Young road users (teenagers and adolescents)

SWOV fact sheet, November 2022

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Summary

This fact sheet describes the road safety of young road users. Wherever possible, the age limit of 10 to 17 was used. During these years, the human brain develops, the hormonal system changes, mobility alters and one's social circles widen and gain more importance. Where some sources (data or literature) use different age limits, we adopted them.

In the Netherlands, an average of 24 youngsters aged 12 to 17 are killed in traffic, most of whom are cyclists. After suicide, road crashes are the second most important cause of death of youngsters aged 10 to 19.

Crash risk for cyclists is higher than for drivers, due to their vulnerability. Young people cycle a lot and are, therefore, relatively often involved in road crashes. For all modes of transport, particularly young road users aged 15 to 17 run a higher risk of injury (per distance travelled; MAIS2+ and not killed) than other age groups. Yet, they are relatively less often killed in traffic than road users of other age groups. Youngsters are more prone to risk behaviour and the influence of peers increases because their brains are still developing. In addition, their cycling skills and hazard recognition are not sufficiently developed yet. Finally, gender is relevant; boys take more risks than girls.

With a ban and interventions focusing on phone use, education, and the moped licence, a reduction of the number of young road casualties is aimed at. It is not exactly clear how effective these measures are. The main effect of the moped licence was a reduction of moped ownership, which also reduced the number of crashes. Other measures that could be effective are: improvement of the cycling infrastructure, (encouraging) bicycle helmet use and hazard recognition training.

1 How many young road users are killed or injured in Dutch traffic?

In the Netherlands, an annual[1] average of 24 young road users aged 12 to 17 are killed in traffic (see *figure 1*). It is unknown how many young road users get injured, because the numbers cannot be disaggregated for age in any reliable way.

[1] This is the annual average of 2009-2018. In later years, the actual numbers were not disaggregated for this age group.

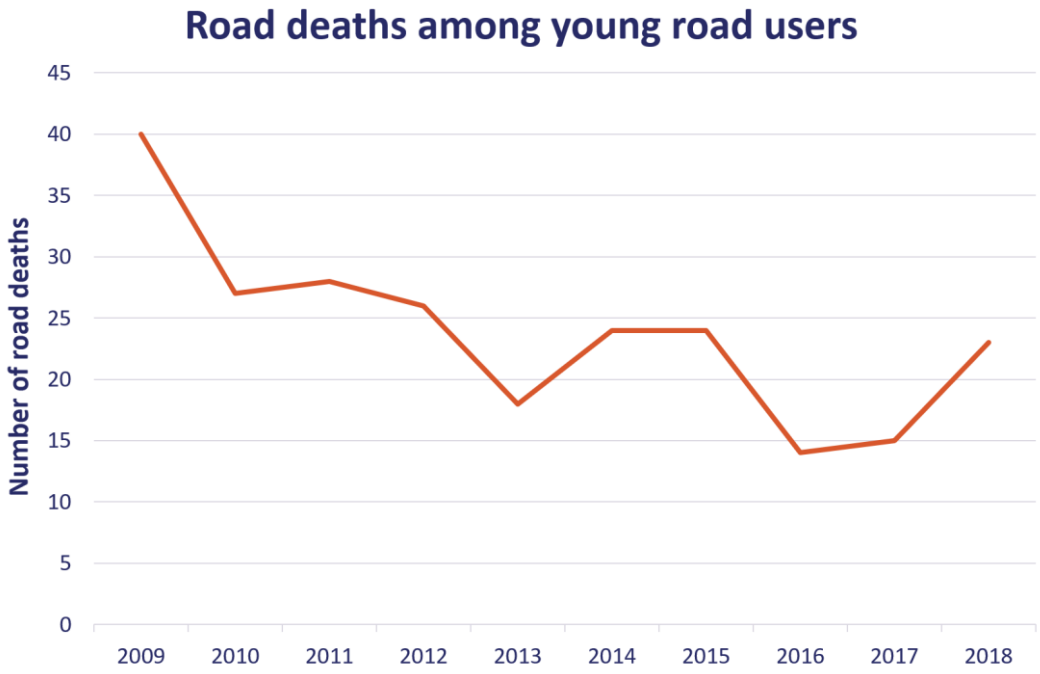

Figure 1. Number of road deaths among young road users aged 12 to 17, between 2009 and 2018[2]. Source: Statistics Netherlands (Road Death Statistics).

2 What is the risk for young road users in the Netherlands?

Young road users aged 15 to 17 are relatively less often killed in traffic than road users of other ages [1]. Yet, in the case of young road users, it is important not to limit our view to road fatalities. After all, this age group does run a higher injury risk (estimated for distance travelled; MAIS2+ and not killed[3]) than all other age groups [1]. Looking at the health burden (expressed as disability-adjusted life years, life years lost and years lived with a disability) these young road users carry 15% of the health burden due to road crashes [1]. The only group with a heavier health burden are the over-75s.

Compared to other non-natural causes of death of youngsters, road crashes are the secondary cause of death after the primary cause of death which is suicide *(Figure 1*).

[2] This is the average for 2009-2018. In later years, the actual numbers were not disaggregated for this age group.

[3] Based on registered numbers.

