Correction for underreporting of road traffic casualties in the Netherlands; relevance and method

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Abstract

Not all road traffic casualties are reported by the police. Using the correct data in addressing road safety issues and evaluation of road safety measures is relevant for designing effective road safety policies, to set the right priorities and act on them. Therefore it is necessary to estimate the higher 'real number' of casualties annually. This can be done by using other sources and/or by comparing and matching different data sources to estimate the number of missing casualties in police data. This paper discusses the Dutch approach of matching different data sources to estimate the real numbers of fatalities and hospitalized road casualties and presents results. For fatalities three sources are available: Death Cause Statistics, Court Files and the Dutch Road Crash Database. For hospitalized casualties there are two sources: the Road Crash Database and the Medical Registration of in-patients. The Medical Registration contains additional information about the severity of the injury: the Maximum AIS score (ICD derived). Matching these two databases also enables to add information about the severity to the crash database and to study the severity development of hospitalized casualties.

Key-words : under-reporting; road casualty; police data; hospital data, data linking, road accident, traffic fatality, injury, death causes, Netherlands

Introduction

Knowledge of the correct size and nature of a country's road safety problem is important to position road safety among other national policy efforts. It must be understood that the road safety problem is likely to be bigger than it initially seems to be. This has several reasons, including the following:

1. The number is higher: not all crashes and casualties are reported (IRTAD, 2006).
2. The impact is larger: the age at which people die or get injured as a result of a road crash is relatively low (compared to the age at which other causes of death and injury occur). This results in a high number of Disability Adjusted Life Years (DALYs) resulting from road crashes.

As a result of this, the socio-economical costs of road crashes and casualties are higher than intuitively estimated.

This paper concentrates on the first item in the list above: underreporting. Furthermore the severity of hospitalized casualties is studied. It is well known that crash reporting in general is not complete. For several reasons, however, it is important to know the real numbers of road crashes and the resulting casualties. For example, it is possible to benchmark road safety with other causes of death and/of loss of quality of life when these real numbers are known. Furthermore, to give road safety measures the right priority it is essential to use real numbers of road casualties in cost benefit analyses. Therefore, the real numbers of road crashes and resulting casualties have to be estimated. Combining the police crash data with alternative sources will improve insight in underreporting and the real numbers. Several methods are available to combine or link sources.

The aims of this paper are:

- to increase awareness of the necessity of having insight in the correct size and nature of road crashes and their consequences;
- to show possibilities to get better insight in the real numbers;
- to show possibilities to harmonize injury severity based on the score on the Abbreviated Injury Scale (AIS);
- to show the development of the number of seriously injured casualties in the Netherlands.

Background

Worldwide

It is known that road crashes lead to loss of life years, loss of quality of life, and material damage. The total number of road fatalities is estimated at almost 1,2 million worldwide, while the estimated number of injured is between 20 and 50 million (Peden, 2004; WHO, 2009). Calculations show that this leads to socio-econimical costs between 1% and 2% of the Gross National Product (Peden, 2004).

The Netherlands

In 2008, 750 persons were killed in traffic in the Netherlands (RWS/DVS, 2009). In addition, approximately 18,000 casualties were hospitalized for a minimum of 24 hours and almost 100,000 persons received first aid treatment at an Accident & Emergency Room. When slightly injured casualties and property damage only crashes are included, this leads to a total of socio-economical costs of about 12 billion Euros (AVV, 2006). This is equal to 2.6% of the GNP and amounts to approximately €750 per inhabitant of the Netherlands. Figure 1 shows the development of the real numbers of road fatalities and casualties in the Netherlands.

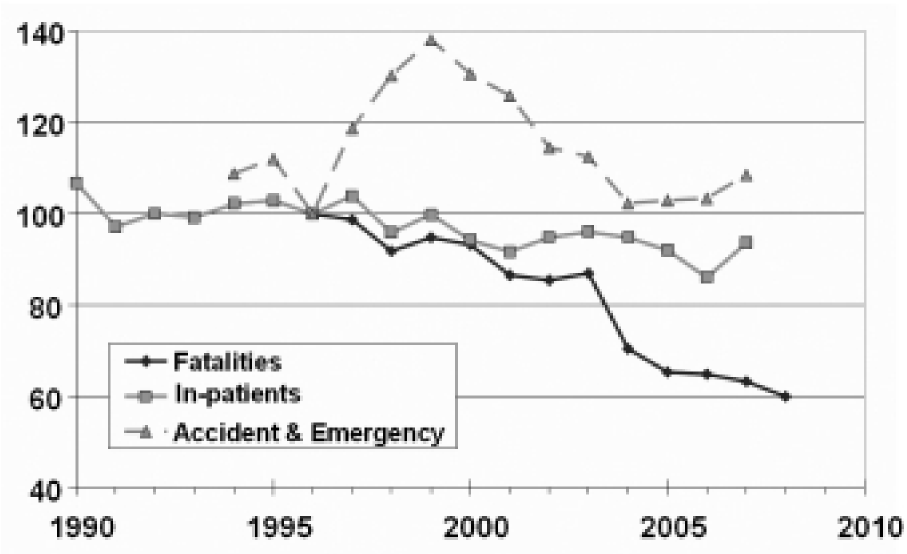

Figure 1. Development of the real number of casualties in the Netherlands by severity. Index 1996=100. Source: CBS/SWOV.

