European Commission

Thematic Report

# Young Novice Drivers



Mobility and Transport

This document is part of a series of 20 thematic reports on road safety. The purpose is to give road safety practitioners and the general public an overview of the most important research questions and results on the topic in question. The level of detail is intermediate, with more detailed papers or reports suggested for further reading. Each report has a 1-page summary.


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# Contents

# Summary

In this report, the term young novice drivers refers to 16-24 year old car drivers. Young novice drivers are over-represented in crashes. At its root the causes for this over-representation are their young age, lack of on-road experience, lifestyle and other factors such as risk-taking. The age factor has two interrelated components: a biological component (i.e., having a brain which has not yet completely matured) and a social component (youth culture, lifestyle). Lack of experience causes a high crash risk due to underdeveloped higher order driving skills like include hazard perception, risk awareness, and calibration. Young drivers can also be more easily distracted, cannot always resist peer pressure, are more often fatigued and drive at night more often than older drivers. Drink driving occurs almost as often with young drivers as with older ones, but it has a more detrimental effect on their driving capabilities. Furthermore, they drive more often than older drivers under the influence of illegal psychoactive substances such as cannabis.

The fact that young drivers drive often in older cars with fewer safety features contributes to their higher risk. Furthermore, they drive more often in circumstances that are difficult for all drivers, such as driving at night and driving with peers. In general, young male drivers have a higher crash risk than young female drivers but only in relation to the most severe crashes.

Given the severity of the problem, EU Member States have taken action, to varying degrees, to reduce young novice driver risk. There is no panacea that will resolve the problem entirely because driving skills tend to be impaired by a lack of experience and factors (like risk-taking tendencies) that are prevalent due to their young age. Moreover, not all young novice drivers are the same. There is evidence that the following measures can be effective:

- More emphasis on higher-order skill training and testing in driving licence systems such as hazard perception and risk awareness training.
- The inclusion in driving licence systems of a learner phase (driving while accompanied by an older more experienced driver) and an intermediate phase where young drivers are allowed to drive independently but with restrictions such as not driving with peers, not driving in the dark, and not with devices which can distract such as mobile phones even when they are ‘hands-free’.
- A lower BAC limit for young drivers provided it is thoroughly enforced.

# 1. What is the problem

Novice drivers are mostly also young drivers. In this report, the term young novice drivers refers to 16-24 year old drivers. These young novice drivers are over-represented in crashes. This is true for all developed nations with mass motorization in which young people mostly start to drive as soon as they have reached the age limit for learning to drive (Vlakveld, 2016). Young novice drivers do not only pose a threat to themselves but also to their passengers and other road users. Their high crash risk is due to two factors: they have little driving experience and they are young. The age effect has two intertwined dimensions. First, their not-yet-completely-matured brains make them prone to distraction, peer pressure, limited impulse control, and to underestimating risks and overestimating their own skills. Second, there is a social dimension related to youth culture and lifestyle.

In the EU, over the period 2015-2019, on average 1,215 young car drivers (18-24 years of age) died each year in a crash (CARE, 2021), representing 16% of all car drivers killed over these years, whereas in 2016, only 8% of all car drivers in the EU were 18-24 years of age. Although there is a clear over-representation of young drivers in fatal car crashes, this over-representation is gradually declining (European Commission, 2018). Young drivers who die in car crashes are mostly male. Over the years 2015-2019, 82% of young car drivers killed were male. However, this over-representation of male drivers in fatal crashes is not unique to young drivers but also exists in other age-groups (CARE, 2021).

# 2. How do novice drivers gain their driving licence

In Europe, young people typically start to practise driving between 16 and 18 years of age. The exact age depends on the age limits applying in the driver licence system of the particular member state. The age at which they can obtain their driving licence is for most European countries at (approximately) 18 years. In Austria, Germany, Ireland, and The Netherlands, it is possible to receive a drivers licence at the age of 17. The restrictions that apply in the first years of a driving career vary between European countries (see overview: Helman et al., 2016). In order to gain a driving licence in Europe, people have to pass a theoretical and practical exam, usually after attending a driving course. In most European countries, young drivers start driving with a provisional licence. The maximum Blood Alcohol Concentration (BAC) with which drivers are allowed to drive is often lower for drivers with a

provisional licence and the demerit point system (if any) is often stricter for drivers with a provisional licence. Many European countries have also included the concept of learner periods in their driving licence system. whereby novice drivers are only allowed to drive with a designated and experienced accompanying driver. In some European countries, this accompanied driving period is before the final driving test (e.g., in Sweden) while in other countries it is after the learner has passed the final driving test but has not yet reached 18 years of age (e.g., in Germany).

The EC proposal in March 2023 for a revision of the Directive on Driving Licences also includes provisions to allow young drivers to gain experience through an accompanied driving scheme from the age of 17.[1]

# 3. Novice drivers and road safety

## 3.1 Crash risk or relative risk

The over-representation of young novice drivers in crashes is an old and persistent problem (Elvik, 2010). It was reported for the first time in the early 1960s and is present in all developed nations with mass motorization in which young people mostly start to drive as soon they have reached the age limit for learning to drive and for taking the driving test (Vlakveld, 2016). Crash risk (the number of crashes per distance driven) is highest after licencing (i.e. when drivers are allowed to drive without an experienced accompanying driver) and decreases rapidly in the first months of independent driving. However, it takes years for the crash risk to cease declining and remains at a low level until it gradually starts to rise again after 65 years of age (e.g. Vlakveld, 2011). Although the size of the effect varies, serious crashes show a substantial over-representation of young drivers relative to the distance driven. This is found in all studies investigating this issue (McCartt et al., 2009). The risk of crashes resulting in at least one killed or seriously injured casualty is higher for young male drivers than for young female drivers (Helman et al., 2017).

## 3.2 Typical crashes

An international review of crash circumstances reveals that young novice drivers are over-represented in crashes in the dark (especially during weekend nights), and on rural roads (Cassarino & Murphy,

[1] https://transport.ec.europa.eu/document/download/964d4edc-5eea-49e1-ae08-2d1e38705713_en?filename=COM_2023_127.pdf

2018). Single vehicle crashes (curves and straight roads), head-rear crashes (where the driver hits a car in front of him), and not giving way at intersections are the most common crashes for American teen drivers (McDonald, Sommers & Winston, 2017). The over-representation of young novice drivers in these crash types is also reported in a somewhat older European study (Clarke et al., 2006).

## 3.3 Causation factors

The high crash risk of young novice drivers is a multi-faceted problem and is not the same with all young drivers. Nevertheless, most causation factors are related to two characteristics: (1) behaviours due to inexperience, and (2) behaviours due to young age (often involving risky behaviours). Higher order skills develop with age; they include mainly hazard perception skills (i.e. the skill of predicting accurately how traffic situations can develop in dangerous situations), calibration skills, and the ability to balance task demands and capabilities. People are ill-calibrated when they underestimate risks and overestimate their own capabilities (Watson-Brown et al., 2019; 2021). In addition, temporary factors such as peer pressure, fatigue, distraction, and being under the influence of psychoactive substances can increase the crash risk of young novice drivers (Cassarino & Murphy, 2018).