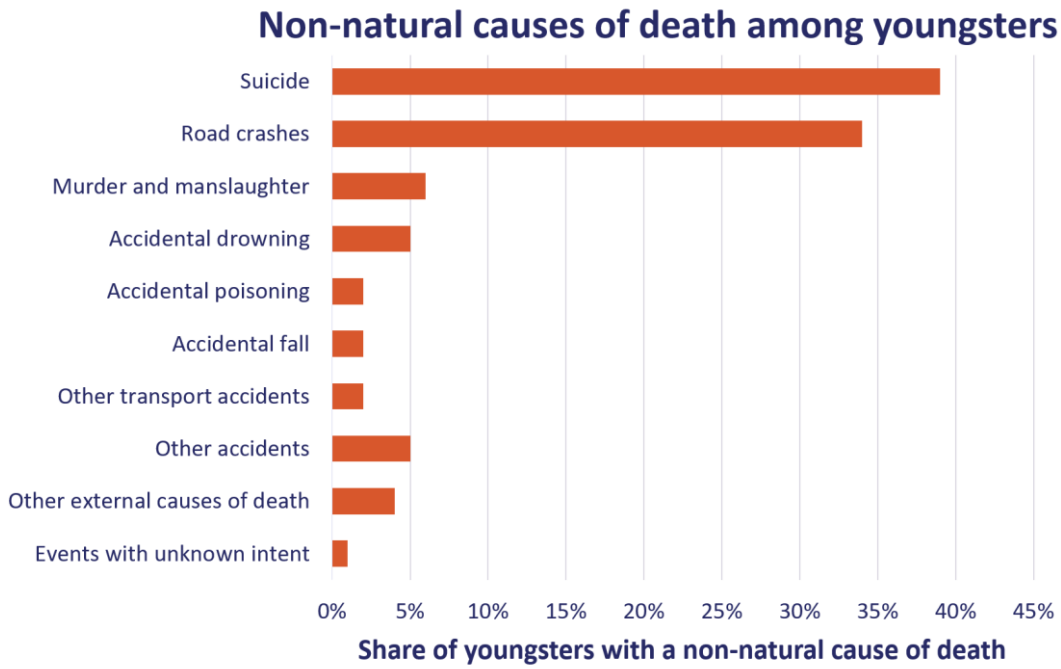

Figure 1. The share of young road users aged 10-19 with a non-natural cause of death in 2011-2020. Source: Statistics Netherlands, causes of death [2].

3 Which modes of transport have most casualties among young road users?

Of young road users (12-17) killed in traffic between 2009 and 2018, the vast majority were cyclists (52%), followed by moped riders (29%) and drivers of cars or delivery vans (18%; *Figure 2*). Young road users cycle a lot, which explains the high share of cyclist casualties; cycling accounts for one third (2000 kms) of the total mobility of young road users aged 12 to 17 [1].

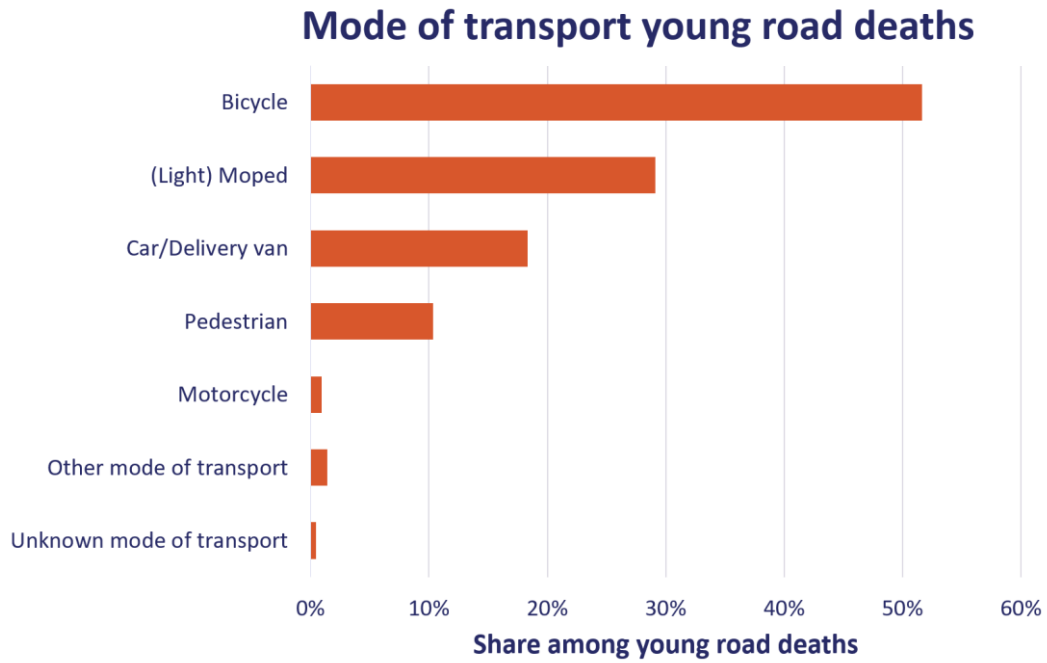

Figure 2. Share of road deaths among young road users aged 12 to 17, between 2009 and 2018, by mode of transport. Source: Statistics Netherlands [3].

4 Where and in what circumstances do most casualties among young road users occur?

Crashes among young road users by speed limit

Most registered[4] road deaths among young road users occur on roads with a speed limit of 50 km/h (mainly in the urban area), followed by roads with a speed limit of 80 km/h and 60 km/h (mainly in the rural area); see *Figure 3*.

4. For disaggregation of road deaths for different road types, we have to rely on road crash registration by the police (BRON). However, not all road deaths are registered here (see SWOV fact sheet *Road deaths in the Netherlands*).

