OPTIMUM RECALL PERIODS FOR ESTIMATING ACCIDENTAL INJURIES IN THE NATIONAL HEALTH INTERVIEW SURVEY

James T. Massey and Joe Fred Gonzalez, Jr., National Center for Health Statistics

Introduction

In 1975 the Health Interview Survey (HIS) in collaboration with the Consumer Product Safety Commission added an accident supplement to the HIS questionnaire in order to collect more detailed information about accidental injuries.

The HIS estimates are based on information collected in a nationwide sample of about 120,000 persons in 40,000 interviewed households. The sampling plan of the survey follows a multi-stage probability design which permits a continuous sampling of the civilian, non-institutionalized population of the United States. A detailed description of the HIS sample design can be found in (1). For acute conditions (includes accidental injuries) HIS usually uses a two-week recall period. The magnitude of the variances using a two-week recall period, however, limits the amount of detail that can be published.

Because of the detailed information desired for accidental injuries, it was decided that a longer recall period should be used if at all possible. Although it has been shown in previous recall studies (2-4) that large memory biases result when long recall periods are used, a six-month recall period was adopted with the stipulation that an analysis would be performed after the data were collected to determine the optimum recall period(s) to use for the final analysis. An accident or injury is counted in the HIS if it was medically attended or activity restricting for as much as a day. This paper will discuss the methodology and results used to determine the optimum recall period(s) for accidental injury data in the HIS.

Methods and Procedures

Annual estimates of accidental injuries based on recall periods of 1, 2, 4, 8, 13, 16, 20, and 26 weeks were computed. For each different recall period, annual estimates were obtained by inflating the number of accidents and injuries reported in the sample by the reciprocal of the respondent's probability of selection into the national HIS sample and by the ratio of a year (52 weeks) to the length of the recall period. The basic HIS estimator that was used contains several other adjustments and is described in (5).

A mean square error (MSE) criterion was selected to compare the annual estimates of accidental injuries for 5 of the 8 recall periods. The mean square error of an estimate X is defined as

$$\text{MSE}(X) = \text{VAR}(X) + [\text{BIAS}(X)]^2.$$

The variance component of the MSE(X) was estimated for each recall period using the balanced half-sample replication technique developed by McCarthy (6). The bias for a given recall period is given by $E(X)-\mu$, where μ is the "true" annual number of accidents or injuries for the total population and $E(X)$ is the expected number of accidents or injuries that will be reported for a given recall period.

The estimator used by NCHS is nearly unbiased conceptually and the bias estimated above is a memory or under-reporting bias. In general, one would expect the recall bias to increase as the length of the recall period increases while the variance decreases for lengthening recall periods since the longer recall periods provide a larger sample of accidents. The optimum recall period is the reference period which yields the smallest mean square error. The optimum recall period may not be the same for all statistics, but hopefully a period can be chosen which is optimum or nearly optimum for all accident and injury statistics.

In most studies of mean square errors an independent assessment is made to determine the value of the parameter μ (i.e., record check studies). Since the only available data for our study were sample data, the value of μ had to be either approximated or assumed. The sample results were also used to estimate $E(X)$. This was accomplished for each statistic by plotting the estimated annual number of accidents and injuries associated with each recall period and fitting a model to the data. The following three models were tested (models 1 and 3 were suggested by Simmons (3)).

Model 1. $y = ae^{-bx^2+\varepsilon}$

Model 2. $y = ae^{-bx+\varepsilon}$

Model 3. $y = a+bx+cx^2+\varepsilon$

Since independent estimates of the variance for each of the statistics were available, the first two models were compared using both weighted and unweighted data. Although the estimates for each of the recall periods for a given statistic are clearly not independent, the covariances were not approximated for the variance-covariance matrix in the evaluation of the models.

The goodness of fit (GOF) criterion used to evaluate the models is given by

$$\text{GOF Index} = \sum_{i=1}^{n} \frac{(Y_i-\hat{Y}_i)^2}{\hat{\sigma}_i^2}$$

where

n = number of recall periods
Y_i = observed value for i^{th} recall period
$\hat{Y}_i$ = predicted value for i^{th} recall period
$\hat{\sigma}_i^2$ = estimated sampling variance of Y_i.

