errors related to inattention or inadequate surveillance are the most important factors in multiple-vehicle, truck-involved crashes where the truck driver has some responsibility, followed by speed and illegal manoeuvres. These factors are the most harmful to other road users, and therefore this would be an area where safety gains might be made. [9]

What is the impact of age and experience on heavy vehicle driver safety?

There is considerable evidence on the independent and combined effects of age and experience on driver safety for car drivers (eg, McCartt, 2009; Mayhew et al, 2003; OECD-ETC, 2006), but less evidence specifically for heavy vehicles. Duke et al (2009) review the available literature and find some support for the hypothesis that younger heavy vehicle drivers (under 27 years) have more likelihood of being involved in a serious crash. However, none of the studies cited by the authors separate age effects from experience effects.

The most comprehensive study is from Campbell (1991), who combined official data on 24,000 crashes involving trucks in the contiguous United States during 1980-84 with a survey of 5,000 truck owners that captured detailed data on the characteristics of trips, including driver age. The relative risk of involvement in a fatal accident was more than four times greater for under-19 year-olds and more than six times greater for 19-20 year olds. Relative risk dramatically decreased after age 21 and continued to gradually decrease until age 27 before stabilising. The over-representation of younger drivers was stable across different categories of travel, including day-night, rural-urban, intra and interstate and type of road.

Other driver-specific information available directly from the accident files showed that drivers under 21 were more likely not to have a valid licence (12% vs 4.3%); to be charged with a violation in regard to the accident (25% vs 15%); to have a driver-related factor coded in relation to the accident (55% vs 40%); to be coded as driving too fast, ran off road, following improperly or failure to keep in lane (45% vs 31%); but were less likely to have been drinking (2.4% vs 3.3%). While the author notes that the study does not show the underlying reasons for overrepresentation of young drivers in fatal crashes, the factors that can be identified relate to maturity and judgement.

Blower (1996) undertook an analysis of accident rates based on the population of commercial driver licence (CDL) holders in Michigan. He found that the youngest drivers had six times the rate of casualty accidents and four times the rate of property damage-only (PDO) accidents compared to all CDL holders, and 20-21 year olds had 2 and 2.5 times the casualty and PDO accident rates respectively. The study also found that truck drivers aged 18 to 21 in Michigan and North Carolina had twice the rate of traffic violations as drivers 30 to 49.

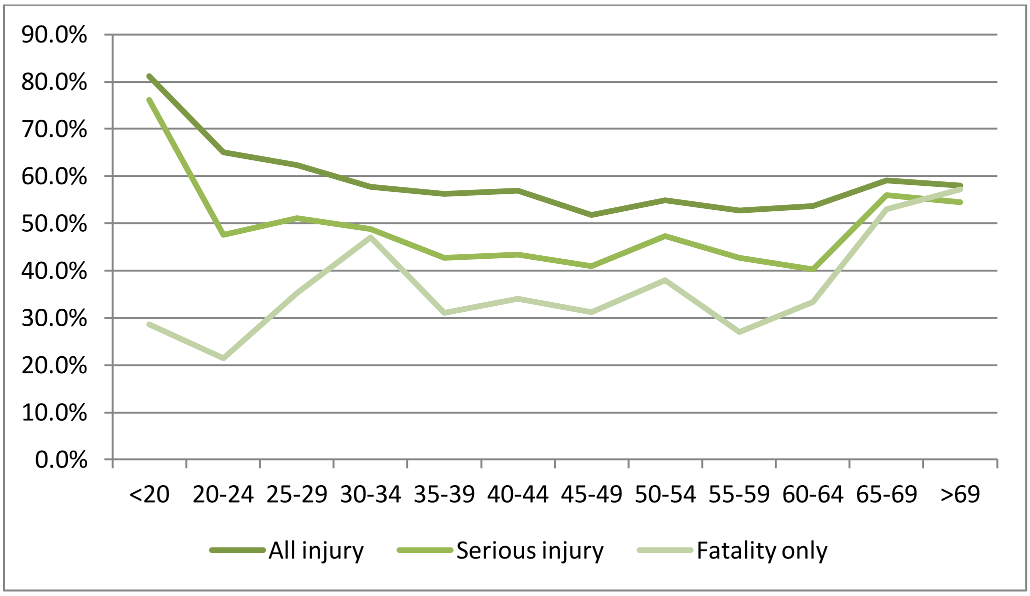
Young drivers involved in accidents were 50% more likely to be charged with a violation than middle-aged drivers. In car vs. truck accidents, young truck drivers were more likely than the car driver to be charged with a hazardous action or violation – the opposite of the case for truck drivers in general. The author’s review of a sample of accident cases involving young drivers revealed that overly aggressive driving, unsafe speed, poor vehicle control and attention deficits all played a role, as did failure to anticipate the unexpected actions of other road users.

