Estimation of the real number of road casualties in Europe

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Abstract

Within this research, the police under-reporting of non-fatal road accident casualties in eight European countries was examined by means of a common methodology applied in each country. Eight national studies were carried out using the common methodology, and this allowed to prepare valid estimates of the level of under-reporting of non-fatal road casualties in Europe in a disaggregate form (namely by country, road user type and injury severity). This provided an insight into the variation of road casualty under-reporting in Europe. Moreover, a new common definition for road casualty severity was proposed that makes use of internationally recognised medical standards. This was established by examining two different injury severity standards, the casualty's length of stay in hospital and the casualty's maximum AIS score. The under-reporting coefficients developed within this research were applied to estimate the real number of non-fatal serious road accident casualties, according to the new proposed common definition. For almost all countries, the actual number of serious casualties according to the new proposed definition was found lower than the number of police-recorded serious casualties. With the newly estimated number of serious casualties, the values of the ratio of serious casualties to fatalities are much less widespread across countries. These remaining differences can thus be attributed to real differences in road safety between the

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countries, after having controlled for the different under-reporting levels and injury severity definitions.

Key words: Road casualty under-reporting; police data; hospital data; correction coefficient; European study.

1. Introduction

Road accident data are collected by the European countries by the use of their own national collection systems, in order to provide detailed and reliable data for road safety policy making and decision support, as well as for road safety analysis and research. In each country, the police is responsible for recording data on road accidents and the related casualties (injuries and deaths) in a national database. These police recorded data are available since 1991 at the CARE database the European database with disaggregate data on road accidents resulting in death or injury. The definition of an Injury Road Accident concerns an incident on a public road involving at least one moving vehicle and at least one casualty (person injured or killed).

However, at present, road accident casualty data cannot be directly compared among countries as the definition of injury severity differs among countries (an accident or casualty which would be recorded as severely injured in one country might be recorded as slightly injured in another, or a crash is reportable in one country and too minor to be reported in another country) and additionally the varying degree of casualty under-reporting in the various countries limits significantly the scope for reliable road accident analyses and comparisons. The police of each country uses different approaches for determining the injury severity of a road casualty, for which detailed information is seldom available. However, the present paper does not focus on the methodology of each national police for determining injury severity but on the difference between the hospital and police reported severity. The only comparable measurement units available internationally are the numbers of fatal accidents and fatalities, for which the degree of under-reporting is significantly lower in most European countries. However, non-fatal accidents and casualties impose a burden on society that is at least as great as fatal accidents and fatalities. Thus, the identification of the real number of non-fatal casualties is very important in order to allow for more complete data to be available at European level. Such data are essential for better understanding of the road safety issue and hence better prevention.

Over the last decades, several studies have attempted to identify the level of under-reporting of road accident casualties. In most studies, comparisons of police records and hospital data show that a significant proportion of injury-producing accidents are not reported to the police (Hvoslef, 1994). As it is the case for police files, hospitals may also use slightly different definitions of what could be a road accident in different countries; however, differences in the

definitions are not significant in general, since they concern very specific cases (i.e. a child falling from his toy cycle in the sidewalk might be considered as a road accident by the hospital but not by the police) therefore it is not expected that these differences significantly affect the results of such studies.

However, the results seem to vary significantly between international studies as the level of under-reporting seems to be associated with numerous factors. These include length of stay in the hospital, physician in charge of the first aid, urban place of the crash, type of vehicle involved, day and time of the crash and blood alcohol concentration (Aptel et al., 1999), or with gender, injury severity and the number of vehicles involved (single vs multiple-vehicle accident) (Lopez et. al., 2000).

A number of studies report results from routine data linking at national level (i.e. in the USA for over a decade as part of the Crash Outcome Data Evaluation System – CODES, 1996), while others link data as part of a specific research project (Rosman, 2001, Amoros et. al., 2006). Thus, road accident casualty record linkage has been applied in a wide range of contexts, although the technical details varied between studies. Consequently, there is need for a benchmark methodology, which will allow for the exploitation in a common way of all road accident casualty data selected from both the police and the hospitals in various countries.

The aim of the present research is to prepare valid estimates of the level of under-reporting of non-fatal road casualties in Europe in a disaggregate form. The results will be used to propose a common measurement unit for the number of people who are seriously injured in road accidents. More specifically, the level of under-reporting is calculated by casualty severity and road user type by the means of a common methodology. This is applied in eight national studies, which allows the actual number of casualties in these countries to be estimated in a uniform way.

2. Methodology

A three-step approach was adopted to achieve the research objectives. Initially, a common methodology for the data collection was developed, which subsequently was used in eight national studies (Broughton et al. 2007). The results of the national studies were processed in a common way to estimate the correction coefficients and to propose a common measurement unit for the number of people who are seriously injured in road accidents.

