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Burden of road traffic injuries: Disability-adjusted life years in relation to hospitalization and the maximum abbreviated injury scale

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ABSTRACT

Background: The consequences of non-fatal road traffic injuries (RTI) are increasingly adopted by policy makers as an indicator of traffic safety. However, it is not agreed upon which level of severity should be used as cut-off point for assessing road safety performance. Internationally, within road safety, injury severity is assessed by means of the maximum abbreviated injury scale (MAIS). The choice for a severity cut-off point highly influences the measured disease burden of RTI. This paper assesses the burden of RTI in terms of disability adjusted life years (DALYs) by hospitalization status and MAIS cut-off point in the Netherlands.
Methods: Hospital discharge register (HDR) and emergency department (ED) data for RTI in the Netherlands were selected for the years 2007–2009, as well as mortality data. The incidence, years lived with disability (YLD), years of life lost (YLL) owing to premature death, and DALYs were calculated. YLD for admitted patients was subdivided by MAIS severity levels.
Results: RTI resulted in 48,500 YLD and 27,900 YLL respectively, amounting to 76,400 DALYs per year in the Netherlands. The largest proportion of DALYs is related to fatalities (37%), followed by admitted MAIS 2 injuries (25%), ED treated injuries (16%) and admitted MAIS 3+ injuries (18%). Admitted MAIS 1 injuries only account for a small fraction of DALYs (4%). In the Netherlands, the diseases burden of RTI is highest among cyclists with 39% of total DALYs. One half of all bicycle related DALYs are attributable to admitted MAIS 2+ injuries, but ED treated injuries also account for a large proportion of DALYs in this group (28%). Car occupants are responsible for 26% of all DALYs, primarily caused by fatalities (66%), followed by admitted MAIS 2+ injuries (25%). ED treated injuries only account for 5% of DALYs in this group.
Conclusions: When using admitted MAIS 3+ or admitted MAIS 2+ as severity cut-off point, 54% and 80% of all DALYs are captured respectively. Assessing the influence of different severity cut-off points by MAIS on the proportion and number of DALYs captured gives valuable information for guiding choices on the definition of serious RTI.

1. Introduction

Road traffic crashes are a global and increasing public health concern (Peden et al., 2004; Lozano et al., 2010). Road safety performance has traditionally been measured by the reduction of fatalities (European Commission, 2013b), but road traffic crashes also cause very large numbers of nonfatal injuries, leading to huge economic and human costs to society. In 2011, on roads within the European Union, for example, almost 1,5 million people were reported to have a non-fatal injury (European Commission, 2013b) compared to about 30.000 fatalities (CARE database) (2014). Around one sixth of the reported non-fatal injuries were estimated to be serious (European Commission, 2013b).

Moreover, the number of road injury casualties shows a less positive development than the number of fatalities in various countries, such as in Sweden, Spain, United Kingdom and Japan (IRTAD 2012). In the Netherlands, the number of fatalities decreased on average by almost 5% annually between 1996 and

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2011, whereas the number of road injuries decreased by only 1% annually between 1993 and 2006 and increased from 2006 to 2011 (Reurings and Bos, 2011).

Since the number of serious RTI is relatively high in relation to the number of fatalities and it shows a less positive trend in many countries, serious RTIs are increasingly adopted by policy makers as an indicator of traffic safety. Reducing the number of serious road injuries is one of the key priority actions in the road safety programe 2011–2020 of the European Commission (European Commission, 2010).

A problem, however, in relation to setting an international target is the lack of a common definition of a serious road injury. Internationally, within road safety, injury severity is assessed by means of the maximum abbreviated injury scale (MAIS), i.e., the maximum score of a six-point scale ranging from 1 (minor injury) to 6 (fatal injury) (Petrucelli et al., 1981). However, it is not agreed upon which MAIS level should be used to define serious road injuries as a policy indicator. In Dutch road safety policy, a serious road injury is defined as a hospitalized non-fatal casualty with an injury score of MAIS 2+. The OECD working group on injury data, IRTAD, proposes to define a 'seriously injured road casualty" as a person with an injury score of MAIS 3+ (IRTAD, 2012). Research to guide further choices in this area is scarce. A main issue in relation to the definition of a serious road injury as a policy indicator is the burden of road injury that is captured when a specific severity cut-off point is selected. To gain insight in the burden of road injuries distinguished by severity cut-off point, state-of-the-art methods to quantify the impact of diseases and injuries on population health may be helpful (Polinder et al., 2012a). Currently, the international standard measure for integrating the fatal and non-fatal consequences of diseases is the disability-adjusted life-year (DALY) (Peden et al., 2002, 2004; Murray et al., 2013; Gabbe et al., 2014), a summary measure of population health that combines the effects of mortality, morbidity and disability into a single measure. Though mortality is an essential indicator of the magnitude of RTI, it is important to realize that for each injury death, there are several thousand injury survivors, with short-term and often also lifelong consequences due to the injury. These non-fatal outcomes should also be measured in order to describe accurately the burden of disease due to RTI. The indicator used to quantify the loss of healthy life due to disease is the DALY).

