Motor vehicle crash fatalities at 30 days in Spain

Catherine Pérez / Eva Cirera / Carme Borrell / Antoni Plasència, on behalf of the work group of the Spanish Society of Epidemiology for the Measuring of the Impact on Health of Road Traffic Accidents in Spain
Agència de Salut Pública de Barcelona, Barcelona, España.

(Fallecidos a 30 días por lesiones producidas en accidente de tráfico en España)

Abstract

Objectives: To assess level of fulfilment and utility of the hospital discharge register (HDR) as a complementary source of information for estimating the number of deaths at 30 days due to motor vehicle crashes in Spain.

Methods: It is a cros-sectional study were we compared the number of people injured due to motor vehicle crashes hospitalised in a public hospital (HDR), in Spain during 2001, with the number of people severely injured or killed due to motor vehicle crashes reported by the police database (Dirección General de Tráfico, DGT) for the same year. A descriptive analysis was carried out by age, sex and region (Autonomous Community), as well as an estimation of the percentage of under-reporting of deaths by the DGT based on two assumptions.

Results: Police reported 27,272 severe injuries and 4,811 deaths during first 24 hours after the crash and after applying a fatality adjustment factor estimated 706 more deaths up to 30 days after the crash. The HDR reported 40,174 urgent hospitalisations. Of these, 1,099 died during the day of hospitalisation or within the following 30 days. The police only notified 68% of all cases that required hospitalisation. According to the number of deaths reported by police and contrasted with hospital register, estimations of the number of deaths at 30 days made by police could represent a level of under-reporting of between 3% and 6.6%, depending on the assumption considered.

Conclusions: This study showed that the HDR is an information source that complements police statistics and is useful to estimate the number of deaths and non-fatal injuries due to motor vehicle crashes in Spain.

Key words: Injury. Traffic accident. Police database. Hospital discharge. Under-reporting. Fatalities.

Resumen

Objetivos: Valorar el grado de cumplimiento y la utilidad del conjunto mínimo y básico de las altas hospitalarias (CMBDAH) para estimar el número de fallecidos a 30 días por accidente de tráfico (AT).

Método: Las poblaciones del estudio fueron los heridos graves y fallecidos por AT registrados en la base de accidentes de la Dirección General de Tráfico (DGT) y los lesionados por AT ingresados en un hospital público. Se ha llevado a cabo un análisis descriptivo por edad, sexo y comunidad autónoma y una estimación del porcentaje de subnotificación de muertes de la DGT según dos asunciones.

Resultados: Según la DGT, se registraron 27.272 heridos graves y 4.811 fallecidos en las primeras 24 h y se estimaron 706 fallecidos con la aplicación del factor de corrección a los 30 días. Según el CMBDAH, se produjeron 40.174 ingresos hospitalarios urgentes, en los que en 1.099 casos se produjo el fallecimiento el mismo día del ingreso o en los 30 días posteriores. Así pues, por la información obtenida por la policía, se detectó el 68% de los casos que requirieron ingreso hospitalario. Tomando como referencia el número de fallecidos según la DGT, completado por las muertes según el CMBDAH, las estimaciones de fallecidos a 30 días realizadas por la DGT fueron entre un 3 y un 6,6% inferiores según la asunción considerada.

Conclusiones: Este estudio pone de manifiesto la utilidad de la información suministrada por el CMBDAH para la obtención de información sobre el número de fallecidos y heridos graves complementaria a las estadísticas policiales.

Palabras clave: Lesión. Accidente de tráfico. Datos policiales. Infranotificación. Víctimas mortales.

Introduction

Statistics about people injured in motor vehicle crashes have traditionally tended to be based on police sources: this is the case in both Spain and other countries. The United Nations Economic Commission for Europe proposed the following definition for people killed as a result of motor vehicle crashes: "people dying at the scene of the crash or in the following 30 days". This implies carrying out a follow-up on all people injured and hospitalized up to the end of that 30 day period. This is not feasible in prac-

The Spanish version of this manuscript can be downloaded (PDF format) from the web (www.doyma.es/gs).