### 3.3.1 Brain development and higher-order skills

The human brain is not completely developed until approximately 25 years of age. The part of the brain that urges us to 'to think first and act later' is the last part to mature. It ensures that previous experience is used to make decisions (Gicquel et al., 2017). The part of the brain that regulates emotions, motivation, and satisfaction of needs matures much quicker (Gogtay et al., 2004). Due to this asynchronous development, young people are more inclined to take risks, are susceptible to peer pressure, and seek to satisfy their own needs such as 'pleasure' (Steinberg, 2008). The capacity of our working memory to enable us to remember items relevant to us also continues to develop during adolescence. The slower development of this capacity is associated with a self-reported increased crash risk (Walshe et al., 2019).

Reference is often made to the lack of higher-order skills in young novice drivers. These skills are not the pure driving skills such as vehicle control and mastering traffic situations but the skills to anticipate hazards, to know their own limitations, and to balance task demands and capabilities (i.e. calibration) (Hatakka et al., 2002). Young novice drivers experience difficulties in assessing risks (Kinnear et al., 2013) and are inclined to overestimate their skills (Fuller et al., 2008). As a result, their behaviour is not necessarily in line with their capabilities

(de Craen, 2010). Young female and male drivers do not differ so much in their (limited) ability to 'see' risks but in their assessment of risks (Cordellieri et al., 2016). That is, young male drivers seem to be less concerned about the consequences of risks than young female drivers. For young novice drivers the ability to 'see' hazards is a consequence of their lack of skills in identifying and understanding safety-related elements of the driving environment (Horswill et al., 2022). Further, due to working memory and impulse control not yet being fully developed, young drivers are less able to process stimuli and focus their attention on relevant elements of the traffic situation, to make decisions, and to plan how to behave (Walshe et al., 2019).

### 3.3.2 Driving experience

Independent of their starting age, novice drivers have the highest crash risk in their first months of independent driving (i.e. when no longer being accompanied by an older and more experienced driver). During these first months the risk of single vehicle crashes in particular declines rapidly (McCartt et al., 2009; Sagberg, 1998). However, after the first year of independent driving, their overall crash risk is still higher than that of more experienced drivers. After this first year the crash risk declines at a much slower pace. It takes years before their crash risk remains at a stable low level. This is because they still have to gain experience in applying the skills acquired in different situations and improve their calibration skills during the first few years after initial qualification (McDonald et al., 2017). The described pattern is more pronounced (higher initial crash age and slower decline in the following period) the younger the age of licensure (Twisk & Stacey, 2007).

### 3.3.3 Factors temporarily reducing fitness to drive

When comparing young drivers with middle-aged drivers and older drivers, temporary factors which affect driving have been studied. These factors affect fitness to drive. The driver should monitor them and calibrate their behaviour accordingly.

- Alcohol consumption in young people varies strongly between EU member states (Bräker & Soellner, 2016). In member states with a high proportion of drinking adolescents, the proportion of excessive drinkers (binge drinking) is also high. On average, young drivers do not tend to drink and drive more often than middle-aged drivers in the EU (Goldenbeld et al., 2020). However, compared with middle-aged drivers, their crash risk is higher at a lower blood alcohol level (Jongen et al., 2018; Peck et al., 2008). This is probably caused by inexperience in driving and a lack of developed higher order skills making them more prone to impairment. Inexperience in managing alcohol consumption may also be a factor. Young drivers also drive more

often under the influence of alcohol with peers in their car (Houwing et al., 2015). Therefore, they not only put their own lives at risk but also those of their passengers, and of course those of the road users with whom they collide.

- In EU member states, young male drivers drive more often under the influence of illegal drugs than either drivers of 25 or more years or young female drivers (Achermann Stürmer, Meesmann & Berbatovci, 2019; Furian et al., 2021). Meta-analyses show that crash risk is not the same for all drugs (Elvik, 2013; Rogeberg & Elvik, 2016; Rogeberg, 2019). While cannabis increases crash risk a little, cocaine and especially amphetamines considerably increase the crash risk. Driving while intoxicated by a combination of drugs, in particular the combination of alcohol and drugs, increases the crash risk most (Asbridge et al., 2017; Herrera-Gómez et al., 2019).
- Young people are inherently curious about new stimuli. They tend to have trouble focusing on the most significant traffic stimuli, and their ability to suppress impulsive reactions is not fully developed. A naturalistic driving study from the USA reveals that while distracted the crash risk of young drivers (16-29 years of age) is increased and for most distracting activities (with the exception of operating a screen) the increase in crash risk is greater than for middle-aged drivers (30-64 years of age) (Gershon et al., 2019; Guo et al., 2017; Lu, Guo & Li, 2020). Young drivers are not distracted more often than middle-aged drivers (Klauer et al., 2014) but the prevalence of particularly distracting activities differs. Young drivers for instance text for 3% of driving time and middle-aged and older drivers for only 1% (Guo et al., 2017).
- For young drivers, fatigue tends to be a more important factor than for older drivers, because they drive more often at night, the time of day when people are naturally inclined to sleep (Lyon et al., 2020). In addition, there is a mismatch between the biological development of the sleep-wake rhythm, the amount of sleep young people need, and the daily rhythm imposed by school, education or work (Jolles, 2019). Yet, fatigue caused by lack of sleep is hard to recognize in young people and therefore difficult to control (Paterson & Dawson, 2017). A UK study shows that lack of sleep prior to driving is related to higher crash risk (Groeger, 2006).

### 3.3.4 Attitudes and social environment

Some young novice drivers adopt a 'sporty driving style' to impress friends (Arnett, 2002). The crash risk is particularly increased for young drivers who enjoy cars and driving, or for those who really enjoy going out (Møller & Sigurðardóttir, 2009). Young drivers tend to be influenced

by their peers. The attitude of their friends towards risky driving behaviour (the peer group standards) affects the extent to which young drivers display risky driving behaviour (Geber et al., 2019; Guggenheim, Taubman – Ben-Ari & Ben-Artzi, 2020; Pagomenos, Rodwell & Larue, 2023). In particular, young drivers who lack impulse control tend to violate traffic rules when peers in the car encourage them to do so (Cascio et al., 2014).
For young drivers with one or more young passengers, crash risk is higher than when they drive without passengers. The presence of young passengers increases risk more strongly for male drivers than for female drivers. For young male drivers, the effect of a passenger being present is more prominent when the passenger is male rather than female (Ouimet et al., 2015). Conversely, when young drivers are accompanied by an older passenger (>30 years of age), their crash risk is lower than when they are unaccompanied (Engström et al., 2008; Ouimet et al., 2010). Parents set the example for their children; a parent's driving behaviour therefore predicts the driving behaviour of young drivers (Taubman - Ben-Ari, et al., 2014). Moreover, a young driver's risk behaviour depends on the extent to which parents encourage safe behaviour and set clear boundaries (Gicquel et al., 2017).

### 3.3.5 Speed

International literature shows that young drivers are relatively often involved in crashes caused by not adjusting their speed to traffic conditions (e.g. by not lowering their speed sufficiently in a curve or when it rains) ((Banz, Fell & Vaca, 2019); McKnight & McKnight, 2003; Clarke, Ward, Bartle & Truman, 2006). The inability to adjust speed to traffic conditions is related to several factors mentioned above, such as insufficient driving experience, lack of calibration skills, inadequately coping with peer pressure, and driving late at night with less traffic. Dutch research into self-reported speeds shows that young drivers do not exceed speed limits on motorways just after gaining their driving licence, but that speeds are at their peak two to three years after licensing (Vlakveld, 2011).

### 3.3.6 Other factors

Young drivers drive relatively often in conditions that also increase crash and injury risk for experienced drivers: they often drive in somewhat older cars with fewer passive and active safety devices (Watson & Newstead, 2009), and they drive more often during periods of darkness, especially during weekend nights. For example, the risk of collision involvement for young drivers in Great Britain is eight times higher between 2 am and 4 am, on both weekdays and weekends (DfT, 2018).

