

Factors Contributing to Crashes among Young Drivers

*Lyndel J. Bates,^{1,2} Jeremy Davey,² Barry Watson,² Mark J. King,² Kerry Armstrong²

العوامل المؤدية إلى الحوادث عند السائقين الصغار

ليندل جوديث بيتس، جيرمي ديفي، باري وأتسون، مارك كينج، كيري أرمسترونج

ABSTRACT: Young drivers are the group of drivers most likely to crash. There are a number of factors that contribute to the high crash risk experienced by these drivers. While some of these factors are intrinsic to the young driver, such as their age, gender or driving skill, others relate to social factors and when and how often they drive. This article reviews the factors that affect the risk of young drivers crashing to enable a fuller understanding of why this risk is so high in order to assist in developing effective countermeasures.

Keywords: Traffic Accidents; Public Health; Accident Prevention; Safety; Automobile Driving; Oman.

الملخص: السائقين الصغار هم من فئة السائقين الأكثر عرضة للحوادث. توجد هناك عدة عوامل تؤدي إلى زيادة احتمال الحوادث عند هذه الفئة من السائقين. بينما جزء من هذه العوامل تعتبر داخلية المنشأ لصغار السائقين مثل العمر، الجنس أو مهارة القيادة، الأخرى لها علاقة بالعوامل الاجتماعية ووقت وعدد مرات القيادة. هذا المقال يستعرض العوامل التي تؤدي لزيادة نسبة الحوادث عند هذه الفئة من السائقين من أجل زيادة المعرفة وكذلك للتوصل إلى طرق فعالة للحد من هذه المشكلة.

مفتاح الكلمات: حوادث الطرق؛ الصحة العامة؛ الوقاية من الحوادث؛ الأمان؛ قيادة المركبات؛ عمان.

YOUNG CAR DRIVERS ARE FIVE TO 10 TIMES more likely to experience injuries as a result of road crashes when compared to drivers among the safest age group. Young males have a higher crash rate than young females.¹ This elevated crash risk is not a new phenomenon and has been reported for at least the last 30 years. This risk falls rapidly during the first few months of driving and then declines more slowly for the next 18 months to two years.²⁻⁵

Within the Omani context, research suggests that the country has one of the highest rates of road crash mortality and morbidity in the world at 30.4 per 100,000 people compared to a global average of 19 per 100,000 people.⁶ Although very recent data from the Royal Oman Police indicate that fatalities from crashes decreased by 22% and injuries decreased by 13% in 2013 compared to the same period in 2012, the issue of young driver road crashes remains a constant concern regardless of changes in the overall data patterns.⁷ Al-Reesi *et al.* found that young Omani drivers reported higher levels of risky driving behaviours compared to wider international samples.⁸ Furthermore, the same authors reported that young drivers are over-represented in road crashes in Oman.⁹ Al-Naamani *et al.*, in a large-scale Oman-based study of hospitalised

road crash victims, found that the majority of patients were young with multiple injuries and that a significant number had resulting symptoms of acquired brain injuries.¹⁰

This review draws on international research evidence to identify the various factors that contribute to the elevated crash risk experienced by young drivers. While many risk-associated driving behaviours may be culturally specific, there is still much to be gained by examining wider international contexts and research to determine risks associated with young drivers.¹¹ Much of this literature may be relevant and appropriate to the Omani context. Furthermore, this review provides a foundation of knowledge which can be used to assist in planning future strategies targeting a reduction in road risk among young Omani drivers.

Many factors influence young novice drivers' behaviours [Figure 1]. These factors include social and situational influences, exposure-related influences and the characteristics of young drivers. Among the young driver characteristics influencing crash risk, there are several further factors, including core and modifiable attributes, situational assessment and decision-making skills as well as driver behaviour.¹² While the model is not new, it comprehensively represents the factors that

¹School of Criminology & Criminal Justice, Griffith University, Mount Gravatt, Queensland, Australia; ²Centre for Accident Research & Road Safety, School of Psychology & Counselling, Queensland University of Technology, Brisbane, Queensland, Australia