Using the upper-estimate of 50 million injured worldwide and 120,000 in the Netherlands, the following indicators can be derived:

	NL	World
Fatalities per million inhabitants	45	160
Injured per million inhabitants	7,200	7,000
Number of fatalities per 1,000 casualties	6	24

As the proportions of injuries per million inhabitants for the Netherlands and the world are more or less equal, the upper-estimate of 50 million injured persons world wide seems a reasonable estimate. However, based on the unequal rate of fatalities per 1,000 casualties it is possible that the estimation of 50 million is a huge underestimation.

Importance of a correct magnitude of the safety problem.

To prevent serious crashes we need insight in the circumstances that lead to these crashes. This should result in the development of measures that have a positive effect on one or more of these circumstances. The effectiveness is assessed on the basis of how many crashes and casualties are prevented by the measure. The correct magnitude of the road safety problem plays an important role here, as it can increase the 'real' effect and can also shed another light on crash types that are underreported. Using the real numbers we are able to prioritise between road safety measures and measures to prevent other causes of death or injury, and also to benchmark between countries.

Furthermore, it is important to know whether the development of fatalities and casualties conforms to the expected results of the measures taken. If there is uncertainty about the development of casualties and fatalities because there is no insight in the real number or in the development of the reporting rate, it can lead to wrong conclusions with evaluation studies.

Road safety will only be capable of claiming the correct priority for prevention policies if the following aspects are taken into account:

- the number of casualties due to road traffic crashes is realistic in comparison with the number of casualties from other causes of death and injury;
- there are measures that can improve safety;
- the socio-economical costs of road safety are realistic, and the calculation methods are comparable with those in other sectors;
- the preventive road safety actions are cost effective and in principle have a lower cost-benefit ratio than other interventions[1].

This can lead to a better justified social and political support and acceptance of road safety measures.

Socio-economical costs of road crashes

The costs of crashes are a dominant part of the socio-economic costs of transport. For the Netherlands the socio-economical costs of unsafety make up 50-70% of the total socio-economical costs of transport, also including those due to the environment, congestion and road safety. The knowledge about socio-economical costs is important to make cost-benefit analyses of road safety measures possible.

The socio-economical costs are defined (AVV, 2006) as:

"the socio-economical costs of road traffic accidents comprises all the costs (direct and indirect) arising from road traffic accidents, including the cost of repair and compensation as they relate to all forms of injury and damage and all costs with claim settlements, as well as all other costs arising from accidents including the cost of lost production, congestion (resulting from traffic jams following an accident), and personal suffering."

[1] In case road safety measures become less efficient than measures outside road safety, then it can be argued that other interventions should be implemented. From that point of view, zero road casualties world decrease welfare(OECD/ITF, 2008).

For the Netherlands the socio-economical costs amount to €12 billion and are the total of the following crash consequences:

	Million €
Fatalities	2,640
Hospitalized casualties	4,655
A&E casualties	767
Slightly injured casualties	352
Material Damage Only	3,912
Total	12,327

Table 1. Costs associated with road crashes in The Netherlands. Source AVV, 2006.

If only police reported data were used for the computation of these costs, the total amount would be €6.1 billion, about 50% of the costs based on the real numbers.

It should be emphasized that the last three categories in Table 1 represent about 40% of the total socio-economical costs. In many countries slight injuries and Material Damage Only crashes are not reported. Therefore, the use of fatalities and hospitalized casualties only could result in an underestimation of 40% of the real costs. In addition, the underreporting of fatalities and hospitalized casualties in the crash database may result in an extra underestimation of the socio-economical costs of one sixth.

Heatco (2006) noticed that the vast majority of countries ignore non-reported crashes in evaluation projects. Heatco recommends the following factors for underreporting in case underreporting is not known (fatalities 1.02; serious injury 1.5; slight injury 3.0, damage only 6.0). In some cases it can be important to differentiate by vehicle type because the reporting rate differs per vehicle type.

Underestimation of the socio-economical costs or the change of the number of crashes or casualties as a result of measures leads to a lower cost-benefit ratio. As a consequence, road safety measures may get a lower priority than they would have been given based on good data.

Crash database and alternative sources in the Netherlands

Several databases are available to give insight in road safety. All these databases serve their own purpose, such as providing the basis for national statistics, health care research or road safety research. Therefore, they may also use different definitions. They all have their own accuracy and reliability with respect to road safety.

Road Crash database

First of all, the Netherlands has a road crash database. This database is the most important source to improve knowledge about the occurrence of road crashes and the causes and circumstances underlying them. As in most countries, these crashes are reported by the police. It is well known that in many countries the crash reporting is neither complete nor representative (Broughton, 2007). This has the following reasons:

- not all crashes need to be reported by the police (for instance minor injury and damage only crashes);
- not all crashes are known to the police;
- not all known crashes or casualties are coded (correctly) in the database;
- the injury was not immediately detected;
- the severity of the injury was misjudged (DFT, 2006; IRTAD, 2006).