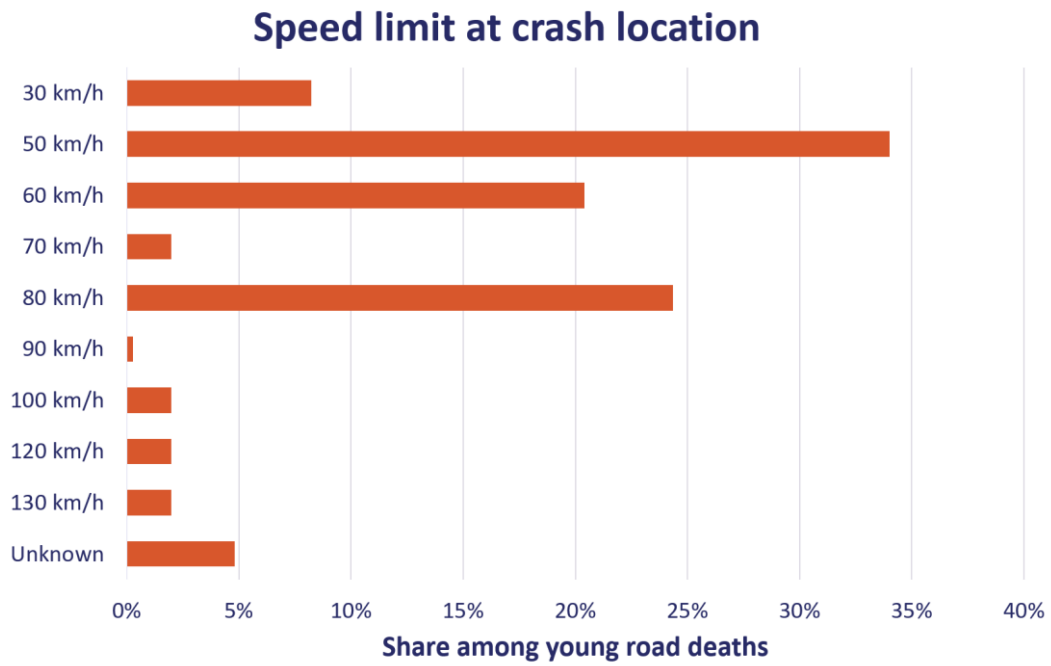

Figure 3. The share of registered road deaths among young road users aged 10-17 (2011-2020) disaggregated for speed limit. Sources: Ministry of Infrastructure and Water Management (BRON), Statistics Netherlands (Road Death Statistics), edited by SWOV.

Time of day and month

Figure 5 presents the share of registered road deaths among young road users (2011-2020) on week days and weekend days per hour. In the 'total number of road deaths' there are three peak periods on weekdays. Two peaks (around 7 to 8 am and between 1 and 5 pm) seem to correspond to the times at which young road users travel to and from school. The third peak (around 8 pm) seems to refer to travels home from sports clubs/hobbies/friends. What is also apparent is that more casualties occur after midnight in the weekend than on weekdays.

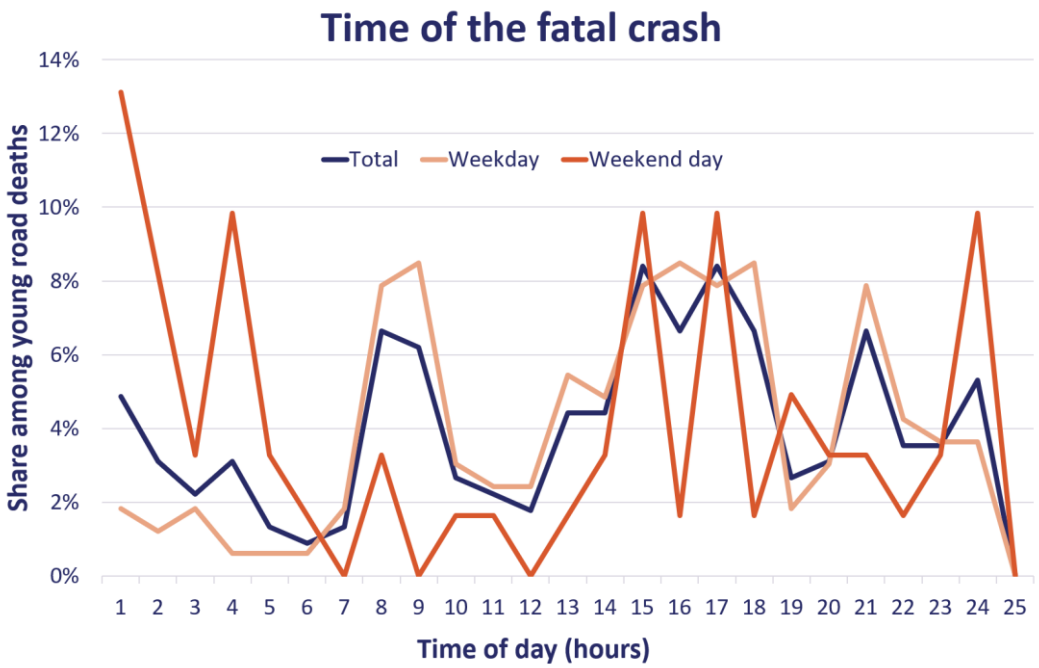

Figure 5. The share of registered road deaths (2011-2020) among young road users aged 10-17, disaggregated for hours of the day. Sources: Ministry of Infrastructure and Water Management (BRON), Statistics Netherlands (Road Death Statistics), edited by SWOV.

Figure 4 presents the monthly number of registered road deaths among young road users between 2011 and 2020. There are no clear differences between the months.

