Health burden of serious road injuries in the Netherlands

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ABSTRACT

**Background:** The consequences of injuries in terms of disabilities and health burden are relevant for policy making. This article provides an overview of the current knowledge on this topic and discusses the health burden of serious road injuries in The Netherlands.

**Methods:** The overview of current knowledge on disabilities following a road crash is based on a literature review. The health burden of serious road injuries is quantified in terms of years lived with disability (YLD), by combining incidence data from the Dutch hospital discharge register with information about temporary and lifelong disability.

**Results:** Literature shows that road traffic injuries can have a major impact on victims’ physical and psychological well-being and functioning. Reported proportions of people with disability vary between 11 and 80% depending on the type of casualties, time elapsed since the crash, and the health impacts considered. Together, all casualties involving serious injuries in The Netherlands in 2009 account for about 38,000 YLD, compared to 25,000 years of life lost (YLL) of fatalities. Ninety percent of the burden of injury is due to lifelong consequences that are experienced by 20% of all those seriously injured in road accidents. Lower leg injuries and head injuries represent a high share in the total burden of injury as have cyclists that are injured in a crash without a motorized vehicle. Pedestrians and powered 2-wheeler users show the highest burden of injury per casualty.

**Conclusion:** Given their major impacts and contribution to health burden, road policy making should also be aimed at reducing the number of serious road injuries and limiting the resulting health impacts.

Introduction

Every year more than 1.2 million people are killed and many more are disabled worldwide due to road traffic crashes (World Health Organization [WHO] 2013). Road traffic crashes are an increasing global public health problem (Bhalla et al. 2014; Lozano et al. 2010; Peden et al. 2004). Road safety performance has traditionally been measured by the reduction of fatalities (European Commission 2013), but road traffic crashes also cause large numbers of nonfatal injuries, with considerable economic and human costs.

Nowadays, serious road injuries are increasingly important for road safety policy making. Reducing the number of serious road injuries is one of the key priority actions in the road safety programme 2011–2020 of the European Commission (European Commission 2010). A previous paper focused on the characteristics and injury patterns of serious injuries in The Netherlands (Weijermars et al. 2015). In addition to the numbers of fatalities and serious road injuries, the health burden of these casualties might become relevant for policy making. Consideration of the health burden of casualties may give rise to other priorities in road safety policy making.

This article provides an overview of the current knowledge on the consequences of road traffic injuries in terms of disabilities and burden of injury and discusses the health burden of serious road injuries in The Netherlands.

Theoretical framework

According to the functional classification of functioning, disability, and health (ICF), injuries may influence human functioning on 3 levels (WHO 2002):

- body or body part, resulting in impairments;
- the whole person, resulting in activity limitations;
- the whole person in a social context, resulting in participation restrictions.

In addition to injuries and other medical factors, personal factors and external factors may influence human functioning as well. Personal factors that are relevant include, for example, age, gender, and social background. External factors include the physical and social environment, such as residence, working environment, and social network (WHO 2002).

The health burden of diseases and injuries is generally expressed in disability-adjusted life years (DALYs; Murray and Acharya 1997). This measure of population health integrates mortality, expressed in years of life lost (YLL), and disability, expressed in years lived with disability (YLD). DALYs are considered to be a useful health indicator for road traffic crashes and
are applied in previous studies as well (e.g., Bhalla et al. 2014; Dhondt et al. 2012, 2013; Holtslag et al. 2008; Lapostolle et al. 2009; Polinder et al. 2007; Polinder et al. 2015; Tainio et al. 2014). In the Discussion we compare our results to the results of some of these previous studies.

