Estimating the Population Burden of Injuries

A Comparison of Household Surveys and Emergency Department Surveillance

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Background: Injuries represent an important public health problem but their incidence is difficult to estimate.

Methods: We conducted a population-based household survey in Greece covering 4079 interviewed individuals. The interviewees reported, for themselves and for cohabitating adults (age 15 years and older; n = 7157), injuries that occurred during the preceding year. Major injuries were defined as those requiring contact with a health institution. We compared these survey data with data obtained through a national Emergency Department Injury Surveillance System (EDISS).

Results: For the month closest to the survey interview, the incidence reported for the responders was 5.9 per 100 person-year, whereas the incidence for cohabitating adults was 3.7 per 100 person-years. These incidence rates declined for months more remote to the interview. Comparison of survey and EDISS data suggested that survey reporting was less accurate for nontraffic-related injuries. Taking into account possible recall and telescoping biases, the best survey estimate of the national annual number of major injuries is 525,000 (5.9 per 100 person-year), whereas the EDISS data yielded an estimate of 1,150,000 major injuries (12.9 per 100 person-years)

Conclusions: Comparison of survey and EDISS data systems provides quantitative assessment of accuracy of the survey data in relation to time of injury before report date, to severity of injury, and to whether the injury is to the interviewee or to a cohabitant. The 2 systems could be used in a complementary way, although EDISS generates information that is medically more accurate and is a more cost-effective data collection system.

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Health care in Greece is generally provided by a national system, with intense competition among its various sectors for limited resources. There are approximately 4500 deaths resulting from injury every year in Greece,[1] a figure that vastly underestimates the burden resulting from injuries. Moreover (and in contrast to other major causes of morbidity and mortality), hospital statistics cannot capture a large degree of the morbidity generated by injuries.[2] It is difficult to study the descriptive epidemiology and the risk factors for injuries without undertaking special studies.

In response to this need, the European Union has launched the European Home and Leisure Accident Surveillance System. The Emergency Department Injury Surveillance System (EDISS) in Greece, an outgrowth of this European Surveillance System, has been in operation since 1996. It generates reliable data that include all types of injuries in all age groups and information about events that led to the injuries. EDISS data are not strictly representative, but national estimates derived from EDISS extrapolations are reasonable approximations for most major groups of injuries.[3]

To assess strengths and limitations of the EDISS data, we have undertaken a household survey of injuries in a representative sample of the Greek population. The study was done in collaboration with the Market Research Bureau Hellas Company.

METHODS

The present survey is part of a larger survey called "Trends," which has served, since 1987, as a monitor of public opinion in Greece. In April and November 2001, a representative sample of 8000 families was chosen through a

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multistage sampling procedure that was stratified by geographic region, type of population, and residence. Of those selected, 3921 families were inaccessible, unable, or unwilling to participate. For the remaining 4079 families, an interview was conducted with the head of household or, if the person was unavailable, another adult. The interview included questions about injuries sustained by adult members of the family (ages 15 years and older) during the preceding 12-month period. Injuries were categorized as "major" if they required contact with a health institution (accident and emergency department of a hospital, healthcare center), and "minor" otherwise. Timing of the injury in relation to the interview was specified only for major injuries, under the assumption that such injuries were better remembered. For major injuries, questions were asked concerning the type of event, the characteristics of the injury, and the mode of treatment. All information was coded according to the EHLASS 1996[4] and the International Classification of Disease (ICD)-9 and ICD-10 coding manuals.

More than one major injury events were reported for 3 adult family members, but only one of the injuries (the more remote in time) was considered in the analysis. This adjustment was done because remote injuries are more likely to be remembered when they are relatively serious and does not seriously affect the overall estimate of incidence.

We compared data generated through this household survey with those obtained through the EDISS. This system relies on injury data collected in the emergency departments of 4 sentinel hospitals, 2 of which are located in the Greater Athens area, the third in mainland Greece, and the fourth on the island of Corfu. Shifts of specially trained health visitors interview patients with all types of injuries. A precoded questionnaire is used, supplemented by a short free text description of injury event. The questionnaire is a modified version of the basic form used by all countries participating in the European Home and Leisure Accident Surveillance System, and includes additional variables on traffic and occupational injuries. The questionnaire covers sociodemographic variables as well as injury characteristics and treatment.