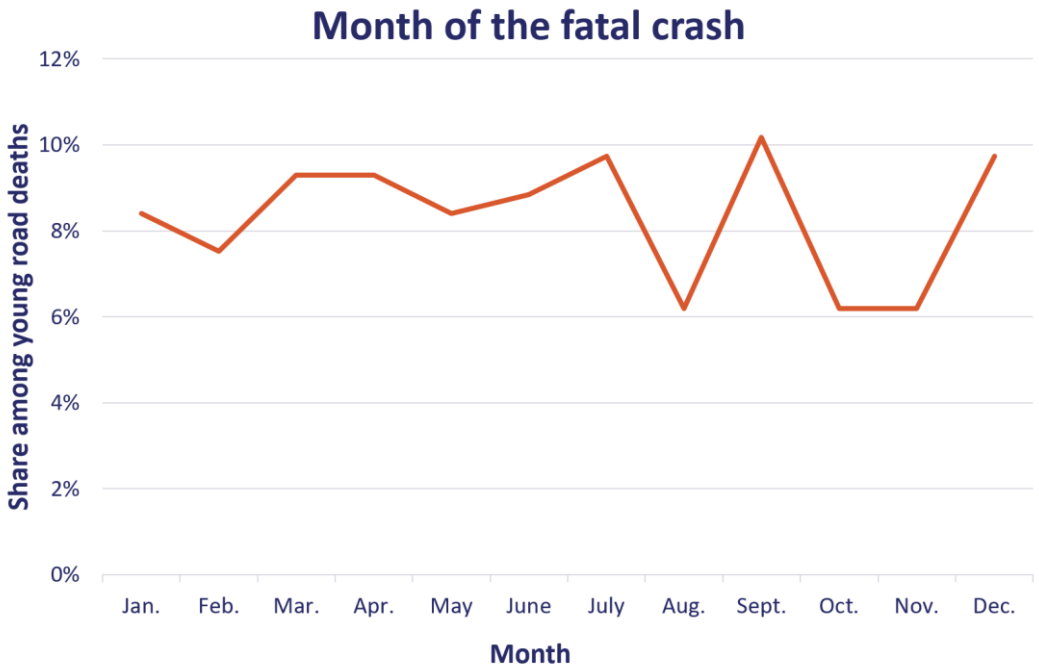

Figure 4. Registered road deaths (2011-2020) among young road users aged 10-17, broken down by month. Sources: Ministry of Infrastructure and Water Management (BRON), Statistics Netherlands (Road Death Statistics), edited by SWOV.

5 What changes does puberty bring?

Brain development and hormones

Around the age of twelve, puberty starts, which changes the hormone system of youngsters. The 'limbic system', or the brain structures involved in emotions, pleasure and motivation, is already functioning as it does in adults. The prefrontal cortex, the 'control system' that ensures that we do not act in haste, are able to plan, and take our (social) environment into account, is not fully grown until the age of 25. An increase of risk behaviour in the early years of puberty could be the result of this asynchronous development [4]. Thus, youngsters are prone to go for fast rewards and enjoyment, while their sense of danger is less developed. As youngsters grow older, risk behaviour diminishes due to the growing maturity of the brain's control system [5] [6] [7].

Apart from detrimental effects, puberty also has some positive effects. The structural biological changes that puberty brings and the substantial malleability of the brain entail a great learning ability. Acquiring new skills is easier for youngsters than for adults and youngsters are more dedicated when making an effort. In addition, a higher performance level for complex tasks is reached when these have been learned at a young age, compared to people who learned these tasks later in life [6].

Changing mobility

As youngsters grow older, their mobility changes. Social needs change as well; they do less with their parents and more with their peers, which implies they also become more independent road users. In addition, youngsters going to secondary school will travel longer distances, and will have access to new modes of transports, such as (light) mopeds [6].

Social environment

For youngsters, their social environment becomes increasingly important. They start to be less influenced by their parents and more by their peers; the latter becoming more important during adolescence [8]. In addition, youngsters that score high on sensation seeking in questionnaires, socialise with peers that have similar scores [9]. This creates a social environment in which risk taking is not only encouraged but also considered commendable. Because youngsters of the same age develop in the same way and experience an increase in sensation seeking, the attraction of joining each other

in finding new thrills increases [9]. Youngsters take more risks when they are in the company of peers than when they are by themselves [7] [10].

6 What are the main causes of crashes with young road users?

Mode of transport

Transport mode is one of the main factors in crashes with young road users. Young road users cycle a lot and cycling involves a higher crash risk than driving for instance (see SWOV fact sheet *Road deaths in the Netherlands*). When cycling, young road users are vulnerable ; unlike cars, bicycles do not offer physical protection against crashes [11]. When teenagers reach secondary school age, the number of annual cycling kilometres quadruples, compared to when they were at primary school. They travel almost as many kilometres by bicycle as they do by car: an average of 2000 km of their total mobility. Adolescents are not allowed to drive independently until they are 18, which means bicycle use – and (light) moped use from the age of 16 – increases. Unlike cars, these vehicles offer no physical protection, which increases injury risk by a factor of 6 (cyclists), 25 ((light) mopeds) or 9 (pedestrians) [6].

Risk behaviour

It is during adolescence that youngsters take more risks. This is due to the way the brain develops in this period. The influence of peers also increases at this time (See the question *What changes does puberty bring?*). By taking more risks in traffic, their crash risk also increases. In children aged 11-13, Twisk & Vlakveld [12] found an association between risk behaviour and crashes. A literature review of mostly American literature by Ouimet et al. [13] shows that, compared to older men, young male drivers run a higher crash risk when they are joined by peers than when they are not (in America driving is permitted at the age of 16).

Cycling skills

A study of teenage cycling skills in the last year of primary school (year 8), at age 11-13, shows that teenagers are poor at recognising danger, and have a limited risk awareness [14]. Youngsters with more cycling experience do not score any better. And, the skills of youngsters that often cycle the same route are worse than the skills of youngsters that cycle more diverse routes. Zeuwts et al. [15] show that, as they grow older and gain more cycling experience, youngsters do develop more cycling skills (balancing, stopping safely, steering, etc.).

Social environment

Peers play a role in unsafe road user behaviour, and it is hard for youngsters to withstand peer pressure [6]. Youngsters are easily challenged, they want to show off, or follow suggestions without thinking. Moreover, when cycling together with others, they have to divide their attention between traffic and each other; this increases their cognitive work load [16]. Cycling together also seems to affect the number of crashes. Research by VeiligheidNL [17] shows that youngsters aged 13-17 most often end up in an emergency room after cycling together with three or more others. Since youngsters often cycle in groups, they may be overrepresented.