Correspondence: Catherine Pérez.
Agència de Salut Pública de Barcelona.
Pl. Lesseps, 1. 08023 Barcelona. España.
E-mail: cperez@aspb.es

Recibido: 5 de abril de 2005.
Aceptado: 19 de diciembre de 2005.

tice, due to the great amount of resources required to carry out such a task.

The procedure employed to count the number of deaths based on the standard definition is variable. There are two basic methods for estimating the real number of motor vehicle crash fatalities at 30 days: *a)* contrasting data provided by police and health service records; *b)* applying a fatality adjustment factor. This is calculated periodically from a follow up of a representative sample of people severely injured in motor vehicle crashes[1,2]. However, this adjustment factor often fails to take into account differences in the severity of injuries and mortality by road user type or other relevant variables (such as the time and place of the crash, the kind of vehicle involved, and the age of the victim). It has been reported that the application of the fatality adjustment factor to all types of crash victims produces bias in the estimation of crash deaths by road user type. This is especially true in the case of pedestrians[3].

Spain adopted the European definition of motor vehicle crash fatalities at 30 days in 1993 through the Ministerial Order of 18th February that modified the logic for compiling statistics on road traffic accidents. This order established that the number of motor vehicle crash fatalities during the first 24 hours must be determined by follow-up of all cases. However, victims dying within 30 days of the crash must be determined by applying the fatality adjustment factor. This was to be deduced from a follow-up study of a representative sample of people severely injured in motor vehicle crashes. Until such time as it is possible to exhaustively follow-up on all victims of motor vehicle crashes, the Dirección General de Trafico (DGT, The Spanish Traffic Authority), under the supervision of the Spanish National Safety Council, will periodically carry out a follow-up study based on a representative sample of people injured at four year intervals, in order to calculate the appropriate adjustment factors[4].

Six adjustment factors were calculated according to the type of area (urban or non-urban roads) and the relationship between the victim and the vehicle (driver, passenger, or pedestrian). The following adjustment factors were determined in the follow-up study carried out in 2000: 2.41 for drivers, 2.24 for passengers and 6.17 for pedestrians for non-urban roads, and 2.17 for drivers, 2.15 for passengers and 4.34 for pedestrians for urban areas.

The application of fatality adjustment factors to estimate the number of deaths based on the standard definition is an intermediate solution until it is possible to establish a mechanism that allows us to accurately establish the real number of motor vehicle crash deaths at 30 days. The present investigation aims to assess the level of fulfilment and utility of the hospital discharge register (HDR) as a complementary source of information for estimating the number of deaths at 30 days due to motor vehicle crashes in Spain.

Methods

This is a cros-sectional descriptive study that compares different records. Two populations were included: *a)* people severely injured or killed as a result of motor vehicle crashes in Spain in 2001, as recorded by the police; *b)* people injured in motor vehicle crashes and urgently hospitalized in any Spanish public hospital and later discharged during the year 2001.

For the description of people severely injured or killed in motor vehicle crashes and estimations of fatalities due to motor vehicle crashes at 24 hours based on police records, we used information provided by the register of accidents and victims for 2001 of the Spanish Traffic Authority (DGT). The definition of severely injured was based on all of the people injured in motor vehicle crashes whose resulting condition required hospitalization for a period of more than 24 hours[5].

From Hospital Discharge Register (HDR) data for the year 2001, we selected episodes of urgent hospitalization that had been recorded as motor vehicle crashes within the variable "Financing Regime". Where this was not applicable, we selected cases in which the external cause of injury (E Code) ranged from E811 to E826, as defined by the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM). It has been estimated that for 2001 the HDR coverage was over 98% of all public hospital admissions.

The following variables were included from the data base of the police dataset: age, sex, region (Autonomous Community) and severity of injury. From the HDR we used the following variables: sex, date of birth, the region in which the hospital was located, date of hospitalization and date of discharge (in order to calculate length of stay), destination on discharge, and diagnoses. The exact time of the hospitalization was not known.