Each national study was carried out following a common framework. This framework consists of linking the national road accident database (maintained usually by the police) to a medical database (from hospitals), to identify all common records and, equally importantly, to copy details from the medical

record of each linked casualty to the corresponding record in the police database. Moreover, national coefficients to estimate the actual casualty totals from the numbers recorded by the police would be calculated and a new definition for serious road injuries based on the most appropriate medical variable(s) would be defined. For the purposes of this study, two injury severity descriptors were considered, namely the casualty's length of stay in hospital and the casualty's MAIS.

The AIS is an injury severity indicator which can be used in order to establish an internationally accepted road injury severity standard. It was a core element in the national studies as (compared to the length of stay) it proved to offer a more robust indicator in order to define a threshold for serious road injury. The AIS is a specialised trauma classification of injuries; it includes an anatomical descriptor of the tissue damage caused by the injury and an immediate severity score, which ranges from 1 to 6 (EGISM 2004, Association for the Advancement of Automotive Medicine 1990). The MAIS is the maximum AIS severity score of a casualty with several injuries. The MAIS was a core element for the identification of the level of under-reporting by injury severity as well as for the establishment of a common definition for serious road injuries. However, in many national studies, the AIS was not directly available in the medical files and had to be calculated from the International Classification of Diseases (ICD-9 or ICD-10) scores. The ICD has been developed collaboratively by the World Health Organization (WHO) and 10 international centres (WHO, 1992) to ensure that medical terms reported on death certificates are internationally comparable. In order to code non-fatal-injury data from medical records, the ICD Clinical Modification (CM) is used, which is currently available for the 9th revision of the ICD (ICD-9), but not for the 10th revision (ICD-10). Moreover, not all countries have migrated from ICD-9 to ICD-10, and the use of dedicated techniques is often needed to convert both types of scores into comparable AIS scores (MacKenzie et al. 1997; ECIP, 2006).

The execution of the national studies for the collection of the appropriate data had to overcome potential obstacles that could limit the extent and validity of the study. Firstly, access to databases of medical information raised ethical issues in some countries. Moreover, the definition of appropriate geographical regions (so that one may be confident that any road accident casualty recorded in the medical databases should also be recorded in the police accident database for that region) was carefully considered. A clearly defined study area was selected for each country, for which medical data on road accident casualties were available. Moreover, police casualty data were selected in order to correspond to the same predefined area.

The linkage of road accident casualty databases involves subjective decisions, to some extent, when specifying the differences that may be tolerated when deciding whether a pair of records actually refers to the same casualty. Moreover, road accident casualties with only slight injuries may not require

significant medical treatment and hence would not be recorded in any medical database; the common methodology does not cover such cases. Several techniques, including probabilistic linking have been developed for record matching from different databases. In these methods, a generalised distance function is defined which quantifies the similarity between pairs of records in the two databases (Reurings et al. 2007). This quantified similarity can be used to assess the probability of the correctness of a match.

The extent of the national studies varies widely in time and space, as does the size of the linked datasets: from 1.600 records in the Czech study to 201.000 records in the UK study. It is inevitable that the strength of the results achieved by the various studies differs, if only on statistical grounds. Overall, however, the results achieved represent an important step forward in comparing the numbers of road accident casualties across European countries.

As indicated in Table 1, the extent of the eight studies varied significantly, as did the size of the combined datasets.

Table 1 to be inserted here

After completing the record linkage between the police and the medical databases, the proportion of accident casualties reported by the police was calculated. In this way, a preliminary assessment of the level of under-reporting in the police data was carried out. The combined police and medical data set of each country was used to produce two distinct 3-dimensional matrices of predefined common format (Figure 1) for casualty counts, based on the severity of their injuries as summarised by the MAIS score and the length of stay in hospital. All eight sets of matrices were compiled in order to identify the under-reporting level in these European countries. Note that road user type was identified from police data, as it was often poorly recorded in medical records

Figure 1 to be inserted here

3. National studies' results

The record linkage results produced in the national studies allowed for the estimation of the correction coefficients that can be applied to police road accident casualty data in order to estimate national casualty totals. The calculation can be performed according to two criteria for the definition of casualty severity: the Length of Stay in hospital and the MAIS. The record linkage in each national study was performed by using a general set of guidelines; however, differences in the police and hospital data collection systems as well as other particularities such as different data availability resulted in slightadjustments of the general approach in order to achieve optimal record linkage.

In general, the medical records were cross-checked regularly with the police accident records. The checking took into account the catchment area of each hospital, comparing the hospital records with police accident records only for that area. The aim was to identify all cases where the same person was present in both sets of records. The outcome was a combined set of police and medical data in which these matched cases were marked. Once the cross-checking of medical and police records was completed, the proportion of accident casualties that was reported by the police was calculated. This provided the level of under-reporting of casualties in the police data (Broughton et al. 2007).