# 4. Countermeasures

## 4.1 Driver training

### 4.1.1 Initial driver training

Despite the idea having intuitive appeal, evaluation studies and meta-analyses have previously shown that formal initial driver training provided by a certified driving instructor generally did not result in lower crash rates after licensing than informal driver training provided by a lay instructor (e.g. a parent) (Beanland et al., 2013; Blomberg & Fisher, 2012; Elvik et al., 2009; Lonero & Mayhew, 2010; Mayhew & Simpson, 2002; Peck, 2011; Wells et al., 2008). However, most of these evaluation studies are old and have a rather weak research design (e.g. no random assignment). Moreover, the effect of basic training at US-American high schools investigated in most of these studies might have been limited because the trainings did probably not address the main causes of crash involvement for their very young participants, namely a lack of higher order skills and motivation to avoid risks like drinking and driving, operating a mobile phone while driving, or peer pressure. Recent study results indicate that initial driver training programs that do so may reduce crash risk after licensing (Horswill et al., 2021; Watson-Brown, Scott-Parker & Senserrick, 2021). In Great Britain, studies have indicated that directing the focus of the driving test on 'real-world' driving rather than manoeuvres could have a beneficial impact (Helman et al., 2017).

### 4.1.2 Graduated driver licence (GDL)

Graduated licensing ensures that novice drivers first gain experience in safer conditions before they are allowed to drive in more demanding traffic situations. Several countries, including the United States, Canada, Australia and New-Zealand have a form of 'graduated driver licensing' system.

Graduated licensing usually consists of three phases:

1. *The learner phase.* In this phase, candidates can only drive while accompanied. Supervisor and learner usually keep a logbook of the manoeuvres accomplished and how they were mastered by the learner. Often, the number of kilometres travelled is also logged. The learner phase typically lasts for a minimum time period (e.g. six months to a year) or requires the accumulation of a minimum number of certified hours of on-road practice. Learner drivers typically have to pass an on-road test and occasionally a theory test before they can proceed to phase 2.
2. *The intermediate phase.* During the intermediate phase, a candidate is allowed to drive independently, but only in conditions

with low crash risk. This phase almost always implies a prohibition on driving under the influence of any alcohol. Often a restriction on driving in the dark (e.g. 11 pm to 5 am) and driving accompanied by peer passengers also applies. In some states handsfree mobile phone use is also not allowed during the intermediate phase. Progression to phase 3 usually occurs after a certain time period (e.g. 6, 12 or 18 months)

3. During this phase, the novice driver is allowed to drive independently without restrictions. In some countries, stricter rules (for instance about alcohol use or heightened strictness in demerit points) apply to novice drivers for a time period until they are considered an experienced driver.

There is strong evidence that fully implemented GDL systems reduce the crash risk of young novice drivers (Curry et al., 2014; Kinnear et al., 2013; McCartt et al., 2010; Russell, Vandermeer & Hartling, 2011; Senserrick & Williams, 2015; Williams, 2017). The impact of GDL systems mainly stems from the fact that these systems postpone independent driving. However, there is some evidence that GDL systems also improve driving skills (Foss, Masten & Martell, 2014) or the understanding of and attitude towards risk (Stanojević et al., 2022) slightly. Strictness of the rules determines the effectiveness of GDL, especially in relation to the number of hours that have to be driven supervised, or the presence of restrictions to drive during the night or with peers as passengers during the intermediate phase. The minimum amount of time the driver has a learner's permit, harsher sanctions, logbook completion, and alcohol restrictions are also important aspects (Hirschberg & Lye, 2020). Although, no EU member state has fully implemented a GDL system, quite a few EU member states have included a learner phase (the first phase in a GDL system) in their driving licence system and some have introduced a provisional licence for beginners that is very similar to the third phase of a GDL system. However, fully implemented intermediate phases with restrictions are rare in Europe.

## 4.2 Additional training

Some EU member states (e.g. Austria, Finland, Luxembourg, Sweden, Slovenia, Estonia, Latvia, and Lithuania) have included a so-called mandatory second phase driver education program in their driving licence system. After young drivers have acquired their driving licence, they have to attend additional driver education usually within the first two years of independent driving (Washington, Cole & Herbel, 2011). These training programs usually consist of a so-called feedback drive, training on an enclosed track, and a group discussion about motivations to drive safely. The feedback drive is carried out in real traffic with a

driving instructor in which feedback is provided about the driving style of the novice driver. The training on the test track is not intended to be a skill training in how to operate a vehicle in emergency situations, but to make young drivers aware how easy it is to lose control and that they have to anticipate and avoid situations that increase risk. The effect of these second phase training programs on crash risk is inconclusive (Keskinen et al., 1999; Mynttinen et al., 2010).

It has been demonstrated that short dexterity trainings addressing skills which drivers only have to apply occasionally, such as skid training, do not reduce crash risk. For instance, obligatory skid courses in Norway, Sweden and Finland have proved not to impact, or even to have an adverse effect, on crash risk (Katila et al., 2004). The courses are too short to automatise the complex actions needed. But they nevertheless lure young drivers into thinking that they have mastered these skills and make them over-confident (Mayhew & Simpson, 2002).

### 4.2.1 Hazard perception

Hazard perception is the skill of 'reading the road and anticipating forthcoming events' (Horswill & McKenna, 2004). That is, the skill to identify potentially dangerous on-road situations and carry out actions that increase the safety margin so that a crash can be averted if the potentially dangerous situation were to materialise. Young novice drivers tend to have poor hazard perception skills (Boufous et al., 2011; Horswill & McKenna,1999; Wells et al., 2008; Wetton, Hill & Horswill, 2011), and there is a correlation between hazard perception skill and crash risk (see for a review: Horswill, 2016). Young novice drivers with poor scores on hazard perception tests have a higher crash risk than young novice drivers with a high score on hazard perception tests (e.g. Horswill, Hill & Wetton, 2015; Wells et al., 2008).

However, drivers can be trained and tested in hazard perception skill (see for reviews: McDonald et al., 2015; Moran, Bennett & Prabhakharan, 2019). Not all research shows positive results for hazard perception training courses: a large-scale randomized controlled trial in the United States has not shown a significant decrease in crash risk after taking the Risk Awareness and Perception Training (RAPT) in the first year of independent driving(Roberts et al., 2021) for the entire research group. Only the participants with a lower socioeconomic status benefitted significantly from the training. A more recent example is the hazard perception training developed at the University of Queensland (Horswill et al., 2021). It makes use of video clips of real crashes shot by dashcams. These videos stop when the first precursors of a crash become visible and the learners have to predict what happens next. Afterwards they are shown what really happened and the trainers also explain what else could have happened. Participants who had attended

the training had higher scores on a hazard perception test than participants who did not attend the training (Horswill et al.,2021) and had a reduced rate of heavy breaking, speeding and over-revving in everyday driving (Horswill et al., 2022). The compulsory testing of hazard perception skill as part of licensing systems for novice drivers has led to reductions in novice driver crashes in at least two countries (the UK and Australia), presumably because it raises the skill levels needed before being allowed to drive (Wells, et al., 2008; Boufous et al., 2011).

