The Effects of Recall on Estimating Annual Nonfatal Injury Rates for Children and Adolescents

ABSTRACT

Objectives. This study used a recent national population survey on childhood and adolescent nonfatal injuries to investigate the effects of recall bias on estimating annual injury rates. Strategies to adjust for recall bias are recommended.

Methods. The 1988 Child Health Supplement to the National Health Interview Survey collected 12-month recall information on injuries that occurred to a national sample of 17 110 children aged 0 through 17 years. Using information on timing of interviews and reported injuries, estimated annual injury rates were calculated for 12 accumulative recall periods (from 1 to 12 months).

Results. The data show significantly declining rates, from 24.4 per 100 for a 1-month recall period to 14.7 per 100 for a 12-month recall period. The largest declines were found for the 0- through 4-year-old age group and for minor injuries. Rates of injuries that caused a school loss day, a bed day, surgery, or hospitalization showed higher stability throughout recall periods.

Conclusions. Varying recall periods have profound effects on the patterns of childhood injury epidemiology that emerge from the data. Recall periods of between 1 and 3 months are recommended for use in similar survey settings. (*Am J Public Health.* 1994;84:599–605)

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Introduction

Injuries have emerged as the principal threat to the health and well-being of children and adolescents. Knowledge of the distribution and determinants of nonfatal injuries in childhood is critical for the development and evaluation of intervention strategies. Population-based surveys are needed to calculate annual injury rates for different subpopulations and/or for different types of injuries. Estimates of nonfatal injury rates in the United States have been based on 2-week recall information obtained from representative samples of households.[1–5] Information ascertained retrospectively through self-reports or proxy reports about exposures or health outcomes may be subject to bias due to differential recall patterns.[6–11] There are two main reasons for recall bias: (1) memory decay—the loss of information due to failure to recall the event, and (2) the "telescoping effect"—the tendency to remember events in the past as if they occurred closer to the present than they really did. Recall bias tends to increase with the enlargement of the recall period inherent in the survey questions.

Since 1957, the National Center for Health Statistics has collected information about injury episodes on the basis of a 2-week recall period.[12] Injuries are identified by asking about reasons for doctor visits or restricted activities within the previous 2 weeks.[3–5] Estimates of annual injury rates are then calculated by multiplying the number of injuries reported for the 2-week recall period by 26 to obtain a 12-month estimate of the numerator. This method may cause the overestimation of injury rates due to telescoping and the magnification of the introduced error by multiplying the number of injuries by 26 to annualize the rate. In addition, the low frequency of injuries in the 2 weeks prior to the interview limits the association of injury with an individual's characteristics. The National Health Interview Survey (NHIS) uses a 2-week recall period for acute conditions because information is lost from failure to remember events over longer periods. Consequently, any attempt to analyze individual or family determinants of injury outcomes based on 2-week recall requires aggregation of data across several years of NHIS surveys to obtain a sample size sufficient for statistical power.

The 1988 Child Health Supplement (CHS) to the NHIS collected information on the occurrence of childhood injuries from an adult respondent, usually the mother. The survey provides the first population-based national data on nonfatal injuries to assist public health

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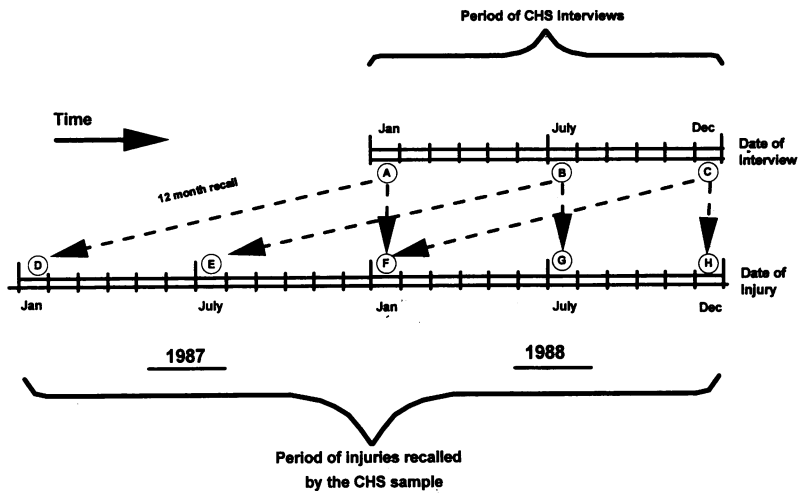