Priority setting in healthcare, surveillance and intervention is based increasingly on burden-of-disease and injury studies using the DALY approach (Murray 1994). This method, which combines premature years of life lost (YLL) with years lived with disability (YLD), has been applied in general injury populations in different countries (Polinder et al., 2012a) and has been adapted to the needs and availability of data on the temporary and permanent consequences of non-fatal injuries (Haagsma et al., 2012). The DALY adaptation of Haagsma et al. (2012) was recently used in a study specifically designed to quantify the combined burden of road traffic injuries and fatalities (Dhondt et al., 2013). This study focused on DALYs per kilometer traveled by mode of transport, and confirmed more general previous work showing the highest disease burden per kilometer in case of motorcycling (Holtslag et al., 2008). But so far the impact of road traffic injuries on population health by MAIS severity has not been quantified.

This paper assesses the burden of road traffic injuries and fatalities in terms of DALYs by MAIS cut-off point in the Netherlands. No prior exclusions of low severity levels are made in our analysis, since previous studies have shown the large potential impact of minor injuries on population health. In the Netherlands we found that almost one fifth of the DALYs of road crashes are caused by low severity injuries that are only treated at the ED without subsequent hospital admission (Polinder et al., 2012b). In Sweden it was observed that 10% of injuries from road crashes with MAIS 1 suffers from permanent consequences and that the majority of permanent consequences of road injuries results from MAIS 1 or MAIS 2 injuries (Malm et al., 2008). Furthermore, several studies conducted in New-Zealand concluded that exclusion of non-hospitalized injuries leads to underestimation of the population impact of injuries (Ameratunga et al., 2006; Derrett et al., 2011; Langley et al., 2011).

Therefore, this paper looks at the combined burden of fatalities due to road crashes and medically treated RTI, including both ED treatments and hospitalizations and including all MAIS severity levels 1–6.

Our paper presents a comprehensive set of tables and figures on the burden of road traffic injuries in the Netherlands. We calculated DALYs in relation to hospitalization and the MAIS. To increase the relevance of our analysis from a policy perspective, a specific focus on MAIS cut off was chosen. This may support choices of traffic safety policy makers on indicators of 'road safety performance' to be preferred or avoided.

We will assess the influence of different severity cut-off points on the proportion and number of DALYs covered.

2. Data and methods

2.1. Data sources

Several data sources were used to provide national data on mortality, the incidence of RTI and their consequences. For road fatalities, data were obtained from Statistics Netherlands for the years 2007–2009 by age group, gender and mode of transport (CBS, 2010). The numbers were multiplied by the Life Expectancy of the respective age group from the Global Burden of Diseases study (Global Burden of Disease, 2010).

Data from the hospital discharge register (HDR, 2007–2009) with full national coverage were used to assess the injuries and their consequences of admitted injury patients. The Dutch injury surveillance system (2007–2009) provides a national representative sample of injured patients who were treated in the emergency department (ED) that was scaled to national level. ED patients consisted of both non-admitted and admitted patients visiting an ED. To avoid double counting of HDR and ED registry, admitted ED patients were excluded from the analysis.

A selection of external causes of the *International Classification of Diseases*, 9th revision was used in the HDR to select RTI (ICD9: E810-E817, E819 + E826, E827, E829, extended with other patients that could be matched to police reports). The mean annual incidence for the period 2007–2009 was used. Readmissions and persons dying within 30 days of the crash were excluded from the HDR data and YLD calculations to prevent double counting with the mortality statistics.

In the HDR and ED system, data by age group, gender, injury type, and mode of transport were available. For the HDR, the mode of transport was checked with matched police reports, which overruled the mode that was present in the HDR E-codes (Reurings and Bos, 2011). Seven main road user groups were identified: pedestrian, bicycle (with and without involvement of a motor vehicle in the crash), moped, motorcycle, car/van and other/unknown.

In the HDR also the abbreviated severity score (AIS) was available. The AIS is developed specifically for the classification of injuries (Gennarelli and Wodzin 2006), describing the type of injury, affected body region, and injury severity in a 7-digit code for each injury that the trauma patient has sustained. To classify trauma patients according to injury severity level AIS scores of each injury can be combined into a single score with the maximum AIS (MAIS), which determines severity level by taking the highest