*Corresponding Author e-mail: L.Bates@griffith.edu.au

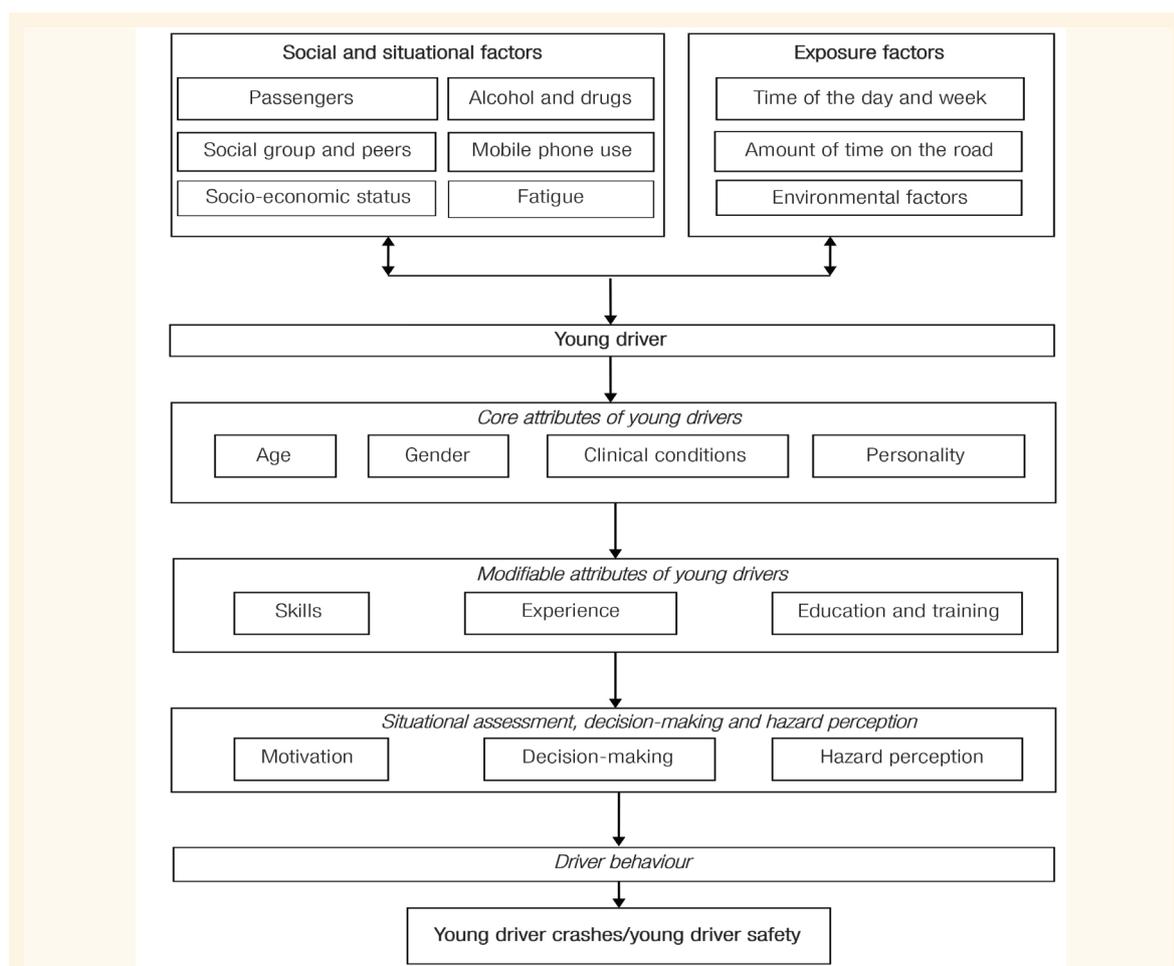


Figure 1: Factors relating to young driver safety.

Adapted from: Williamson A. *Young drivers and crashes: Why are young drivers over-represented in crashes? Summary of the issues.*¹²

influence novice driver behaviour. The original figure has been updated by the current authors to include socio-economic status, mobile phone use and fatigue in social and situational factors.

Social and Situational Factors Influencing Novice Driver Behaviour

Social and situational factors such as socio-economic status, passengers, impairment, mobile phone use, fatigue, social group and peers affect the crash risk of novice drivers.¹²

SOCIO-ECONOMIC STATUS

Drivers of all ages, including younger drivers who belong to lower socio-economic groups experience higher crash risks.¹³ A recent Australian study found that young drivers from such backgrounds were twice as likely to be hospitalised as a result of a crash when compared with young drivers from higher socio-economic backgrounds.¹⁴ This result occurred even after controlling for driver exposure and place of

residence. The impact of socio-economic status on crash risk appears to persist over time.¹⁵

PASSENGERS

The presence of passengers similar in age to the young driver increases the risk of crashing. Chen identified that young drivers between 16 and 19 years old were more likely to experience a fatal crash if they carried one or more passenger, and the more passengers that were carried in a vehicle, the higher the crash risk.¹⁶ There are a number of proposed reasons for this increased crash risk. It is possible that the presence of passengers may distract young drivers, leading to driving errors and thus increasing their crash risk.^{17–19} Alternatively, passengers may encourage drivers to conform to the prevailing norms of their social group.²⁰ While a driver may choose to drive in a risky manner on a given occasion, the support of their passengers will encourage this behaviour to continue.

The gender of both the driver and the passengers plays an important role in the driver's crash risk and driving behaviour in this effect. For instance, one study

identified that male drivers drove approximately five miles per hour faster with a male passenger in the vehicle than with a female passenger in the vehicle.²¹ Drivers with only male passengers were more likely to crash when compared with drivers who only had female passengers. Chen found that driver deaths per 1,000 crashes more than doubled when there were two or more male passengers and also doubled if there was a combination of male and female passengers. Although female passengers also increased crash risk, they did so at a much lower rate.¹⁶

ALCOHOL AND DRUGS

Alcohol increases the crash risk for all drivers, including young drivers.^{22,23} One study suggested that where alcohol or drug use was reported as a factor, adolescent drivers were 3.3 times more likely to sustain a severe injury.²⁴ Despite this, drunk driving may be limited to particular groups of young drivers.²⁵ One Australian study of drivers aged 17–25 years old found that 78.8% had not driven under the influence of alcohol in the previous month, 20% had driven under the influence of alcohol between one and 10 times and 1.2% had driven under the influence of alcohol more than 11 times in the previous month.²⁶ Morrison *et al.* found that the groups most likely to drive under the influence of alcohol included those dependent on alcohol and cannabis, males, those from lower socio-economic backgrounds, individuals with lower educational attainment and those who were unmarried.²⁵ In addition, another study found that if an individual had travelled as a passenger with a drunk driver when they were an adolescent, the likelihood that they would drive a vehicle under the influence of alcohol when they were a young adult aged 18–24 years old increases by over 60%.²⁷

There is a small but significant group of young drivers who report driving under the influence of drugs. Researchers who studied a sample of university students found that 17% of the sample aged 18–21 years old reported having driven under the influence of drugs and that 13% of this group had done so in the past 12 months.²⁸ Research has suggested that driving under the influence of cannabis may be a more significant problem than driving under the influence of alcohol, even though more young people drink alcohol than smoke cannabis.²⁹ Participants who had driven under the influence of cannabis in the previous year had more than four times the crash risk compared to those who had never smoked cannabis.²⁹ There was no increase in the crash risk for participants who smoked cannabis but did not drive under the influence of cannabis.