FIGURE 1—Timing of Child Health Supplement interviews and corresponding injury recall periods.

agencies in determining policy objectives and priorities. The NHIS CHS used a 12-month recall period for obtaining information about medically attended injuries rather than the usual 2-week recall period. This longer recall period is likely to produce lower annual estimates than shorter recall periods, owing to memory decay, but may produce higher frequencies of injuries for analysis. The choice of the most appropriate recall period is based on balancing the need for reliable and accurate information with the need for an adequate number of injuries in the data to provide sufficient statistical precision and power.

The purpose of this study was to analyze the effects of using different recall periods on estimated annual injury rates for various subpopulations and for different types of injuries. In so doing, we evaluated the magnitude of the bias and determined the most reliable approach for analysis and interpretation with respect to the recall periods involved.

Methods

Source of Data

The NHIS is a representative sample of the US civilian noninstitutionalized population.[5] The survey collects information about social and economic characteristics, acute and chronic conditions, restricted and limited activity, and physician contacts or any other health care utilization. The 1988 NHIS sample was completed in 47 485 households containing 122 310 persons, 94.9% of whom completed the interviews.[1]

The CHS was added to the core NHIS for the period January 1988 to January 1989 and was designed to produce a representative sample of US children from 0 through 17 years of age. One child in each household with children in the eligible age range was selected, resulting in a sample of 17 110 completed interviews. The information was obtained by face-to-face interview with a responsible adult in the household, usually the child's mother. The survey included such topics as parental history, birth history, school and day care experiences, developmental and behavioral problems, acute and chronic childhood conditions, and other information including a detailed set of items on occurrences of accidents, injuries, and poisonings. Additional information on the methods and design of the 1988 NHIS and CHS surveys is reported elsewhere.[1]

Operational Definition of an Injury

Two screening questions were used: (1) "During the past 12 months, did ____ have an accident, injury, or poisoning that required medical attention?" (2) "How many accidents, injuries, or poisonings did ____ have in the last 12 months that required medical attention?" Beginning with the most recent injury, the respondent was asked to answer questions about the timing and cause of the injury, the place where it happened, the nature of the injury, and restriction of activity, doctor visits, and hospitalizations that resulted from the injury. Information was collected for each of up to 11 injuries reported.

Injuries occurring prior to the recall period that resulted in chronic conditions were not included. Injuries resulting from misadventures or complications of medical care (*International Classification of Diseases* E codes 870–879[13]) were excluded from the analyses. Also excluded were secondary conditions that resulted from injuries already accounted for in a previous injury report.

Timing of the Injury Episode

Interviews were evenly distributed throughout the 1988 calendar year and constituted a nationally representative sample for each individual month of interview. Figure 1 presents the relationship between the date of the interview and the timing of the reported injury. For example, an individual interviewed in January of 1988 (A) may report an injury that occurred within the same week as the interview (F) or an injury that occurred in January 1987, 12 months prior to the interview (D). On the other hand, an individual interviewed 1 year later, in late December of 1988 (C), may report an injury in the same week as the interview (H) or an injury 12 months earlier, in January of 1988 (F). The array of injury events reported for a 12-month recall period covers a calendar period of 2 full years, from January 1987 through December 1988.

To assess the bias resulting from estimates based on different recall periods, the amount of time elapsed between the occurrence of a reported injury and the timing of the interview must be known. Thus, the following timing question was added: "In what month and year did the accident, injury, or poisoning occur?" With information on the month and year in which both the injury and the interview took place, the time interval between the two events can be calculated.