The method of least squares was used to estimate the coefficients for each of the models and the number of observations n was either 5 or 6, since variances were not computed for all 8 recall periods. Even though the observations for a given accident statistic are not independent and the distribution of the GOF Index is unknown, the index still provides a means of comparing the relative fit of the models. Once a satisfactory model had been obtained the predicted points along the curve were used to represent the expected number of accidents or injuries for the different recall periods. If one assumes that there is very little memory bias associated with recall periods of two weeks or less, any one of three points along the fitted curve can be used to approximate μ: the y-intercept, the one-week value, or the two-week value. Each of the values has a different appeal and the one-week value on the curve was arbitrarily chosen to represent the parameter μ. All of the biases were then obtained by subtracting the points along the fitted curve (for any recall period) from the one-week value. The use of one value as the parameter is an over-simplification since each recall period covers a slightly different accident population for the 1975 collection year. It is highly unlikely, however, that the parameter changes to any significant degree from one recall period to another and the use of a single value should not affect any of the conclusions. Thus, by squaring the bias and adding the variance, an estimated MSE was obtained. The MSE's were then divided by μ^2 to obtain a relative MSE for interpretive purposes.

Results

Annual estimates were computed for 23 types of accidents for the 8 different recall periods and for 5 types of injuries by age and recall periods. Estimates were also obtained for a number of subpopulations along with variances for 5 or 6 recall periods. For most of the statistics estimated an unexpected result occurred; the estimate based on a one-week recall period was smaller than the estimate based on a two-week recall period. Further investigation revealed several possible reasons for this unexpected behavior. The first and foremost involves the definition of an accident. Accidents are counted in the HIS survey only if they receive medical attention and/or cause some activity restriction for at least one day. It was discovered that all of the accidents that occurred during the reference period, but received medical attention or reduced activity after the reference period (usually during interview week), were not counted in the HIS tally. This problem is most severe for the weekend just prior to the interview week, which begins officially at midnight on Sunday. Thus, while the one-week estimate is affected the most, the estimates for the other recall periods are also affected. There is also apparently some "telescoping" into the standard HIS two-week reference period which tends to offset the bias just discussed. Here, telescoping refers to the situation where accidents that occur more than two weeks ago are reported as occurring in the two-week reference period. For most types of accidents the estimate based on a one-week recall period was approximately 5 percent less than the estimate based on a two-week recall period. Further research by NCHS is planned in this area.

Figure 1 shows the annual estimate of total persons injured as a percent of the estimate based on a one-week recall period by type of accident and recall period. Two conclusions can be immediately drawn from the curves shown in Figure 1. The first is the continuous underestimation of total persons injured as the recall period becomes longer. The estimate of total persons injured using a six-month (26 weeks) recall period is only about 60 percent of the estimate based on a one-week recall period. The second conclusion that can be drawn from Figure 1 is the relationship between memory bias and the type of accident--the more severe the type of accident, the smaller the memory bias. For example, the estimate of persons injured in motor vehicle accidents is 25 percent less for the six-month recall period than for the one-week recall period, while the drop-off for persons injured by one-time lifting or exertion is nearly 50 percent. The relationship between the severity of injury and memory bias can be seen even clearer by examining Figure 2. Figure 2 presents the annual estimate of injuries as a percent of the estimate based on a one-week recall

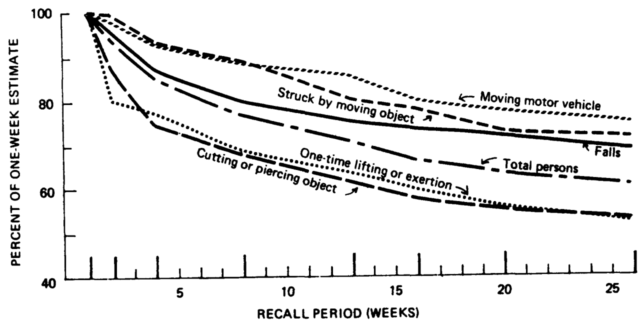

Figure 1. Annual Estimate of Total Persons Injured as a Percent of the Estimated Based on a One-Week Recall Period by Type of Accident and Recall Period.