A recent analysis has suggested that the data from EDISS could be extrapolated with reasonable approximations to countrywide estimates of the burden of injuries.[3] By the end of 2000, 140,817 adults with injuries have been recorded in the EDISS database, and distributions by sex, age, type of event, type of injury, and form of treatment were compared with those derived from the household population survey. Because of the large coverage of the EDISS database, its estimates are practically free of sampling error. For the household survey-based estimates of injury rates, full stratification by the additional variables used in the survey design was not feasible as a result of the small number of injuries. Preliminary checks suggested that injury rates did not vary appreciably across such stratification. For this reason, the sampled households here are treated as being approximately a (cluster) random sample of Greek households. The survey-based estimates and 95%confidence intervals (CIs) are then obtained by using: (1) inference for one-sample proportions for evaluating injury rates in the interviewees themselves, and (2) ratio estimation for cluster sampling[5] for evaluating injury rates reported by the interviewees for other members of households (cohabitants).

RESULTS

Interviewees reported 127 major injuries for themselves and another 136 major injuries for their cohabitants (Table 1). Among interviewees of the same sex and for equal time duration, reported injury incidence was considerably higher for recent versus past reference period and considerably higher for self versus cohabitants. Self- reported injuries tended to be more frequent among men than among women, whereas women interviewees tended to provide more complete information when injuries were reported for cohabitants.

The best estimate of the total annual number of injuries among men and women adults in Greece (n = 8,900,000) based on this household survey is 5.9 per 100 person-years (95% CI = 3.3–8.5), which corresponds to approximately 525,000 people (CI = 294,000–757,000). The analogous estimate based on the EDISS database is 1,150,000 (incidence 12.9 per hundred person-years). Thus, even after taking into account sampling error, the household survey reflects systematic differences from the estimate of EDISS.

Table 2 compares the demographic distribution of EDISS database (140,817 injured persons) and the survey (557 injured persons), combining major and minor injuries. With respect to sex, EDISS shows the well-known higher proportion of injuries among men (59%), whereas the male preponderance is not evident in the household survey. With respect to age, injured persons over 65 years were strikingly underrepresented in the household survey.

In Table 3, details of adult injuries recorded in EDISS are compared with "major" injuries from the household survey. The discrepancy between data sources was greater for road traffic injuries than for other types (32% in the household survey compared with 18% in the EDISS data). There is evidence of overrepresentation in the household survey of fractures, burns, nerve, and internal organ injuries as well as poisoning. This indicates that focusing only on "major" injuries in the survey creates an overrepresentation of more severe injuries in comparison with EDISS. This is supported by the fact that in the EDISS database, 47% of injured persons receive some form of treatment and 11% are hospitalized, whereas the corresponding proportions in the survey are 28% and 24%.

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TABLE 1. Injury Events That Occurred Over a Period of 1 Year and Required Contact With a Healthcare Institution ("Major Injuries"), as Reported by 4079 Adults for Themselves and 7157 Other Adult Family Members, by Sex of the Interviewee and Timing of the Event in Relation to the Interview

	Reported for Self				Reported for Others			
Interviewee	π	≤1 Month	2–3 Months	4–11 Months	π*	≤1 Month	2–3 Months	4–11 Months
Men								
Events (n)	2061	12	9	51	3622	7	19	25
Rate† (95% CI)		7.0 (3.0–10.9)	2.6 (0.9–4.3)	3.3 (2.4–4.2)		2.3 (1.1–4.9)	3.1 (2.0–5.0)	0.9 (0.6–1.4)
Women								
Events (n)	2018	8	16	31	3535	15	23	47
Rate† (95% CI)		4.8 (1.5–8.0)	4.8 (2.4–7.1)	2.0 (1.3–2.8)		5.1 (3.1–8.4)	3.9 (2.6–5.9)	1.7 (1.3–2.4)
Total								
Events (n)	4079	20	25	82	7157	22	42	72
Rate† (95% CI)		5.9 (3.3–8.5)	3.7 (2.2–5.1)	2.7 (2.1–3.3)		3.7 (2.4–5.6)	3.5 (2.6–4.8)	1.3 (1.1–1.7)

*π refers to number of adult family members for whom the interviewer reported information.
†rate = number of events per 1000 person-years.