SOCIAL GROUP AND PEERS

A young driver's social group may affect their driving behaviours by encouraging them to take greater risks.¹² Peers can affect a driver's behaviour both directly and intentionally as well as indirectly and inadvertently. For instance, two studies found that peers could directly encourage drivers to engage in risky behaviours such as speeding.^{21,30} If a driver believes that driving in a certain way is expected by their peers, they may be more inclined to drive that way. It appears that young drivers who believe that their friends are unlikely to punish them if they drive in a risky manner, or who imitate the risky driving behaviour and attitudes of their friends, are more likely to drive in a risky manner. Alternatively, young drivers who believe that their friends are not supportive of risky driving behaviour are less likely to drive in a risky manner.³¹

Social factors such as a tolerance of breaking road rules also affect decision-making, with these factors more likely to affect younger than older drivers.³² Younger drivers tend to drive safely because of a sense of legal obligation while older drivers consider the negative outcomes if they do not comply. However, younger drivers display more tolerance of those who commit violations. Compared with older drivers, younger drivers believe more people commit violations.³³

MOBILE PHONE USE

Research has suggested that mobile phone use while driving reduces performance, with younger drivers more likely to use their mobile phones while driving.^{34,35} In addition, it has been found that young drivers are more likely to be severely injured if they are distracted by a mobile phone while driving.³⁶ The involvement of mobile phones with driving has been found to reflect the level of cognitive and behavioural association that people have with their phones.³⁷ Studies have revealed that young people who are more involved with their mobile phones are more likely to indicate that they would use their mobile phones in some way while driving, including texting, and furthermore, that they would deliberately hide this behaviour.^{37,38}

FATIGUE

Driving while fatigued appears to be a common behaviour, with younger drivers more strongly affected by sleepiness.³⁹ Within a sample of 17–25-year-old drivers, 67.3% reported driving while fatigued between one and 10 times in the previous month.²⁶ A further 9.7% indicated that they had done so 11 or more times in the previous month.²⁶ However, another study found that younger people are less likely than older

drivers to drive while sleepy, but if they did attempt to drive while sleepy, they were also less likely to pull over and rest.⁴⁰ Driving while fatigued is a risky behaviour, with research suggesting that young drivers who are influenced by fatigue are a contributing factor for fatal crashes involving two vehicles.⁴¹

Exposure Factors Influencing Novice Driver Behaviour

Driving patterns that influence crash risks have been reported to be affected by the amount of time spent on the road, as well as by the time of day, the day of the week and the environment.¹² Young drivers have been found to have a higher crash rate than other age groups after controlling for their greater exposure.¹

AMOUNT OF TIME ON THE ROAD

Using data from 1995, Williams identified that 16–19-year-olds in the USA were involved in 17 crashes per million miles travelled.² However, the crash risk fell rapidly among those aged 20–24; they were involved in nine crashes per million miles travelled. Research using American mileage data from 2000–2001 identified that the crash risk per mile had fallen for 16-year-old drivers, although this age group still had the highest risk of being involved in a fatal and nonfatal crash per miles driven when compared with all but the very oldest drivers.⁴²

TIME OF DAY AND WEEK

It has been found that young drivers were more likely to crash at night and over the weekend.² Although older drivers also had an increased crash risk at these times, the crash risk for younger drivers increased at a disproportionate rate.¹² A summary of studies from around the world evaluating night-time driving restrictions, and graduated driver licensing systems that include a night-time driving restriction, concluded that limiting driving at night reduced both the number of crashes and the rate of crash involvement at this time for young novice drivers.⁴³ This finding was also corroborated by a more recent study.⁴⁴

ENVIRONMENTAL FACTORS

The weather is an important influence on the crash rates of all drivers, although these factors have been found to have a disproportionate impact on young drivers.⁴⁵ For example, Canadian research suggested that young drivers who drove above the speed limit in intemperate weather crashed more frequently.⁴⁶ In addition, young drivers were also more likely to be involved in crashes when fog and smoke were

present.⁴⁷

The level of urbanisation is another factor that impacts crash rates. One Australian study considered the various crash risks amongst young drivers who lived in urban, regional and rural settings.⁴⁸ The study found that those who lived in urban areas had a higher crash risk, although no significant difference was found in terms of being involved in crashes that resulted in an injury. Young drivers who lived in regional or rural areas were more likely to be involved in only a single vehicle crash.⁴⁸

Young Driver Attributes

As depicted in Figure 1, there are four categories of young driver factors that are relevant for explaining their heightened crash risk: (1) core attributes; (2) modifiable attributes; (3) situation assessment and decision-making characteristics, and (4) the types of driver behaviour.¹²

CORE ATTRIBUTES

The core attributes of the young driver are relatively fixed or enduring and are hence unlikely to change due to external influences.^{12,49} These attributes include age, gender, personality and clinical conditions.