The timing item was added to the CHS instrument only for the last two quarters of the annual sample (i.e., for those interviews occurring between July and December 1988). The respondents interviewed in July 1988 (B) reported recall of injuries occurring in the preceding 12 months, or from July 1987 (E) through July 1988 (G). Similarly, those interviewed in late December 1988 (C)

reported injuries occurring from January 1988 (F) through December 1988 (H). Thus, these data reflect seasonality over a 1.5-year period (from E through H). The present study is based on timing information available for the latter two quarters of the sample. The NHIS sampling technique ensures that the two quarters of available data provide a nationally representative sample.

Calculation of Recall Intervals

The smallest time unit for which timing of the interview and timing of the injury exists is a 1-month period. Therefore, recall time intervals are calculated by subtracting the calendar month of the injury from the interview month. The timing of an interview or the injury event was assumed to be the midpoint of the month in the reporting month. On the basis of this assumption, each calculated interval actually covers a potential recall period of 2 full months.

To illustrate, say an interview that took place in May 1988 reported an injury occurring in April 1988. In this case, the recall interval is calculated as 1 month. However, the sample might include an injury event occurring on April 30 and an interview on May 1, the following day, and a second injury event on April 1 reported from an interview on the last day of May. Despite the fact that the actual time gap between the injury and the interview was only 1 day in the first case and almost 2 months in the second case, both cases represent a 1-month recall period.

The recall period time interval scale involves 12 scores—a score of 1 represents a recall period of 1 day to 2 months, a 2 represents a period of 1 to 3 months, and so on up to a score of 12, which represents a recall period of 11 to 13 months prior to the interview. From a mathematical point of view, this method of calculation creates a smoothing effect between the time-interval scores by virtue of the 1-month overlap between intervals that minimizes random fluctuations occurring between months of interview.

Injuries reported during the calendar month in which the interview took place resulted in a score of 0 months elapsed between the month of the injury and the month of the interview. This interval is incompatible with the other 12 timing categories. First, it covers half the time range covered by other recall intervals (a mean period of only 2 weeks), and second, it results in a range that includes a 12.5-month period. This problem is resolved by adding the injuries with a timing duration of 0 to those reported in the first month. Assuming that both the interviews and the injuries in the 0-month period occurred at the midpoint of the month, the combined 0- and 1-month period is 6 weeks. Therefore, the combined number of reported injuries was multiplied by the proportion of 1.5 months out of a year. Since all subsequent recall periods include the events from the 0-month category in their respective numerators, the multiplier was calculated as follows:

$$12/(j + 0.5),$$

where j = the months elapsed between the injury and the interview. This solution is frequently used in the calculation of life tables. Smith, for example, describes a life-table method in which events occurring in the same month as the interview are excluded from the life tables.[14]

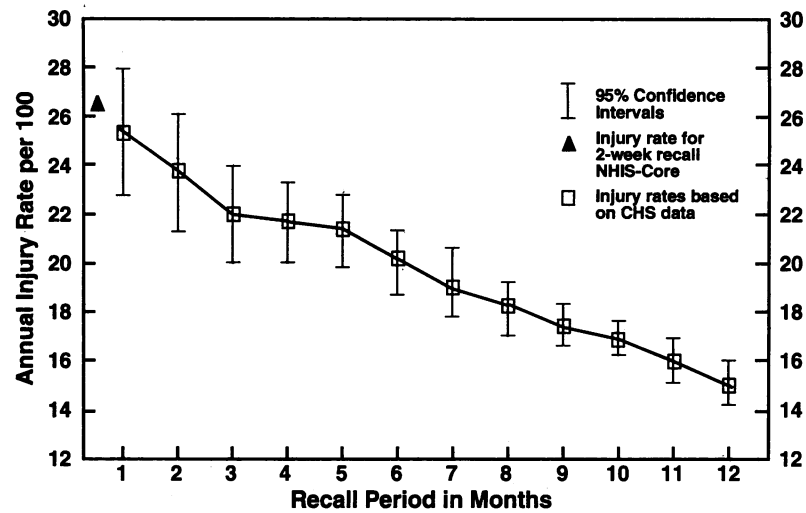

FIGURE 2—Estimated annual injury rates, by recall period, for all children 17 years of age and younger.