Hazard recognition and risk assessment

Young road users are not too good at hazard recognition; the more complex the situation, the poorer they perform [14] [18] [19]. Research shows that even if they do recognise the hazard, they underestimate the danger of a situation more often than adults do, and they need more time to decide whether a situation is hazardous [20] [21]. When youngsters have time to reflect, for example when completing a questionnaire, they do not show less awareness of hazards than adults do and are sometimes even more aware of possible risks. When youngsters are asked about their risky road user behaviour, they overestimate the fatality risk to an unrealistic degree [18].

Gender

Boys are more prone to take risks than girls. Self-reporting shows girls to attach more importance to safe cycling than boys [22]. In addition, boys appear to be more sensation seeking, showing a later peak (at age 19) in sensation seeking behaviour than girls (peak at age 16) [9]. Boys aged 12 to 17 are more often killed in traffic than girls of that same age (*Figure 7*). However, it is unknown whether they participate in traffic more often than girls, which would imply a higher exposure to risk. Therefore, traffic risk for boys versus girls is also unknown.

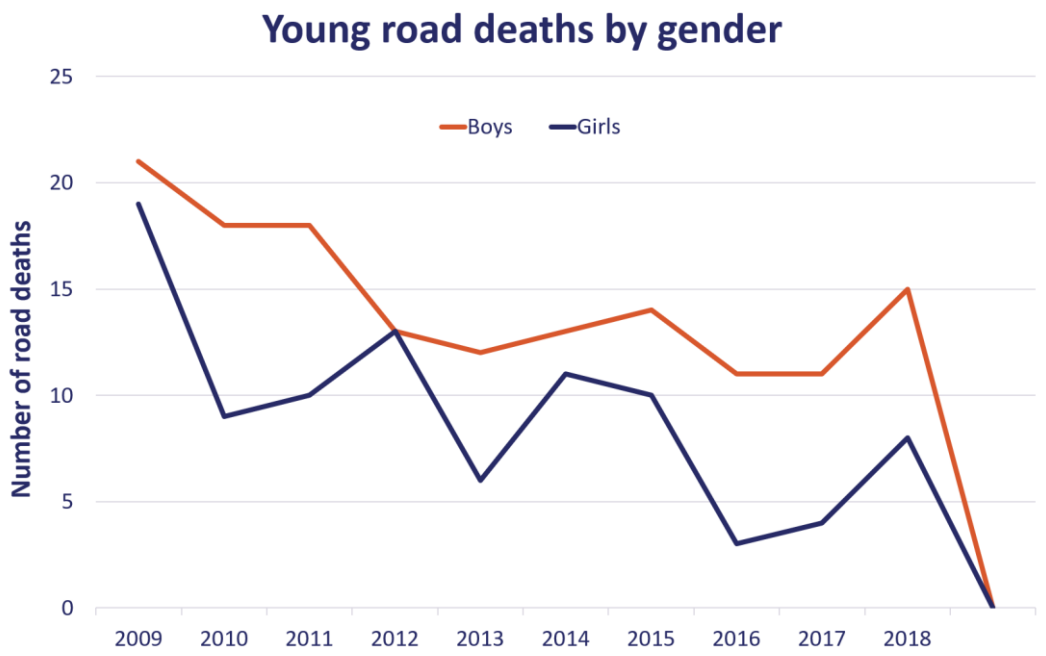

Figure 5. Number of registered road deaths among boys and girls aged 12 to 17 between 2009 and 2018. Source: Statistics Netherlands (Road Death Statistics).

7 What is a young road user's risk of distraction (e.g. by phone use)?

It is unknown to what extent distraction is a factor in crashes among young road users. Information about distraction among (young) cyclists is only known from self-reported behaviour and self-reported crashes. Goldenbeld et al. [23] found that 12- to 17-year-old youngsters that said they listened to music or made calls while cycling had a 1.6 higher risk of crashing than cyclists that did not. What was remarkable is that these youngsters indicated to pay more attention to traffic when they were using a device. This self-reported compensation strategy was also found in another questionnaire study [24]. It found that a majority of young cyclists (16-18) adapted their behaviour during phone calls or while listening to music by cycling more slowly or looking around more. A field study among young cyclists (aged 16-18) by Stelling-Kończak et al. [25] showed that one fifth to one third of the particpants looked around more while listening to music. However, what was also apparent was that about half the participants looked around less often while listening to music. This was such a substantial percentage that the study was called off. Therefore – and on account of the limitations of self-reported behaviour – more evidence is needed to allow for conclusions about the crash risk of distraction in traffic for young road users, on the one hand, and about the compensation strategy they might apply to decrease crash risk. For more information, see SWOV fact sheet *Distraction in traffic*.

8 What is the risk of alcohol and/or drug use for young road users?

Alcohol

Research shows that only a very small minority of cyclists aged 10 to 17 that ended up in an ER, had drunk alcohol in the six hours preceding the crash [26]. The standard limit for cyclists is 0,5g/L. As the blood alcohol content (BAC) rises, injury risk increases. For more information, see SWOV fact sheet *Driving under the influence of alcohol*.

Drugs

The prevalence of youngsters' traffic participation while under the influence of drugs is unknown. We do know something about the effect drugs can have on skills that are important for traffic participation. For more information, see SWOV fact sheet *Drugs and medicines*.

9 What other risks do young road users run?

(Souped-up) (light) moped and speed pedelecs

After cycling, riding a (light) moped is the transport mode with most road deaths among youngsters. It is unknown how many of their vehicles were souped up. Nowadays, mopeds and light mopeds are not vehicles typically used by youngsters. Up to 2010, a relatively large share of (light) moped casualties were younger than twenty; currently the casualties are more often distributed among all ages.