We carried out a descriptive analysis for people injured and killed in motor vehicle crashes, calculating percentages and 95% confidence intervals, in order to study the distribution of the two study groups. The estimation of the number of deaths notified by the DGT based on adjustment factors was compared with the number of deaths calculated by the DGT and complemented with data from the HDR based on the two following assumptions: *a)* that the police only recorded fatalities relating to people who died at the scene of the crash or while being moved; *b)* that the police registered as fatalities victims who died at the scene of the crash, while being moved, and during the first day of hospitalization.

Results

Level of fulfilment of the information in the HDR

The socio-demographic and administrative variables and principal diagnoses were complete in more than 98% of cases. External causes of injury (E Code) were recorded in 70% of cases, and in 65% reference was made to a motor vehicle crash. However, the majority of the E codes were of a non-specific nature. As a result, specific information relating to the kind of accident and/or road user type (driver, passenger or pedestrian) was only recorded in 11% and 21% of cases, respectively. This prevented analysis based on the specific characteristics of the crash or of the vehicle.

Comparison between people severely injured and killed (DGT) and people injured and hospitalized (CHDR)

According to the records of the DGT, 100,393 motor vehicle crashes occurred in the year 2001, with a total of 155,116 victims, of whom 27,272 were severely injured and 5,517 died. Of these, 4,811 died within the first 24 hours and a further 706 deaths were estimated within the period of between 24 hours and 30 days after hospitalization based on application of the adjustment factor.

According to the HDR, 40,174 injured people were urgently hospitalized as a result of the motor vehicle crashes that took place in 2001. Of these, 1,099 subsequently died within the first 30 days following hospitalization and 99 did so later.

Table 1 shows a similar distribution for severely injured according to age and sex for data provided by the DGT and the HDR. In the case of fatalities, the proportion of people over 59 years of age was greater among those hospitalized than among deaths reported by the police. The 27,272 people who were severely injured (and therefore susceptible to hospitalization) reported by the police in 2001 amounted to 68% of the 40,174 people who were injured and actually hospitalized in Spanish public hospitals in that same year. No significant differences in this percentage of under-reporting were observed with respect to the sex of the person injured, but this did occur with respect to age: those under 15 and over 74 were less represented in the records of the police. A great deal of variability was observed with respect to distribution by region, with Ceuta and Melilla presenting high rates of under-reporting whereas in other regions, such as the Balearic Islands and Castilla y León, DGT records tended to over-report with respect to those of the HDR. It is important to bear in mind that whereas the records of the DGT include the region in which the accident occurred, those of the HDR record the region in which the victim was hospitalized (which in some cases may not be the same as that in which the motor vehicle crash actually took place).

Estimation of the number of deaths according to the two sources of information

According to data from the DGT, 4,811 persons died as a result of motor vehicle crashes in the first 24 hours following the accident, with this number rising to 5,517 according to the estimation of motor vehicle crash fatalities at 30 days. According to data from the HDR, 1,099 persons died in the 30 days following hospitalization, with 223 of them dying on the same day that they were admitted to hospital. For estimations of the real number of deaths at 30 days, two assumptions were made:

Assumption A: Supposing that the number of deaths in the first 24 hours after the accident provided by the DGT only refers to deaths at the scene of the crash, the number of deaths at 30 days could be estimated as: *Deaths recorded by the DGT + hospital deaths = 4,811 + 1,099 = 5,910.*

Assumption B: Supposing that the number of deaths in the first 24 hours after the crash according to data from the DGT includes deaths occurring on the same day as hospitalization: *Deaths recorded by the DGT + hospital deaths at 30 days – hospital deaths at 0 days = 4,811 + 1,099 – 223 = 5,687.*

Based on these suppositions, the 5,517 deaths at 30 days estimated by the DGT would represent an underestimation of –6.6% with respect to assumption A and of -3% with respect to assumption B (table 2). In the first assumption the underestimation was similar for both sexes (-5.9% men, -2.5% women), whereas in the second, it was greater amongst men (-5.8%) than amongst women (-1%). Figure 1 shows these percentages by age groups. With increasing age, the tendency to underestimate deaths increases, reaching its greatest level amongst those in the over 74 age group. Figure 2 shows percentages of variation according to the region in which the accident occurred (presupposing that this was the same region as that of hospitalisation). As can clearly be observed, a high degree of heterogeneity was observed between the different regions.