Certain limitations on some of the national studies prevented for calculating fully disaggregate national coefficients for these countries. More specifically, in Austria 71% of all police records could not be matched. This can be partly attributed to the fact that no out-patients are recorded in the Austrian database therefore this amount can be explained by the police coded “slightly injured” persons, who are not hospitalised. Furthermore, the Austrian medical as well as police records contain no information about the date of birth of the casualty while the medical records contain no information about the road user type of a casualty, so it is only possible to calculate overall conversion factors, i.e. not by road user type. Moreover, the records contain only one ICD code per casualty, whereas the software used to estimate MAIS uses up to 27 ICD codes. Consequently it has only been possible to calculate conversion factors by Length of Stay. In Spain, the road user type information is not available in the hospital database so correction coefficients by road user type were not calculated. Finally, in Hungary the only categories available for the road user type in the Hospital database are vehicle occupants and pedestrians.

Firstly, the estimation of correction coefficients based on length of stay as injury severity descriptor is introduced. The estimation of correction coefficients based on MAIS as injury severity descriptor is then introduced. In both cases, the results of the UK study are exploited in order to present the calculation of the correction coefficients as well as the underlying assumptions. Furthermore, the UK results are used as an example in order to present the calculation of the actual number of road accident casualties. Subsequently, the correction coefficients for the rest of the countries are presented.

It must be emphasised that two fundamental assumptions underlie the calculations in the following sections: i) that the hospital registering is complete, i.e. all casualties requiring hospital attendance were recorded by the hospitals (while cases recorded by the police and not from the hospitals are considered not injured) and ii) that the medical and police data have been linked correctly, i.e. the links that have been made are valid, whereas records that have not been linked genuinely refer to different people. If it were suspected that there is under-reporting in the hospital data as well, then capture-recapture methods could be use to estimate the number of casualties not recorded by any source (Brenner,

1994). The validity of the second assumption depends upon the accuracy of the data in the two sets of records that are used for the linking process, but it is inescapable. The accuracy of the linkage achieved could only be checked rigorously with access to the personal identifiers in the two sources of information for at least a subset of records. Such highly confidential information was not available to any of the national studies.

3.1 Coefficients related to the length-of-stay

Within the UK study police road accident data (STATS19) from Scotland for the years 1997-2005 were linked with medical data from the Scottish Hospital In-Patient System (SHIPS). The SHIPS dataset includes 47,297 records for the years 1997 to 2005 which were matched to the STATS19 data and a total of 26,625 (56%) links were achieved.

In order to calculate the national correction coefficients by the casualty's length of stay in hospital, the total number of casualties by severity level should be estimated. Firstly, there are cases that were present in the police but not in the hospital database. As a consequence of the two assumptions previously mentioned, those casualties did not receive medical treatment so can be considered as not seriously injured, considering that the length of stay defines the injury severity. Secondly, the casualties that were present only in the hospital database need to be divided between the "serious" and "slight" categories as the definition is used in practice by the police. For that purpose, these casualties are distributed for each Length of Stay (LoS) pro rata between the serious and slight categories (since there is no reason to believe that the non-matched cases would be distributed differently by the police than the matched cases, and the distribution of these matched cases is based on large samples). The results of the record linkage are presented in Table 2.

Table 2 to be inserted here

The correction coefficients express the real number of casualties corresponding to each casualty recorded by the police. This is calculated by dividing the total number of casualties for a given severity level by the respective police recorded number. In the present section, the severity level is defined by the length of stay in hospital, so an example of the calculation could be as follows:

According to Table 2, 30,265 casualties in total were recorded as serious by the police and 11,463 casualties in total (police and hospital) were hospitalised for more than 3 days. Therefore, there were 11,463/30,265=0.38 casualties who stayed in hospital for more than 3 days, for each serious casualty recorded by the police. It is noted that the 4977 hospital records that were not recorded by the police were not added to the serious as a whole, but distributed between the serious and slight categories as mentioned before. Therefore:
7158*(7158+1117+4977) / (7158+1117) = 11,463

Moreover, 1789/147,098=0.012 casualties were in hospital for more than 3 days and correspond to each slight casualty recorded by the police.

Therefore, if a serious casualty was defined as the one spending more than 3 days in hospital, the real number of serious road accident casualties would be: 0.38 x number of serious casualties reported by the police + 0.012 x number of slight casualties reported by the police.

The first part of the equation refers to the actual police under-reporting (casualties not reported by the police), while the second part refers to casualties that were mis-reported by the police (serious casualties that were reported as slight, resulting from the fact that the proposed definition of 'more than 3 days in hospital' is different from the one used by the police). Given the lack of standard definition for serious road injuries, a level of mis-reporting would most likely exist for any type of definition adopted. Based on this approach, the coefficients shown in Table 3 were estimated for the UK national study.

Table 3 to be inserted here

The same calculation method was followed in the rest of the national studies and the respective results are presented in Table 4. Despite the fact that the same structure is used in each case, the certain limitations that were discussed in the previous section result in differences in detail (i.e. in the level of disaggregation).