Younger drivers have higher crash risks than older drivers, with research indicating that the youngest group of drivers have the highest risk.⁵⁰ This higher crash risk has been found to be due to a lack of experience and a propensity to drive in high-risk situations.⁵¹ Masten *et al.* found that younger drivers also lacked driving skill, were immature, lack risk perception abilities and overestimated their own driving skills.⁵² An Australian study found that young drivers had lower risk aversion, higher risk propensity and stronger motives for risky driving.⁵³

Gender appears to be an important factor in young driver crash risk. Young male drivers had a higher propensity to take risks than young female drivers.⁵⁴ A study in Jordan identified that male drivers travelled more kilometres per year than female drivers.⁵⁵ The same study identified that males of all ages had higher crash rates than females. However, this difference was greatest among those aged 18–25 years.⁵⁵

Personality factors, such as sensation-seeking, aggressiveness and egocentrism, have also been found to affect the crash risk of a young driver.^{12,49,56} Sensation-seeking is defined as the willingness to take physical and/or social risks to fulfil a need for varied, novel and complex sensations.⁵⁷ When compared with older drivers, young drivers were more likely to demonstrate a greater propensity to take risks

as well as stronger motives for drunk driving and speeding when compared with older drivers.⁵³ High-risk young drivers tended to have a greater propensity for sensation-seeking.⁵⁸ Sensation-seeking has been linked to risky driving behaviours, including speeding, drunk driving and following the vehicle ahead too closely.^{59–61} However, more recent research, while identifying a link between thrill/adventure-seeking and not wearing a seatbelt, did not identify a link between drunk driving, speeding and driving while fatigued. These inconsistent results may be a result of cultural differences.⁶²

A small group of younger drivers affected by clinical conditions may also have a higher crash risk.¹² Research has suggested that several conditions can increase a driver's crash risk. These include stroke; myocardial infarction; underlying cardiovascular disease; affective or psychological disorders, including anxiety, depression and related conditions; sleep disturbances, and visual deficiencies.⁶³ Recent research in Australia found a link between young drivers with psychological distress and risky driving, although the exact nature of the relationship was not discovered.⁶⁴

Conditions such as attention deficit hyperactivity disorder (ADHD) have been found to impact the young driver's behaviours and crash risk.^{65,66} For example, young drivers with ADHD were more likely to speed and had a higher risk of injury.⁶⁷ They were also more likely to crash. The effect of ADHD on driving errors and crashes was found to decrease as the affected individual aged, as they were likely to develop more effective coping strategies that enabled them to decrease their risk.⁶⁸

Furthermore, young drivers who engaged in self-harming behaviours had an increased risk of being involved in a crash, with a high proportion of crashes involving multiple vehicles. This crash risk remained even after controlling for psychological distress and substance abuse.⁶⁹ Despite this finding, low levels of psychological distress, defined as poor mental health including symptoms of depression and anxiety, were identified as decreasing the crash risk.⁷⁰

MODIFIABLE ATTRIBUTES

The modifiable attributes of young drivers include skill and experience as well as the levels of education and training received. Driving skill relates to the ability to operate a vehicle in traffic and reflects both an individual's cognitive and psychomotor abilities.¹² Young drivers need to develop the ability to operate a motor vehicle with minimal cognitive resources. This allows them to free up cognitive space to concentrate on other aspects of driving, such as negotiating traffic.⁷¹ Individuals still developing their cognitive

driving skills tend to be overly reliant on formal traffic rules or laws, which can contribute to them failing to anticipate the mistakes of other road users. One study compared the novice driver's assessment of their driving skills against the assessment of their driving examiner in both Finland and Sweden. The study identified that while a large proportion of the novice drivers accurately assessed or underestimated their driving skills, approximately 30% of the Finnish and between 53–70% of the Swedish sample overestimated their driving skill.⁷²

However, it takes more than skill to drive safely. Young people must be able to apply their skills and make judgements depending on the situation.¹² Driver training tends to focus on the development of driving skills and involves learning specific methods and techniques of driving and operating a vehicle.⁷³ In contrast, driver education programmes tend to focus on teaching young drivers how to apply their skills.

Obtaining on-the-road experience is an important factor in reducing crashes. However, age and experience are highly correlated, making it difficult to identify if one is more important than the other in predicting the risk of crashing.^{50,74} McCartt *et al.* reviewed 11 studies that examined the effects of age and experience on crash risk.⁷⁴ They concluded that teenage drivers had higher crash rates than older drivers, particularly those older than 25 years, after controlling for the length of time since receiving their license. They also concluded that crash risk was reduced when individuals had held their licences for a longer period of time.⁷⁴ In the studies that attempted to distinguish the relative importance of age and experience, the effect of experience was stronger, with the exception of one study.⁷⁴ Research using a sample of students and staff from a major university in Oman identified that both the age of the driver and years of driving experience were related to rates of self-reported crash involvement.⁸

Research in Sweden found that lowering the age requirement for obtaining a learner licence and increasing the amount of supervised driving practice time prior to obtaining a driver's licence reduced the crash risk by approximately 40% once solo driving commenced.⁷⁵ This research evaluated the introduction of a nation-wide initiative. For this reason, the study may have been confounded by factors such as age, socio-demographic variables and general crash rates. However, the study design attempted to estimate the effects of these factors.⁷⁵

SITUATIONAL ASSESSMENT, DECISION-MAKING AND HAZARD PERCEPTION

Driving requires the driver to use a set of multifaceted, interconnected and simultaneous competencies, including psychomotor, cognitive and perceptual proficiencies.⁷⁶ Young drivers are asked to develop and use these skills during their teenage years when quick and radical physical, cognitive and psychosocial changes occur.^{49,76}

A young driver's skill in assessing the road environment as well as their motivations play a role in determining their on-the-road behaviours and related crash risk. The ability to detect, assess and react to developing traffic situations is known as hazard perception.⁷⁷ This skill is important in reducing crash risk and may be one reason for the difference in crash risks between novice and more experienced drivers.⁷⁸ Novice drivers tend to focus on the lane and road markings close to their car. More experienced drivers look at the horizon and use their peripheral vision to maintain their position within the lane.⁷⁹

An individual's capacity to make decisions while driving also affects their crash risk. Both internal and external factors affect the driver's ability to make decisions. Drivers with more developed skills have an increased cognitive capacity to make decisions. For instance, as the driving task becomes more automated, more cognitive capacity becomes available, allowing the driver to make more effective decisions.⁷⁸