Discussion

This study represents the first attempt to develop and use data relating to people injured in motor vehicle crashes and hospitalized in public hospitals based on the Hospital Discharge Register (HDR) for the whole of Spain. The study also documents the percentage of under-reporting of motor vehicle crash fatalities at 30 days by the police.

Table 1. People severely injured and killed in motor vehicle crashes reported by police (DGT), and people who were injured hospitalised or who died in hospitals (HDR) by sex, age and region

	DGT				HDR				Total difference HDR-Severely injured DGT	
	Severely injured		Fatalities < 24 hours		Injured		Fatalities 24 hours-30 days			
	n	%	n	%	n	%	n	%	n	%
Sex										
Men	19,069	71.8	3,639	76.4	27,279	70.0	798	72.6	9,008	67.9
Women	7,503	28.2	1,124	23.6	11,687	30.0	300	27.3	4,484	62.6
Unknown	700	2.6	48	1	10	0.0	1	0.1		
Age										
< 15 years	1,044	4	129	2.7	2,999	7.7	27	2.5	1,982	34.5
15-29 years	11,137	43	1,538	32.8	16,381	42.0	333	30.3	5,577	66.6
30-44 years	6,382	24.7	1,194	25.4	8,201	21.0	173	15.7	1,992	76.2
45-59 years	3,699	14.3	851	18.1	5,235	13.4	159	14.5	1,695	68.6
60-74 years	2,605	10.1	649	13.8	4,173	10.7	189	17.2	1,757	59.7
> 74 years	1,018	3.9	334	7.1	1,926	4.9	209	19.0	1,117	47.7
Unknown					61	0.2	9	0.8		
Region (Autonomous Community)										
Andalucía	4,589	16.8	753	15.7	5,103	13.1	182	16.6	696	86.8
Aragón	1,318	4.8	195	4.1	1,260	3.2	61	5.6	3	99.8
Asturias	631	2.3	80	1.7	989	2.5	14	1.3	372	62.9
Islas Baleares	821	3	150	3.1	480	1.2	3	0.3	–338	170.0
Islas Canarias	838	3.1	168	3.5	1,053	2.7			215	79.6
Cantabria	285	1	44	0.9	437	1.1	18	1.6	170	62.6
Castilla-La Mancha	1,701	6.2	341	7.1	1,959	5.0	52	4.7	310	84.6
Castilla y León	2,633	9.7	532	11.1	2,399	6.2	91	8.3	–143	105.7
Cataluña	4,111	15.1	710	14.8	7,344	18.8	157	14.3	3,390	54.8
Comunidad Valenciana	2,771	10.2	440	9.1	4,570	11.7	130	11.8	1,929	59.0
Extremadura	674	2.5	142	3	963	2.5	49	4.5	338	66.6
Galicia	2,579	9.5	404	8.4	5,027	12.9	104	9.5	2,552	50.3
Madrid	1,767	6.5	338	7	2,796	7.2	130	11.8	1,159	60.4
Murcia	763	2.8	168	3.5	1,427	3.7	44	4.0	708	51.9
Navarra	227	0.8	100	2.1	230	0.6	2	0.2	5	97.8
País Vasco	1,338	4.9	179	3.7	1,903	4.9	42	3.8	607	68.8
La Rioja	176	0.6	65	1.4	208	0.5	8	0.7	40	81.5
Ceuta	19	0.1	2	0	123	0.3			104	15.4
Melilla	31	0.1			71	0.2	1	0.1	41	43.1
Unknown					634	1.6	11	1.0		
Total	**27,272**		**4,811**		**38,976**		**1,099**		**12,803**	**68.1**