Cycling in the dark

The specific crash risk for youngsters when cycling in the dark is unknown. What we do know is that for all age groups, and thus for youngsters as well, the share of crashes in twilight and darkness is larger than the share of bicycle kilometres travelled in twilight and darkness. In addition, youngsters appear to travel most in twilight and darkness [27]. Compared to adults, youngsters were shown to use bicycle lights relatively less often [28]. In general, more crashes occur in the dark. During the evening rush hour, more crashes occur in darkness than in daylight. Particularly pedestrians and cyclists run a higher crash risk in twilight and darkness [29] [30] [31]. When a cyclist has a functioning front and rear light, crash risk drops by 17% [32]. Yet, the researchers say that the uncertainty of the outcome is substantial. The quality of the bicycle lights was not taken into account either (the results refer to bicycle lights that were common between 2002 to 2010).

10 What measures have been taken to improve road safety for youngsters and what is their effect?

Ban on handheld phone use while cycling

Since July 2019, use of handheld phones or other electronic communication and information processing devices while cycling has been prohibited [33]. In 2021, this legislative amendment was evaluated by means of a questionnaire [34]. This showed that one in five cycling youngsters aged 12 to 17 indicates having thereafter used their phone less often. This corresponds to the research findings of TeamAlert & Samsung [35], which shows that, since then, four out of five youngsters aged 12 to 24 (most of them aged 15 to 18) have still used their phones while cycling. It is unknown whether the slight decrease in phone use by young cyclists has also resulted in fewer crashes.

Education

Traffic education is either formal or informal. Formal education is a legally required component of lessons, for example at primary schools. Not much is known about the effect of traffic education; an effect on crash risk has not yet been proven. Some evaluations, however, show that traffic education may affect (self-reported) behaviour or attitudes, provided the programme was well designed. The features of a well-designed programme (and more about traffic education) can be found in SWOV fact sheet *Traffic education*.

Informal traffic education is taken care of in daily life, for example by parents. Young road users gain hands-on experience while their parents point out potential hazards on the way home. Accompanied driving (2toDrive), when adolescents drive accompanied by a supervising adult, is an example of informal education (see SWOV fact sheet *Driver training and driving tests*).

Cycling mode & PhoNo

In the Netherlands, several interventions have been developed to discourage phone use among young cyclists. Their effectiveness is unknown. In late 2014, insurance company Interpolis introduced a cyclist app called ‘Fietsmodus' (Cycling mode). The app aimed to discourage smartphone use by young cyclists, by awarding credit points when the app was active *and* the phone was not used. The effect of the app was not studied. In addition, Interpolis developed the PhoNo app in 2019, again aiming to reduce smartphone use by young cyclists. A SWOV evaluation [36] showed that, although participants evaluated the app favourably, the effects on smartphone use by young cyclists was not clear. The uncertainty was partially caused by findings that were inconsistent and hard to interpret.

Moped licence

In 2006, the moped certificate was replaced by the moped licence. This mainly affected moped ownership. The number of (light) moped casualties decreased relatively soon after licence introduction, as a direct consequence of the decrease of young (light) moped riders [37], but not

in statistically significant numbers. For more information, see SWOV fact sheet *Moped and light-moped riders*.

11 What are potential measures to further increase safety for young road users?

Infrastructural measures

Infrastructural measures for pedestrians and cyclists, provided they are properly applied, are effective for all road users, and thus for young ones as well. The negative development of bicycle-only crashes, for example crashes with bollards, argues for improved infrastructure layout [38]. Keeping young road users in mind, safe school routes could be a first contribution. For more information, see SWOV fact sheet *Infrastructure for pedestrians and cyclists*.

Bicycle helmets

Bicycle helmets protect cyclists from head and brain injuries. In the Netherlands, most touring cyclists wear bicycle helmets, but in ordinary traffic hardly anyone does. Research [39] among youngsters aged 12 to 24 shows that 78% of them never wear helmets. Weijermars et al. [40] have studied the potential casualty reduction if all cyclist were to wear helmets all of the time. Although young cyclists are not mentioned separately, what does become apparent is that the number of road deaths would decrease by 85 and the number of serious road injuries by 2500-2600, if all cyclists wore helmets all of the time. Proven results in Denmark show that it is feasible to substantially increase the percentage of bicycle helmet use without any coercion or mandatory helmet wear [41].

For more information, see SWOV fact sheet *Bicycle helmets*.

Training

There are some indications that resilience training and hazard recognition training work for young road users [15]. This could also be done using Virtual Reality (VR). By means of VR training, primary school pupils aged 9 to 12 practised safe road user behaviour while cycling or walking. The evaluation showed that children's road user skills improve by practising in a VR environment. However, the children's level of retention is unknown, nor do we know whether they were able to put into practice what they had learned [42]. Resilience training for young car drivers, from the age of 17 onwards, appears to have reduced crash risk in Australia, including crash risk in the dark [43] [44]. Hazard recognition training also seems to affect Situational Awareness [45]. More research into the learning capacities of youngsters could result in training programmes that are tailor-made and that take their strengths and weaknesses into account [46].

Publications and sources

Below you will find the list of references that are used in this fact sheet; all sources can be consulted or retrieved. Via Publications you can find more literature on the subject of road safety.

[1]. Twisk, D.A.M., Bos, N.M. & Weijermars, W.A.M. (2017). *Road injuries, health burden, but not fatalities make 12- to 17-year olds a high risk group in the Netherlands*. In: European Journal of Public Health, vol. 27, nr. 6, p. 981-984.

[2]. CBS Statline (2021). *Overledenen; belangrijke doodsoorzaken (korte lijst), leeftijd, geslacht*. CBS. Accessed on 17-05-2022 at https://opendata.cbs.nl/statline/#/CBS/nl/dataset/7052_95/table?ts=1652282605033.

[3]. CBS Statline (2022). *Overledenen. Doden door verkeersongeval in Nederland, wijze van deelname*. CBS. Accessed on 17-05-2022 at https://opendata.cbs.nl/statline/#/CBS/nl/dataset/71936ned/table?ts=1652282995825.