[9] The most detailed data collection and analysis reported in the literature comes from the United States, but some caution needs to be exercised when drawing conclusions from this, owing to the significantly different road system, and the large number of kilometres travelled by heavy vehicles on the interstate system consisting mainly of divided, multi-lane roads.

In Finland, Hakkanen and Summala (2001) studied 337 fatal two-vehicle accidents involving a truck-trailer combination during 1991-97. They reported that the odds of being the primary originator of the accident were 3.5 times higher for drivers under 30 compared to drivers over 50.

Data available from New Zealand's Crash Analysis System (CAS) for 2008-14 indicates that truck drivers under the age of 20 who are involved in an accident resulting in injury are much more likely to be assigned responsibility for the accident. As shown in Figure 3, this holds for all injury accidents and for serious and fatal accidents combined, but not for fatal accidents alone, although numbers are small for the latter case.

Figure 3: Percentage of heavy vehicle drivers involved in injury accidents in NZ assigned full or partial responsibility, 2008-14



Source: NZTA data extract, February 2015

The effects of truck driver age and experience in accident risk is considered by Sullman et al (2002), whose primary purpose was to evaluate the effect of aberrant driving behaviours (errors, lapses and violations) on truck driver crash risk. The study used self-reported accident involvement and driving behaviours in 378 New Zealand truck drivers, the majority of whom worked hauling logs, milk or petrol (hence likely to have been driving larger truck-trailer combination vehicles). They found that younger driver age was significantly correlated with accident involvement, driving violations and aggressive violations as well as with higher preferred driving speed. Driver age was very highly correlated with truck driving experience, so the study does not separate age from experience factors (although experience was not significantly correlated with aggressive violations).[10]

In a naturalistic study of local and short haul commercial truck drivers, Hanowski et al (2000) found that age was the most significant predictor of safety-significant driver errors, outweighing other factors such as drowsiness or other fatigue-related measures.

[10] It is worth noting that a logistic regression model incorporating age, experience, mileage and driver behaviour factors accounted for just 11% of the variability in accident risk.

One study that found a stronger experience relationship was that of Kanek and Jovanis (1992), whose primary purpose was to study the effect of consecutive driving hours and multiday driving patterns on accident risk. In this study driver age was categorised as less than 40 years, 40-50 and over 50 years, while experience was counted as years driving for the same company, rather than total driving experience. No significant difference in relative risk between age categories was found. Drivers who had been driving for the same company for more than ten years had a lower accident risk than those with less experience. However, drivers with one to five years' experience had a higher relative risk than those with less than one year – perhaps reflecting the fact that the company studied tended to hire experienced drivers and the time with the firm did not represent a driver's total experience.

Summary and Conclusion

Overall, there have been fewer, less rigorous studies of the relationship between age, experience and accident risk for truck drivers than for car drivers. However, available findings report higher accident risk for younger drivers, particularly for drivers under 21 years of age. When involved in an accident younger drivers are also more likely to be judged to have contributed to the accident. Findings suggest that maturity and judgement, rather than just driving experience, are factors in age-related accident risk. These findings suggest a precautionary approach to lowering the effective minimum age for driving the heaviest vehicles or for seeking a more important role for younger, less experienced drivers in the truck driving workforce.

What vehicle-related factors have an impact on safety?

The primary vehicle-related factor that has an effect on road safety is total vehicle mass. Campbell (1991) reports the findings of Eicher et al (1982) who concluded that accidents involving a large truck (defined in the US as more than 11.8 tonnes) had about twice the probability of fatality as an accident not involving a large truck.