TABLE 2. Percent of Injured Persons by Sex and Age for Injury Events Among Adults Recorded in the EDISS Database and for Those Reported in a Representative Household Survey Concerning Injury Events Sustained by 11,242 Adults Over a 1-Year Period, by Severity of Injury and Timing in Relation to Interview

		Household Survey						
		Major Injuries*				Minor Injuries		
		Reported for Self		Reported for Others				
	EDISS (n = 140,817)	≤3 Months (n = 45)	4–12 Months (n = 82)	≤3 Months (n = 64)	4–12 Months (n = 72)	Reported for Self (n = 198)	Reported for Others (n = 557)	Total (n = 96)
Sex								
Male	59	47	62	53	63	43	31	48
Female	41	53	38	47	37	57	69	52
Age								
15–24	25	25	23	27	28	18	27	23
25–44	34	29	44	34	28	46	34	39
45–54	23	42	26	34	34	29	30	31
≥65	18	4	7	5	10	7	8	7

*Major injuries defined as those injuries for which a healthcare institution was contacted.
EDISS indicates Emergency Department Injury Surveillance System.

DISCUSSION

We compared injury estimates between household survey-based and hospital-based reports. Our findings suggest that surveys do not necessarily provide a method for ascertaining the burden of injuries that is as accurate or as efficient as the hospital-based reports. Some of our findings provide additional support to earlier work,[2] whereas some other findings address issues that have received less attention.

A limitation of the survey is the low response rate among the participants, a characteristic shared by many household surveys. The survey was performed at two time periods, thus decreasing the likelihood of missing seasonality-linked variations. Strict comparability with EDISS is precluded given the choice of sentinel hospitals. However, the objective of these surveillance systems is to complement each other rather than to substitute one for another.

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TABLE 3. Percent Distribution by Type of Injury Events and Characteristic of Injury Among Adults Recorded in the EDISS Database and Major Injury Events Reported in a Representative Household Survey Concerning 11,242 Adults Over a 1-Year Period

		Household survey				
		Reported for Self		Reported for Other		
Variable	EDISS (n = 140,817)	≤3 Months (n = 45)	4–12 Months (n = 82)	≤3 Months (n = 64)	4–12 Months (n = 72)	Total (n = 263)
Type of event						
Home and leisure	54	51	36	49	44	43
Road traffic	18	29	40	23	32	32
Occupational	12	20	17	25	16	19
Other	3	0	2	3	7	4
Unspecified	13	0	5	0	1	2
Outcome						
Examination-first aids	40	51	44	51	39	46
Treatment and follow up	47	25	31	30	25	28
Hospitalization	11	22	24	19	30	24
Death	0	0	0	0	6	1
Other	2	2	1	0	0	1
Type of injury						
No injury	1	5	0	5	2	2
Bruise	35	9	18	22	13	16
Open wound	19	11	16	19	13	15
Fracture	19	27	34	19	31	28
Dislocation	12	20	11	17	14	15
Concussion	6	2	6	3	4	5
Amputation	0	0	1	0	3	1
Burn	2	4	5	3	6	5
Injury to nerves	0	7	1	4	2	3
Internal organ	0	7	3	0	4	3
Suffocation–drowning	0	0	0	0	1	0
Poisoning	0	0	0	2	4	1
Foreign body	4	2	0	0	1	1
Other	1	4	1	6	1	3
Unknown	1	2	4	0	1	2