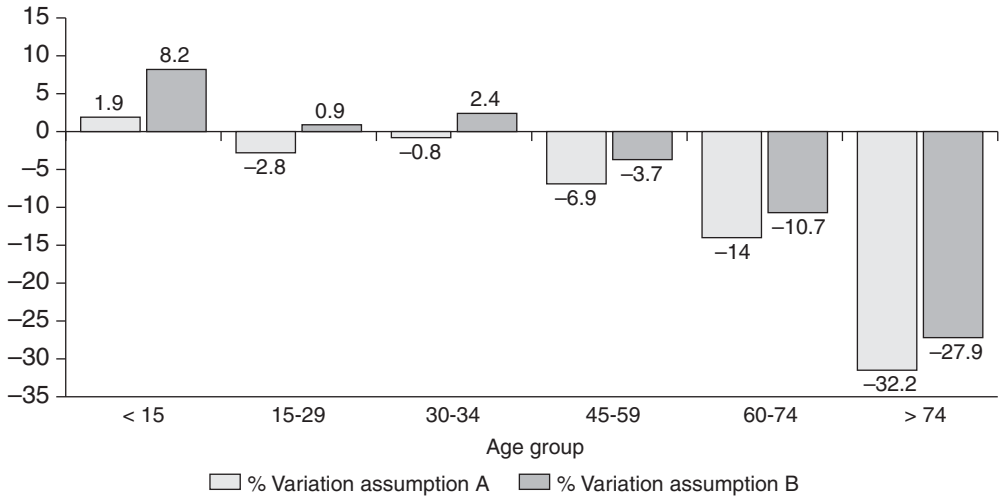
DGT: Spanish Traffic Authority; HDR: Hospital Discharge Records.

Table 2. Percentage variation in the global estimation of motor vehicle crash fatalities according to two different assumptions

	«Real» estimates (DGT+HDR)	DGT[a] estimates	% variation[b]	CI 95%
Assumption A[c]	5,910	5,517	–6.6	–7.2 –6.0
Assumption B[d]	5,687	5,517	–3.0	–3.4 –2.6

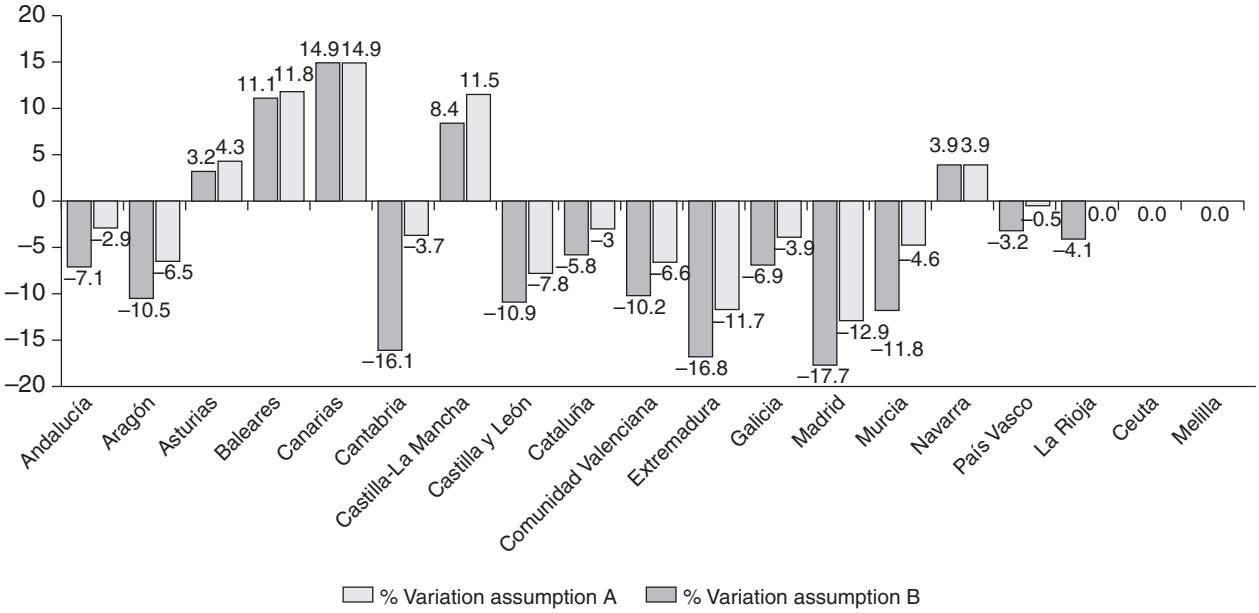
[a]DGT estimates: deaths reported by DGT (4,811) + deaths estimated by application of the adjustment factors (706).
[b][(DGT estimates/«Real» estates)-1] × 100.
[c]Assumption A: deaths reported by DGT (4,811) + deaths HDR up to 30 days (1,099).
[d]Assumption B: deaths reported by DGT (4,811) + deaths HDR up to 30 days (1,099) – deaths HDR on day 0 (223).
DGT: Spanish Traffic Authority; HDR: Hospital Discharge Records.