Evans and Frick (1993) conclude that there is a consistent, exponential relationship between the mass ratio of two vehicles involved in an accident and the relative mortality risk of the driver in the lighter vehicle. The authors assess multiple confounding factors (eg ,angle of accident, age of car, driver age, and seatbelt use), and conclude that "when other factors are equal, 1) The lighter the vehicle, the less risk to other road users; and 2) The heavier the vehicle, the less risk to its occupants" (1993, p.223). Thus, the driver of a car involved in a crash with a medium truck has 12 to 34 times the fatality risk of the truck driver, and in a crash with a heavy truck has 22 to 44 times the fatality risk.

A number of studies have looked at the accident risk of different kind of vehicle configurations. Campbell's (1991) study, described above, found that the relative risk of fatal accident involvement was 1.09 for combination vehicles and 0.80 for single unit trucks, compared to all heavy vehicles.

Christie and Fabre (1999) estimated that in Australia in 1995 there were 3.91 fatalities per million kilometres driven by articulated trucks as opposed to 3.2 for rigid trucks and 1.13 for light passenger vehicles.

A study conducted by Campbell et al (1988) considered the confounding factor that larger combination vehicles were likely to drive more miles on better-quality roads (divided highways) as compared to smaller truck-trailer combinations. The authors provided an estimate **w**hich showed that, correcting for the type of road driven on, rigid truck-trailer combinations and double semi-trailers had a slightly higher rate of fatal accidents compared to rigid trucks and single semi-trailers.[11]

Grislis (2010) summarises data from the US Federal Highway Administration (2004) indicating that during 1995-1998, the fatal accident rate per 100 million vehicle miles travelled was approximately 10 percent higher for multiple trailers than for single trailers.

Turner & Nicholson (2009) provide a useful summary of the ways in which size, weight and configuration mediate accident risk. These include:

- More heavily laden trucks take longer to stop
- High loads raise the centre of gravity of the truck and increase rollover risk, while placement of loads, or movement of loose or liquid loads can shift the centre of gravity and affect braking and handling
- Additional articulation, axles and wheels add handling characteristics which complicate braking and steering
- As vehicle dimensions get larger, this changes their relationship to roadways that may have been designed for smaller, lighter commercial trucks (eg, by off-tracking or blocking other road users' view of road signs).

The authors provide a synthesis of evidence on the safety record of oversize/overweight vehicles. They conclude that in general, as commercial vehicles become larger, accident risk decreases and accident severity increases. However, they conclude that more research is needed and many previous recommendations for better data to allow investigation of the relationship between truck size and configuration and safety have not yet been addressed.

Table 1 summarises the collision involvement rate of different semi-trailer and trailer combinations in a prospective study in Ontario. This had the advantage that all vehicles in the study travelled on the same roads, removing this confounding factor. In general, the collision rate increased with size and number of axles of the trailer combinations. A striking result is the safety record of B-train doubles (second trailer connected to the first by a fifth wheel), which had half the collision rate of 4-axle semitrailers, and just 25% the rate of A-train and C-train doubles. [12] [13]

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[11] Bobtails (tractor units driven without a semi-trailer) had a significantly elevated crash risk compared to all other vehicle types.
[12] In Ontario, accident rates were also correlated with the dynamic performance of the different truck-trailer types.
[13] A confounding factor is that the largest combination vehicles are likely to be driven by older and more experienced drivers, due both to historical driver licensing policies and to driver selection by trucking companies.

Table 1: Accident rates of different tractor-trailer combinations in Ontario, Canada

Tractor-trailer classification	Collisions/100 MVM
1- and 2-axle semitrailers	0.72
3-axle semitrailer	0.97
4-axle semitrailer	1.06
5+ axle semitrailer	1.66
A-train and C-train double	2.14
B-train double	0.58
Average	0.82

Source: adapted by Turner & Nicholson (2009) from Corredor et al (2005).

Summary and Conclusion

Heavy vehicles are not more likely overall to be involved in an accident than light passenger vehicles,. However, their greater mass and other physical features means that any accident in which they are involved has a greater risk of harm.

Available studies suggest that larger combination vehicles have a slightly higher rate of involvement in fatal accidents than smaller rigid trucks. Taking into account the various confounding factors of road type, distance travelled, and interaction with other traffic it is not clear whether these vehicles are less or more likely to be involved in an accident. Even if their accident rate is the same or lower, this is counteracted by the greater harm when they are involved in an accident.

The technical handling characteristics of heavy vehicles and combinations can affect safety and both knowledge and skills of drivers need to be evaluated in a licensing system. Given that vehicle mass is the biggest risk factor for other road users, it is reasonable to continue to also base licence classes on weight and to set higher thresholds for driving the heaviest vehicles.