Calculating Estimates of Annual Injury Rates per Recall Interval

Weighted annual rates were calculated for recall periods ranging from 1 to 12 months in 1-month increments. Estimated annual injury rates based on a specific recall period are based on the weighted number of injuries reported for that period multiplied by the proportion of the year represented by that recall period and divided by the weighted total number of respondents in the subsample of interest. A constant of $K = 100$ was used to obtain estimated rates per 100 children in the population. Note that the recall periods are mutually inclusive so that a 2-month period, for example, includes the 1-month period. Identical calculations were repeated for different age and sex groups and for different types of injuries. All calculations were carried out using appropriate personal weights. SESUDAAN linear regression methodology was used to calculate 95% confidence intervals for each estimated rate.[15] Approximately 9% of injuries had missing data codes on the timing of the event and thus were not included in the calculation of the numerators for the recall period–specific rates. To maintain the most accurate representation of rates, the data were adjusted for missing data by adding the relative proportion of the injuries with missing data on timing to each recall period–specific rate.

Results

A total of 2854 injuries occurred during the entire survey year. Complete data on 2773 injuries resulted in a total annual injury rate of 16.3 injury episodes per 100 children from 0 through 17 years of age. Of all children reported by their parents to have sustained injuries, 347 (14.9%) had more than one injury. All subsequent results presented here are based on the latter two quarters of the sample for which timing injury information was available.

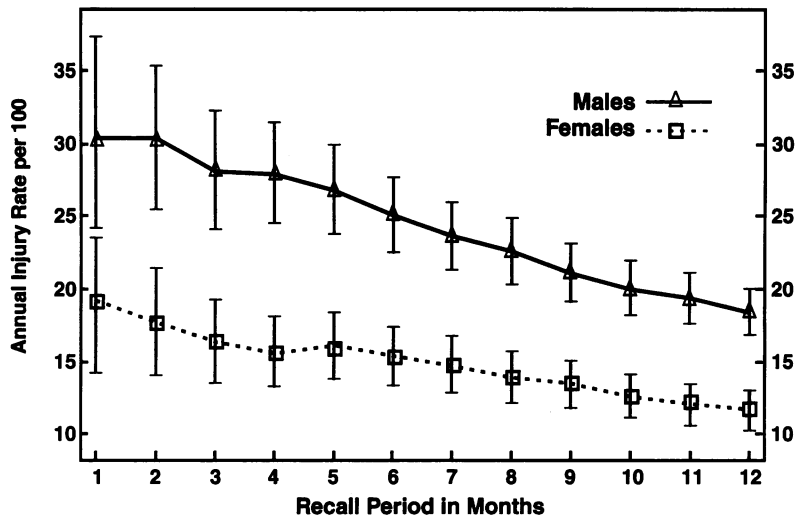

FIGURE 3—Sex-specific estimated annual injury rates, by recall period.