Figure 1. Percentage variation of estimates of the number of motor vehicle crash fatalities, by age group and by assumption.



–% Variation according to assumption A: [(DGT estimates/assumption A estimates)-1] x 100.
–% Variation according to assumption B: [(DGT estimates/assumption B estimates)-1] x 100.0.
DGT: Spanish Traffic Authoroty; HDR: Hospital Discharge Records.

Figure 2. Percentage variation of estimates of the number of motor vehicle crash fatalities, by region and by assumption.



–% Variation according to assumption A: [(DGT estimates/assumption A estimates)-1] x 100.
–% Variation according to assumption B: [(DGT estimates/assumption B estimates)-1] x 100.
DGT: Spanish Traffic Authoroty; HDR: Hospital Discharge Records.

Level of fulfilment of the HDR and limitations of the data

Socio-demographic and administrative variables and diagnoses of disease and injury were generally shown to present a good level of fulfilment. Even so, variables such as road user type and type of crash, as provided by the external cause of injury codes, were not sufficiently well documented to be of great utility. As a result, it was not possible to appropriately analyse these variables. Although these problems are not exclusive to this country[6], their potential importance justifies taking extra measures to ensure the quality of information relating to these variables. The strategies that have been used until now for the remaining variables, and which are linked to the financing of hospitals, should be considered or amplified for variables involving incomplete information, and in particular with respect to the code for external causes of injury.

Furthermore, the characteristics of the information source imply certain operative limitations that must also be taken into consideration: although the HDR enjoys wide public coverage (98% for 2001), it excludes data from private hospitals. This could explain some of the differences observed between different territories; ie, the number of private beds available varies from one region to another. Furthermore, the lack of a personal identifier prevented us from eliminating potential cases of duplicated episodes or re-hospitalizations. Nevertheless, the number of such cases was minimized by the exclusion of non-urgent hospitalizations. This problem is examined in the literature and there is evidence that the lack of a means for identifying duplicates could lead to an overestimation of the incidence of injuries[7].

Another problem that must be taken into account is the lack of information about the time of hospitalization. Hence, an accurate estimate of the real number of fatalities is rather imprecise, regardless of the assumption employed. Finally, and as occurs in other countries, it must be assumed that the recording of crashes by the police is not complete[8-10]. In general, the level of under-reporting tends to be greater for less serious crashes, for those involving fewer people or not involving third parties, and for crashes that occur in urban areas[11].

Estimation of the number of people severely injured and killed at 30 days

Comparisons between the two sources of information show that at least a third of the patients hospitalized due to motor vehicle injuries were not identified by the police as being severely injured (and therefore regarded as susceptible to hospitalization). As a result, these cases would not have been the object of a follow-up 30 days after hospitalization in cases when such action would otherwise have been carried out. This could have been because the crash was not recorded by the police (lack of coverage) or due to misclassification, with severe injuries being incorrectly diagnosed as minor injuries and therefore not meeting the general criteria for hospitalization.