Consequences of road traffic injury for human functioning

Ameratunga et al. (2004) concluded from a literature review that 21–57% of injured car occupants who are admitted to a hospital experience long-term health problems. Their results are based on 8 studies that differ from each other in terms of study setting and period, duration of follow-up, and definitions of exposure and outcome. Other available studies report varying proportions of road casualties that experience disabilities. For an overview see Table A1 (see online supplement). Reported proportions vary between 11 and 80%, depending on the groups of road casualties, duration of follow-up, and type of disabilities that were taken into account. Table A1 summarizes the results of the most relevant studies that discuss different types of disabilities resulting from road traffic injuries.

Some studies discuss specific consequences such as impairments, pain, functional problems, financial problems, impact on leisure or sports activities, impact on familial or affective life, and work-related problems. Functional disabilities mainly concern mobility-related problems and problems with daily activities. Haukeland (1996), for example, stated that 67% of the respondents with after-effects reported having mobility problems and 33% reported having difficulties with cleaning or washing. Moreover, road traffic injuries might also have psychological consequences. Both a French study and a UK study report a prevalence of 16% for posttraumatic stress disorder (PTSD) 1 year after the crash (Hours et al. 2013; Mayou and Bryant 2003). A Japanese study reported a prevalence of 7.5% for PTSD and 9.4% for serious depression for casualties of motor vehicle crashes (Nishi et al. 2013). Mehta and Ameratunga (2012) conducted a literature review on PTSD among children and reported a prevalence of 13 to 25% between 4 and 12 months after the crash.

Some studies compare consequences for road traffic casualties that are admitted to a hospital and those that are not (Ameratunga et al. 2006; Berecki-Gisolf et al. 2013; Polinder et al. 2015). Other studies make a distinction between different injury severity levels (Bull 1985; Haukeland 1996; Hours et al. 2010, 2013; Malm et al. 2008; Nhac-Vu et al. 2011; Polinder et al. 2015). In general, consequences appear to be larger for casualties admitted to a hospital and for casualties with more severe injuries. This does not mean that casualties with less severe injuries or casualties not admitted to a hospital do not encounter negative health impacts. Whiplash-associated disorders (WAD) are especially relevant in this respect, because they are often considered minor injuries, yet almost 50% of the casualties report after-effects half a year or longer after the crash (Haukeland 1996).

The probability of disability depends on age, gender, traffic mode, and the type of injury. Various studies report that older people experience greater health impacts from injuries than younger people (Bull 1985; Gabbe et al. 2012; Haukeland 1996; Hours et al. 2010; Polinder et al. 2007). Some of these studies have a wider scope than road traffic injuries. Haukeland (1996) and Maraste et al. (2003) compared disabilities in adults and children and both concluded that children report disabilities less frequently than adults. Moreover, women appear to experience more disabilities resulting from injuries than men (Gabbe et al. 2012; Haagsma et al. 2009; Haukeland 1996; Polinder, Meerding, et al. 2007; Polinder, van Beeck, et al. 2007; Walton et al. 2013). The proportion of casualties that report disabilities also appears to differ between transport modes. Both Bull (1985) and Hours et al. (2010) found that injured riders of powered 2-wheelers relatively often report disabilities. Tournier et al. (2014) found that cyclists more often report good recovery at 2 years’ follow-up than other road users. According to Mayou and Bryant (2003), however, the probability of a disability is comparable between transport modes, with car occupants reporting more pain. Regarding the type of injury, several studies found that injuries to the lower extremities relatively often result in disabilities (Bull 1985; Fort et al. 2011; Haagsma et al. 2009; Haukeland 1996; Hours et al. 2010; Nhac-Vu et al. 2011; Polinder et al. 2007). Other injuries that lead to serious disabilities include spinal cord injuries (Haukeland 1996; Laursen and Moller 2012; Polinder et al. 2007), multiple or complex injuries (Haukeland 1996; Laursen and Moller 2012), injuries to the head (Bull 1985; Fort et al. 2011), and hip fractures (Polinder et al. 2007).