Most countries use the reporting by the police as their source for the number of road crashes and casualties. Usually the police are notified when injury or damage is caused by one citizen to another. When there is minor material damage, but a victim needs proper medical treatment, an ambulance is called first. If an (insured) motor vehicle is involved the police is notified secondly, however not always. In case of a non-motorized crash or a single vehicle crash it is less likely that the police is informed, which results in a missing case in the police reports.

For the interpretation of the reported cases it is important to know which cases are likely to be missing. The entire crash process should be analysed, including information with respect to who calls who, and what task and responsibility each person has (medical, juridical, traffic flow, insurance, accident investigation, etc). This indicates possible leaks where a case is not noticed or not reported to the proper authority.

Alternative sources

Death cause statistics, hospital databases and surveys can also give information about the numbers of road traffic casualties. These databases generally do not contain information about the cause or circumstances of the crash, and are of limited relevance for detecting preventive measures. However, these databases are important to investigate the level of underreporting and may reveal relevant injury patterns.

These databases can be analysed individually, but also by combining or linking the databases. Linking databases makes it possible to get more information on one casualty. For instance, matching crash data with hospital data can increase the knowledge about the injuries related to several types of crashes: it is possible to see the development of the severity related to types of crashes. Linking also makes it possible to make better estimates of the real numbers and can result in knowledge about which types of crash have lower or higher reporting rates.

Although there are many good reasons to link databases, it can also be very useful to just use one alternative source, especially if linking is not possible because of privacy regulations or because no key can be defined to link one case to an equivalent in the other file. For example, if the alternative source is more complete, more accurate or more reliable with respect to the real numbers than the crash database, it may be better to use the alternative source rather than the crash database.

In the Netherlands this is the case with the hospital database. With a reporting rate of more than 90% it is more correct than the crash database which has a reporting rate for in-patients of less than 60% (see below). Research also showed that the coverage of the crash database for motor vehicle crashes is much better (about 80% and quite constant), while the coverage for non-motor vehicle crashes is poor (about 25% and decreasing).

Alternative sources also create opportunities to benchmark road fatalities with other causes of death or injury, as is illustrated in Figures 2 and 3. Figure 2 shows the age dependency of the number of unnatural death causes. It is easy to see for example that in the age group 10-24 road traffic is responsible for the highest proportion of fatalities.

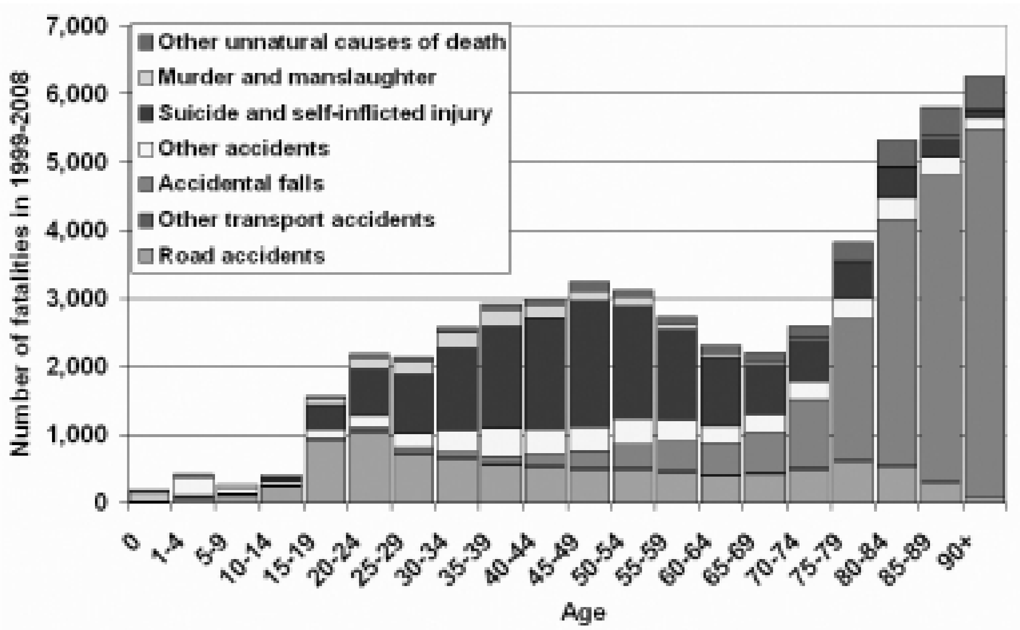

Figure 2. Fatalities by external cause in the Netherlands.
Source: CBS Unnatural death (sum 1999-2008).

When we use the same causes and study the number of persons injured and hospitalized, the picture shifts to other accidents (dominated by medical complications). The number of hospitalized persons for suicide is low compared to that of other causes and deaths;

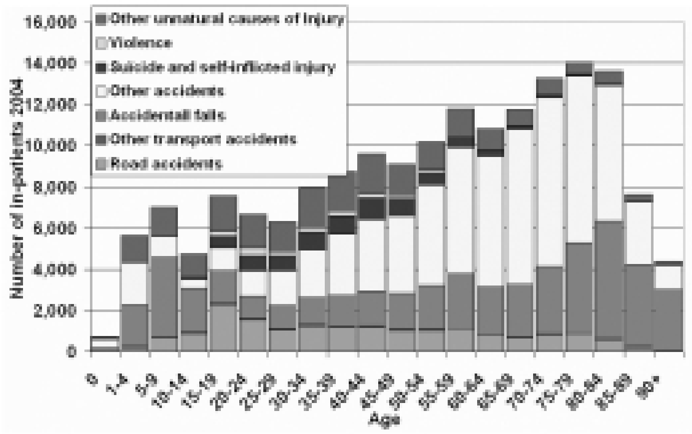

Figure 3. In-patients by external cause of their injury in the Netherlands.
Source: CBS-LMR Unnatural causes of Injury (2004).