### 4.2.2 Resilience training

Resilience training is about motivational skills that are not only relevant for driving but also relevant for other aspects of life, such as resisting peer pressure. Senserrick et al. (2021) evaluated the effect a resilience training course had on the crash risk of young novice drivers in Australia in the 13 years after succession of the training. The training course consisted of a one-day community seminar that is preceded an followed by multiple smaller sessions that focus on common youth risks including driver and passenger risks. They found that such a training program reduced crash risk and showed promise. However, the research design of this evaluation study was rather weak because no random assignment was applied.

## 4.3 Exposure measures

Elvik (2010) argues that the young novice driver problem is more difficult to solve than other road safety problems because part of the problem is inherent given the nature of young people and this cannot be changed. Due to the late development of the part of the brain involving executive function and early emotional maturity, young drivers will always remain somewhat more adventurous than older and more experienced drivers. If then the scope for improvement of attitudes towards safe driving is limited, it is still possible to reduce crash rates of young drivers by having them drive less, for example by stimulating the use of public transport among young people. This was not intended to be a road safety measure but it had a strong road safety effect on the crash involvement of young male drivers. As already mentioned, GDL systems postpone independent driving and therefore can also partly be considered as an exposure measure.

## 4.4 Legislation

### 4.4.1 Lower alcohol limit for novice drivers

The EC proposal in March 2023 for a revision of the Directive on Driving Licences includes that novice drivers should be subject to a zero-

tolerance alcohol limit for a minimum of two years after passing their test (EC, 2023). American and Australian research shows that lowering the alcohol limit for young people results in less drink-driving and fewer crashes (Byrne et al. 2016; Senserrick & Williams, 2015). However, in Dutch research no effect on the prevalence of drink-driving was observed after lowering the blood alcohol concentration (BAC) limit for young drivers (I&O Research, 2021). Nor did the number of alcohol-related fatalities or seriously injured young road users decrease in the first two years after the introduction of the lower (BAC) limit for young drivers (Weijermars & van Schagen, 2009). Having reviewed the relationship between crashes and the BAC limit for drivers of all ages in EU member states, Castillo-Manzano et al. (2017) concluded that member states with the lowest BAC limit do not necessarily have the fewest alcohol-related road fatalities per capita. Furthermore, an international meta-analysis shows that enforcement of driving under influence of alcohol reduces crash risk (Erke, Goldenbeld & Vaa, 2009). Thus we can conclude that in EU member states with a zero BAC limit, prevalence of drink-driving and the alcohol-related crash rate can still be high when enforcement is low. Therefore, low BAC limits for young drivers can only be an effective countermeasure if enforced thoroughly.

### 4.4.2 Rehabilitation courses

Some EU member states have special mandatory rehabilitation courses for young offenders. Rehabilitation courses are mostly intended for severe and/or multiple offences, for example driving under influence of alcohol or severe speeding. Most of the time these courses are linked to a demerit point system such as in Germany. Young offenders can keep their licence if they attend these courses. There are numerous evaluation studies and various meta-analyses on the effectiveness of these often-short interventions, but only a few of these studies are about rehabilitation courses that are exclusively for young drivers. Furthermore, most evaluation studies have a weak design. Most studies do not have a robust control group, random assignment is not possible most of the time, and only few studies have recorded offences, or even better, officially recorded crashes as outcome variables. Although most studies find a positive effect (e.g. on the likelihood to reoffend), only few studies can actually identify a reduction in crash risk (Kluppels, Dellanoy & Silverans, 2021; SUPREME, 2007). Not all courses are equally effective, as a recent Dutch study shows: no reduction of recidivism was found among the participants of a course specifically developed for young drink drivers (Blom, Bolderdijk & Weijters, 2017). The authors of the SUPREME report conclude that effective rehabilitation courses should be tailored to the needs of the offenders, the group size should be small, the time between offence and course should be short, and course leaders should be skilled.

## 4.5 Vehicles

### 4.5.1 Advanced Driver Assistant Systems (ADAS)

Safe vehicles, for example vehicles with high Euro NCAP scores, provide greater protection for car occupants when involved in a crash. Vehicle safety equipment and technology protect occupants and other road users in the event of a crash, reduce the likelihood of a collision (e.g., autonomous emergency braking systems) or warn drivers for dangers (e.g., blind spot monitoring or drowsiness alert systems). Some ADAS can even take over part of the driving task, such as lane keeping systems and adaptive cruise control. As of July 2022, some ADAS are mandatory for new car types in EU member states (European Union, 2019). ADAS can be beneficial for young novice drivers because lack of practice means that the execution of driving tasks is not yet fully automated and therefore error prone. However, young drivers should practice their skills in order to acquire a sufficient level of automatic (subconscious) behaviour. Stimulating the use of ADAS for young drivers is therefore a topic of discussion (Weast, Mueller & Kolodge, 2022). Although ADAS, like collision warning systems, can decrease crash risk for drivers in general, the specific effect of these systems on young drivers is not yet well studied. Research in the USA suggests that young drivers decrease the following distance to the vehicle ahead when using a collision warning system (Bao et al., 2020; Jermakian et al., 2017). It is important to note that drivers have to learn when and how to safely apply ADAS and learn when to trust and/or use them, and when not to. In a discussion with driving instructors and driver examiners Helman and colleagues (2016) noted that training and testing on the safe use of ADAS is still limited. The most important reason reported was the lack of standardization: how to operate a system can differ from brand to brand.

### 4.5.2 Monitoring and feedback systems

In-car systems, commonly known as black box or telematics products, monitor driving behaviour with sensors and sometimes also cameras. They can detect harsh braking, speeding, rapid acceleration, and hard turning. Some systems have dashcams that record the road ahead. Implementation of monitoring/feedback systems is typically voluntary and often related to an insurance product. Typically, these systems provide aggregated feedback – either to the insurance or to the young drivers themselves (e.g. smooth driving score or number of times the speed limit was exceeded). Sometimes real-time feedback (e.g. "you are driving too fast!") is provided as well. Research shows that monitoring/feedback systems can reduce risk-related driving behaviour (Toledo & Lotan, 2017). Moreover, research on young drivers has shown that driving style, as measured by g-forces (harsh braking, rapid

acceleration, hard turning) is associated with the occurrence of minor crashes (Simons-Morton et al., 2012). Barriers to adoption of non-commercial systems include acceptance by young drivers and their parents, sometimes due to privacy issues. Positive framing may improve the acceptance rates, for example by adding a game element (Shanly et al., 2018).

### 4.5.3 'Do not disturb' and soft blocking for mobile phones

Mobile phone use while driving can be prevented by certain phone apps. Various apps are available, such as the 'do not disturb apps' for Android phones and Apple phones. The apps can block incoming messages for as long as the young driver is behind the wheel, reducing the potential for distraction. Use of these apps is voluntary and may not reduce risk for young drivers who display the most dangerous behaviours (Caird & Horrey, 2017). Installing a 'soft blocking' app – which only blocks the telephone sound while driving – is a less rigorous option that might therefore be easier to accept (Albert & Lotan, 2019). In the Netherlands, the Auto-modus app of insurance company Interpolis was assessed. This app not only blocks incoming messages, but also hands out compliments or awards merit points to young drivers when they have not used their phones while driving. Compared with a control group, the participants reported less phone use in the weeks they used the app (de Groot-Mesken et al., 2016). Nevertheless, there is little evidence on the prevalence and use of 'do not disturb' settings or soft blocking apps.

# 5. Further reading

Fisher, D.L, Caird, J.K., Horrey, W.J, & Trick, L.M. Eds. (2017). Handbook of Teen and Novice drivers; Research, Practice, Policy, and Directions, Boca Raton: CRC Press Taylor & Francis Group.