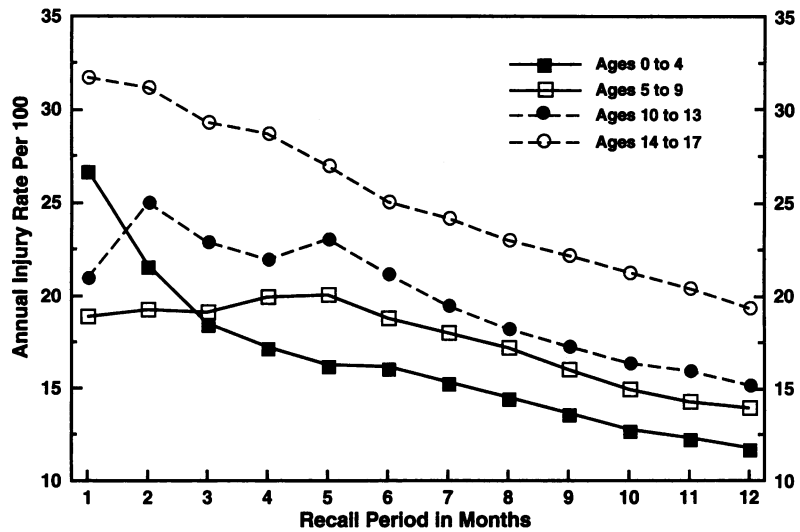

FIGURE 4—Age-specific estimated annual injury rates, by recall period.

Analyses of Recall Bias

Figure 2 shows weighted annual estimated injury rates for all 12 recall periods. These data show a substantial linear decline of the estimated annual rates, from 24.4 per 100 for a 1-month recall period to 14.7 per 100 for a 12-month recall period. The black triangle at top left of the figure represents the 26.4 per 100 injury rate based on a 2-week recall period that most closely approximates the inclusion criteria used in the CHS data (namely, injuries defined as acute conditions, onset during the past 2 weeks, first injury per injury episode, not an adverse effect of medical care, and no doctor visit more than 2 weeks ago). Rates calculated for longer recall periods are based on a larger number of observed injuries in the numerator compared with rates calculated for shorter recall periods. Thus, the confidence intervals are larger for short recall periods and smaller for longer recall periods.

These results demonstrate the critical importance of the length of the recall period in calculating an estimate of injury rates for children. According to these findings, the incidence of injuries among American children can vary from one injury in three children per year, based on a 2-week recall period, to one injury in seven children per year, based on a 12-month recall period.

The results in Figure 2 raise two questions: (1) What are the characteristics of the injuries that tend to be underreported as the recall period is increased? and (2) What are the characteristics of the injuries that tend to be remembered and reported even at 12 months? To answer these questions, we repeated the analyses for different sex and age groups and for injuries of different severity.

Differences in Recall Patterns by Sex

Figure 3 presents estimated annual injury rates per recall period interval by sex. The rates for boys are significantly higher than those for girls for all recall periods. Boys' rates show a sharper decline, from 30 per 100 for a 1-month recall period to about 18 per 100 for a 12-month recall period. A similar slope is shown for girls, whose rates decline from about 17.5 per 100 for a 1-month recall period to about 11 per 100 for a 12-month interval. In both cases, the amount of decline represents about 40% of the rate calculated for the 1-month recall interval.

Differences in Recall Patterns by Age Group

The data presented in Figure 4 show marked differences in recall decline among children in different age groups. Adolescents' rates decline from approximately 32 per 100 for a 1-month recall period to about 19 per 100 for a 12-month recall period. The slope of decline is stable across the 12-month period. The recall of injuries for children aged 5 through 9 and 10 through 13 years is stable for the first 5 months of the recall intervals. However, a remarkable finding is the sharp fall of estimated annual rates for children from 0 through 4 years of age, from a rate of about 27 per 100 for a 1-month recall period to a rate of about 16 per 100 for a 5-month recall period—a fall of over 70% of the decline for the total 12-month period.

Age-specific patterns of recall may differ for boys and girls. To investigate this possibility, we repeated the age-specific analyses for boys and girls separately. The results for age groups

younger than 13 years show similar slopes by sex, despite significant differences in the magnitude of the injury rates between the two sex groups. For adolescents aged 14 through 17 years, the recall of injuries among females appears to be stable across recall intervals, compared with the significant decline found among males. This difference is due, in part, to the difference in the magnitude of rates for adolescents by sex and to the larger number of injuries to be remembered or forgotten by mothers of adolescent boys compared with the smaller number of injuries sustained by girls. Yet the decline for adolescent boys remained sharp and linear across the 12-month period.