In the Dutch road crash statistics we have seen that the development of in-patients lags behind on the decrease of fatalities (Figure 1). Analysis of the hospital data can give a more detailed view of the development of the severity of in-patient injuries (van Kampen, 2007).

Estimating the real numbers

In order to estimate the number of missing cases there is a need of other (independent) sources on road crashes and casualties. Most European countries have a Population Register and Death Cause Statistics. Also, hospitals have data about their in-patients and/or treatments at the Accident & Emergency, and ambulance services may have information on the people they bring to a hospital. First, the numbers from these different sources can be compared with the official (police-reported) road crash information.

Road Fatalities

In Figure 4 shows the number of road fatalities in the Netherlands in 2004 as reported by three sources: the Death Cause Statistics, Court Files and the police reported Road Crash Database: The real number should lie somewhere between the maximum of the single sources and the sum of all three sources. If all sources share a common variable, such as age group or gender, the maximum can be determined for each subgroup, which increases the lower boundary of the real number.

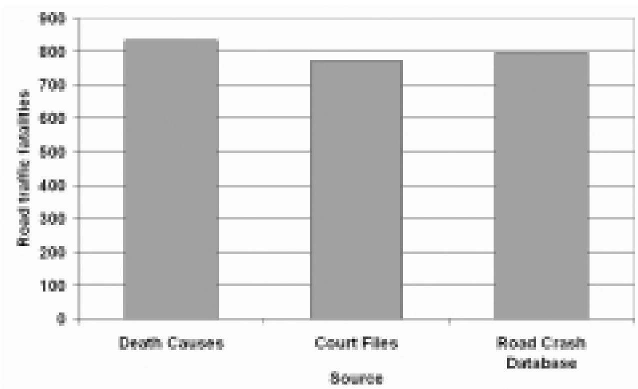

Figure 4. Traffic fatalities by three different sources.
Definitions are harmonized, i.e. on Dutch public roads, within 30 days, excluding suicides. Source CBS (2004).

In order to identify the overlap between different sources, cases should be matched individually. If there is a personal identifier in two sources, the intersection between the sources can be determined easily. However, it becomes more complicated if sources use different identifiers or if the identifiers are not available for research because of privacy regulations.

If two sources do not share a common identifier, matching can be done by comparing other characteristics in both data files. If date of birth and date of crash/hospital admittance are equal for a pair of records in both databases it is likely that the records describe the same person. This becomes even more likely if other available characteristics are equal, such as region, gender, name of casualty, traffic mode, severity, hospital name, external cause of injury is a road crash et cetera.

This approach could work if all information were coded correctly. However, it is in the human nature to minimize paperwork and not to check the input or to leave out information that looks less important. The lack of quality of the data can really frustrate the linking of files, preventing a proper determination of the intersection of two sources.

In Figure 5 the number of road fatalities in the Netherlands in 2004 is displayed by three matched sources: Death Cause Statistics (corrected for inhabitants crashed on other than Dutch roads), Court Files and Road Crash Database: 77% of the cases are present in all three sources. A total of 881 different cases have been recognized, of which 833 are present in the Death Cause Statistics (95%), 772 in the Court Files (88%) and 796 in the Road Crash Database (90%).

The procedure to compare traffic fatalities with Death Cause Statistics was recognized as a best practice by the project Supreme (Berends, 2005).

It can be argued (Stipdonk, 2004) that there are also road fatalities missing in all files. As this number is small (5) and there is no information about them, these fatalities are omitted in the overall estimation. The calculation was done on the condition that the sources are independent and the definitions are comparable. This is not entirely the case, as two sources (Court Files and the Road Crash Database) are filled by the police and the sources have different target groups. Although the target group can be filtered to comply with the other files (e.g. crashes on Dutch roads only), extension, however, is not possible. This explains why certain cases, such as non-inhabitants, are not observed in this source. Also for the Death Cause Statistics the place and date of death are more relevant than the place and date/time of the crash.

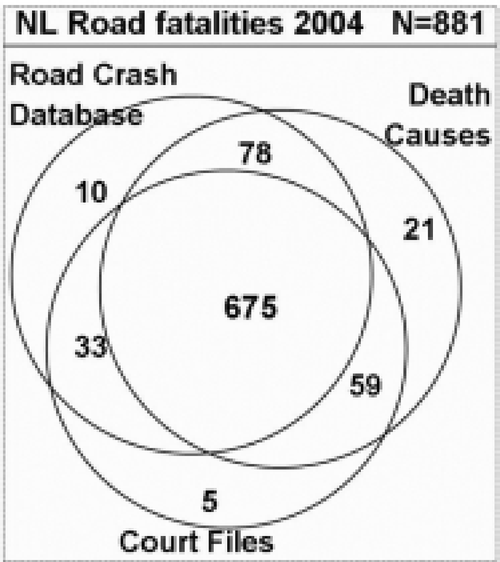

Figure 5. Traffic fatalities by three different sources, corrected for overlap.
The intersection makes 77%. 19% of the cases exist in 2 out of 3 sources
4% is in one source only. Source CBS (2004).