Some studies have shown that relying on police officers to assess the severity of injuries may introduce certain bias[11-13]. For example, Laumon and Martin observed that 3.4% of people injured in crashes who were reported by the police to have suffered only minor injuries were, in fact, severely injured according to the Maxim Abbreviated Injury Severity scale[14] (MAIS). Similarly, 54.3% of people considered severely injured according to police records were classified as having only moderate or minor injuries by the MAIS. These same sources also refer to the fact that the police tend to overestimate the severity of injuries of certain types of road user, such as pedestrians.

The level of underestimation of deaths at 30 days made by the DGT with respect to those really occurring (based on the records of the DGT and on data from the HDR) oscillates between –3% and –6.6%, according to the assumption considered. This is similar to what was found in a study conducted in The Netherlands[15] in which estimates based on police statistics were shown to under-report hospitalizations by 7%. This under-reporting increases with the age of the victim and is particularly important amongst victims over 60 years of age. On the other hand, in the case of the under 15s, there is no under-reporting whatsoever and there could even be some degree of overestimation in the case of children. In addition, the failure to correctly identify serious injuries to children could also be due to the fact that children have a much greater probability of survival after suffering serious injuries than adults. On the other hand, in the case of the elderly, the opposite would tend to occur. Furthermore, in the case of people who already have a rather poor state of health, relatively minor injuries may lead to complications and even result in death.

Under-reporting of people injured in motor vehicle crashes in police records has also been reported in other studies. Nakahara and Wakai refer to the fact that only half of the children under 7 years of age who required medical treatment were reported as needing it by the police[16]. Other studies have cited levels of under-reporting of between 9% and 20%[12,17].

The variability in under-reporting from one region to another is more difficult to explain as many of factors may be involved. These could include: variations in the coverage of private services (not included in this study); the fact that the region in which the crash occurred may not always have been the same region in which hospitalization took place; and the smaller number of crash fatalities in some regions.

This study constitutes a first attempt to estimate the number of motor vehicle crash fatalities at 30 days carried out in Spain without the need to apply an adjustment factor. The Hospital Discharge Register (HDR) was shown to be a useful tool for this purpose, but the definitive application of these data must involve establishing a probabilistic record linkage between the two data sources and other sources of relevant and related information such as hospital emergency records, if and when these are available. To achieve this goal, it is necessary to have access to more variables as this would make it possible to link records with a greater degree of validity. Given the lack of personal identifiers, it would at least be useful, to know the victim's date of birth (only his/her age is currently known) in the case of the DGT records. It would also be useful to know the time of hospitalization, type of crash, and vehicle involved (which would imply a greater level of fulfilment of the external cause of injury, E Code) in the case of HDR data. Ideally, knowing the name and surnames and/or National Identification Number of the victim would help to establish stronger record linkage and would allow more reliable estimations of the number of people injured and killed in motor vehicle crashes.

Given the quality and the utility of the data relating to hospitalizations presented in this study, it would certainly be useful for hospital emergency services to incorporate a similar information system providing a minimum data set including diagnoses and external cause codes when applicable. This would complement existing information provided on hospitalizations and would allow closer monitoring of the impact of road safety policies. It would, for example, make possible to observe trends relating to both the number of people injured and also the severity of these injuries.

In summary, this study constitutes the first attempt to describe the pattern of motor vehicle injuries in Spain and highlights the utility of the Hospital Discharge Register for this purpose. This tool, which was originally designed for administrative management purposes, could also be used to complement data provided by police records, on the number of deaths and severe injuries resulting from motor vehicle crashes. Improving the quality and level of fulfilment of external cause codes would also be of particular interest for planning and evaluating of road safety policies.