OECD. (2006). Young drivers: the road to safety (ITRD E130375). Retrieved from: https://www.oecd-ilibrary.org/transport/young-drivers_9789282113356-en

# 6. References

AA Road Safety Foundation (2019). Young drivers' rural road risk analysis. Retrieved from https://static1.squarespace.com/static/5d0a03b295f37b00018da721/t/60a61b440a15fb41b5b21961/1621498697090/AA+Charitable+Trust++final-young-drivers-rural-road-risk-exploratory-analysis-updated.pdf

Achermann Stürmer, Y., Meesmann, U. & Berbatovci, H. (2019). ESRA2 (E-Survey of Road users'Attitudes) Thematic report No. 5: Driving under the influence of alcohol and drugs. Swiss Council for Accident Prevention, Bern, Switzerland.

Albert, G., & Lotan, T. (2019). Exploring the impact of "soft blocking" on smartphone usage of young drivers. Accident Analysis and Prevention, 125, 56-62. doi:10.1016/j.aap.2019.01.031

Arnett, J. J. (2002). Developmental sources of crash risk in young drivers. Injury Prevention, 8 (suppl 2), ii17-ii23. doi:10.1136/ip.8.suppl_2.ii17

Asbridge, M., Wickens, C., Mann, R., & Cartwright, J. (2017). Alcohol, Cannabis, and New Drivers. In D. L. Fisher, J. K. Caird, W. J. Horrey, & L. M. Trick (Eds.), Handbook of Teen and Novice Drivers. Boca Raton: CRC Press.

Banz, B.C., Fell, J.C. & Vaca, F.E. (2019). Complexities of young driver injury and fatal motor vehicle crashes. In: Yale Journal of Biology and Medicine, vol. 92, nr. 4, p. 725-731.

Bao, S., Wu, L., Yu, B., & Sayer, J. R. (2020). An examination of teen drivers' car-following behavior under naturalistic driving conditions: With and without an advanced driving assistance system. Accident Analysis & Prevention, 147, 105762. doi:https://doi.org/10.1016/j.aap.2020.105762

Beanland, V., Goode, N., Salmon, P. M., & Lenné, M. G. (2013). Is there a case for driver training? A review of the efficacy of pre- and post-license driver training. Safety Science, 51(1), 127-137. doi:10.1016/j.ssci.2012.06.021

Blom, M., Bolderdijk, D., & Weijters, G. (2019). Recidive na maatregelen rijvaardigheid en geschiktheid (Cahier 2019-20).

Blomberg, T. I. F. D., & Fisher, D. L. (2012). A fresh look at driver education in America (DOT HS 811 543).

Boufous, S., Ivers, R., Senserrick, T., & Stevenson, M. (2011). Attempts at the Practical On-Road Driving Test and the Hazard Perception Test and the Risk of Traffic Crashes in Young Drivers. Traffic Injury Prevention, 12(5), 475-482. doi:10.1080/15389588.2011.591856

Bräker, A. B., & Soellner, R. (2016). Alcohol drinking cultures of European adolescents. European Journal of Public Health, 26(4), 581-586. doi:10.1093/eurpub/ckw033

Byrne, P. A., Ma, T., Mann, R. E., & Elzohairy, Y. (2016). Evaluation of the general deterrence capacity of recently implemented (2009–2010) low and Zero BAC requirements for drivers in Ontario. Accident Analysis & Prevention, 88, 56-67. doi:https://doi.org/10.1016/j.aap.2015.12.002

Caird, J. K., & Horrey, W. J. (2017). A Review of Novice and Teen Driver Distraction. In D. L. Fisher, J. K. Caird, W. J. Horrey, & L. M. Trick (Eds.), Handbook of Teen and Novice Drivers. Boca Raton: CRC Press.

Caird, J. K., Simmons, S. M., Wiley, K., Johnston, K. A., & Horrey, W. J. (2018). Does Talking on a Cell Phone, With a Passenger, or Dialing Affect Driving Performance? An Updated Systematic Review and Meta-Analysis of Experimental Studies. Human Factors, 60(1), 101-133. doi:10.1177/0018720817748145

CARE (2021) Community database on road accidents in the European Union. https://ec.europa.eu/transport/road_safety/specialist/observatory/care-database_en

Cascio, C. N., Carp, J., O'Donnell, M. B., Tinney, F. J., Bingham, C. R., Shope, J. T., . . . Falk, E. B. (2014). Buffering social influence: Neural correlates of response inhibition predict driving safety in the presence of a peer. Journal of Cognitive Neuroscience, X(Y), 1–13. doi:doi:10.1162/jocn_a_00693

Cassarino, M., & Murphy, G. (2018). Reducing young drivers' crash risk: Are we there yet? An ecological systems-based review of the last decade of research. Transportation Research Part F: Traffic Psychology and Behaviour, 56, 54-73. doi:10.1016/j.trf.2018.04.003

Clarke, D. D., Ward, P., Bartle, C., & Truman, W. (2006). Young driver accidents in the UK: The influence of age, experience, and time of day. Accident Analysis & Prevention, 38(5), 871-878.

Cordellieri, P., Baralla, F., Ferlazzo, F., Sgalla, R., Piccardi, L., & Giannini, A. M. (2016). Gender Effects in Young Road Users on Road Safety Attitudes, Behaviors and Risk Perception. Frontiers in Psychology, 7 (1412). doi:10.3389/fpsyg.2016.01412

Curry, A. E., Hafetz, J., Kallan, M. J., Winston, F. K., & Durbin, D. R. (2011). Prevalence of teen driver errors leading to serious motor vehicle crashes. Accident Analysis & Prevention, 43, 1285-1290.

Curry, A. E., Elliott, M. R., Pfeiffer, M. R., Kim, K. H., & Durbin, D. R. (2014). Long-term changes in crash rates after introduction of a Graduated Driver Licensing decal provision. American Journal of Preventive Medicine, 48(2), 121-127.

de Craen, S. (2010). The X-factor; a longitudinal study of calibration in young novice drivers.

de Groot-Mesken, J., Wijnen, W., Stelling-Konczak, A., & Commandeur, J. J. F. (2016). Interpolis SlimOpWeg-programma: de AutoModus-app; Vragenlijstonderzoek naar het effect van een app om smartphonegebruik in de auto te verminderen (R-2016-3).

DfT (2018). Young Car Drivers Road Safety Factsheet (2016). Retrieved from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/706516/young-car-drivers-factsheet.pdf

Elvik, R., Høye, A., Vaa, T., & Sørensen, M. (2009). The handbook of road safety measures (2 ed.). Bingley, UK: Emerald Group Publishing Limited.

Elvik, R. (2010). Why some road safety problems are more difficult to solve than others. Accident Analysis & Prevention, 42(4), 1089-1096.

Elvik, R. (2013). Risk of road accident associated with the use of drugs: A systematic review and meta-analysis of evidence from epidemiological studies. Accident Analysis & Prevention, 60, 254-267. doi: https://doi.org/10.1016/j.aap.2012.06.017

Engström, I., Gregersen, N. P., Granström, K., & Nyberg, A. (2008). Young drivers-Reduced crash risk with passengers in the vehicle. Accident Analysis and Prevention, 40(1), 341-348. doi:10.1016/j.aap.2007.07.001

Erke, A., Goldenbeld, C. & Vaa, T. (2009). The effects of drink-driving checkpoints on crashes—A meta-analysis. In: Accident Analysis & Prevention, vol. 41, nr. 5, p. 914-923.