How do different countries approach heavy vehicle driver licensing?

There are a number of approaches to heavy vehicle classification and licensing. Most jurisdictions use trailer weight and configuration as a dividing line between different classes of heavy vehicle licence, while New Zealand, Australia and Europe also distinguish licence classes on the basis of vehicle weight. European and North American licensing systems further distinguish between commercial and non-commercial heavy vehicle licences. These jurisdictions all require drivers to have a car licence as a prerequisite to obtaining a heavy vehicle licence. Most require licence candidates to demonstrate specific theoretical knowledge about heavy vehicle driving and road rules and to undertake some form of on-road assessment in the relevant heavy vehicle class.

Beyond these commonalities, there are differences. Jurisdictions place varying emphases on age, experience, driving record, education and training to determine access to different licence classes. One key difference is that New Zealand and Australia have implemented experience-based graduated driver licensing systems (GDLS) for heavy vehicles, while Canada, the United States and the European Union have not (Mayhew, 2007). [14] However, although the latter jurisdictions do not have a formal GDLS, some have historically had different minimum ages for driving different kinds of trucks. This means that drivers in these jurisdictions are likely to gain experience driving smaller trucks and trailers before obtaining the highest licence class, resulting in what could be termed a 'quasi' GDLS. [15]

In addition, both New Zealand and Australia modify graduated licensing requirements under some circumstances. In Australia, this is through an exemptions system, with specific criteria established by different states and territories (though a process to harmonise these nationally is currently underway). New Zealand reduces minimum time requirements for drivers over 25, especially those who take approved training courses.

In North America and Europe, most emphasis is placed on the use of robust theoretical and practical assessments to determine suitability for driving the heaviest vehicles. A framework for these assessments is established by federal standards in the US and by an EU-wide resolution in Europe (Mayhew, 2007). [16] In some European countries, training is mandatory – for example, Germany, Austria and Norway all require a minimum number of both theoretical and practical lessons (Mayhew, 2007). While training is not mandated in North America, training courses designed to prepare drivers for their driving test are relatively intensive with a high number of supervised driving hours.[17]

Both the US and Canada also establish safe driving requirements for heavy vehicle licence candidates, such as requiring no serious offenses during the 2-year period prior to licence applications. These do not seem to be present in Europe to the same extent, although Austria has a 2-year probationary period for HV licence candidates.

Driver licensing and workforce supply

The past decade has seen considerable attention to heavy vehicle licensing systems in the context of concerns about workforce shortages. These concerns and discussions have been repeated across different jurisdictions with different kinds of heavy vehicle licensing systems, including Australia, Europe, Canada and the United States (Fabre and Christie, 1999; Mayhew, 2007).

[14] The basic philosophy of a GDLS is to allow drivers to gain experience in lower-risk driving conditions before 'graduating' to unrestricted driving. In Australia and New Zealand's truck licensing systems, this takes the form of requiring minimum experience in light truck and trailer classes before allowing progression to heavier and more complex truck-trailer combinations.

[15] For example, until 2009 the United Kingdom allowed trucks up to 7.5 tonnes and combination vehicles up to 12 tonnes to be driven at age 18, but heavier vehicles and combinations could only be driven over the age of 21.

[16] The US, Canada and Europe all have detailed lists of topics to be covered in knowledge tests and off-road and on-road practical assessments. Driving assessments in the EU must include at least 45 minutes on the road. In British Columbia the driving test is 1 to 1 ½ hours (depending on class) but actual on-road time is 35-45 minutes. In other Canadian jurisdictions on-road time is 30-35 minutes. British Columbia requires vehicles used in the assessment to be loaded to a minimum weight (28 tonnes for large combination vehicles). The EU also has minimum weight and size requirements for the vehicles and trailers used in driving assessments.

[17] For example, in a US evaluation of the relationship between training courses attended by 'new entrant' commercial drivers and safety (American Transport Research Institute, 2008), the 10 courses considered ranged between 88 and 272 hours of training and 'behind the wheel' hours ranged between 25 and 48 for nine out of 10 programmes (152 in one).

A common theme is turnover and an aging workforce, and the measures taken to address shortages (Randle, 2009; Weiss, 2013).[18] A general trend in response has been to replace (or propose replacing) age and experience requirements with enhanced training and vocational education.