The ability to perceive potential hazards improves with driving experience.⁸⁰ However, hazard perception skills may be affected by other factors such as sleepiness. One Australian study identified that novice drivers were significantly slower at anticipating hazards at night in comparison to during the day, while experienced drivers did not differ in their ability to anticipate hazards at different times.⁸¹

As well as differences in hazard perception skills, inexperienced and more experienced drivers have been found to differ in their hazard anticipation abilities, particularly regarding vehicle and eye behaviours.⁸² Research has indicated that it is possible to train a novice driver to anticipate hazards and that the effects of this training will persist for up to a week; in addition, it was found that this training could be generalised to the open road.⁸²

DRIVER BEHAVIOUR

The final factor that increases the crash risk of young novice drivers is their driving behaviour. The ways in which drivers behave on the road, including their violations of road rules, may increase their crash risk.¹²

Self-reported risky driving behaviours by young drivers were linked with a 50% increased risk of crashing.⁸³ Young drivers were more likely to exceed the speed limit, drive too close to other vehicles and signal poorly.²⁰ 'Hooning' describes driving in a manner that is irresponsible and dangerous in public areas, and includes illegal street racing.⁸⁴ Research has suggested that 'hoons', are most likely to be young males aged 16 to 24 years;⁸⁵ this group can be considered a risky group and their driving records are more likely to include traffic infringements, licence sanctions and crashes than other drivers.⁸⁶

Conclusion

In many countries around the world young drivers have, over time, persistently had higher crash rates than older drivers and this is also the case in Oman. These increased crash rates are due to a number of factors, including the amount of driving exposure, the time this driving takes place, social and peer factors, and factors that are intrinsic to the young driver. Recent data has identified a number of characteristics associated with young driver crashes including variables associated with age, gender, passenger characteristics, the time of day, speed, type of vehicle, license status and nationality, amongst others. Developing an understanding of these factors and how they increase crash risk is critical to developing appropriate countermeasures. Most significantly, there is a large amount of data from around the world that identifies the vulnerability of young drivers, and the fact that much of this research is relevant to the Omani context must not be forgotten. There is only a very small amount of research concerning young drivers within Oman and the other Gulf Cooperation Council countries. There is obviously a critical need for more research within Oman if the country is to successfully respond to the pressing issue of crash-related mortality and morbidity. While recognising the unique and cultural characteristics of young drivers within the Omani context, the authors believe that valuable lessons can be learnt from international research. It is critical that effective countermeasures are adopted and implemented in order to reduce the crash rates experienced by young drivers. Furthermore, if Oman is to respond rapidly to this issue, international research in managing young drivers may provide useful insights and strategies that could be quickly assimilated, adopted and implemented in the current driving environment.

ACKNOWLEDGEMENTS

The authors appreciate the feedback provided by the anonymous reviewers and the editors as part of the peer-review process.