The number of fatalities in the Netherlands is small enough for semi-automated matching and manual inspection to recognize unique cases. However, this is not the case for injured traffic casualties. Automated matching is required here.

Injured road casualties

In the Netherlands, there is no unique personal ID available in either the Road Crash Database or the Medical Registration of in-patients (LMR). However, identification of matching cases is possible by making use of six variables:

1. Date/time of crash / hospital admittance;
2. Date of birth;
3. Gender;
4. Region of hospital;
5. Severity in police record (killed, not on the spot, hospitalized, A&E treated);
6. External cause of injury in hospital record (E-code within the range E810-E829).

The variables Severity and E-code merely filter possible cases from the complete data file.

In the Dutch linking procedure, it is allowed that the values are not exactly equal; however a difference is punished with a distance. So a gender unknown or a typing error of 1 digit in the date of birth does not prevent a link between a pair, but if another pair has a shorter distance the other pair is preferred.

As an example for the distance associated with a difference between crash and medical record, the Epoch-difference is shown (Reurings, 2007). The Epoch-difference is defined as the difference between crash occurrence and hospital admittance (date/time). There are two ranges: the hospital admittance is after the crash, or the hospital admittance of the possible pair is before the crash (of course this cannot happen, but because of inaccuracy of data/time notation (e.g. at midnight) a difference can be tolerated, if other values are equal)

$$A_{ij} = 100 * (\alpha_i - \beta_j)^2/16 \text{ if } \alpha_i \geq \beta_j$$

$$A_{ij} = 100 * (\alpha_i - \beta_j)^2 \text{ if } \alpha_i < \beta_j$$

in which α_i is the epoch of hospital entry (date/hour) and β_j the epoch of the crash (date/hour/minute), both expressed in days. This distance A_{ij} is constructed in such a way that it equals 100 for a time difference of -1 and +4 days.

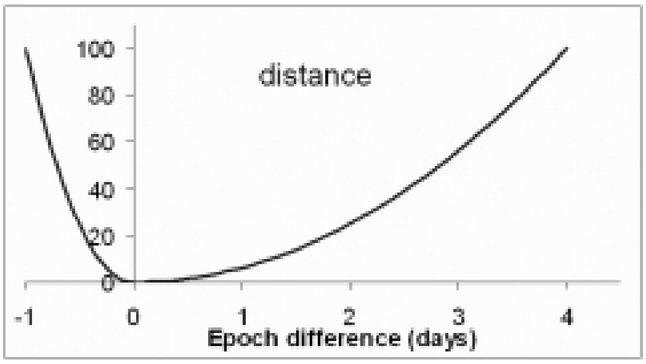

Figure 6. Dependence of distance to the difference in time.

When the total distance (sum of 6 distances) between two records is smaller than 55, and the next best record is at least 30 further away, the pair is matched and seen as belonging to the same person. If the distance is higher or the alternative pair closer, or if no pair could be formed, the records are not matched; it is a single case that is not reported in the other source.

The key to a single record in the file consists of the values of the six variables above. If the number of possible keys is much larger than the actual number of casualties, then each casualty may have a unique key within the file. This is necessary in order to match records (keys) in one file to identical keys in the other file. In this example the number of possible keys (at least 24*365 $_{\text{(time/date)}}$ * 100*365 $_{\text{(birth date)}}$* 2 $_{\text{(gender)}}$ * 12 $_{\text{(region)}}$ * 3 $_{\text{(severity)}}$ * 2 $_{\text{(external cause)}}$ = 46000 million) is indeed much larger than the number of casualties (34.106 in 2004, including slight injuries that are not expected to have been hospitalized). However, one should be aware that some groups, like young males, are much more involved in traffic crashes, and therefore the density of keys is much higher here. For example for 16 year old males the number of keys is 200 times smaller, whereas the number of casualties is only a factor 30 smaller. The space of keys is 6 times more dense, but still sufficient.

Matching 1997-2003 Road Crash Database with Medical Registration

In The Netherlands several linking studies have been performed in order to match the Road crash Database (further referred to as police file) and the Medical Registration LMR (Polak, 2000; Reurings et al., 2007). In this paper we report on the findings of Reurings et al.[2], who matched data for the years 1997-2003, and on some validations which were carried out in 2009 (SWOV to be published).

Before linking with the Road Crash Database (all 324,717 casualties, including slightly injured which are not supposed to match with an in-patient), 200,766 possibly relevant cases were selected from the Medical Registration, which covers all of the Netherlands. The following external causes (ICD9-clinical modification) were selected: E800-E829+E928+E958+E988. The first group (E800-E829) consists of transport crashes, while the three latter codes (E928, E958 and E988) are dedicated to unknown accident causes, suicide attempts and unknown injury causes. They are included in the linking process in order to find badly coded in-patients among them, who are present as traffic casualties in the Road Crash Database. All cases in the group E810-E817+ E819+E826,E828,E829, which correspond to clinically treated in-patients who did not die within 30 days are interpreted as traffic casualties. This group is extended with some matched cases for all other E-codes.