Table 4 to be inserted here

3.2 Coefficients related to the Maximum Abbreviated Injury Scale

The correction coefficients estimated from a casualty's MAIS score are presented in this section. The MAIS scores have been calculated from the ICD10 or ICD9 injury codes (depending on which was available for each national study). MAIS 9 is a code generated by the mapping algorithm that represents not known, i.e. the ICD10 codes were not sufficiently detailed to assign an MAIS score. The incidence of MAIS equal to 9 appears less frequently among serious casualties than among slight and the percentage not reported by police is greater than for MAIS 1 which is intuitive.

As for the calculation by length of stay, a number of issues need to be addressed in order to estimate the correction coefficients by MAIS. Firstly, casualties recorded by the police and not by the hospitals need to be assigned MAIS scores. As mentioned in the calculation by length of stay, the assumptions made imply that these casualties have not attended hospital for inpatient treatment; therefore it is unlikely that their MAIS will have exceeded 3. Also, some MAIS 2 casualties could well be treated as outpatients. It is reasonable to assume that all of these casualties had MAIS 1 or 2, but that they cannot be distributed reliably

between 1 and 2. Secondly, casualties recorded by the hospital but not by the police need to be categorised by police severity level (slight or serious). These casualties were distributed pro rata at each MAIS level to simulate the police severity coding. The last issue concerns the treatment of the 'unknown' MAIS 9 scores, which appear on the hospital database. As those casualties seem to have relatively minor injuries, it appears reasonable to treat them as cases with MAIS < 3.The classification resulting from these treatments is presented in Table 5.

Table 5 to be inserted here

The calculation of the correction coefficients is the same as for the length of stay, therefore it can be calculated that for each serious casualty in the police records, there are (5108+418+118+319) / (17,434+12,831) = 0.20 casualties with MAIS higher than 2. Furthermore, a small proportion of casualties recorded as 'slight' by the police, actually had an MAIS score higher than 2 in the hospital records. More specifically, (670+61+2+31)/(8764+138,334) = 0.005 casualties with MAIS higher than 2 correspond to each slight casualty recorded by the police. Consequently, if seriously injured casualties were to be defined as those with MAIS>2, the actual total number of serious casualties could be estimated as:
0.20 $\times$ number of serious casualties reported by the police + 0.005 $\times$ number of slight casualties reported by the police.

The correction coefficients by MAIS score for the UK are presented together with the correction coefficients for the rest of the countries, in Table 6. The calculation of the correction factors was preformed exactly in the same way for all the countries involved in the study. Any slight differences in the national studies concerned the record linkage process (which is discussed above) and not their products, which were used in order to calculate the under-reporting coefficients by the same method. However, the particularities of some national studies discussed in the beginning of this section prevented the calculation of correction coefficients by full disaggregation for these countries.

Table 6 to be inserted here

4. A common definition for serious road injuries

In addition to the calculation of the correction coefficients, the results of the present study allow for the investigation of a new definition for serious road injuries that can be applied in international studies. The broad choice lies between a definition based on the casualty's length of stay in hospital, and a definition based on the MAIS score.

According to Brasel et al (2007), it appears that length of stay is likely to be significantly influenced by clinical practices and the availability and organisation

of hospital services rather than by the level of road safety. On the contrary, the results based on MAIS are more likely to monitor casualty and injury severity trends reliably.

For example, the trends in the linked data of the UK national study show how MAIS and length of stay for road accident casualties have developed. The operational procedures were unchanged between 1997 and 2005 which was the reference period of the study. Any changes in the annual data cannot result from changes in the hospital data collection procedure but should be caused by changes in the number and nature of casualties, or in the criteria used to admit, treat and discharge hospital in-patients. As far as the length of stay is concerned, the distribution in the linked records clearly shows a shift towards shorter stays in hospital from 1997 to 2005. As for MAIS, from 1997 the trends show a consistent pattern which is likely to reflect changes in road safety rather than external influences, (Broughton et al. 2007). This supports the conclusion that it is more reliable to base a new definition for serious road casualties on MAIS rather than on length of stay.

Finally, the MAIS threshold to choose for the definition of serious casualty had to be decided. According to the AIS classification, AIS equal to 2 describes a moderate injury while AIS 3 describes a serious injury. However, there were cases of casualties who did not survive with AIS=2 or even AIS=1. Nevertheless, it was finally decided to use the original definition of the AIS documentation. Considering also technical difficulties to estimate MAIS 1 and 2 separately with the available data, it was concluded that the optimal definition of serious casualty for use in international studies should be a non-fatal casualty with MAIS from 3 to 6 (inclusive).

5. Calculation of the real number of road casualties in Europe

The national studies carried out in the eight European countries allowed for the estimation of the real number of road accident casualties, from the number of casualties recorded by the police, in a disaggregate form, namely by road user type and injury severity (Length of Stay / MAIS). The national studies used accident data from national accident databases that had been compiled from police accident reports. Most studies used files of medical data compiled by national or regional authorities from hospital records. Although the extent of the national studies varies among countries, the results can be considered as a first step towards comparable figures of non-fatal road casualty data across Europe.