References

- Elvik R. Why some road safety problems are more difficult to solve than others. *Accid Anal Prev* 2010; 42:1089–96. doi: 10.1016/j.aap.2009.12.020.
- Williams AF. Teenage drivers: Patterns of risk. *J Safety Res* 2003; 34:5–15. doi: 10.1016/S0022-4375(02)00075-0.
- Lewis-Evans B. Crash involvement during the different phases of the New Zealand Graduated Driver Licensing System (GDLS). *J Safety Res* 2010; 41:359–65. doi: 10.1016/j.jsr.2010.03.006.
- Mayhew DR, Simpson HM, Pak A. Changes in collision rates among novice drivers during the first months of driving. *Accid Anal Prev* 2003; 35:683–91. doi: 10.1016/S0001-4575(02)00047-7.
- McCartt AT, Shabanova VI, Leaf WA. Driving experience, crashes and traffic citations of teenage beginning drivers. *Accid Anal Prev* 2003; 35:311–20. doi: 10.1016/S0001-4575(02)00006-4.
- World Health Organization. Global Status Report on Road Safety 2013: Supporting a decade of action. From: www.who.int/violence_injury_prevention/road_safety_status/2013/en/ Accessed: May 2014.
- Directorate General of Traffic, Royal Omani Police. Facts and Figures. Muscat: Modern Color Press, 2014.
- Al Reesi H, Al Maniri A, Plankermann K, Al Hinai M, Al Adawi S, Davey J, et al. Risky driving behavior among university students and staff in the Sultanate of Oman. *Accid Anal Prev* 2013; 58:1–9. doi: 10.1016/j.aap.2013.04.021.
- Al-Maniri AA, Al-Reesi H, Al-Zakwani I, Nasrullah M. Road traffic fatalities in Oman from 1995 to 2009: Evidence from police reports. *Int J Prev Med* 2013; 4:656–63.
- Al-Naamani A, Al-Adawi S. ‘Flying coffins’ and neglected neuropsychiatric syndromes in Oman. *Sultan Qaboos Univ Med J* 2007; 7:75–81.
- Davey JD, Freeman JE. Improving road safety through deterrence-based initiatives: A review of research. *Sultan Qaboos Univ Med J* 2011; 11:29–37.
- Williamson A. Young drivers and crashes: Why are young drivers over-represented in crashes? Summary of the issues. Sydney: University of New South Wales, 1999.
- Males MA. Poverty as a determinant of young drivers’ fatal crash risks. *J Safety Res* 2009; 40:443–8. doi: 10.1016/j.jsr.2009.10.001.
- Chen HY, Ivers RQ, Martiniuk AL, Boufous S, Senserrick TM, Woodward M, et al. Socioeconomic status and risk of car crash injury, independent of place of residence and driving exposure: Results from the DRIVE Study. *J Epidemiol Community Health* 2010; 64:998–1003. doi: 10.1136/jech.2009.091496.
- Chen HY, Senserrick TM, Martiniuk A, Ivers RQ, Boufous S, Chang HY, et al. Fatal crash trends for Australian young drivers 1997–2007: Geographic and socioeconomic differentials. *J Safety Res* 2010; 41:123–8. doi: 10.1016/j.jsr.2009.12.006.
- Chen LH. Teenage driver crash risk: The effect of passengers. Baltimore, Maryland: Johns Hopkins University, 1999.
- Preusser DF, Ferguson SA, Williams AF. The effect of teenage passengers on the fatal crash risk of teenage drivers. *Accid Anal Prev* 1998; 30:217–22. doi: 10.1016/S0001-4575(97)00081-X.
- Begg DJ, Stephenson S, Alsop J, Langley J. Impact of graduated driver licensing restrictions on crashes involving young drivers in New Zealand. *Inj Prev* 2001; 7:292–6. doi: 10.1136/ip.7.4.292.
- Lam LT, Norton R, Woodward M, Connor J, Ameratunga S. Passenger carriage and car crash injury: A comparison between younger and older drivers. *Accid Anal Prev* 2003; 35:861–7. doi: 10.1016/S0001-4575(02)00091-X.
- Baxter JS, Manstead ASR, Stradling SG, Campbell KA, Reason JT, Parker D. Social facilitation and driver behaviour. *Brit J Psychol* 1990; 81:351–60. doi: 10.1111/j.2044-8295.1990.tb02366.x.
- Simons-Morton B, Lerner N, Singer J. The observed effects of teenage passengers on the risky driving behavior of teenage drivers. *Accid Anal Prev* 2005; 37:973–82. doi: 10.1016/j.aap.2005.04.014.
- Begg DJ, Langley JD, Stephenson S. Identifying factors that predict persistent driving after drinking, unsafe driving after drinking, and driving after using cannabis among young adults. *Accid Anal Prev* 2003; 35:669–75. doi: 10.1016/S0001-4575(02)00045-3.
- Voas RB, Romano E, Fell J, Kelley-Baker T. Young impaired driver involvement in fatal crashes. In: Transportation Research Board of the National Academies. Young impaired drivers: The nature of the problem and possible solutions. Washington DC: Transportation Research Board, 2009. Pp. 9–17.
- Vachal K, Malchouse D; Research Faculty. What can we learn about North Dakota’s youngest drivers from their crashes? *Accid Anal Prev* 2009; 41:617–23. doi: 10.1016/j.aap.2009.02.014.
- Morrison L, Begg DJ, Langley JD. Personal and situational influences on drink driving and sober driving among a cohort of young adults. *Inj Prev* 2002; 8:111–5. doi: 10.1136/ip.8.2.111.
- Harbeck EL, Glendon AI. How reinforcement sensitivity and perceived risk influence young drivers’ reported engagement in risky driving behaviors. *Accid Anal Prev* 2013; 54:73–80. doi: 10.1016/j.aap.2013.02.011.
- Evans-Whipp TJ, Plenty SM, Toumbourou JW, Olsson C, Rowland B, Hemphill SA. Adolescent exposure to drink driving as a predictor of young adults’ drink driving. *Accid Anal Prev* 2013; 51:185–91. doi: 10.1016/j.aap.2012.11.016.
- Davey JD, Davey T, Obst PL. Drug and drink driving by university students: An exploration of the influence of attitudes. *Traffic Inj Prev* 2005; 6:44–52. doi: 10.1080/15389580590903168.
- Asbridge M, Poulin C, Donato A. Motor vehicle collision risk and driving under the influence of cannabis: Evidence from adolescents in Atlantic Canada. *Accid Anal Prev* 2005; 37:1025–34. doi: 10.1016/j.aap.2005.05.006.
- Simons-Morton BG, Ouimet MC, Chen R, Klauer SG, Lee SE, Wang J, et al. Peer influence predicts speeding prevalence among teenage drivers. *J Safety Res* 2012; 43:397–403. doi: 10.1016/j.jsr.2012.10.002.
- Scott-Parker B, Watson B, King MJ. “If they say go faster or something I’ll probably go faster”: Peer influence upon the risky driving behaviour of young novices. In: Australasian Road Safety Research, Policing and Education Conference, 28–30 August 2013, Brisbane, Queensland, Australia.
- Delhomme P, Meyer T. Control motivation and young drivers decision making. *Ergonomics* 1998; 41:373–93. doi: 10.1080/001401398187099.
- Yagil D. Instrumental and normative motives for compliance with traffic laws among young and older drivers. *Accid Anal Prev* 1998; 30:417–24. doi: 10.1016/S0001-4575(98)00003-7.
- McCartt AT, Hellinga LA, Braitman KA. Cell phones and driving: Review of research. *Traffic Inj Prev* 2006; 7:89–106. doi: 10.1080/15389580600651103.
- Walsh SP, White KM, Hyde MK, Watson B. Dialling and driving: Factors influencing intentions to use a mobile phone while driving. *Accid Anal Prev* 2008; 40:1893–900. doi: 10.1016/j.aap.2008.07.005.