In Table 2 the matched cases and unmatched traffic casualties are marked yellow. The other numbers refer to cases that are not considered a hospitalized traffic casualty, because of death within 30 days, day-treatment only, E-code outside the range of road crashes or only slight injury according to the police.

	Medical file Traffic casualties	Medical file, not a hospitalized traffic casualty	Not in medical file	Not in medical file, not a traffic casualty	SUM
Police hospitalized	48,735	3,547	3,205	27,069	234,717
Police slight	11,497			230,664	
Not in police file	63,354	3,470	*(2,826)*		
Not in police file, not a traffic casualty		70,163			
SUM	200,766				

Table 2. Distribution of matched and not-matched casualties from police file and medical file 1997-2003.

The intersection of the two files consists of 60,232 cases. Furthermore, the real number is composed of the remainder of both files: Medical 63,354 cases and Police 3,205 cases. It must be noted that the 3,205 cases in the police remainder file are an estimate to prevent double counting. The idea is that the 27,069 cases that are hospitalized according to the police report, in fact either

- are not hospitalized (the injury was misjudged);
- have a pairing record in the medical file, but for some reason could not be matched (poor data quality in one or more key variables). These cases are already included in the 63,354; in order to avoid double counting these cases are omitted.

Therefore, it is assumed that 4% of the police reported hospitalized casualties (79.984) is not recorded in the medical file. All other unmatched cases are interpreted as not a hospitalized traffic casualty.
With a Capture-Recapture technique (Wittes et al., 1974) it was estimated that another 2,826 cases were missing in both files. This results in a total real number of 129,617 hospitalized road traffic casualties, excluding fatalities and day-treatment. All other cases are interpreted as not belonging to the group of hospitalized traffic casualties.

Table 3 shows the average annual distribution of all hospitalized traffic casualties over the different sources. The hospital file contains 94% of the total real number of casualties (intersection + remainder file). The police file contains 49%.

[2] Part of this research has also been published within the framework of SafetyNet(Broughton et al, 2007). In this SafetyNet report and in IRTAD(2006) linking studies applied in other countries can be found.

police and hospital 8,605 46%	Police, not hospital 458 2,5%
hospital, not police 9,051 49%	neither police nor hospital 404 2,2%

Table 3. Annual average number of hospitalized road traffic casualties.

When we study the distribution over the different parts over the years, the following picture can be constructed:

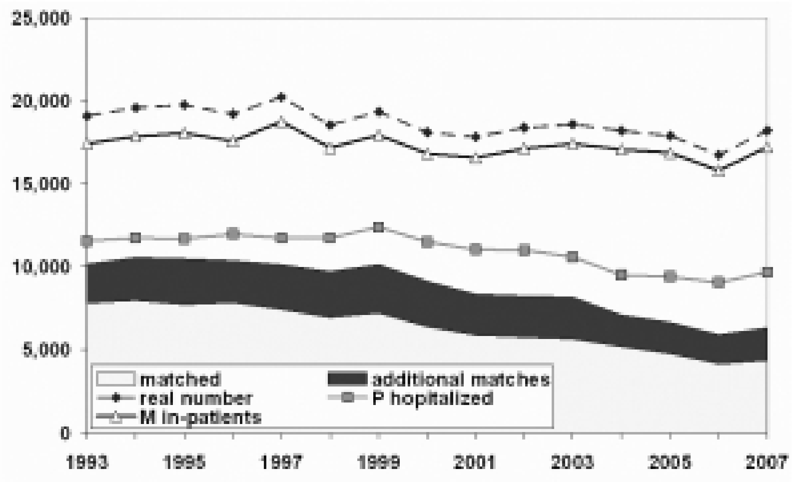

Figure 7. The number of hospitalized traffic casualties. Source SWOV.

The number of reported casualties in the police file is shown (p hospitalized) as is the number of reported traffic in-patients in the medical file (M in-patients). The result of the linking procedure is also shown (area), but the matches are split in the real intersection of both parts (blue) and the matches between non-traffic E-codes in the medical file or between casualties not hospitalized according to the police (purple). The real number is also shown (dashed).

The real number very well follows the number of in-patients with a traffic E-code.

This implicates that some variables, like age and gender can be studied better using the medical file, as the coverage of the total is much better than the police file. Some other characteristics (that are not available in a medical file) can only be studied using the Crash Database, such as road type, intersection type, street lights et cetera. However, one should be aware that less than 50% of the cases are taken into the research and that the cases that have not been studied may have other crash characteristics.

Some variables, available in both files, show different values, such as the mode of transport.

Validation of the linking method

In order to validate the matches found, both files were polluted with additional records, in order to see if the same pairs were still matched. The pollution was done by adding casualties from the next and the previous year, but with a date of crash shifted -364 and +364 days respectively and likewise for the date of admission. So both files were 3 times larger and the space of keys was 3 times more dense in both files. This was done for the year 1998. The result was that 99.5% of the matched pairs were identical. 0.5% of the matches were matched with another record, and in addition 1% more pairs were formed with a record with a shifted date. This shows that the linking method is reliable when applied to the Dutch situation.