Data and methods

Selection of serious road injuries

The results in this article are based on data from the hospital discharge register (LMR-Dutch Hospital Data) for the period 2000 to 2009. The LMR-DHD is a national database that includes all patients admitted to a Dutch hospital. Road injuries are selected in the LMR-DHD by selecting a number of external causes (coded in the International Classification of Diseases, Revision 9, Clinical Modification [ICD9-CM 1986]: E810-E816, E818-E819 + E826, E827, E829, extended with other patients that could be matched to police reports). Readmissions and persons dying within 30 days of the crash were excluded from the data.

We are interested in the burden of injury of serious road injuries. In The Netherlands, a serious road injury is defined as a hospitalized nonfatal road casualty with a Maximum Abbreviated Injury Scale (MAIS) score of MAIS 2+ (see Gennarelli and Wodzin 2005). Therefore, only casualties with an MAIS score of 2 or more are included in the analyses. The MAIS score for each patient is obtained by mapping all reported injuries (up to 10) in ICD9-CM to AIS-1990 with ICDmap90 (Johns Hopkins University 1998). In total, 148,985 serious road injuries are included in the analyses (91,421 men and 57,564 women).

The LMR-DHD includes 86% of all MAIS 2+ casualties in The Netherlands. The actual number of MAIS 2+ casualties is determined by a method that determines weight factors for each road traffic casualty in the LMR-DHD (for more information see Reurings and Stipdonk 2011). The same factors are applied to estimate the total burden of injury of all casualties on the basis of the health burden of the individual records. The weight factor differs between casualties and has an average of 1.16 (1/0.86).
Calculation and analysis of burden of injury

The health burden of serious road injuries is quantified in terms of Years Lived with Disability (YLD), using a standardized method proposed by Haagsma et al. (2012) that combines injuries with information about acute and lifelong disability. The incidence data for our study are extracted from the LMR and linked to information about disability using the EUROCOST injury classification. More specifically, all reported injuries (up to 10) according to ICD9-CM were assigned to one of the 39 EUROCOST groups (Table A2, see online supplement), following the hierarchical scheme proposed by Polinder et al. (2008).

The burden of injury \( B \) for all serious road injuries \( i, i = 1, \ldots, N \), is calculated with Eqs. (1) and (2).

\[
B_{[YLD]} = \sum_{i=1}^{N} B_i 
\]

\[
B_i = DW_{a(i)} + P_l(i) \times DW_{l(i)} \times (LE_i - \text{age}_i - 1) \tag{2}
\]

where \( B_i \) is the burden of injury of serious road injury, \( i = 1, \ldots, N \), where \( N \) is the number of serious road injuries; \( f(i) \) is the EUROCOST injury group, \( j = 1, \ldots, 39 \) of casualty; \( DW_{a(i)} \) is the disability weight for disability during first year for each EUROCOST group; \( DW_{l(i)} \) is the disability weight for lifelong disability for each EUROCOST group; \( P_l(i) \) is the proportion of cases with lifelong consequences for each EUROCOST group; \( LE_i \) is the life expectancy of casualty \( i \) given its age and gender.

For each EUROCOST injury group, the proportion of injury cases with lifelong consequences \( (Pl) \) and injury-specific disability weights \( (DW) \) of acute (the first year) and lifelong consequences are provided by Haagsma et al. (2012). A disability weight reflects the impact of a health condition and has a value between 0 (full health) and 1 (entirely disabled, dead). The proportions \( (Pl) \) and disability weights \( (DW) \) are based on a longitudinal study of functional outcomes in injury patients in The Netherlands (Polinder et al. 2007). Polinder et al. (2007) collected this information for a sample of over 8,500 injury patients aged 15 years and older, applying the EQ-5D classification of health 2.5, 5, 9, and 24 months after the patients attended an emergency department of a hospital. For each EUROCOST injury group, Haagsma et al. (2012) provided disability weights for casualties admitted to the hospital and for casualties that were only treated at the emergency department. Because our study focuses on serious road injuries, we applied the disability weights for hospital admitted casualties. Age- and gender-specific life expectancies are available at Statistics Netherlands (Statline 2013) for each age year and calendar year. We compared the health burden of serious road injuries (YLD) with the health burden of road fatalities (YLL). The health burden of fatalities is calculated in a similar way as the health burden of serious road injuries, with \( DW_{a} = 1 \), \( DW_{l} = 1 \), and \( Pl = 1 \).

