Population-Based Surveys as Sources of U.S. Injury Data and Special Methodological Problems

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In the United States, as in most countries, records of fatalities, hospitalizations, and treatment in trauma centers or emergency rooms are the standard sources of injury data.[1,2] These sources are frequently used to indicate relative magnitude of the injury problem with some potential ranking according to severity (Figure 1).[3] For fatalities, population-based census data for age, sex, residence and race are used as the denominator to determine injury death rates for specific demographic risk factors.[1,4]

Denominator data are problematical for non-fatal injury rates due to incomplete ascertainment at the medical treatment source for the population at risk.[5] Special studies are required to determine the population characteristics of persons using the treatment source.[6] Population data are needed as denominators to estimate the magnitude of the injury problem relative to the population at risk. In addition, population-based data are necessary to perform risk factor assessment according to either population or exposure characteristics in order to target interventions appropriately. Evaluation of intervention outcomes and planning for service area programs require knowledge of population characteristics for both injuries and risk factor distributions.

In addition, the many different disconnected sources of medical treatment in the U.S. result in a major gap for complete enumeration of injury data. The National Center for Health Statistics (NCHS) recently completed the first reports of emergency room and hospital outpatient department national surveys to supplement visit rate data previously based on hospital discharge and physician office surveys.[7,8,9,10] Denominators are based on U.S. Census data with estimates available only for broad age, place of residence and other demographic groupings due to sample sizes. These national surveys are limited to information available in medical records. Risk factor and exposure information is not available from these sources. Gaps exit for those persons who go untreated or are treated at home. Injury outcomes of most treated injuries, including severity and activity restriction, are generally unknown. Ability to compare population characteristics of the injured to the uninjured is limited. All of these factors reinforce the need for population-based injury data using some form of survey instrument. The following discussion of data sources and special methodological problems describes features that are pertinent for surveys used to obtain either injury or population risk factor data. Studies using census data as denominators for records from treatment sources are not discussed below.[11,12]

Population-Based Sources

Data sources may be generated by: (a) linking treatment or fatality records to survey data; (b) surveying special populations of interest; or (c) performing special studies to obtain risk factors for specific injuries. Some examples of each approach include the following:

- *linking treatment, fatality, and administrative records to survey data*:

  (1) injured patients are identified at treatment source (emergency rooms, trauma centers, poison control centers) with additional information obtained about the patient and/or injury circumstances through a questionnaire, phone call or visit.[13,14,15]

  (2) injury deaths are identified through death certificates with followback questionnaires to next-of-kin, treatment facilities and medical examiners or coroner reports such as in the 1986 National Mortality Followback Survey.[16,17]

(3) administrative crash occupant-specific records on medical and financial data collected at the scene are linked to emergency room, hospitalization, rehabilitation, and long term care records to create population-based information for evaluation of exposure and longitudinal effects.[18]

- *surveying of special interest populations*:

  (1) populations limited by age groups, such as children or the aging.[19,20]

  (2) populations surveyed for occurrence of special events, such as crime victimization.[21]

  (3) populations with small numbers and/or non-representative residential locations requiring tailored sample designs, such as farm injury surveys.[22,23,24]

  (4) Longitudinal followups of cohorts yielding data for selected types of injuries such as occupational injuries,[25] falls in the aging,[20] or injuries by family characteristics in multigenerational studies.[26]

- *performing special risk factor studies for specific injuries*:

includes case control and/or field studies with cases identified at a treatment source or through fatality records and controls selected through survey of case or injury characteristics;[27,28,29] and cross-sectional or prospective surveys designed to identify risk factors for specific injuries.[30]

The common element among all approaches to population-based surveys is the incorporation of direct queries to individuals for additional information beyond that which is available from existing vital, administrative, or treatment records.

For the U.S. the primary source of estimates of total magnitude and rates of non-fatal injuries is the National Health Interview Survey (NHIS). Census denominators used for age- and sex-specific injury rates are similar to those available for fatalities with modification to reflect the civilian non-institutionalized population sample design.[31] The NHIS is a continuous survey covering approximately 50,000 households per year. The sample frame is a complex multistage design based on the U.S. census. The strength of the survey is the comprehensive representative design which allows national estimates for the resident civilian non-institutionalized population. Injury questions are based on both medically attended and/or activity restricting injury events yielding less biased estimates than data based on treatment sources alone. Analytic potential goes beyond the age, sex, race, and place information available on death certificate records to yield injury information on socioeconomic factors such as income. For example, Figure 2 shows the elderly poor are more likely to be injured at home than any other age group, which is useful information for targeting risk factor analysis.