Survey respondents reported more injuries for times closer to the interview. This observation is well known in the literature of injuries.[6–9] Little attention, however, has been given to its explanation and implication for estimation. Recall bias[10] can decrease the likelihood that the interviewee reports an event in the more distant past. In contrast, telescoping bias can distort the reported timing of events.[11,12] The number of events reported in a long time period is not necessarily affected, but with telescoping bias, the interviewee brings forward in time events that happened in a more distant part of that time period. To the degree that "recall bias" is responsible, the reported frequency during the most recent time-window is the most accurate for that window. However, if telescoping bias is at work, the reported frequency during the most recent time-window is the least accurate, even though in both situations, the most recent time window has the largest reported frequency.

The correct attribution to recall bias or telescoping bias requires comparison of the survey to an external, more objective, source of data. Our study provides such a comparison. Specifically, if telescoping bias were the predominant reason for the increased frequency of injuries at proximal times, then we would expect that the survey frequency for the whole year (127 of 4079 = 3.11; 3.11 per 100 person-years × 8,900,000 = 277,100) would be unaffected by that bias and so would be close to the fre-

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quency of EDISS. However, this calculation only increases the discrepancy between the figures provided by these 2 databases (277,100 estimated by the household survey compared with 1,150, 000 by EDISS), suggesting that recall bias, not telescoping bias, is primarily responsible for distorting the survey data.

Survey respondents also reported substantially more severe injuries, an observation consistent with earlier work.[6,7] In addition, the frequency reported by adult interviewees was higher for injuries inflicted to them than to other household members (Table 2), which is in line with a finding by Peterson et al.[13] for children interviewees. The apparent underreporting of injuries for elders (65 years and older) can perhaps be attributed to compromised memory of the elderly or lower prioritization of events in the life of the elderly by cohabitants who provided the information or to selection factors that might have tended to exclude elderly persons from the sample.

The higher proportion of male injuries in EDISS has two explanations. First, EDISS has more severe injuries than the survey with "major" and "minor" injuries combined. Second, in reality, the male preponderance increases with severity (with death the extreme). This is supported by the fact that in the household survey, remote injuries that were presumably serious enough to be remembered did show the male preponderance (62% and 63%). In addition, there seemed to be a tendency for men to dismiss a fraction of minor injuries (43% and 31%).

These findings add strength to evidence that population surveys provide more reliable injury information for severe injuries (including traffic injuries), for injuries regarding the interviewee (rather than other household members), and for the recent past (within 2 months).[7–9] The nationwide annual frequency of injuries is most likely closer to that estimated by EDISS than by the household population survey.

As a general observation, for a one-time survey to have an interview time-window small enough to avoid recall bias, the sample size would need to be impractically large to generate enough injuries for meaningful analysis. This suggests that a panel design,[14] in which the same group of subjects would be frequently reinterviewed, offers a better design for estimating injury frequencies. Such a design can also capture times trends in injury frequency, which are missed by a one-time survey.

An advantage of the hospital-based data of EDISS compared with a panel survey is that the former can better capture information concerning difficult-to-reach individuals such as migrants, elderly, or mentally impaired persons living alone. Moreover, obtaining detailed injury information often requires eliciting related information on the medical and healthcare aspects of the injury. As has previously been pointed out,[15] this task is more reliably performed by dedicated healthcare professionals than by social survey personnel.

An advantage of the panel survey is that it can provide exposure data related to the injuries. Exposure data are critical for evaluating injury risk associated with specific activities. For instance, to evaluate the risk of injury to a child riding a bicycle in the street requires information on how long the child is riding, the child's age, and the type of street. By definition, exposure data from hospital-based sources are limited to the cases, that is, the subjects who get injured. Although methods have been developed for evaluating risks using only cases,[16] estimation of injury risks for many exposures can still be best validated when exposure is also available for control subjects.

In conclusion, population surveys can be useful for the generation of basic data to which information from population-based accident and emergency departments could be anchored. Although surveys are not a substitute, specially designed population surveys can provide exposure patterns of the underlying populations to various factors that may play a role in risk, and hence ultimately prevention of injuries.

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