[4]. Casey, B.J., Getz, S. & Galvan, A. (2008). *The adolescent brain*. In: Developmental Review, vol. 28, nr. 1, p. 62-77.

[5]. Vlakveld, W.P. (2014). *Hersenontwikkeling en ongevalsrisico van jonge bestuurders. Een literatuurstudie [Brain development and crash risk of young novice drivers. A literature study].* R-2014-26 [Summary in English]. SWOV, Den Haag.

[6]. Twisk, D.A.M. (2014). *Protecting pre-license teens from road risk: Identifying risk-contributing factors and quantifying effects of intervention strategies*. Dissertation Maastricht University, Maastricht.

[7]. Gardner, M. & Steinberg, L. (2005). *Peer influence on risk taking, risk preference, and risky decision making in adolescence and adulthood: an experimental study*. In: Developmental Psychology, vol. 41, nr. 4, p. 625–635.

[8]. Bokhorst, C.L., Sumter, S.R. & Westenberg, P.M. (2010). *Social support from parents, friends, classmates, and teachers in children and adolescents aged 9 to 18 years: Who is perceived as most supportive?* In: Social Development, vol. 19, nr. 2, p. 417-426.

[9]. Romer, D. (2010). *Adolescent risk taking, impulsivity, and brain development: Implications for prevention*. In: Developmental Psychobiology, vol. 52, nr. 3, p. 263-276.

[10]. Brown, B.B. (2004). *Adolescents' relationships with peers*. In: Lerner, R.M. & Steinberg, L. (red.), Handbook of adolescent psychology Wiley, Hoboken, NJ, p. 363–394.

[11]. Twisk, D. (2014). *Oorzaken van riskant verkeersgedrag bij adolescenten*. In: Tijdschrift voor Jeugdgezondheidszorg: themanummer Veiligheid, vol. 46, p. 116-118.

[12]. Twisk, D. & Vlakveld, W. (2019). *Social environment versus cycling competency predicting risk-taking in 11- to 13-year-old cyclists in the Netherlands*. In: Traffic Injury Prevention, vol. 20, nr. sup3: 2018 ICSC.

[13]. Ouimet, M.C., Pradhan, A.K., Brooks-Russell, A., Ehsani, J.P., et al. (2015). *Young drivers and their passengers: A systematic review of epidemiological studies on crash risk*. In: Journal of Adolescent Health, vol. 57, nr. 1, Supplement, p. S24-S35.e26.

[14]. Twisk, D., Wesseling, S., Vlakveld, W., Vissers, J., et al. (2018). *Higher-order cycling skills among 11- to 13-year-old cyclists and relationships with cycling experience, risky behavior, crashes and self-assessed skill*. In: Journal of Safety Research, vol. 67, p. 137-143.

[15]. Zeuwts, L.H.R.H., Deconinck, F.J.A., Vansteenkiste, P., Cardon, G., et al. (2020). *Understanding the development of bicycling skills in children: A systematic review*. In: Safety Science, vol. 123, p. 104562.

[16]. Gheorghiu, A., Delhomme, P. & Felonneau, M.L. (2015). *Peer pressure and risk taking in young drivers' speeding behavior*. In: Transportation Research Part F: Traffic Psychology and Behaviour, vol. 35, p. 101-111.

[17]. Valkenberg, H., Nijman, S., Schepers, P., Panneman, M., et al. (2017). *Fietsongevallen in Nederland - SEH-behandelingen in 2016*. VeiligheidNL, Amsterdam.

[18]. Reyna, V.F. & Farley, F. (2006). *Risk and rationality in adolescent decision making: implications of theory, practice en public policy*. In: Psychological Science in the public interest, vol. 7, nr. 1, p. 50.

[19]. Meyer, S., Sagberg, F. & Torquato, R. (2014). *Traffic hazard perception among children*. In: Transportation Research Part F: Traffic Psychology and Behaviour, vol. 26, p. 190-198.

[20]. Geus, E. de, Vlakveld, W.P. & Twisk, D.A.M. (2020). *Peer distraction: an experiment to assess impact on adolescent and adult cyclists' hazard perception*. In: Journal of Transportation Safety & Security, vol. 12, nr. 1, p. 66-81.

[21]. Feenstra, H., Ruiter, R.A. & Kok, G. (2012). *Go fast! Reaction time differences between adults and adolescents in evaluating risky traffic situations*. In: Journal of Health Psychology, vol. 17, nr. 3, p. 343-349.

[22]. Colwell, J. & Culverwell, A. (2002). *An examination of the relationship between cycle training, cycle accidents, attitudes and cycling behaviour among children*. In: Ergonomics, vol. 45, nr. 9, p. 640-648.

[23]. Goldenbeld, C., Houtenbos, M., Ehlers, E. & Waard, D. de (2012). *The use and risk of portable electronic devices while cycling among different age groups*. In: Journal of Safety Research, vol. 43, p. 1-8.

[24]. Stelling-Konczak, A., Hagenzieker, M. & Wee, G.P. van (2014). *Cyclists and traffic sounds: the results of an internet survey*. In: Proceedings of the 3rd International Cycling Safety Conference (ICSC2014). 18-19 November 2014, Gothenburg, Sweden.

[25]. Stelling-Konczak, A., Vlakveld, W.P., Gent, P. van, Commandeur, J.J.F., et al. (2018). *A study in real traffic examining glance behaviour of teenage cyclists when listening to music: Results and ethical considerations*. In: Transportation Research Part F, vol. 55, p. 47-57.

[26]. VeiligheidNL (2017). *Fietsongevallen in Nederland. SEH-behandelingen 2016*. VeiligheidNL, Amsterdam.