By combining the proportions of injury cases with lifelong consequences per EUROCOST injury group \( (Pl) \) with the number of serious road injuries for that injury group, we determined the overall proportion of serious road injuries with lifelong consequences (Eqs. (3)).

\[
Pl = \frac{\sum_{j=1}^{39} N_j \times Pl_j}{N} \tag{3}
\]

The total burden of injury for all serious road injuries and the average burden per serious road injury are calculated for different travel modes, different EUROCOST injury groups, and different age groups. All 148,985 serious road injuries reported in the LMR-DHD during the years 2000 to 2009 were included. The EUROCOST classification provides information on the type and body region of the injury. The distribution of the injury and the burden of injury over body regions is illustrated in Figure 1 by means of so-called burden-of-injury body profiles, using colored pictures of human body figures. These profiles are inspired by the injury body profiles developed by Hoeglinger (in Broughton et al. 2007) and show the distribution of injuries and burden of health over the body. Comparison between left and right reveals the difference between the number of injuries and their health burden.

Results

The health burden of serious road injuries in the Netherlands

In 2009, about 18,900 people were seriously injured in road traffic crashes in The Netherlands. By applying Eqs. (1) and (2) and an average factor of 1.16 to correct for underreporting on the reported traffic casualties in the hospital file, we estimated that these serious road injuries account for roughly 38,000 YLD. To compare, 720 people died in Dutch traffic in 2009 and these fatalities account for 25,000 YLL. The average health burden per serious road injury is about 2.1 YLD, compared to 35 YLL per fatality. The main part (90%) of the burden of injury is due to lifelong consequences. Of all serious road injuries, about 20% have lifelong consequences. The average burden per casualty for these lifelong consequences is 8.4 YLD \( (N = 34,129) \). The average burden per person decreases with age (see Table 1), because the remaining life expectancy decreases with age. The acute burden of injury increases with age, indicating that older people
bicycle crashes (Schepers and Klein Wolt 2012), which are in a crash without a motor vehicle. These are mostly single of serious road injuries can be attributed to cyclists injured in a crash without a motor vehicle. As a result of this high incidence, 30% of the burden of injury over the period 2000–2009 were cyclists injured in a crash without a motor vehicle. However, the incidence is very high for this latter group: 37% of the serious road injuries in the period 2000–2009 were cyclists injured in a crash without a motor vehicle. However, the incidence is very high for 2-wheeler users and lowest for cyclists injured in a crash with motor vehicles.

**Burden of injury for different groups of serious road injuries**

Table A2 shows the burden of injury for different EUROCAST injury groups. Spinal cord injuries have the highest burden of injury per casualty. However, relatively few casualties have spinal cord injuries (less than 1% of all 148,985 serious road injuries). The share of spinal cord injuries in the total burden of all serious road injuries is 9%. The total burden of injury is highest for fractures in knee and lower legs (22% of the burden of injury of all serious road injuries), followed by other skull–brain injury (18%) and concussion (13%).

Table 2 shows the incidence and health burden of serious road injuries for relevant crash types. The average burden of injury per casualty is highest for pedestrians and powered 2-wheeler users and lowest for cyclists injured in a crash without a motor vehicle. However, the incidence is very high for this latter group: 37% of the serious road injuries in the period 2000–2009 were cyclists injured in a crash without a motor vehicle. As a result of this high incidence, 30% of the burden of serious road injuries can be attributed to cyclists injured in a crash without a motor vehicle. These are mostly single-bicycle crashes (Schepers and Klein Wolt 2012), which are much more often nonfatal than crashes with motor vehicles. Hence, though the number of fatalities is dominated by crashes with motor vehicles, the number of serious injuries (and thus the burden of injury) is dominated by crashes without motor vehicles.