European Union. (2019). REGULATION (EU) 2019/2144 on type-approval requirements for motor vehicles and their trailers, and systems, components and separate technical units intended for such vehicles, as regards their general safety and the protection of vehicle occupants and vulnerable road users. Retrieved from https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019R2144&from=EN

European Commission (2018). Traffic Safety Basic Facts; Young people (18-24). Retrieved from https://ec.europa.eu/transport/road_safety/sites/default/files/pdf/statistics/dacota/bfs2018_young_people.pdf

Foss, R., Masten, S., & Martell, C. (2014). Examining the Safety Implications of Later Licensure: Crash Rates of Older vs. Younger Novice Drivers Before and After Graduated Driver Licensing. Retrieved from https://aaafoundation.org/wp-content/uploads/2017/12/OlderVsYoungerLicensingCrashesReport.pdf

Fuller, R., Bates, H., Gormley, M., Hannigan, B., Stradling, S., Broughton, P., . . . O'dolan, C. (2008). The conditions for inappropriate high speed: A review of the research literature from 1995 to 2006. (Road Safety Research Report 92). Retrieved from https://www.researchgate.net/profile/Stephen-Stradling/publication/254419363_The_Conditions_for_Inappropriate_High_Speed_A_Review_of_the_Research_Literature_from_1995_to_2006/links/55e4bb9d08ae6abe6e903206/The-Conditions-for-Inappropriate-High-Speed-A-Review-of-the-Research-Literature-from-1995-to-2006.pdf

Furian, G., Kaiser, S., Senitschnig, N. & Soteropoulos, A. (2021). *Young Road Users: ESRA2 Thematic report Nr. 14*. Austrian Road Safety Board - KFV, VIenna, Austria.

Geber, S., Baumann, E., Czerwinski, F., & Klimmt, C. (2019). The Effects of Social Norms Among Peer Groups on Risk Behavior: A Multilevel Approach to Differentiate Perceived and Collective Norms. Communication Research, 48(3), 319-345. doi:10.1177/0093650218824213

Gershon, P., Sita, K. R., Zhu, C., Ehsani, J. P., Klauer, S. G., Dingus, T. A., & Simons-Morton, B. G. (2019). Distracted Driving, Visual Inattention, and Crash Risk Among Teenage Drivers. American Journal of Preventive Medicine, 56(4), 494-500. doi:https://doi.org/10.1016/j.amepre.2018.11.024

Gicquel, L., Ordonneau, P., Blot, E., Toillon, C., Ingrand, P., & Romo, L. (2017). Description of Various Factors Contributing to Traffic Accidents in Youth and Measures Proposed to Alleviate Recurrence. Frontiers in Psychiatry, 8 (94). doi:10.3389/fpsyt.2017.00094

Gogtay, N., Giedd, J. N., Lusk, L., Hayashi, K. M., Greenstein, D., Vaituzis, A. C., . . . Thompson, P. M. (2004). Dynamic mapping of human cortical development during childhood through early adulthood. Proc Natl Acad Sci U S A, 101(21), 8174-8179. doi:10.1073/pnas.0402680101

Goldenbeld, C., Torfs, K., Vlakveld, W., & Houwing, S. (2020). Impaired driving due to alcohol or drugs: International differences and determinants based on E-Survey of Road Users' Attitudes first-wave results in 32 countries. IATSS Research. doi:https://doi.org/10.1016/j.iatssr.2020.07.005

Groeger, J. A. (2006). Youthfulness, inexperience, and sleep loss: the problems young drivers face and those they pose for us. Injury prevention: journal of the International Society for Child and Adolescent Injury Prevention, 12 Suppl 1(Suppl 1), i19-i24. doi:10.1136/ip.2006.012070

Guggenheim, N., Taubman – Ben-Ari, O., & Ben-Artzi, E. (2020). The contribution of driving with friends to young drivers' intention to take risks: An expansion of the theory of planned behavior. Accident Analysis & Prevention, 139, 105489. doi: https://doi.org/10.1016/j.aap.2020.105489

Guo, F., Klauer, S. G., Fang, Y., Hankey, J. M., Antin, J. F., Perez, M. A., . . . Dingus, T. A. (2017). The effects of age on crash risk associated with driver distraction. Int J Epidemiol, 46(1), 258-265. doi:10.1093/ije/dyw234

Hatakka, M., Keskinen, E., Gregersen, N. P., Glad, A., & Hernetkoski, K. (2002). From control of the vehicle to personal self-control; broadening the perspectives to driver education. Transportation Research Part F: Traffic Psychology and Behaviour, 5(3), 201-215. doi: http://dx.doi.org/10.1016/S1369-8478(02)00018-9

Helman, S., Vlakveld, W., Fildes, B., Oxley, J., Fernández-Medina, K., & Weekley, J. (2016). Study on driver training, testing and medical fitness: final report. Retrieved from https://ec.europa.eu/transport/road_safety/sites/default/files/dl_study_on_training_testing_med_fitness.pdf

Helman, S., Wallbank, C., Chowdhury, S., Hammond, J., Kinnear, N., Buttress, S., Grayson, G. B. (2017). Transforming the practical driving test (PPR828). Retrieved from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/640646/transforming-the-practical-driving-test-research-report.pdf

Herrera-Gómez, F., García-Mingo, M., Colás, M., González-Luque, J. C., & Alvarez, F. J. (2019). Drivers who tested positive for cannabis in oral fluid: A longitudinal analysis of administrative data for Spain between 2011 and 2016. BMJ Open, 9(8). doi:10.1136/bmjopen-2018-026648

Hirschberg, J., & Lye, J. (2020). Impacts of graduated driver licensing regulations. Accid Anal Prev, 139, 105485. doi:10.1016/j.aap.2020.105485

Horswill, M. S. (2016). Hazard Perception in Driving. Current directions in psychological science, 25(6), 425-430. doi:10.1177/0963721416663186

Horswill, M. S., Hill, A., & Wetton, M. (2015). Can a video-based hazard perception test used for driver licensing predict crash involvement? Accident Analysis & Prevention, 82(0), 213-219. doi:http://dx.doi.org/10.1016/j.aap.2015.05.019

Horswill, M. S., Hill, A., Rodwell, D., Larue, G. S., Bates, L., & Watson, B. (2021). A brief and unsupervised online intervention improves performance on a validated test of hazard perception skill used for driver licensing. Transportation Research Part F: Traffic Psychology and Behaviour, 78, 130-136. doi: https://doi.org/10.1016/j.trf.2021.02.003

Horswill, M.S., Hill, A., Buckley, L., Kieseker, G., et al. (2022). *An online hazard perception training course reduces heavy braking, speeding, and over-revving rates during everyday driving.* In: Transportation Research Part F: Traffic Psychology and Behaviour, vol. 87, p. 54-68.

Horswill, M. S., & McKenna, F. P. (1999). The development, validation, and application of a video-based technique for measuring an everyday risk-taking behavior: Drivers' speed choice. Journal of Applied Psychology, 84(6), 977-985. doi:10.1037/0021-9010.84.6.977

Houwing, S., Twisk, D., & De Waard, D. (2015). Alcoholgebruik van jongeren in het verkeer op stapavonden (R-2015-12).

I&O Research. (2021). Rijden onder invloed in Nederland in 2006-2019: Ontwikkeling van het alcoholgebruik van automobilisten in weekendnachten.