According to the proposed definition for serious road injuries, the real number of seriously injured is calculated by adding two components: the real number of serious casualties for each casualty reported as serious by the police (N1) and the real number of serious casualties for each casualty reported as slight by the police (N2). The first component depicts the degree of serious injury under-

reporting while the second depicts the police misreporting of road casualties. Therefore, the actual number of serious casualties in the examined countries is equal to N1+N2 and is presented in Table 7. In the same way, the methodology can be used for the calculation of the real number of slight casualties. This would comprise again of two elements, the real number of slight casualties for each casualty reported as serious by the police (N1 – which in this case would be the misreporting) and the real number of slight casualties for each casualty reported as slight by the police (N2 – which in this case would be the under-reporting). The source of the numbers of casualties reported by the police is the CARE database of the European Commission. The estimated results are calculated for the period 2003-2005. The definition of serious and slight casualty in France changed in 2005, so the conversion factors only apply up to 2004.

It is interesting to note that for all countries except Greece, the actual number of serious casualties according to the new proposed definition is lower than the number of police-recorded serious casualties. The fact may be attributed to a higher degree of police misreporting serious casualties as slight, more than in the other examined countries. In fact in Greece, Police data tends more often to underestimate than overestimate the severity of the injuries (Petridou et. al., 2009). Moreover, it is interesting to note that before the application of the correction coefficients, the rate of the serious injuries to fatalities ranged from 1.42 in Greece to 11.41 in the Netherlands; while after the calculation of the actual number of serious casualties, the rate ranges from 1.11 in Czech Republic to 4.68 in the Netherlands. The specific countries values of the rate seriously injured / killed are much less widespread after the adoption of the common MAIS-based definition and the correction for under-reporting. In other words, the remaining differences in this rate can be attributed to real differences of road safety between the countries, after having controlled for different levels of under-reporting and different definitions of injury severity.

Table 7 to be inserted here

6. Conclusions

The present paper has provided good estimates of the level of non-fatal road accident casualty under-reporting in Europe in a disaggregate form, by developing appropriate correction coefficients for several European countries. The under-reporting of road casualties by casualty severity and road user type was calculated for eight countries using a common methodology, and this allowed the real number of casualties to be estimated in a uniform way.

For the first time, a common methodology was applied to eight European countries by the means of national studies which brought together various sources of road accident casualty data. The common framework of the national studies as well as the similarity of the linkage techniques allowed a common

process to be used to estimate the correction coefficients. The results of the present paper can be considered as a first step towards a systematic and routine process for preparing non-fatal road casualty data on a consistent basis from the national data recorded by the police.

The usability and the extrapolation of the correction coefficients calculated within this study are subject to certain limitations resulting from the execution of the national studies. More specifically, although the study areas were selected carefully for each country in order for the police data to correspond to the exact catchment areas of the examined hospitals, the size of the samples varies widely, the definition of the hospital data varies, as the time and areas considered varies from months to years and from single cities to whole countries. Furthermore, the differences in the data linking methodologies as well as the randomness involved in every database linkage process may have affected the study results. However, the correction coefficients as well as the calculation of comparable numbers of non-fatal road accident casualties among European countries represent an important step forward for the exploitation of the non-fatal casualty data in the future.

A new definition for non-fatal road accident casualties is proposed and it is supported by the findings of several national studies. The new definition uses a medical severity standard (Abbreviated Injury Scale) which is available or can be easily calculated for casualties recorded in the medical databases of most European countries. This definition can be used as a common benchmark for comparing non-fatal road casualty figures among European countries. The adoption of this definition could be the first step towards more comparable road casualty data in the future as it is based on an internationally recognized severity measure. Finally, it can be exploited for comparing long time series of historical non-fatal casualty data that are available for several European countries, as long as the respective correction coefficients are developed.

This research opens the way for the application of the common methodology in all European countries. The execution of national studies in more European countries can significantly enhance cross-country road safety comparisons and can assist in the execution of more meaningful road accident analyses by using the long time series of data that are available for non-fatal casualties in the European road accident database with disaggregate data (CARE). However, special attention should be given to the study limitations (representative sample, clearly defined study area, uniform record-linkage techniques).

Acknowledgments

This research was co-financed by the European Commission, within the SafetyNet Integrated Project of the 6th Framework Programme.

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Table 1. National study characteristics

Country	Study area	Period	Sample size
Austria	National	2001	69,233
Czech Republic	Kromeriz,central Moravia	2003-2005	1649
France	Département of Rhône	1996-2003	90,457
Greece	Island of Corfu	1996-2003	11,915
Hungary	Part of Budapest	Aug 2004 - Jan 2006	3459
Netherlands	National	1997-2003	129,616
Spain	Castilla y Leon	July-December 2005	8113
UK	Scotland	1997-2005	201,006

Table 2. Record linkage results by length of stay - UK

Length of Stay	Police		Not police	Estimated total	
	serious	slight		serious	slight
Outpatient	1152	1179	3596	2929	2998
Overnight	4434	4336	7219	8084	7905
1-3 days	4690	2132	4880	8045	3657
>3 days	7158	1117	4977	11,463	1789
Not hospital	12,831	138,334		12,831	138,334
Total	30,265	147,098	20,672	43,352	154,683