The fraction of serious road injuries with lifelong consequences is highest for pedestrians and for cyclists injured in crashes without motor vehicles, whereas the burden of injury per lifelong injury is highest for occupants/riders of motor vehicles.

**Burden-of-injury body profiles**

Figure 1 shows the distribution of injuries (left) and of the burden of injury (right) over the body. Head injuries are most prevalent (N = 45,739; 31% of all MAIS 2+ casualties had a head injury), whereas both head injuries and lower leg injuries contribute substantially to the burden of injury; 31 and 33% of the total burden of injury is due to head injuries and lower leg injuries, respectively. Lower leg injuries have a higher share in the burden of injury than in the number of injuries (19% of all 148,985 MAIS 2+ casualties have a lower leg injury), indicating that the average burden per injury is relatively high for lower leg injuries. The average burden per injury is high because (1) some lower leg injuries have high disability weights and proportions of lifelong disabilities and (2) casualties with lower leg injuries are relatively young compared to, for example, casualties with hip or upper leg injuries. Young casualties have a higher remaining life expectancy (LE – age).

Figure 2 provides more information about the distribution of the burden of injury and temporary and permanent injuries over the body regions. The left figure compares the burden of injury (YLD) for the first year (acute, short-term, left) and remaining life (lifelong, long-term, right). The lifelong burden of injury is dominated by head injuries (32% of all 285,134 YLD) and lower leg injuries (35%). These injuries have a higher share in the long-term burden of injury than in the burden of injury (they each account for 22% of the 32,026 acute YLD). Hip and upper leg injuries, on the other hand, have a higher share in the short-term burden of injury (27%) than in the long-term burden of injury (16%).

The right figure compares the distribution of injuries (number of injured persons) with temporary (left) and lifelong (right) consequences over the body regions. Hip and upper leg injuries have a high share in the number of permanent injuries (31% of all 34,129 serious injuries with permanent injuries have hip/upper leg injuries), as do lower leg injuries (27% of all permanent injuries). The reason that hip and upper leg injuries have a relatively low share in the lifelong burden of injury is that these injuries are most common in older people, who have a relatively short remaining life expectancy and thus a relatively short duration of lifelong disability. Thus, hip and upper leg injuries are less relevant regarding their contribution to the total health impact, whereas many individual casualties do encounter lifelong disabilities as a result of these injuries.

### Table 1. Number of serious injuries and burden of injury per age group (totals for 2000–2009).

| Age | Number of MAIS 2+ | Acute per casualty | Lifelong per casualty with lifelong injury | Average per casualty | Total |
|-----|-------------------|--------------------|------------------------------------------|----------------------|-------|
| 0–17 | 27,613            | 0.19               | 14.63                                    | 3.37                 | 93,151|
| 18–24 | 17,665            | 0.19               | 13.78                                    | 3.06                 | 54,138|
| 25–39 | 26,413            | 0.20               | 11.23                                    | 2.48                 | 65,435|
| 40–59 | 37,588            | 0.21               | 7.23                                     | 1.74                 | 65,432|
| 60+   | 39,706            | 0.26               | 5.58                                     | 0.98                 | 39,005|
| Total | 148,985           | 0.24               | 8.35                                     | 2.13                 | 317,161|

The share of spinal cord injuries in the total burden of all serious road injuries is 9%. The total burden of injury is highest for fractures in knee and lower legs (22% of the burden of injury of all serious road injuries), followed by other skull–brain injury (18%) and concussion (13%).