Jermakian, J. S., Bao, S., Buonarosa, M. L., Sayer, J. R., & Farmer, C. M. (2017). Effects of an integrated collision warning system on teenage driver behavior. Journal of Safety Research, 61, 65-75. doi: https://doi.org/10.1016/j.jsr.2017.02.013

Jolles, J. (2019). Het tienerbrein; Over de adolescent tussen biologie en omgeving. Amsterdam: Amsterdam University Press B.V.

Jongen, S., van der Sluiszen, N. N. J. J. M., Brown, D., & Vuurman, E. F. P. M. (2018). Single- and dual-task performance during on-the-road driving at a low and moderate dose of alcohol: A comparison between young novice and more experienced drivers. Human Psychopharmacology, 33(3). doi:10.1002/hup.2661

Katila, A., Keskinen, E., Hatakka, M., & Laapotti, S. (2004). Does increased confidence among novice drivers imply a decrease in safety?: The effects of skid training on slippery road accident. Accident Analysis & Prevention, 36(4), 543-550.

Keskinen, E., Hatakka, M., Katila, A., Laapotti, S., & Peräaho, M. (1999). Driver training in Finland. IATSS Research, 23(1), 78-84.

Kinnear, N., Kelly, S. W., Stradling, S., & Thomson, J. (2013). Understanding how drivers learn to anticipate risk on the road: A laboratory experiment of affective anticipation of road hazards. Accident Analysis & Prevention, 50(0), 1025-1033. doi:http://dx.doi.org/10.1016/j.aap.2012.08.008

Kinnear, N., Lloyd, L., Helman, S., Husband, P., Scoons, J., Jones, S., . . . Broughton, J. (2013). Novice drivers: Evidence Review and Evaluation; Pre-driver education and training, Graduated Driver Licensing,and the New Drivers Act (PPR673)

Klauer, S. G., Guo, F., Simons-Morton, B. G., Ouimet, M. C., Lee, S. E., & Dingus, T. A. (2014). Distracted Driving and Risk of Road Crashes among Novice and Experienced Drivers. New England Journal of Medicine, 370(1), 54-59. doi:doi:10.1056/NEJMsa1204142

Kluppels, L., Dellannoy, S., & Silverans, P. (2021). Kortdurende educatieve maatregelen voor verkeersovertreders (2021-R-09-NL). Retrieved from https://www.vias.be/publications/Kortdurende educatieve maatregelen/KF-20-EXANT-EDUC-FINAL-NL-Kortdurendeeducatievemaatregelen.pdf

Lyon, C., Mayhew, D., Granié, M.-A., Robertson, R., Vanlaar, W., Woods-Fry, H., . . . Soteropoulos, A. (2020). Age and road safety performance: Focusing on elderly and young drivers. IATSS Research, 44(3), 212-219. doi:https://doi.org/10.1016/j.iatssr.2020.08.005

Lonero, L., & Mayhew, D. R. (2010). Teen driver safety; Large-scale evaluation of driver education review of the literature on driver education evaluation.

Lu, D., Guo, F., & Li, F. (2020). Evaluating the causal effects of cell phone distraction on crash risk using propensity score methods. Accident Analysis & Prevention, 143, 105579. doi: https://doi.org/10.1016/j.aap.2020.105579

Mayhew, D. R., & Simpson, H. M. (2002). The safety value of driver education and training. Injury Prevention, 8(suppl 2), ii3-ii8. doi:10.1136/ip.8.suppl_2.ii3

McCartt, A. T., Mayhew, D. R., Braitman, K. A., Ferguson, S. A., & Simpson, H. M. (2009). Effects of age and experience on young driver crashes: Review of recent literature. Traffic Injury Prevention, 10(3), 209 - 219.

McCartt, A. T., Teoh, E. R., Fields, M., Braitman, K. A., & Hellinga, L. A. (2010). Graduated Licensing Laws and Fatal Crashes of Teenage Drivers: A National Study. Traffic Injury Prevention, 11(3), 240-248. doi:10.1080/15389580903578854

McDonald, C. C., Goodwin, A. H., Pradhan, A. K., Romoser, M. R. E., & Williams, A. F. (2015). A Review of Hazard Anticipation Training Programs for Young Drivers. Journal of Adolescent Health, 57(1, Supplement), S15-S23. doi: http://dx.doi.org/10.1016/j.jadohealth.2015.02.013

McDonald, C. C., Sommers, M. S., & Winston, F. K. (2017). Novice Teen Driver Crash Patterns. In D. L. Fisher, J. K. Caird, W. J. Horrey, & L. M. Trick (Eds.), Handbook of Teen and Novice Drivers. Boca Raton: CRC Press.

Møller, M., & Sigurðardóttir, S. B. (2009). The relationship between leisure time and driving style in two groups of male drivers. Transportation Research Part F: Traffic Psychology and Behaviour, 12(6), 462-469. doi: https://doi.org/10.1016/j.trf.2009.08.005

Moran, C., Bennett, J. M., & Prabhakharan, P. (2019). Road user hazard perception tests: A systematic review of current methodologies. Accident Analysis & Prevention, 129, 309-333. doi: https://doi.org/10.1016/j.aap.2019.05.021

Mynttinen, S., Gatscha, M., Koivukoski, M., Hakuli, K., & Keskinen, E. (2010). Two-phase driver education models applied in Finland and in Austria – Do we have evidence to support the two phase models? Transportation Research Part F: Traffic Psychology and Behaviour, 13(1), 63-70. doi:10.1016/j.trf.2009.11.002

Ouimet, M. C., Pradhan, A. K., Brooks-Russell, A., Ehsani, J. P., Berbiche, D., & Simons-Morton, B. G. (2015). Young drivers and their passengers: A systematic review of epidemiological studies on crash risk. Journal of Adolescent Health, 57(1), s24-S35.e26. doi:10.1016/j.jadohealth.2015.03.010

Ouimet, M. C., Simons-Morton, B. G., Zador, P. L., Lerner, N. D., Freedman, M., Duncan, G. D., & Wang, J. (2010). Using the U.S. National Household Travel Survey to estimate the impact of passenger characteristics on young drivers' relative risk of fatal crash involvement. Accident Analysis & Prevention, 42(2), 689-694. doi: https://doi.org/10.1016/j.aap.2009.10.017

Pagomenos, A., Rodwell, D. & Larue, G.S. (2023). *Predicting young drivers' safe behaviour of stopping in the dilemma zone.* In: Transportation Research Part F: Traffic Psychology and Behaviour, vol. 92, p. 283-300.

Paterson, J. L., & Dawson, D. (2017). Fatigue and Road Safety for Young and Novice Drivers. In D. L. Fisher, J. K. Caird, W. J. Horrey, & L. M. Trick (Eds.), Handbook of Teen and Novice Drivers. Boca Raton: CRC Press.

Peck, R. C. (2011). Do driver training programs reduce crashes and traffic violations? — A critical examination of the literature. IATSS Research, 34(2), 63-71. doi: http://dx.doi.org/10.1016/j.iatssr.2011.01.001

Peck, R. C., Gebers, M. A., Voas, R. B., & Romano, E. (2008). The relationship between blood alcohol concentration (BAC), age, and crash risk. Journal of Safety Research, 39(3), 311-319. doi: https://doi.org/10.1016/j.jsr.2008.02.030

Roberts, S.C., Zhang, F., Fisher, D. & Vaca, F.E. (2021). The effect of hazard awareness training on teen drivers of varying socioeconomic status. In: Traffic Inj Prev, vol. 22, nr. 6, p. 455-459.