[27]. Schepers, P., Nägele, R. & Mak, P. (2019). *Mogelijkheden verbetering campagne fietsverlichting. Evaluatie op basis van monitoronderzoek en literatuur*. Ministerie van Infrastructuur en Milieu, Rijkswaterstaat, Water Verkeer en Leefomgeving, Delft.

[28]. Aarts, L.T., Schepers, J.P., Goldenbeld, C., Decae, R.J., et al. (2020). *De Staat van de Verkeersveiligheid. Doelstellingen 2020 worden niet gehaald*. R-2020-27. SWOV, Den Haag.

[29]. Bijleveld, F.D. & Stipdonk, H.L. (2013). *De relatie tussen het ingaan van de wintertijd en het aantal verkeersslachtoffers [The relation between the end date of daylight saving time and the number of road traffic casualties. Is there an increase in the number of casualties when the clock is set back one hour?]*. R-2013-8 [Summary in English]. SWOV, Leidschendam.

[30]. Reurings, M.C.B., Vlakveld, W.P., Twisk, D.A.M., Dijkstra, A., et al. (2012). *Van fietsongeval naar maatregelen: kennis en hiaten. Inventarisatie ten behoeve van de Nationale Onderzoeksagenda Fietsveiligheid (NOaF) [From bicycle crashes to measures: knowledge and knowledge gaps. Inventory for the benefit of the National Research Agenda Bicycle Safety (NOaF)]*. R-2012-8 [Summary in English]. SWOV, Leidschendam.

[31]. Twisk, D.A.M. & Reurings, M.C.B. (2013). *An epidemiological study of the risk of cycling in the dark: The role of visual perception, conspicuity and alcohol use*. In: Accident Analysis & Prevention, vol. 60, p. 134-140.

[32]. Kuiken, M. & Stoop, J. (2012). *Verbetering van fietsverlichting. Verkenning van beleidsmogelijkheden*. Ministerie van Infrastructuur en Milieu (IenM), Directoraat-Generaal Rijkswaterstaat, Dienst Verkeer en Scheepvaart DVS, Delft.

[33]. Ministerie van IenW (2019). *Besluit van 24 juni 2019 tot wijziging van het Reglement verkeersregels en verkeerstekens 1990 en de bijlage, bedoeld in artikel 2, eerste lid, van de Wet administratiefrechtelijke handhaving verkeersvoorschriften in verband met uitbreiding van het verbod van het tijdens deelname aan het verkeer vasthouden van mobiele elektronische apparaten, tot fietsers en trambestuurders (uitbreiding verbod vasthouden mobiele telefoon in het verkeer)*. Staatsblad 2019, 237. Ministerie van Infrastructuur en Waterstaat, Den Haag.

[34]. Kalders, P., Dielen, C. & Wools, T. (2022). *Evaluatie wijziging artikel 61a RVV 1990*. Arcadis, Amersfoort.

[35]. TeamAlert & Samsung (2019). *Jongeren en verkeersveiligheid. Onderzoek naar smartphonegebruik tijdens het fietsen*. TeamAlert, Utrecht.

[36]. Stelling-Kończak, A., Hermens, F. & Kint, S.T. van der (2019). *Effectiviteit van een app tegen smartphonegebruik op de fiets. Evaluatiestudie van de PhoNo-app*. R-2019-27. SWOV, Den Haag.

[37]. Goldenbeld, C., Wijlhuizen, G.J., Vlakveld, W.P., Commandeur, J.J.F., et al. (2013). *Evaluatie van het bromfietspraktijkexamen. Onderzoek naar de werking van het bromfietspraktijkexamen en voorbereidende theorielessen op de verkeersveiligheid [Evaluation of the moped riding test. Effectiveness concerning road safety of the moped riding test and preparatory theory lessons]*. R-2013-6 [Summary in English]. SWOV, Leidschendam.

[38]. Aarts, L., Wijlhuizen, G.J., Gebhard, S., Goldenbeld, C., et al. (2021). *De Staat van de Verkeersveiligheid 2021. Doelstellingen voor 2020 definitief niet gehaald – hoe nu verder?* R-2021-21. SWOV, Den Haag.

[39]. Meer, M. van (2020). *Jongeren en de fietshelm*. Stichting TeamAlert, Utrecht.

[40]. Weijermars, W.A.M., Boele-Vos, M.J., Stipdonk, H.L. & Commandeur, J.J.F. (2019). *Mogelijke slachtofferreductie door de fietshelm*. R-2019-2. SWOV, Den Haag.

[41]. Olsson, B. (2021). *Hjelmrapport: Brug af cykelhjelm 2020*. [Summary in English]. Rådet for Sikker Trafik, København Ø.

[42]. Wijlhuizen, G.J. & Kint, S. van der (2018). *Verkeersvaardigheidstraining met virtual reality voor basisschoolleerlingen. Evaluatie van het WegWijs VR-experiment*. R-2018-12. SWOV, Den Haag.

[43]. Senserrick, T., Ivers, R., Boufous, S., Chen, H.-Y., et al. (2009). *Young driver education programs that build resilience have potential to reduce road crashes*. In: Pediatrics, vol. 124, nr. 5, p. 1287-1292.

[44]. 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.

[45]. Scott-Parker, B., Wilks, L. & Huang, B. (2018). *Situation awareness fast-tracking, including identifying escape routes (SAFER): Evaluation of the impact of SAFER on learner driver situation awareness skills*. In: Transportation Research Record, vol. 2672, nr. 33, p. 1-10.

[46]. Dahl, R.E. (2004). *Adolescent brain development: a period of vulnerabilities and opportunities. Keynote address*. In: Annals of the New York Academy of Sciences, vol. 1021, p. 1-22.

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SWOV

SWOV Institute for Road Safety Research

PO 93113

2509 AC The Hague

Bezuidenhoutseweg 62

+31 70 317 33 33

info@swov.nl

www.swov.nl

@swov / @swov_nl

linkedin.com/company/swov