### Table 2. Number of serious injuries and burden of injury per transport mode (totals for 2000–2009).

| Transport mode | N MAIS 2+ | Acute per casualty | Lifelong per casualty with lifelong injury | Average per casualty | Total |
|----------------|-----------|--------------------|------------------------------------------|----------------------|-------|
| Pedestrian     | 10,559    | 0.22               | 9.82                                     | 2.76                 | 29,178|
| Cyclists in crash without motor vehicle | 55,484  | 0.23               | 5.91                                     | 1.73                 | 95,930|
| Cyclist in crash with motor vehicle | 15,430  | 0.21               | 8.75                                     | 2.17                 | 33,532|
| Moped          | 20,392    | 0.21               | 10.91                                    | 2.70                 | 55,109|
| Motorcycle     | 10,989    | 0.21               | 10.17                                    | 2.31                 | 25,399|
| Car/van        | 27,852    | 0.20               | 10.45                                    | 2.11                 | 58,830|
| Other          | 8,279     | 0.22               | 9.65                                     | 2.32                 | 19,183|
| Total          | 148,985   | 0.21               | 8.35                                     | 2.13                 | 317,161|

The right figure compares the distribution of injuries (number of injured persons) with temporary (left) and lifelong (right) consequences over the body regions. Hip and upper leg injuries have a high share in the number of permanent injuries (31% of all 34,129 serious injuries with permanent injuries have hip/upper leg injuries), as do lower leg injuries (27% of all permanent injuries). The reason that hip and upper leg injuries have a relatively low share in the lifelong burden of injury is that these injuries are most common in older people, who have a relatively short remaining life expectancy and thus a relatively short duration of lifelong disability. Thus, hip and upper leg injuries are less relevant regarding their contribution to the total health impact, whereas many individual casualties do encounter lifelong disabilities as a result of these injuries.
et al. 2015). However, the application of this method has some limitations.

This article describes the state of knowledge regarding the consequences of road traffic injuries and provides information on the burden of injury of serious road injuries (MAIS 2+) in The Netherlands. The method we applied to estimate the burden of injury of serious road traffic injuries has been applied to road traffic crashes before (e.g., Dhondt et al. 2013; Polinder et al. 2015). However, the application of this method has some limitations.

1. Disability weights and proportions of lifelong disabilities may vary between individual casualties, depending on, for example, age and specific injuries sustained. We applied average disability weights and proportions of lifelong disabilities per EUROcost injury group. These weights and proportions were determined on the basis of a cohort study of a broad group of injured victims, including not only road traffic injuries but also injuries from unintentional falls, fires, and other external causes. The average disability weights and proportions of lifelong disability per EUROcost injury group might differ from weights for road traffic casualties. This could result in an underestimation or overestimation of the burden of injury for road traffic injuries.

2. Psychological consequences (e.g., PTSD) are not taken into account. This results in an underestimation of the actual burden of injury (Haagsma et al. 2011).

3. We were not able to correct for a decrease in life expectancy, though trauma patients have a lower life expectancy (Davidson et al. 2011). This would yield a nonnegligible value of YLL that should be added to the YLD to give an accurate burden of injury.

4. For some EUROcost injury groups there is no specific disability weight for inpatients. In those cases, we applied the disability weight of patients treated at an emergency department only. This leads to an underestimation of the health burden of road traffic injuries.

This study has added value in several ways. First of all, it provides a comprehensive and up-to-date overview of the current knowledge on the consequences of road traffic crashes on human functioning. Literature on this topic appeared to be quite fragmented. Available studies focus on various types of disabilities, consider different groups of casualties (hospitalized or not, limited to road traffic injuries or injuries in general, specific transport modes), and consider different time frames (half a year, a year, or multiple years after a crash). This article provides an overview of the available studies and discusses the main conclusions that can be drawn from the available literature.