Rogeberg, O. (2019). A meta-analysis of the crash risk of cannabis-positive drivers in culpability studies—Avoiding interpretational bias. Accident Analysis & Prevention, 123, 69-78. doi: https://doi.org/10.1016/j.aap.2018.11.011

Rogeberg, O., & Elvik, R. (2016). The effects of cannabis intoxication on motor vehicle collision revisited and revised. Addiction, 111(8), 1348-1359. doi: https://doi.org/10.1111/add.13347

Russell, K. F., Vandermeer, B., & Hartling, L. (2011). Graduated driver licensing for reducing motor vehicle crashes among young drivers. Cochrane Database Syst Rev(10), Cd003300. doi:10.1002/14651858.CD003300.pub3

Sagberg, F. (1998, August 9-14). Month-by-month changes in accident risk among novice drivers. Paper presented at the 24th International Conference of Applied Psychology, San Francisco.

Senserrick, T., Möller, H., Rogers, K., Cullen, P., et al. (2021). *Youth Resilience Education and 13-Year Motor Vehicle Crash Risk.* In: Pediatrics, vol. 148, nr. 6.

Senserrick, T., & Williams, A. F. (2015). Summary of literature of the effective components of graduated driver licensing systems. Retrieved from Sydney: https://www.parliament.vic.gov.au/images/Attachment_to_Submission_no._75_-_Literature_Review_of_Effective_Components_of_Graduated_Licensing_Schemes.pdf

Shanly, C., Ieti, M., Warren, I., & Sun, J. (2018). BackPocketDriver-a mobile app to enhance safe driving for youth.

Simons-Morton, B. G., Zhang, Z., Jackson, J. C., & Albert, P. S. (2012). Do Elevated Gravitational-Force Events While Driving Predict Crashes and Near Crashes? American Journal of Epidemiology, 175 (10), 1075-1079. doi:10.1093/aje/kwr440

Stanojević, P., Lajunen, T., Jakšić, D., Jovanović, D., et al. (2022). Effectiveness of implementing a Graduated Driver Licensing (GDL) law among young Serbian drivers. In: Journal of Safety Research.

Steinberg, L. (2008). A Social Neuroscience Perspective on Adolescent Risk-Taking. Developmental review : DR, 28(1), 78-106. doi:10.1016/j.dr.2007.08.002

SUPREME (2007). Thematic Report: Rehabilitation and Diagnostics (SER-TREN/E3-2005-SUPREME-S07.53754). Retrieved from https://ec.europa.eu/transport/road_safety/sites/default/files/pdf/projects_sources/supreme_f3_thematic_report_rehabilitation_and_diagnostics.pdf

Taubman - Ben-Ari, O., Musicant, O., Lotan, T., & Farah, H. (2014). The contribution of parents' driving behavior, family climate for road safety, and parent-targeted intervention to young male driving behavior. Accident Analysis & Prevention, 72, 296-301. doi: https://doi.org/10.1016/j.aap.2014.07.010

Theeuwes, J. (2021). Self-explaining roads: What does visual cognition tell us about designing safer roads? Cognitive Research: Principles and Implications, 6(1), 15. doi:10.1186/s41235-021-00281-6

Thomas, F. D., Rilea, S., Blomberg, R. D., Peck, R. C., & Korbelak, K. T. (2016). Evaluation of the safety benefits of the risk awareness and perception training program for novice teen drivers. Retrieved from: http://library.swov.nl/action/front/cardweb?id=342482

Toledo, G., & Lotan, T. (2017). Feedback technologies to young drivers. In D. L. Fisher, J. K. Caird, W. J. Horrey, & L. M. Trick (Eds.), Handbook of Teen and Novice Drivers; Research, Practice, Policy, and Directions (pp. 305-318). Boca Raton: CRC Press.

Twisk, D.A.M. & Stacey, C. (2007). Trends in young driver risk and countermeasures in European countries. In: Journal of Safety Research, vol. 38, nr. 2, p. 245-257.

Vlakveld, W. (2011). Hazard anticipation of young novice drivers; Assessing and enhancing the capabilities of young novice drivers to anticipate latent hazards in road and traffic situations; Proefschrift Rijksuniversiteit Groningen.

Vlakveld, W. (2016). Developed Nations. In D. L. Fisher, J. K. Caird, W. J. Horrey, & L. M. Trick (Eds.), Handbook of Teen and Novice Drivers; Research, Practice, Policy, and Directions. Boca Raton: CRC Press.

Walshe, E. A., Winston, F. K., Betancourt, L. M., Khurana, A., Arena, K., & Romer, D. (2019). Working Memory Development and Motor Vehicle Crashes in Young Drivers. JAMA network open, 2(9), e1911421. doi:10.1001/jamanetworkopen.2019.11421

Washington, S., Cole, R. J., & Herbel, S. B. (2011). European advanced driver training programs: Reasons for optimism. IATSS Research, 34(2), 72-79. doi: http://dx.doi.org/10.1016/j.iatssr.2011.01.002

Watson, L. M., & Newstead, S. V. (2009). Vehicle safety and young drivers, Stage 1 – Profile of young driver vehicles (Final Report). Retrieved from Melbourne, Australia: https://www.semanticscholar.org/paper/VEHICLE-SAFETY-AND-YOUNG-DRIVERS-STAGE-1%3A-PROFILE-Newstead/8311524f7de02edea3050bb117742b806481a6eb

Watson-Brown, N., Scott-Parker, B., & Senserrick, T. (2019). Association between higher-order driving instruction and risky driving behaviours: Exploring the mediating effects of a self-regulated safety orientation. Accident Analysis & Prevention, 131, 275-283. doi: https://doi.org/10.1016/j.aap.2019.07.005

Watson-Brown, N., Scott-Parker, B., & Senserrick, T. (2021). Higher order training supporting competence, autonomy, relatedness (HOT-CAR): A model to improve learner drivers' higher order skills. Transportation Research Part F: Traffic Psychology and Behaviour, 80, 79-89. doi: https://doi.org/10.1016/j.trf.2021.03.013

Watson-Brown, N., Senserrick, T., Freeman, J., Davey, J., et al. (2021). Self-regulation differences across learner and probationary drivers: The impact on risky driving behaviours. In: Accident; analysis and prevention, vol. 154, p. 106064.

Weast, R.A., Mueller, A.S. & Kolodge, K. (2022). *Learning to drive: Parental attitudes toward introducing teen drivers to advanced driver assistance systems.* In: Traffic Injury Prevention, vol. 23, nr. 1, p. 1-5.

Weijermars, W. A. M., & van Schagen, I. N. L. G. (2009). Tien jaar Duurzaam Veilig: verkeersveiligheidsbalans 1998-2007 (R-2009-14).

Wells, P., Tong, S., Sexton, B. F., Grayson, G. B., & Jones, E. (2008). Cohort II: A study of learner and new drivers. Retrieved from http://webarchive.nationalarchives.gov.uk/20100513151012/http:/www.dft.gov.uk/pgr/roadsafety/research/rsrr/theme2/cohort2/cohrtiimainreport.pdf

Wetton, M. A., Hill, A., & Horswill, M. S. (2011). The development and validation of a hazard perception test for use in driver licensing. Accident Analysis & Prevention, 43(5), 1759-1770. doi: http://dx.doi.org/10.1016/j.aap.2011.04.007

Williams, A. F. (2017). Graduated driver licensing (GDL) in the United States in 2016: A literature review and commentary. J Safety Res, 63, 29-41. doi:10.1016/j.jsr.2017.08.010


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