Table 3. Correction coefficients based on length of stay - UK

Length of Stay	Car occupant		Motorcyclist		Pedal cyclist		Pedestrian		Other		All	
	Serious	slight	serious	slight	serious	slight	serious	slight	serious	slight	serious	slight
outpatient/ overnight	0.33	0.06	0.34	0.14	1.16	0.25	0.28	0.08	0.42	0.06	0.36	0.074
1-3 days	0.21	0.02	0.36	0.08	0.68	0.06	0.26	0.03	0.29	0.02	0.27	0.025
>3 days	0.32	0.01	0.49	0.03	0.40	0.01	0.41	0.02	0.54	0.01	0.38	0.012
all	0.86	0.09	1.20	0.25	2.24	0.33	0.95	0.13	1.25	0.10	1.01	0.111
>=1 day	0.53	0.03	0.85	0.11	1.08	0.08	0.66	0.05	0.82	0.03	0.64	0.037

Table 4. Correction coefficients based on length of stay - Other countries

			Length of stay (days)				
			<1	1-3	>3	all	>=1
AT	All road users	Serious	0.17	0.33	0.53	1.03	0.86
		Slight	0.051	0.051	0.025	0.127	0.076
CZ	Car occupant	Serious	0.1	0.09	0.11	0.29	0.19
		Slight	0.28	0.06	0.01	0.35	0.07
	Motorcyclist	Serious	0.19	0	0.09	0.28	0.09
		Slight	0.34	0.04	0.01	0.39	0.06
	Pedal cyclist	Serious	0.71	0.3	0.5	1.51	0.8
		Slight	2.57	0.15	0.02	2.74	0.17
	Pedestrian	Serious	0.19	0.07	0.31	0.57	0.38
		Slight	0.98	0.16	0.02	1.16	0.18
	Other	Serious	0	0.13	0	0.13	0.13
		Slight	0.19	0.02	0	0.21	0.02
	All road users	Serious	0.23	0.11	0.19	0.53	0.3
		Slight	0.72	0.08	0.02	0.82	0.09
FR	Car occupant	Serious	1.12	0.18	0.48	1.78	0.66
		Slight	1.91	0.04	0.03	1.98	0.07
	Motorcyclist	Serious	1.28	0.19	0.67	2.14	0.86
		Slight	2.61	0.11	0.09	2.81	0.2
	Pedal cyclist	Serious	4.82	0.58	1.22	6.62	1.8
		Slight	9.82	0.31	0.13	10.26	0.44
	Pedestrian	Serious	0.79	0.14	0.48	1.41	0.62
		Slight	1.44	0.07	0.08	1.59	0.14
	Other	Serious	1.16	0.41	0.9	2.47	1.31
		Slight	2.18	0.05	0.05	2.28	0.1
	All road users	Serious	1.21	0.2	0.57	1.98	0.77
		Slight	2.23	0.06	0.05	2.34	0.11
GR	Car occupant	Serious	1.36	1.12	0.25	2.73	1.37
		Slight	1.86	0.85	0.14	2.84	0.98
	Motorcyclist	Serious	4.62	1.31	0.62	6.54	1.93
		Slight	5.40	1.25	0.39	7.03	1.64
	Pedal cyclist	Serious	14.00	0.27	0.64	14.91	0.91
		Slight	4.00	3.27	0.64	7.91	3.91
	Pedestrian	Serious	0.37	0.85	0.56	1.78	1.41
		Slight	2.76	0.70	0.35	3.81	1.05
	Unknown	Serious	15.72	0.47	0.11	16.30	0.58
		Slight	13.40	0.97	0.25	14.62	1.22
	All road users	Serious	3.91	1.15	0.49	5.55	1.64
		Slight	4.64	1.04	0.30	5.98	1.34
HU	Vehicle occupant	Serious	0.12	0.1	0.35	0.57	0.45
		Slight	0.34	0.13	0.032	0.5	0.16
	Pedestrian	Serious	0.04	0.08	0.37	0.48	0.44
		Slight	0.17	0.16	0.069	0.4	0.22
	All road users	Serious	0.1	0.1	0.35	0.55	0.45
		Slight	0.31	0.13	0.038	0.49	0.17
NL	Car occupant	Serious	0.13	0.4	0.39	0.92	0.78
		Slight	0.017	0.036	0.014	0.067	0.05
	Motorcyclist	Serious	0.1	0.46	0.68	1.25	1.14
		Slight	0.022	0.067	0.049	0.138	0.116