In the United Kingdom, the Young Drivers Scheme was introduced in the mid-2000s to promote earlier entry to truck driving as a career and allow drivers to obtain a licence for the heaviest vehicles before their 21st birthday. Its limitations included the fact that drivers were tied to a particular employer, often earned apprentice wages, and would lose their licence status if they changed employer (Trucking News, 2011). In 2009, the scheme was ended when the European-wide Certificate of Professional Competence (CPC) was introduced. The CPC is compulsory for all professional heavy vehicle drivers. The initial qualification involves four stages of tests (a two-part theory test, case studies, a practical test and a vehicle safety demonstration) and all holders must take 35 hours of approved education and training every five years. Following its introduction, the UK and Ireland have reduced the minimum age for driving the heaviest combination vehicles from 21 to 18 for drivers who obtain the CPC initial qualification (Randle, 2009).

In New Zealand, the workplace training programme (now the Accelerated Licensing Process, or ALP) was implemented in 2003 with the aim of allowing quicker progression to driving the heaviest combination vehicles for drivers who work for accredited employers. This programme has been used by only a small number of drivers and the majority of companies who originally signed up have not continued their participation.

In 2009, the Australian Trucking Association prepared a proposal for an accelerated pathway through the GDLS based on enhanced competency training, linked into a national vocational qualification (Australian Trucking Association, 2009). The Australian proposal had some similarity to a proposal by the Road Transport Forum in New Zealand in 2009, which suggested simplifying the heavy vehicle licensing system by reducing the number of classes and allowing quicker progression (under this proposal, a Class 5 / multi-combination licence could be obtained by age 18 ½).

Evaluation of different licensing systems

In general, there is very little research on the effect of different interventions and licensing requirements on heavy vehicle road safety.

One study in the United States looked at the safety outcomes of different heavy vehicle driver training programmes (American Transport Research Institute, 2008). Ten different training programmes were included, ranging from 72 to 288 contact hours, and the safety record of graduates was evaluated over their first 18 months as a commercial driver. No relationship was found between safety and length of training, or time dedicated to a particular aspect of training, with one exception. Time spent learning about accident procedures was significantly associated with lower accident risk. The authors surmise that this might be related to an improved understanding and appreciation for mitigating crashes.

No studies have been found that have systematically evaluated the impact of different heavy vehicle licensing systems, either through cross-jurisdictional comparison or through ‘before and after’ evaluations following system change.

[18] For example, in Europe, this has involved the use of Eastern European trucking companies which have been reported to have a high rate of safety violations (Trucking News, 2011).

Some researchers have nevertheless discussed the merits of alternative systems. Christie and Fabre (1999) discussed the introduction of a GDLS for heavy vehicle licensing in Australia, while evaluating the possibility of 'fast-tracking' criteria based on psychological testing. They concluded that a GDLS for heavy vehicles would not necessarily have a significant effect on workforce supply; and that there was no validated, reliable and acceptable test that could determine which drivers were eligible for fast-tracking.

Mayhew and Christie (1999) conducted a 'state-of-the-art' review of heavy vehicle driver licensing policies which recommended that a probationary licensing system for heavy vehicle drivers be introduced in Canada. This was followed up by Mayhew (2007), who again considered the possibility of a probationary licensing system and / or a graduated truck licensing system. The author concluded that both GDLS and probationary licensing systems had potential to produce safety improvements; however, he did not recommend the introduction of a graduated system because of concerns about its effect on driver supply.

Given the paucity of studies specifically on heavy vehicle licensing, it is difficult to determine whether systems based on gradual accumulation of experience (such as Australia's and New Zealand's) result in improved road safety, and if so, how much and what type experience is needed. A principled argument for a graduated system is that it delays exposure to higher-risk driving conditions until a driver has gained greater maturity and experience (as seen in this review, these factors do have a clear relation to heavy vehicle road safety).[19] As noted earlier, other systems have achieved similar outcomes by setting a different minimum age for different vehicle classes, while the safe driving requirements in North America provide a further check on a driver's suitability to drive the largest vehicles.