While the sample size is adequate to estimate injury rates for broad age groups by income and place, the NHIS demonstrates that even such a large continuous sample has inadequate size to make such estimates for even five year age groups or for the nature of injuries on an annual basis. Many injury researchers are facing this sample size dilemma when designing studies of risk factors targeted to specific locations, ages, or exposures. The NHIS provides useful examples of methodological problems for population-based injury data because the sample size and information are complete enough to demonstrate the problem issues. Therefore, the following discussion of common methodological problems of injury surveys are based on NHIS data but are not specific to this national survey. Many survey methodological problem issues which are not specific to injury research are discussed elsewhere and are not addressed in this paper.[32,33,34]

Methodological Problems

Sample Size

As mentioned above, very large continuous surveys such as the NHIS may be of insufficient size to provide national estimates for even five year age groups or for the nature of injuries on an annual basis. In the case of the NHIS, the reference period used to accumulate injury episode occurrences is the previous two weeks, selected to reduce the amount of bias associated with respondent memory loss.[35] One solution to obtain an adequate sample size at the national level has been to accumulate the data from the prior two week reference period over a three year period. Resulting estimates have reliable precision for broad categories of injury types (or nature), smaller age groupings or impairments.[36,37]

Another solution for sample size limitations is to extend the reference period. To address the problem of the limited sample size for small age groups for injuries to U.S. children, the 1988 Child Health Supplement (CHS-NHIS) was added to the NHIS. The length of the recall period was extended to the previous 12 months to increase the probability of the child being injured in the reference period. However, injuries were limited to only those receiving medical attention.

Studies of specific populations of interest frequently require extra details. By obtaining injury data by month and year of age on a larger sample in the CHS-NHIS the effects of developmental stages and changing exposures are more clearly demonstrated to show how risk factors interact (Figure 3). Using year of age, differences in age-specific rates focus attention on injuries occurring in the places where children have the most exposures by age as their activities move from home to school.

Effects of Recall

Lengthening the recall period for the CHS-NHIS had the effect of decreasing the overall estimate of injury rates.[38] By asking when the injury occurred, attrition in injury rates was measurable by length of time from the interview to the injury event. Figure 4 shows that recall is affected by severity. Overall, the best recall period was one month with a continuing decrease after three months, particularly for minor injuries. Using the estimates according to the length of time from the injury event, overall injury rates estimates may be adjusted to what they would have been using a one month recall period. This is an important issue for most surveys currently in the field due to the need to balance recall effects against sample size needs. Adding the injury date allows corrections.

Medically-Attended and Activity Restricting Injuries

Analysis of NHIS data by injury type demonstrates the methodological strength of probing for injury episodes by asking about both medical attention and activity restrictions. Some types of injuries with high rates of medical attention do not result in high rates of activity restriction (Figure 5). Conversely, injuries serious enough to cause activity restriction do not always receive medical attention. Figure 5 demonstrates that head injuries (skull fractures and intracranial injuries) and open wounds or lacerations usually receive medical attention. Yet, less than half of medically attended head injuries and 30 percent of open wounds or lacerations result in any restriction of activity. A far greater proportion of lower limb fractures or sprains and strains cause restrictions of activity. Yet, between 10 to 20 percent of these latter injury types do not receive medical attention. Analytic results of studies may be strongly affected by differences in rates of medical attention.[39] In one study of the effect of access to medical care on estimates of injury rates, we found that about 30 percent of injuries serious enough to have an impact on the child did not receive medical attention when there was no medical care coverage (health insurance or Medicaid).[40]

Severity Measures

Since receipt of medical attention is not always a reliable indicator of severity or the impact on the injured person, it is important to obtain estimates on how the injury affected the person leading, in turn, to assessment of relative severity.[38] Analysis of small age groupings with information on effects of the injury on the child demonstrated that medically attended injuries of young children were more than twice as likely to be minor than severe (Figure 4). The proportion of total medically attended injuries that were considered severe increased with the age of the child.

Lay Terminology

Figure 5 also demonstrates the importance of using lay terminology to identify injury diagnoses in population-based surveys. Since some injuries have not received a medical diagnosis, lay terminology is needed to obtain an adequate description of the nature of the injury to facilitate coding of diagnostic categories. Even persons who received medical attention do not always understand the clinical terminology for the diagnosis or parts of the body affected. Probes about the part of the body affected, pictures of body parts, and alternate phrasing suggestions will help to identify the injury site.