	Moped rider	Serious	0.14	0.49	0.69	1.31	1.17
		Slight	0.017	0.045	0.03	0.092	0.075
	Pedal cyclist	Serious	0.22	0.89	1.22	2.33	2.11
		Slight	0.029	0.083	0.055	0.167	0.138
	Pedestrian	Serious	0.12	0.49	0.71	1.31	1.2
		Slight	0.022	0.061	0.046	0.129	0.107
	Other	Serious	0.08	0.39	0.39	0.86	0.78
		Slight	0.009	0.029	0.014	0.052	0.043
	All road users	Serious	0.15	0.52	0.65	1.32	1.17
		Slight	0.021	0.051	0.029	0.101	0.08
ES	All road users	Serious	0.01	0.19	0.46	0.67	0.66
		Slight	0.007	0.051	0.05	0.107	0.101

Table 5. Record linkage results by MAIS - UK

	Police		Not police		Not hospital		Estimated total	
MAIS	Serious	Slight	Serious	Slight	Serious	Slight	Serious	Slight
1 or 2	13,797	8299	11,019	7028	12,831	138,334	37,647	153,661
3	3139	412	1969	258	0	0	5108	670
4	226	33	192	28	0	0	418	61
5	75	1	43	1	0	0	118	2
6	197	19	122	12	0	0	319	31
Total	17,434	8764	13,345	7327			43,610	154,425

Table 6. Correction coefficients based on MAIS, other countries

			MAIS					
			1-2	3	4	5	All	>=3
CZ	Car occupant	Serious	0.97	0.07	0.01	0.02	1.08	0.11
		Slight	1.11	0.01	0.00	0.00	1.12	0.01
	Motorcyclist	Serious	1.03	0.05	0.00	0.05	1.12	0.09
		Slight	1.17	0.01	0.00	0.00	1.18	0.01
	Pedal cyclist	Serious	1.11	0.30	0.17	0.03	1.61	0.50
		Slight	3.50	0.04	0.00	0.00	3.54	0.04
	Pedestrian	Serious	1.05	0.31	0.00	0.04	1.40	0.35
		Slight	1.77	0.04	0.00	0.00	1.80	0.04
	Other	Serious	0.88	0.13	0.00	0.00	1.00	0.13
		Slight	1.00	0.00	0.00	0.00	1.00	0.00
	All road users	Serious	1.07	0.15	0.03	0.03	1.28	0.21
		Slight	1.56	0.02	0.00	0.00	1.58	0.02
FR	Car occupant	Serious	1.32	0.35	0.12	0.05	1.84	0.51
		Slight	2.38	0.03	0.00	0.00	2.41	0.03
	Motorcyclist	Serious	1.35	0.69	0.10	0.05	2.18	0.83
		Slight	3.13	0.11	0.01	0.00	3.25	0.12
	Pedal cyclist	Serious	4.69	1.64	0.26	0.07	6.67	1.97
		Slight	10.39	0.27	0.00	0.00	10.66	0.27
	Pedestrian	Serious	1.01	0.43	0.10	0.03	1.58	0.57
		Slight	1.90	0.08	0.01	0.00	2.00	0.10
	Other	Serious	1.52	0.69	0.30	0.07	2.58	1.06
		Slight	2.67	0.05	0.01	0.00	2.73	0.06
	All road users	Serious	1.43	0.52	0.12	0.05	2.11	0.68
		Slight	2.69	0.05	0.01	0.00	2.75	0.06
GR	Car occupant	Serious	4.08	0.57	0.00	0.00	4.65	0.57
		Slight	6.09	0.15	0.01	0.01	6.25	0.17
	Motorcyclist	Serious	6.89	0.60	0.07	0.01	7.57	0.68
		Slight	10.72	0.17	0.01	0.01	10.91	0.19
	Pedal cyclist	Serious	7.50	0.00	0.17	0.00	7.67	0.17
		Slight	23.75	1.00	0.17	0.00	24.92	1.17
	Pedestrian	Serious	2.49	0.31	0.13	0.00	2.93	0.45
		Slight	3.91	0.13	0.00	0.00	4.04	0.14
	Other	Serious	11.45	0.53	0.17	0.00	12.14	0.69
		Slight	15.41	0.07	0.02	0.00	15.50	0.09
	All road users	Serious	5.92	0.52	0.08	0.00	6.52	0.60
		Slight	9.10	0.15	0.01	0.01	9.28	0.17
HU	Vehicle occupant	Serious	0.83	0.43	0.06	0.02	1.35	0.52
		Slight	1.28	0.04	0.00	0.00	1.33	0.04
	Pedestrian	Serious	0.86	0.22	0.08	0.05	1.21	0.35
		Slight	1.16	0.02	0.00	0.00	1.19	0.03
	All road users	Serious	0.84	0.38	0.06	0.03	1.32	0.48
		Slight	1.27	0.04	0.00	0.00	1.31	0.04
NL	Car occupant	Serious	1.07	0.18	0.02	0.01	1.29	0.22
		Slight	1.02	0.01	0.00	0.00	1.02	0.01
	Motorcyclist	Serious	1.21	0.32	0.03	0.02	1.59	0.37
		Slight	1.04	0.01	0.00	0.00	1.05	0.02
	Pedal cyclist	Serious	1.90	0.66	0.05	0.02	2.63	0.73
		Slight	1.10	0.04	0.00	0.00	1.14	0.04
	Pedestrian	Serious	1.23	0.31	0.03	0.02	1.59	0.36