Second, this article provides information on the health burden of serious road injuries (MAIS 2+) in The Netherlands and adds to the current knowledge on health burden of serious road injuries in general. A previous Dutch study was limited to patients with severe trauma (Injury Severity Score > 15) treated in one of the Dutch hospitals (Holtslag et al. 2008). Because our study analyzes all MAIS 2+ trauma, it results in a lower average burden per victim (2 YLD compared to 12 YLD). Another Dutch study (Polinder et al. 2015) focused on the burden of injury of different MAIS scores and of hospitalized and nonhospitalized victims. According to Polinder et al. (2015), MAIS 2+ casualties account for 43% of the health burden of road crashes, fatalities account for 37%, whereas less severe injuries account for 18% of the health burden. Our article focuses on the burden of injury for different groups of serious road injuries (MAIS 2+), stratified by travel mode, age, and type of injury.

We found that 90% of the burden of serious road injuries in The Netherlands is due to lifelong consequences that are encountered by about 20% of the victims. These results are similar to the results of Dhondt et al. (2012), who found that 15% of the victims encountered lifelong consequences and that 91% of the burden of injury was due to lifelong disability. Tainio et al. (2014) used the global burden of disease classification and weight factors to determine the burden of injury of road traffic injuries in Sweden and found that only 2% of the injuries resulted in lifelong consequences and these are responsible for 96% of the burden of injury. This difference in fraction is most probably due to the fact that Tainio et al. (2014) included all road traffic injuries, whereas our study includes MAIS 2+ injuries only. Tainio et al. also reported a higher burden of injury per lifelong injury (14.7 YLD compared to 8.4 YLD in our study).

Regarding the burden of injury for different travel modes, our study relates the burden of injury to the number of casualties, whereas some of the previous studies (Dhondt et al. 2013; Holtslag et al. 2008) related the burden of injury to distance traveled. From all studies, powered 2-wheeler users appear to be a relevant target group; they have a high burden per casualty and per distance traveled. Tainio et al. (2014) also provided YLDs per injured persons for different travel modes and also reported a high burden of injury for powered 2-wheeler users, but they found a relatively low burden of injury for pedestrians.
Regarding the burden of injury for different travel modes, our results partly correspond to the results of Tainio et al. (2014), who also found that powered 2-wheeler users have a relatively high acute burden of injury per casualty. However, they reported a relatively low YLD per casualty for pedestrians. Their study also includes less severe injuries. Other previous studies (Dhondt et al. 2013; Holtslag et al. 2008) related the burden of injury to distance traveled and also found a relative high burden for powered 2-wheeler.

Lapostolle et al. (2009) and Tainio et al. (2014) also provided information on the burden of injury for different types of injuries, but both applied a different classification of injuries. Both studies found that intracranial injuries, spinal cord injuries, and fractures account for the highest YLD. These results are in line with our results, because we found that concussion and other skull–brain injury, as well as fractures of knees, lower legs, and ankles, as spinal cord injuries are major contributors to the burden of injury.

The most novel part of our study is that it adds information about the distribution of the burden of road traffic injury and of acute and lifelong injuries over the body parts, which is visualized using burden-of-injury figures. The distribution of the burden of injury over the body parts is in line with conclusions from previous studies, focusing on disabilities or burden of injury of all injuries. Both from our study and from previous studies (Bull 1985; Fort et al. 2011; Haagsma et al. 2009; Haukeland 1996; Hours et al. 2010; Polinder et al. 2007), lower leg injuries come forward as injuries that have large health impacts.

From the literature review it can be concluded that road traffic injuries can have major impacts on victims’ functioning and physical and psychological well-being. Reported risks of disability in the literature vary between 11 and 80% dependent on the type of road traffic casualties, time elapsed since the road traffic crash, and the considered health impacts.

From the estimation of the health burden of serious road injuries (MAIS 2+) in The Netherlands it can be concluded that about 20% of the serious road injuries encounters lifelong consequences. These lifelong consequences are responsible for about 90% of the health burden of serious road injuries. The burden of injury of seriously injured is twice that of fatalities. Given their major impacts and contribution to health burden of serious road crashes, road policy making should also be aimed at reducing the number of serious road injuries and to limiting their health impacts.

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