Medical severity of casualties

By use of software ICDmap90 (Johns Hopkins University, 2002), all injury codes (maximum 9) were mapped to the AIS1990 standard. This resulted in a Maximum AIS score which indicates the severity of the injuries for each in-patient in the Medical Registration.
For all cases that were not available in the Medical Register (i.e. 6,031 cases from police remainder file and not reported cases) the same distribution over MaxAIS is proposed. For all cases that were not available in the police file (i.e. 66,180 cases from medical remainder file and not reported cases) the same distribution over the severity that the police would have assigned is proposed. This results in the following numbers:

	Casualties by police severity			
MaxAIS	hospitalized	slight	Total	share
0 no injury	4,091	1,481	5,572	4%
9 undetermined	2,090	605	2,695	2%
1 minor	14,296	4,420	18,717	14%
2 moderate	54,364	13,250	67,615	52%
3 severe	27,308	3,495	30,803	24%
4 serious	2,439	203	2,642	2%
5-6 critical / untreatable	1,491	81	1,572	1%
Total	106,080	23,537	129,617	

Table 4. Casualties by police severity and Maximum AIS score.

Table 4 shows that approximately 20% of all police reported hospitalized casualties only suffer minor or undetermined injuries or is only taken in for observation (no injury), and discharged without treatment.

Persons whose severity was misjudged by the police, are somewhat less severely injured; however 16% of the matched cases still have severe or more serious injury (MaxAIS $\geq$ 3) instead of the slight injury reported by the police.

As the medical file contains more than 90% of the relevant cases (selectable), the medical file can also be studied as a single source, without linking to the Road Crash Database.

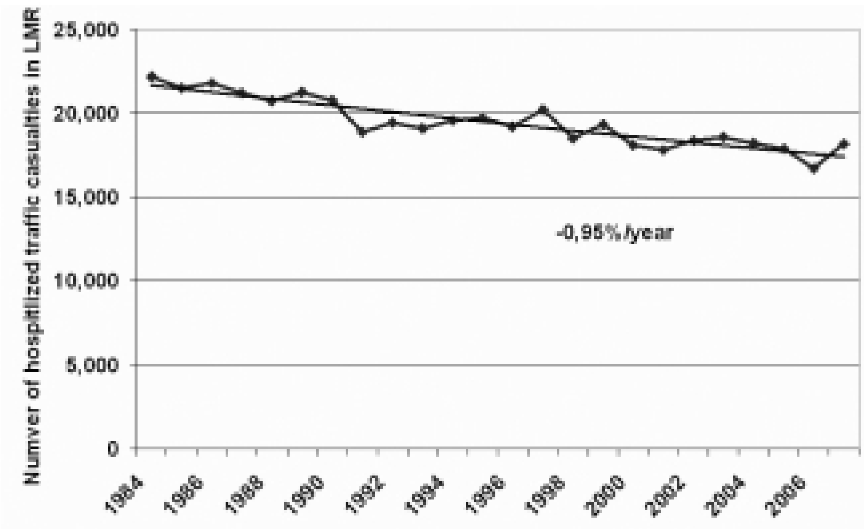

Figure 8. The real number of hospitalized traffic casualties as derived from LMR.

Whereas the total number of hospitalized persons decreases with 1% per year in Figure 8, the picture becomes different if we split cases into MaxAIS groups and add involvement of a motor vehicle in the crash (see Figures 9 and 10).

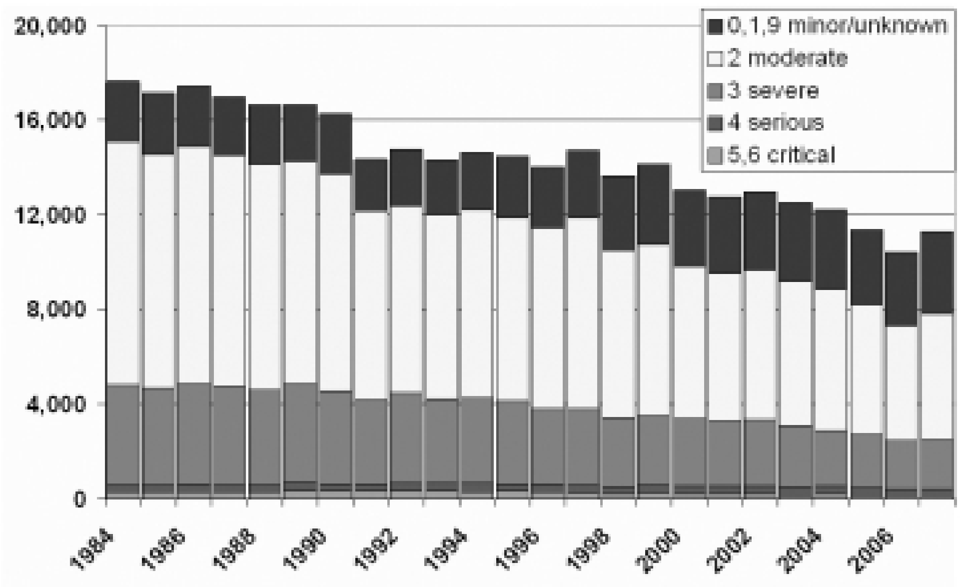

Figure 9. The number of hospitalized traffic casualties in motor vehicle crashes, by Maximum AIS-severity.