Differences in Recall by Type of Injury Severity Measure

Figure 5 presents estimated annual injury rates by recall intervals for three types of injury severity measures: (1) injuries resulting in surgery or hospitalization (i.e., severity based on medical treatment); (2) injuries resulting in at least 1 full bed day or 1 full school loss day (i.e., severity based on restriction of activity); and (3) injuries that did not result in any of the above consequences (i.e., minor injuries). Note that the first two severity types are not mutually exclusive; however, minor injuries are exclusive of the other two types.

As expected, minor rates decline linearly in magnitude, from 17.5 for a 1-month recall period to about 10 per 100 for a 12-month recall period. On the other hand, patterns are stable for both types of severity of injuries. Injuries that resulted in a doctor visit (not shown in Figure 5) show a slope very similar to that of minor injuries, indicating that reported doctor visits do not explain the variation in recall.

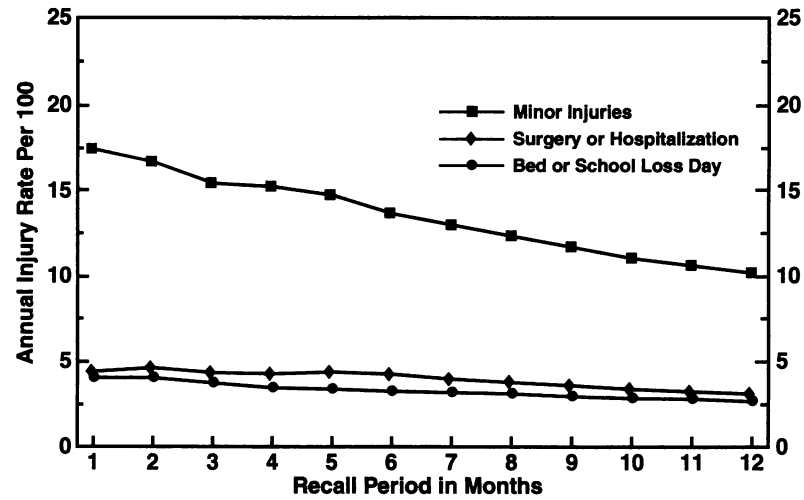

FIGURE 5—Estimated annual injury rates, by severity and recall period.

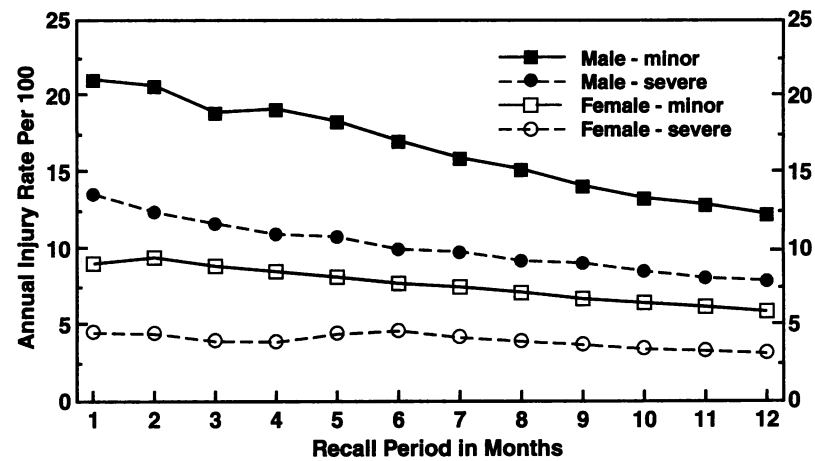

FIGURE 6—Sex-specific estimated annual injury rates, by severity and recall period.