36. Neyens DM, Boyle LN. The influence of driver distraction on the severity of injuries sustained by teenage drivers and their passengers. *Accid Anal Prev* 2008; 40:254–9. doi: 10.1016/j.aap.2007.06.005.
37. Gauld CS, Lewis I, White KM. Concealing their communication: Exploring psychosocial predictors of young drivers' intentions and engagement in concealed texting. *Accid Anal Prev* 2014; 62:285–93. doi: 10.1016/j.aap.2013.10.016.
38. White KM, Walsh SP, Hyde MK, Watson BC. Connection without caution? The role of mobile phone involvement in predicting young people's intentions to use a mobile phone while driving. *J Australasian Coll Road Safety* 2012; 23:16–21.
39. Watling CN, Armstrong KA, Smith SS. Sleepiness: How a biological drive can influence other risky road user behaviours. In: *Proceedings of the 2013 Australasian College of Road Safety (ACRS) National Conference, Adelaide, South Australia, Australia*. Pp. 1–12.
40. Watling CN. Sleepy driving and pulling over for a rest: Investigating individual factors that contribute to these driving behaviours. *Pers Individ Dif* 2014; 56:105–10. doi: 10.1016/j.paid.2013.08.031.
41. Weiss HB, Kaplan S, Prato CG. Analysis of factors associated with injury severity in crashes involving young New Zealand drivers. *Accid Anal Prev* 2014; 65:142–55. doi: 10.1016/j.aap.2013.12.020.
42. Ferguson SA, Teoh ER, McCartt AT. Progress in teenage crash risk during the last decade. *J Safety Res* 2007; 38:137–45. doi: 10.1016/j.jsr.2007.02.001.
43. Lin ML, Fearn KT. The provisional license: Nighttime and passenger restrictions: A literature review. *J Safety Res* 2003; 34:51–61. doi: 10.1016/S0022-4375(02)00081-6.
44. Fell JC, Todd M, Voas RB. A national evaluation of the nighttime and passenger restriction components of graduated driver licensing. *J Safety Res* 2011; 42:283–90. doi: 10.1016/j.jsr.2011.06.001.
45. Nokhandan MH, Bazrafshan J, Ghorbani K. A quantitative analysis of risk based on climatic factors on the roads in Iran. *Meteorol Appl* 2008; 15:347–57. doi:10.1002/met.77.
46. Andrey J, Hambly D, Mills B, Afrin S. Insights into driver adaptation to inclement weather in Canada. *J Transp Geogr* 2013; 28:192–203. doi: 10.1016/j.jtrangeo.2012.08.014.
47. Abdel-Aty M, Ekram AA, Huang H, Choi K. A study on crashes related to visibility obstruction due to fog and smoke. *Accid Anal Prev* 2011; 43:1730–7. doi: 10.1016/j.aap.2011.04.003.
48. Chen HY, Ivers RQ, Martiniuk AL, Boufous S, Senserrick T, Woodward M, et al. Risk and type of crash among young drivers by rurality of residence: Findings from the DRIVE Study. *Accid Anal Prev* 2009; 41:676–82. doi: 10.1016/j.aap.2009.03.005.
49. Shope JT. Influences on youthful driving behavior and their potential for guiding interventions to reduce crashes. *Inj Prev* 2006; 12:i9–14. doi: 10.1136/ip.2006.011874.
50. McKnight AJ, McKnight AS. Young novice drivers: Careless or clueless? *Accid Anal Prev* 2003; 35:921–5. doi: 10.1016/S0001-4575(02)00100-8.
51. Wylie J. Variation in Relative Safety of Australian Drivers with Age. From: www.infrastructure.gov.au/roads/safety/publications/1996/pdf/Safe_Age_1.pdf Accessed: Mar 2014.
52. Masten SV, Hagge RA. Evaluation of California's graduated driver licensing program. *J Safety Res* 2004; 35:523–35. doi: 10.1016/j.jsr.2004.08.006.
53. Hatfield J, Fernandes R. The role of risk-propensity in the risky driving of younger drivers. *Accid Anal Prev* 2009; 41:25–35. doi: 10.1016/j.aap.2008.08.023.
54. Prato CG, Toledo T, Lotan T, Taubman-Ben-Ari O. Modeling the behavior of novice young drivers during the first year after licensure. *Accid Anal Prev* 2010; 42:480–6. doi: 10.1016/j.aap.2009.09.011.
55. Al-Balbissi AH. Role of gender in road accidents. *Traffic Inj Prev* 2003; 4:64–73. doi: 10.1080/15389580309857.
56. Zakrajsek JS, Shope JT, Ouimet MC, Wang J, Simons-Morton BG. Efficacy of a brief group parent-teen intervention in driver education to reduce teenage driver injury risk: A pilot study. *Fam Community Health* 2009; 32:175–88. doi: 10.1097/FCH.0b013e318199482c.
57. Arnett JJ, Offer D, Fine MA. Reckless driving in adolescence: 'State' and 'trait' factors. *Accid Anal Prev* 1997; 29:57–63. doi: 10.1016/S0001-4575(97)87007-8.
58. Scott-Parker B, Watson B, King MJ, Hyde MK. Revisiting the concept of the 'problem young driver' within the context of the 'young driver problem': Who are they? *Accid Anal Prev* 2013; 59:144–52. doi: 10.1016/j.aap.2013.05.009.
59. Arnett J. Drunk driving, sensation seeking, and egocentrism among adolescents. *Pers Individ Dif* 1990; 11:541–6. doi: 10.1016/0191-8869(90)90035-P.
60. Jonah BA. Sensation seeking and risky driving: A review and synthesis of the literature. *Accid Anal Prev* 1997; 29:651–65. doi: 10.1016/S0001-4575(97)00017-1.
61. Jonah BA, Thiessen R, Au-Yeung E. Sensation seeking, risky driving and behavioral adaptation. *Accid Anal Prev* 2001; 33:679–84. doi: 10.1016/S0001-4575(00)00085-3.
62. Hatfield J, Fernandes R, Job RF. Thrill and adventure seeking as a modifier of the relationship of perceived risk with risky driving among young drivers. *Accid Anal Prev* 2014; 62:223–29. doi: 10.1016/j.aap.2013.09.028.
63. Sagberg F. Driver health and crash involvement: A case-control study. *Accid Anal Prev* 2006; 38:28–34. doi: 10.1016/j.aap.2005.06.018.
64. Scott-Parker B, Watson B, King MJ, Hyde MK. The psychological distress of the young driver: A brief report. *Inj Prev* 2011; 17:275–7. doi: 10.1136/ip.2010.031328.
65. Rosenbloom T, Wultz B. Thirty-day self-reported risky driving behaviors of ADHD and non-ADHD drivers. *Accid Anal Prev* 2011; 43:128–33. doi: 10.1016/j.aap.2010.08.002.
66. Watson BC, Mihovilovich S. Motor SMART: A driver education, judgement training and mentoring program for novice drivers with ADHD. In: *Third National Conference on Injury Prevention and Control, May 1999, Brisbane, Queensland, Australia*.
67. Barkley RA, Murphy KR, Kwasnik D. Motor vehicle driving competencies and risks in teens and young adults with attention deficit hyperactivity disorder. *Pediatrics* 1996; 98:1089–95.
68. Reimer B, D'Ambrosio LA, Gilbert J, Coughlin JF, Biederman J, Surman C, et al. Behavior differences in drivers with attention deficit hyperactivity disorder: The driving behavior questionnaire. *Accid Anal Prev* 2005; 37:996–1004. doi: 10.1016/j.aap.2005.05.002.
69. Martiniuk AL, Ivers RQ, Glozier N, Patton GC, Lam LT, Boufous S, et al. Self-harm and risk of motor vehicle crashes among young drivers: Findings from the DRIVE Study. *CMAJ* 2009; 181:807–12. doi: 10.1503/cmaj.090459.
70. Martiniuk AL, Ivers RQ, Glozier N, Patton GC, Senserrick T, Boufous S, et al. Does psychological distress increase the risk for motor vehicle crashes in young people? Findings from the DRIVE Study. *J Adolesc Health* 2010; 47:488–95. doi: 10.1016/j.jadohealth.2010.03.010.
71. McDonald WA. Young Driver Research Program: A review of information on young driver performance characteristics and capacities. From: www.monash.edu.au/miri/research/reports/atsb129.pdf Accessed: Mar 2014.
72. Mynttinen S, Sundström A, Koivukoski M, Hakuli K, Keskinen E, Henriksson W. Are novice drivers overconfident? A comparison of self-assessed and examiner-assessed driver competences in a Finnish and Swedish sample. *Transp Res Part F Traffic Psychol Behav* 2009; 12:120–30. doi: 10.1016/j.trf.2008.09.002.