Circumstances

The minimum basic data elements to obtain International Classification of Disease external cause of injury codes (E-codes) have been strongly recommended in the U.S.[41] Consistency at this minimum level has allowed comparison with other data that uses E-codes. For example, by obtaining the minimum information needed for e-coding in the 1988 NHIS-CHS, a comparison of nonfatal injury causes to fatal causes was possible (Figure 6).[19] An important finding for non-fatal injuries is that the leading causes are far different from the leading causes for fatal injuries. Combined with data on severity, such comparisons provide information to redirect attention to relative injury burdens. E-codes frequently are not specific enough for individual product exposures or activities. Population-based studies can be tailored to provide the amount of detail and degree of specificity needed for both risk factor and intervention analyses. This important information is often not available in existing administrative or treatment data sources. Some specific study needs include details on place of injury, activities at the time of injury, involvement of others and intent.

Summary

Methodological problems of population-based injury surveys include inadequate sample sizes, incomplete recall of injury events, lack of measures of severity, uncertain diagnosis on nature of injuries, and differential effects from varying degrees of access to medical care. One solution to eliminate sample size problems is expansion of the recall period to include more injury events. Adjustment for loss of information due to extended recall may be made by obtaining the date of the injury event to create correction factors for injury rates by time between interview and event. Obtaining information on duration and type of restrictions of activity due to injury provide severity measures that do not rely solely on access to medical care. Use of lay terminology to describe the nature of the injury facilitates coding of comparable diagnostic categories. Finally, obtaining age data by birth date provides the flexibility to analyze risks associated with changing developmental stages and exposures.

Realistic community perception of risk is needed to build support for appropriately targeted program priorities.[2,42] Community education on risks requires unbiased population-based data for comparisons across injury causes, severity and costs. Without the use of all available data sources linked to population descriptors, efficient resource allocation becomes extremely difficult, if not impossible.

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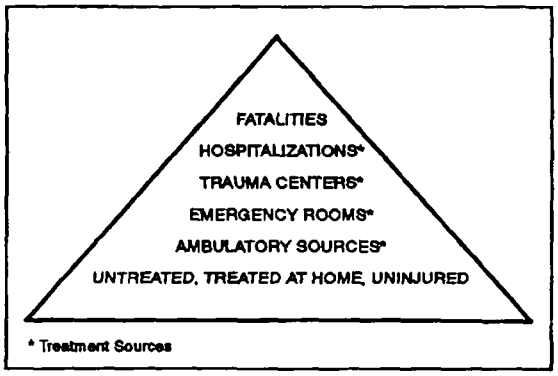