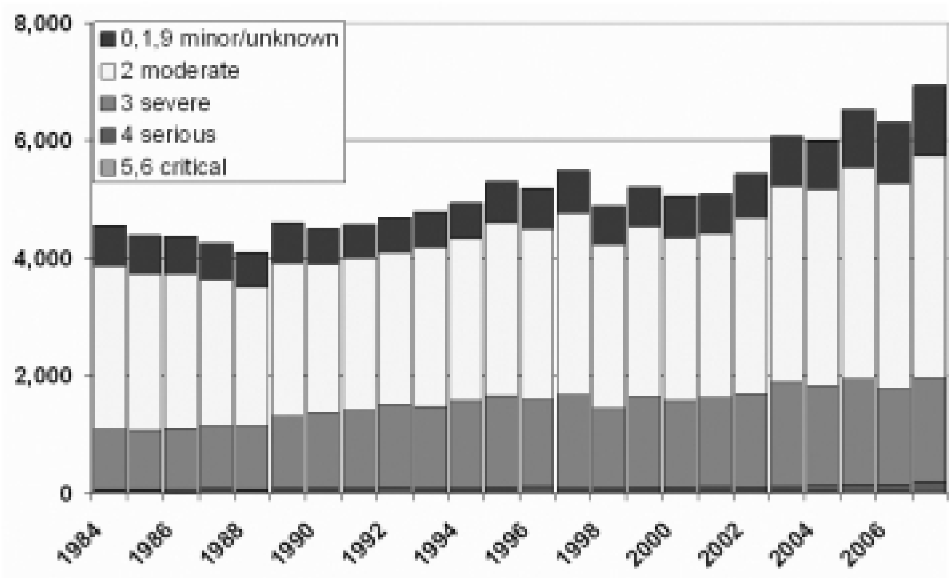

Figure 10. The number of hospitalized traffic casualties in crashes without any motor vehicles involved, by Maximum AIS-severity.

The casualties in crashes without any motor vehicles involved mostly consists of bicyclists.
Conclusions that can be drawn from these figures are that:

- The number of casualties with minor or no injury in the Medical Register increases over the years.
- The number of casualties in motor vehicle crashes decreases much more rapidly than the total of all hospitalized casualties. The number of MaxAIS $\geq$ 2 decreases with 2.9% (average 1984-2007); this is equal to the development of fatalities (3.0%).
- The number of casualties in crashes without motor vehicles involved increases over the years.
- In crashes without a motor vehicle involved, the share of severely injured casualties (MaxAIS $\geq$ 2) doubles from 20% in 1984 to 42% in 2007.
- In 2007, 25% of all hospitalized traffic casualties suffer from injuries with MaxAIS $\geq$ 3. 50% of all hospitalized traffic casualties has injuries with MaxAIS = 2.

In their studies many countries concentrate on fatalities only; also international comparisons usually focus on fatalities. If countries were to investigate their underreporting and severity development, injured casualties would become much more comparable. Considering medically severely injured (MaxAIS $\geq$ 3) as well as fatalities would increase the subject of road safety studies with a factor of 6. Starting at moderately injured (MaxAIS $\geq$ 2) would increase the number with another factor of 3 (18 in total compared to fatalities only). One should be aware that moderate is hospital terminology. Casualties suffering injuries AIS rated 2 may experience long term disabilities and a lower quality of life.

Within the IRTAD group it was promoted that the definition of severe casualties could be harmonized internationally by applying it to persons hospitalized. (IRTAD, 2003). The research of SafetyNet (Broughton, 2007) has shown that a harmonised definition on MaxAIS is even more suitable for comparison, it is, however, more difficult to derive.

Conclusions:

It is well known that reporting systems of roads crashes using police data suffer from the fact of underreporting. Two types of problems exist: underreporting and biased reporting.

1. Underreporting is not a big problem, if it can be quantified. Neglecting underreporting is a problem, as it leads to difficulties in country comparisons and to wrong priority settings in competition with other fields.
2. Bias in the reported cases is a problem, as it is more difficult to quantify it for relevant subsets of the data. Unknown bias can lead to wrong priorities within the field of road safety.
3. In order to quantify underreporting and bias, it is necessary to find or develop alternative sources (such as causes of death, hospital databases). These can be used individually as well as linked to each other.
4. For the analysis of the development of the number of casualties, it is necessary to realise that the level of underreporting and/or bias is not constant in time.
5. A better insight in the severity development is possible with the use of a hospital database with severity indicators (e.g. AIS).

Recommendations:

1. Underreporting coefficients should differentiate by the most relevant characteristics, such as year, severity, mode and involvement of a motor vehicle.
2. When real numbers are not used, the adverb ‘reported’ should be used, for instance. “reported hospitalized casualties”.
3. Splitting of the (real) number of casualties by MaxAIS score is a good starting point to harmonize the definition of severe injury and make data more comparable.

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