Recall of Age- and Sex-Specific Injury Rates by Injury Severity

To investigate the possibility that the recall differences found for sex and age groups reflect severity differences in the pattern of injuries sustained, we examined sex- and age-specific injury rates for different measures of injury severity by recall periods. Based on the results presented in Figure 5, we constructed a dichotomous measure of injury severity. Injuries resulting in at least 1 bed day, 1 school loss day, surgery, or hospitalization were defined as severe injuries. All other injuries were defined as minor injuries. Figure 6 contrasts the results for minor and severe injuries. Minor injuries have a stronger decline in injury rates across the recall periods for both boys and girls. Minor injury rates for both sexes show similar slopes of decline across the recall periods. However, severe rates appear to be more stable across recall periods for girls than for boys.

Figure 7 shows that severe rates are more stable than minor rates across recall periods for all age groups. This is true in particular for school-aged children between the ages of 5 and 13 years (Figures 7b and 7c). A sharp decline in both minor and severe rates across the first 3 months of recall intervals is found among preschool children. For children from 5 through 9 years of age, a decline in minor injury rates begins only after the 6th month of recall. Minor and severe rates for adolescents decline across recall intervals, although the decline of minor injuries appears to be stronger.

Discussion and Recommendations

The findings presented above suggest that varying recall periods used for calculating national estimates of annual injury rates can be expected to have profound effects on both the magnitude

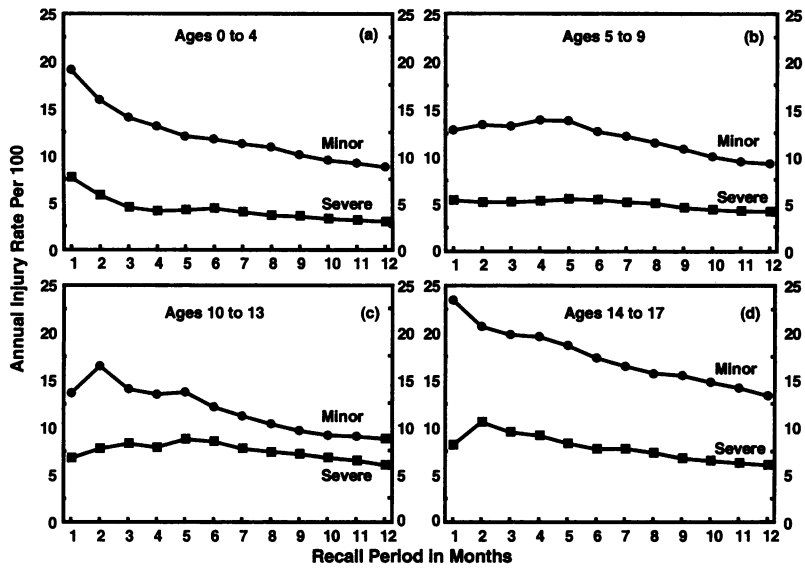

FIGURE 7—Age-specific estimated annual injury rates, by severity and recall period.

and composition of injury estimates. The findings also suggest that recall bias, in varying degrees, is present for all subpopulations, regardless of injury severity, although the effects of recall bias are significantly lower for severe injuries. It is probable that the decline in injury rates across recall periods observed in this study is a function of (1) loss of memory and (2) the "telescoping" tendency to report injury events as if they occurred in more recent calendar months than they actually did. The fall from 26.4 per 100 for a 2-week recall period to 24.4 per 100 for a 1-month recall period suggests that telescoping may be causing overestimation of injury rates by using such a small recall period as 2 weeks. The tendency to recall past events as if they occurred closer to today may cause some respondents to report an event occurring 15 or 16 days ago as if it occurred in the 14 days prior to interview. Reporting error of this type is magnified by a factor of 26 when calculating an annual rate based on a 2-week period. A similar telescoping error results for a 1-month recall period with half the magnitude of bias. Unfortunately, there is no way to test the telescoping hypothesis with the NHIS CHS data alone.