Figure 1. Data sources

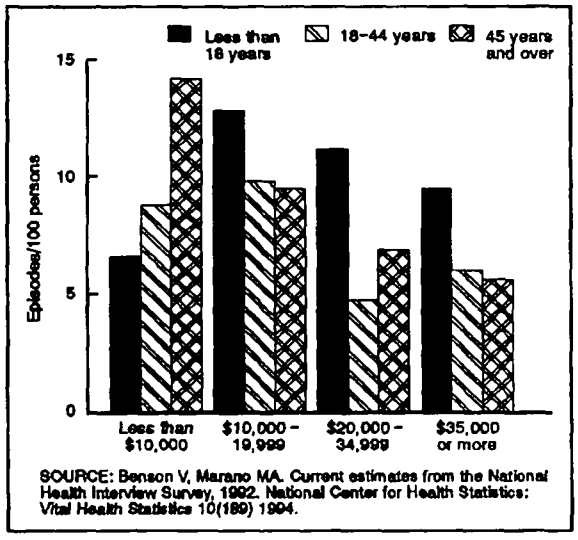


Figure 2. Injury episodes occurring at home by age and income

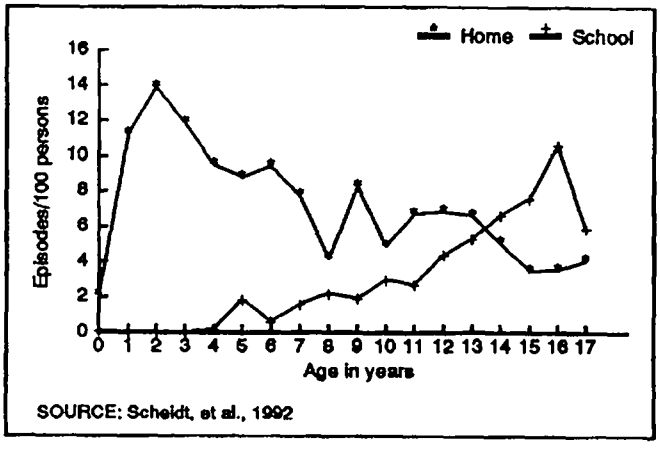


Figure 3. Place of injury by age of U.S. children

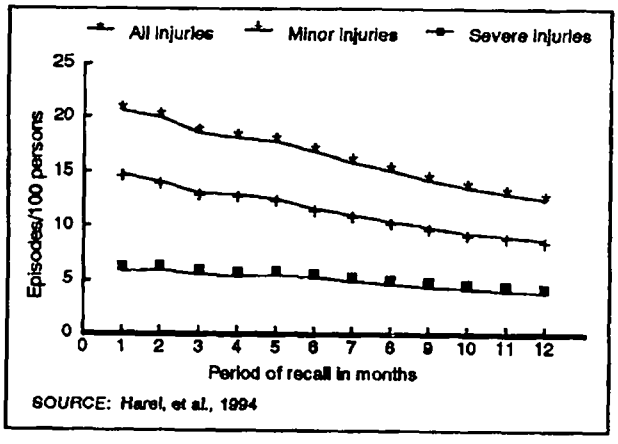
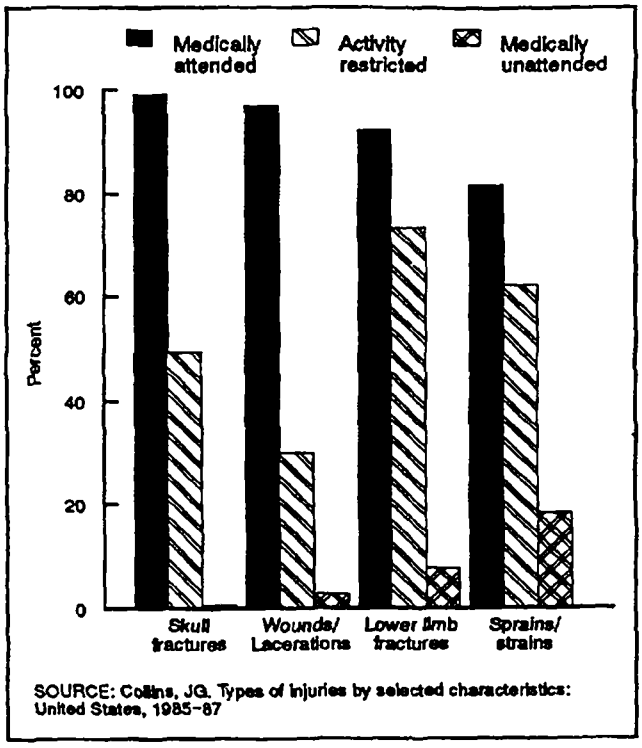
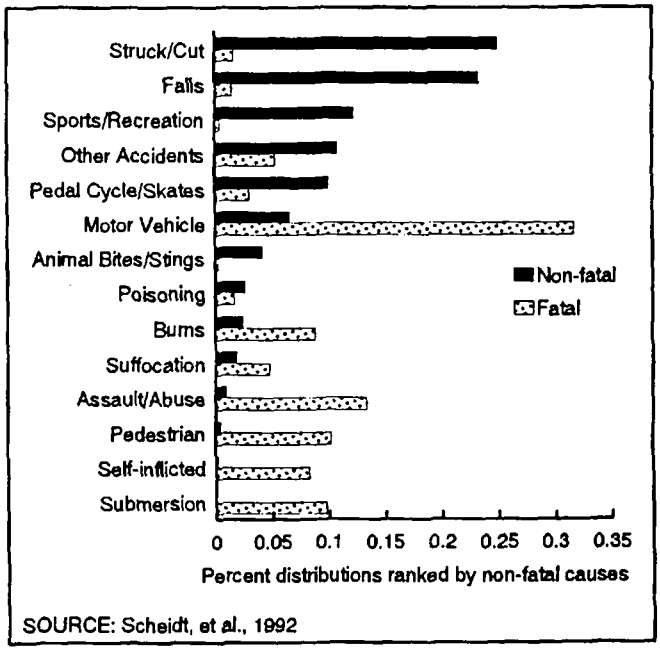


Figure 4. Estimated annual injury rates by severity and recall period



SOURCE: Collins, JG. Types of injuries by selected characteristics: United States, 1985-87

Figure 5. Medical attention and restricted activity for selected injuries



SOURCE: Scheidt, et al., 1992

Figure 6. Causes of Non-fatal and Fatal Injuries for US children