		Slight	1.04	0.02	0.00	0.00	1.06	0.02
	Other	Serious	1.24	0.18	0.02	0.01	1.45	0.21
		Slight	1.01	0.01	0.00	0.00	1.02	0.01
	All road users	Serious	1.29	0.33	0.03	0.02	1.67	0.37
		Slight	1.04	0.01	0.00	0.00	1.05	0.02
ES	All road users	Serious	1.22	0.16	0.08	0.03	1.48	0.26
		Slight	1.06	0.01	0.00	0.00	1.07	0.02
UK	Car occupant	Serious	1.15	0.13	0.01	0.00	1.30	0.15
		Slight	1.03	0.00	0.00	0.00	1.03	0.00
	Motorcyclist	Serious	1.34	0.25	0.01	0.00	1.61	0.27
		Slight	1.13	0.01	0.00	0.00	1.14	0.01
	Pedal cyclist	Serious	2.54	0.26	0.02	0.00	2.83	0.29
		Slight	1.24	0.01	0.00	0.00	1.25	0.01
	Pedestrian	Serious	1.05	0.18	0.03	0.01	1.28	0.23
		Slight	1.03	0.01	0.00	0.00	1.04	0.01
	Other	Serious	1.62	0.23	0.01	0.00	1.88	0.26
		Slight	1.06	0.01	0.00	0.00	1.07	0.01
	All road users	Serious	1.24	0.17	0.01	0.00	1.44	0.20
		Slight	1.04	0.00	0.00	0.00	1.05	0.01

Table 7. Calculation of the real number of casualties according to the proposed definition for serious road injuries

	Fatalities	Serious casualties			Slight casualties			Real serious	**Real Serious**	Real Serious
	CARE*	CARE*	factor 1	N1	CARE*	factor 2	N2	(N1+N2)	**Police Serious**	Fatalities
Czech republic	1,372	4,716	0.21	990	29,252	0.018	527	1,517	**0.32**	1.11
France	5,794	18,321	0.68	12,458	94,007	0.061	5,734	18,193	**0.99**	3.14
Greece	1,644	2,338	0.6	1,403	18,650	0.173	3,227	4,629	**1.98**	2.82
Hungary	1,300	8,381	0.48	4,023	19,015	0.04	761	4,783	**0.57**	3.68
Netherlands	861	9,828	0.37	3,636	24,541	0.016	393	4,029	**0.41**	4.68
Spain	4,861	23,945	0.26	6,226	117,286	0.018	2,111	8,337	**0.35**	1.72
United Kingdom	3,454	32,478	0.2	6,496	254,253	0.009	2,288	8,784	**0.27**	2.54

** The European road accident database with disaggregate data*

Data for all countries except France concern average yearly casualties for the period 2003-2005
French data concern average yearly casualties for the period 2003-2004, due to a change in national serious injury definition on 2005.

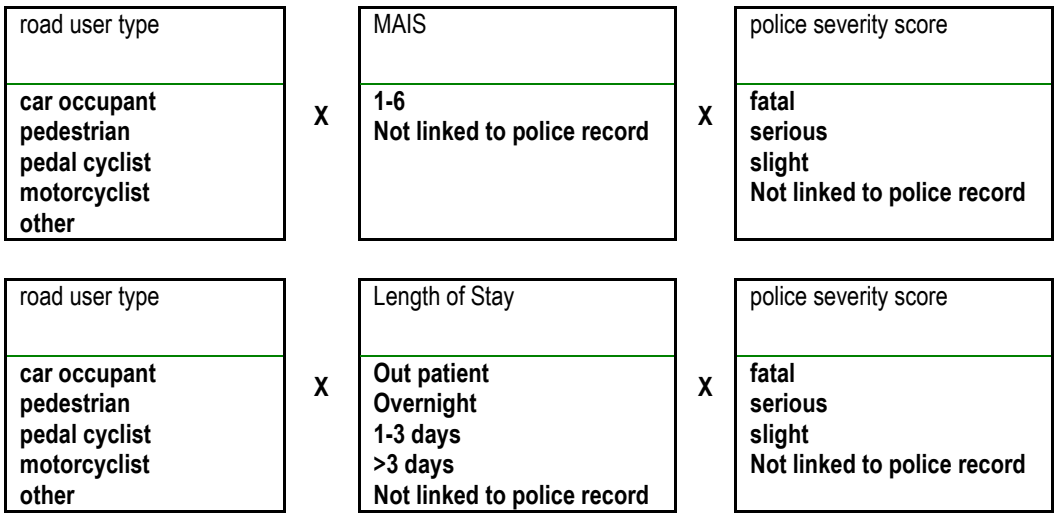

Figure 1. Structure of the matrices for the calculation of the correction coefficients