According to the results for all injuries, the incidence of medically attended injuries among American children can vary from a high of one injury in three children per year, based on a 2-week recall period, to a low of one injury in seven children per year, based on a 12-month recall period. By any public health standard, such differences are unacceptable when rates are used to determine priorities in allocating resources for preventive interventions. From an empirical research point of view, such differences imply that results cannot be compared across studies using different recall periods without a clear understanding of the factors affecting the differences in rates.

Sex and Age Differences

Many critical policy decisions are made on the basis of age-specific differences in injury rates. The American Academy of Pediatrics guidelines for well-child supervision,[16] for example, place more emphasis on injury prevention for preschool children than on prevention for older children and adolescents. A recent review of one series of federally funded research projects investigating the patterns and determinants of childhood injuries suggests that nearly 50% of the projects focus on preschool children, compared with only 7% devoted to adolescent injuries.[17] A reason for the emphasis on younger children is suggested from the findings shown in Figure 4. A report based on a 1-month recall period would conclude that children newborn through 4 years experience a relatively high injury rate, second only to the rates of adolescents aged 14 through 17 years. On the other hand, a report basing its findings on a 12-month recall period would conclude that children newborn through 4 years have lower injury rates than children of all other ages.

Severity of Injury

It is assumed that the reporting of severe injuries is less likely to be affected by increased recall periods than is the recall of minor injuries, and that different measures of injury severity will result in different patterns of injury recall, especially when the mother is the source of information. From analyses provided in this report, injuries with serious effects on daily life—for example, loss of school days, surgery, and hospitalization—are less susceptible to memory decay than minor injuries. Consequently, injury patterns emerging from short recall periods have a higher proportion of *minor* injuries than do injury patterns based on longer recall periods.

Recall Bias Issues Not Covered by This Study

The recall bias issues described in this report are applicable only to proxy information obtained from sampled children's parents. It is likely that similar declines in estimated annual injury rates might be found for rates based on responses obtained from the sampled children themselves. However, children, especially adolescents, may or may not recall injuries for reasons different from those of their parents. It is strongly recommended that a similar recall bias analysis be conducted on national data on adolescent injuries based on self-reports. A comparison of recall patterns from such an analysis with those presented above might provide further insight into the different recall forces that affect parents and children.

Implications for Analysis and Interpretation of National Survey Data on Childhood Injuries

The results of this study will help guide the analysis and interpretation of results using information from population-based surveys. In most cases, questions about injuries use one recall period (usually a 12-month period) as a basis for information. Findings based on such data may be influenced by recall bias and should be interpreted accordingly. To

account for recall effects, analyses should be repeated for minor and severe injuries. It is also recommended that researchers conduct sex-specific analyses by the four age categories presented in this paper: preschool children (0 through 4 years), elementary school aged children (5 through 9 years), middle school aged or pubescent children (10 through 13 years), and adolescents (14 through 17 years).*

Implications for the Design of Future Survey Questionnaires

National surveys are a critical source of information for monitoring and studying trends in injuries in childhood and adolescence. The need to include as many injuries as possible in such databases will result in the adoption of a 12-month rather than a 2-week or 1-month recall period. For this reason, it is strongly recommended that retrospective information gathered include the exact time (the date or at least the calendar month) when each reported injury took place. From this timing information an assessment of the magnitude and composition of recall bias can be made as a first step in analyzing the data. Such a procedure will provide more reliable and accurate information, which is essential for developing national intervention priorities. □

*See National Auxiliary Publication Service (NAPS) document 05094 for 5 pages of appendix material (adjustment tables for estimating annual medically attended childhood injury rates). Please order directly from NAPS c/o Microfiche Publications, PO Box 3513, Grand Central Station, New York, NY 10163-3513. Enclose with your order $7.75 for paper copy or $4.00 for microfiche (US funds only, from a US bank). For orders from outside the United States and Canada, add postage of $4.50 for paper copy or $1.50 for microfiche. There is a $15.00 invoicing charge for all orders filled before payment.

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