73. Langford J. Using the research to reduce novice driver crashes. Proceedings of the Developing Safer Drivers and Riders Conference. Brisbane: ACRS and Travelsafe Committee, 2002.
74. McCartt AT, Mayhew DR, Braitman KA, Ferguson SA, Simpson HM. Effects of age and experience on young driver crashes: Review of recent literature. *Traffic Inj Prev* 2009; 10:209–19. doi: 10.1080/15389580802677807.
75. Gregersen NP, Berg HY, Engström I, Nolén S, Nyberg A, Rimmö PA. Sixteen years age limit for learner drivers in Sweden: An evaluation of safety effects. *Accid Anal Prev* 2000; 32:25–35. doi: 10.1016/S0001-4575(99)00045-7.
76. Keating DP, Halpern-Felsher BL. Adolescent drivers: A developmental perspective on risk, proficiency, and safety. *Am J Prev Med* 2008; 35:S272–7. doi: 10.1016/j.amepre.2008.06.026.
77. Vidotto G, Bastianelli A, Spoto A, Sergeys F. Enhancing hazard avoidance in teen-novice riders. *Accid Anal Prev* 2011; 43:247–52. doi: 10.1016/j.aap.2010.08.017.
78. Sagberg F, Bjørnskau T. Hazard perception and driving experience among novice drivers. *Accid Anal Prev* 2006; 38:407–14. doi: 10.1016/j.aap.2005.10.014.
79. Leung S, Starmer G. Gap acceptance and risk-taking by young and mature drivers, both sober and alcohol-intoxicated, in a simulated driving task. *Accid Anal Prev* 2005; 37:1056–65. doi: 10.1016/j.aap.2005.06.004.
80. Borowsky A, Oron-Gilad T, Parmet Y. Age and skill differences in classifying hazardous traffic scenes. *Transp Res Part F Traffic Psychol Behav* 2009; 12:277–87. doi: 10.1016/j.trf.2009.02.001.
81. Smith SS, Horswill MS, Chambers B, Wetton M. Hazard perception in novice and experienced drivers: The effects of sleepiness. *Accid Anal Prev* 2009; 41:729–33. doi: 10.1016/j.aap.2009.03.016.
82. National Highway Traffic Safety Administration. Evaluation of PC-based Novice Driver Risk Awareness: Final report. From: www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/810926.pdf Accessed: May 2014.
83. Ivers R, Senserrick T, Boufous S, Stevenson M, Chen HY, Woodward M, et al. Novice drivers' risky driving behavior, risk perception, and crash risk: Findings from the DRIVE Study. *Am J Public Health* 2009; 99:1638–44. doi: 10.2105/AJPH.2008.150367.
84. Leal NL, Watson BC, Armstrong KA. Risky driving or risky drivers? Exploring driving and crash histories of illegal street racing offenders. *Transportation Res Rec* 2010; 2182:16–23. doi: 10.3141/2182-03.
85. Palk G, Freeman J, Kee AG, Steinhardt D, Davey J. The prevalence and characteristics of self-reported dangerous driving behaviours among a young cohort. *Transp Res Part F Traffic Psychol Behav* 2011; 14:147–54. doi: 10.1016/j.trf.2010.11.004.
86. Leal NL, Watson BC. The road safety implications of illegal street racing and associated risky driving behaviours: An analysis of offences and offenders. *Accid Anal Prev* 2011; 43:1547–54. doi: 10.1016/j.aap.2011.03.010.