This lack of evidence means it is difficult to evaluate any proposals to replace age and experience requirements with intensive training and education. However, the evidence from the car driving literature is that, in general, the safety benefits of experience in lower-risk conditions cannot be replicated or replaced by intensive education and training (eg, Mayhew et al, 1998; Peck, 2011). While other jurisdictions have not been able to justify moving *towards* a graduated licensing system for heavy vehicles, any move *away* from an experience-based system in New Zealand would need to be treated with considerable caution.[20]

Summary and Conclusion

The graduated driver licensing systems for heavy vehicles used in New Zealand and Australia differ from those in the Northern Hemisphere, which place more emphasis on training, education and testing, in conjunction with minimum age and safe driving requirements. However, the different systems tend to achieve the common outcome of limiting access to the largest combination vehicles to older, more experienced drivers who have demonstrated the ability to drive safely.[21] No clear evidence has been found that one type of system is superior to another; however, they all set relatively high thresholds to help manage the risk posed by heavy vehicles to their drivers and (especially) other road users. Any significant changes in New Zealand would need to be based on a careful assessment of the safety value of current requirements and the extent to which this could be maintained by alternative approaches.

[19] For car drivers, 'higher risk' means driving at night time and with peer-age passengers. For truck drivers, the greatest risk is to other road users from the mass and configuration of heavy vehicles, so driving smaller vehicles represents a 'lower risk' stage while the driver gains experience.

[20] Changes proposed in Australia – such as redefining experience as log book hours or kilometres driven instead of time do not necessarily go against the principles of a graduated system.

[21] A factor not specifically acknowledged in the literature is that in some jurisdictions insurance companies provide a further layer of regulation by 'pricing in' the higher risk of younger, less experienced drivers. New Zealand's no-fault accident insurance system limits the extent to which driver risk is priced in by insurance companies.

SUMMARY

This paper has provided an overview of literature on heavy vehicle safety, including driver, and licensing-related factors that influence safety outcomes. Given time constraints, it is necessarily brief, and more detailed analysis of each of the categories discussed here might provide some additional value.

In general, heavy vehicles are not more likely to be involved in accidents than light passenger vehicles, and when they are, their drivers are less likely to be judged to have been responsible for the accident. Despite this, trucks continue to account for a disproportionate number of fatalities and injuries due to the greater harm they cause when accidents do occur. In addition, despite the restriction of larger combination vehicles to older, more experienced drivers, there is some evidence that they have a slightly higher rate of involvement in fatal accidents than smaller rigid trucks (although there is not specific evidence for this in New Zealand). In other words, any reduction in crash rates is largely countered by greater crash impact related to increasing vehicle mass.

Factors that have been identified as critical in the light passenger vehicle accident rate, including alcohol and night driving, are less prevalent for heavy vehicles. Loss of control by the truck is a more important factor in single-vehicle truck crashes than in truck-car crashes. In multiple vehicle crashes where the truck driver is judged to be responsible, inattention, poor observation, inappropriate speed and breaking road rules are the key factors.

Although there is relatively little truck-specific evidence on the effects of age and experience on driver safety, available research consistently shows that younger and less experienced drivers have a significantly higher accident risk than older drivers, and this is most pronounced under the age of 21. In addition, when they are involved in accidents, younger drivers are more likely to be judged to be responsible for the accident than older drivers. No study has rigorously separated the effects of age and experience, but researchers seem to suggest that there a relationship between judgement and maturity and accident risk.

A number of emerging technologies may contribute to improved heavy vehicle safety, including features that improve braking, stability and handling, and others that provide information and feedback to the driver. The technologies with the greatest safety impact are likely to be introduced slowly, at best. The most effective technological measure for reducing heavy vehicle-related harm is divided roads. New Zealand has a programme of investment to install more median barriers, particularly in high-risk, high volume rural areas. However, given the country’s challenging geography and low traffic densities, these will not be practical in all settings.

International heavy vehicle licensing systems have both similarities and differences. New Zealand’s and Australia’s use of a graduated licensing system for heavy vehicles is unique, although the structure of heavy vehicle licensing in other jurisdictions means that young drivers will often obtain experience in smaller trucks before moving to larger combination vehicles. Any proposals to exchange age and experience requirements for intensive training and testing are unproven and not supported by evidence from car-specific research, which suggests that where experience provides safety benefits, it cannot usually be substituted by education and training. An overall conclusion of the review is that licensing conditions which restrict larger vehicles and truck-trailer combinations to older, more experienced drivers are largely justified.

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