Annex

Work group

F. Javier Álvarez (Universidad de Valladolid), Mónica Colás (Dirección General de Tráfico), Julia González (Dirección General de Salud Pública, Ministerio de Sanidad y Consumo), Juan Carlos González-Luque (Dirección General de Tráfico), Pablo Lardelli (Universidad de Granada), Candelaria Mederos (Dirección General de Tráfico), Isabel Ricart (Agència de Salut Pública de Barcelona), Teresa Robledo (Dirección General de Salud Pública, Ministerio de Sanidad y Consumo), Agustín Rivero (Ministerio de Sanidad y Consumo), María Seguí-Gómez (Universidad de Navarra), and Pilar Zori (Dirección General de Tráfico).

This study has been partially published in the report: Pérez K, Cirera E, and work group of the Spanish Society of Epidemiology for the Measuring of the Impact on Health of Road Traffic Accidents in Spain. Estudio de la mortalidad a 30 días por accidentes de tráfico (EMAT-30). Madrid: Ministerio de Sanidad y Consumo; 2004.

Acknowledgements

This study was financed by the Dirección General de Salud Pública, Ministerio de Sanidad y Consumo and conducted with the support of the Dirección General de Tráfico (DGT).

References

1. IRTAD. Under-reporting of road traffic accidents recorded by the police at the international level. Special Report OCDE-Road Transport Programme. Norway: Public roads administration; 1994.
2. Berns S, Brühning E. Definitions and data availability compilation and evaluation of A-level roads and hospitalised victims in OECD countries. Accident and injury definitions. IRTAD Special Report, 1998.
3. Plasència A, Orós M, Diego J. Estadísticas de mortalidad por accidente de tráfico. Med Clin (Barc). 1994;103:159.
4. Seguimiento de heridas graves a 30 días. Madrid: Ministerio de Interior. Dirección General de Tráfico; 2001.
5. Anuario Estadístico de Accidentes 2001. Madrid: Dirección General de Tráfico. Ministerio del Interior; 2002.
6. Langlois JA, Buechner JS, O'Connor EA, Nacar EQ, Smith GS. Improving the E coding of hospitalizations for injury: do hospital records contain adequate documentation? Am J Public Health. 1995;85:1261-5.
7. Smith GS, Langlois JA, Buechner JS. Methodological issues in using hospital discharge data to determine the incidence of hospitalized injuries. Am J Epidemiol. 1991;134:1146-58.
8. Rosman DL, Knuiman MW. A comparison of hospital and police road injury data. Accid Anal Prev. 1994;26:215-22.
9. Cercarelli LR, Rosman DL, Ryan GA. Comparison of accident and emergency with police road injury data. J Trauma. 1996;40:805-9.
10. Cryer PC, Westrup S, Cook AC, Ashwell V, Bridger P, Clarke C. Investigation of bias after data linkage of hospital ad-

missions data to police road traffic crash reports. Inj Prev. 2001;7:234-41.
11. Laumon B, Martin JL. Analysis of bias in the epidemiological knowledge of road accidents in France. Rev Epidemiol Sante Publique. 2002;50:277-85.
12. Agran PF, Castillo DN, Winn DG. Limitations of data compiled from police reports on paediatric pedestrian and bicycle motor vehicle events. Accid Anal Prev. 1990;22:361-70.
13. Simpson HF. Comparison of hospital and police casualty data: a national study. Crowthorn, Berkshire.mTransport research Laboratory, 1996.
14. AAAM (Association for the Advancement of Automotive Medicine). The Abbreviated Injury Scale, 1990 Revision. Estados Unidos: AAAM, des Plaines, Il; 1990.
15. Racioppi F, Eriksson L, Tingvall C, Villaveces A. Preventing road traffic injury: a public health perspective for Europe. Ginebra: World Health Organization; 2004.
16. Nakahara S, Wakai S. Under-reporting of traffic injuries involving children in Japan. Inj Prev. 2001;7:242-4.
17. Harris S. The real number of road traffic accident casualties in The Netherlands: a year-long survey. Accid Anal Prev. 1990;22:371-8.