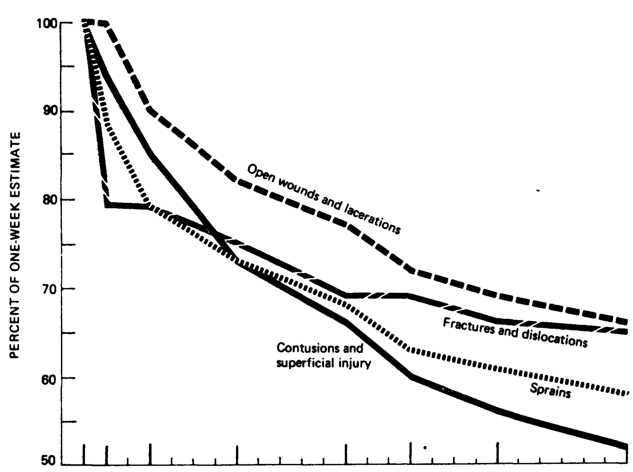

Figure 2. Annual Estimate of Injuries as a Percent of the Estimate Based on a One-Week Recall Period by Type of Injury and Recall Period.

period by type of injury and recall period. As the reference period extends to six months the estimate for open wounds and lacerations falls off by 25 percent, whereas the estimate for contusions and superficial injuries falls off by nearly 50 percent. Figure 2 also shows a significant drop in the estimates of injuries for the shorter recall periods. Figures 1 and 2 present a representative sample of the types of accidents and injuries studied.

Figure 3 is similar to Figure 2 except that curves are shown for age groups rather than types of injuries. The estimate of total number of injuries for persons under 6 using a six-month recall period was less than 50 percent of the estimate based on a one-week recall period. The age group with the next worst drop-off was the 6-16 year olds, while the age group with the smallest drop-off was the 17-24 year olds. A partial explanation seems to be the difference in the reporting of accidents and injuries by self-respondents versus the reporting by proxy respondents (in the HIS survey persons under 17 cannot respond for themselves). The 1974 HIS accident data seem to substantiate this finding by showing that the rate of injury for self-respondents is always greater than the rate of injury for proxy respondents, with the exception of the 65+ age group. One would also expect the fall-off curve for females to be less pronounced than the fall-off curve for males, since housewives often respond for their husbands. This, however, was not true for the accident data and no general conclusions can be drawn without further study.

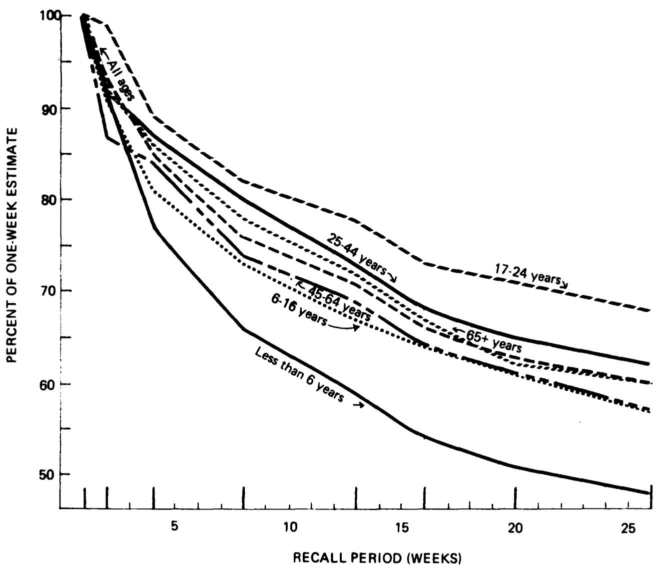

Figure 3. Annual Estimate of Injuries as a Percent of the Estimate Based on a One-Week Recall Period by Age and Recall Period.

The estimates shown in Figures 1-3 based on a one-week recall period are adjusted estimates (except for falls). As mentioned in the previous section, the estimate based on a one-week recall period was almost always less than the estimate based on a two-week recall period. The adjusted one-week estimates were obtained by approximating annual totals using the second week prior to the interview week rather than the first week prior to the interview week. The annual estimate based on a two-week recall period was doubled and then the estimate based on a one-week recall period was subtracted from it. The three models given in the previous section were tested for some 15 selected decay curves and the results are shown in Table 1. Although no one model was best for all 15 curves, the polynomial model $y=a+bx+cx^2$ provided a good fit for most of the curves and was chosen to estimate E(X) for each recall period and to generate the one-week value for μ.

Table 1. Comparison of Goodness of Fit Index for Accidental Injury Models

Type of Accident or Injury	Model: $Y=ae^{-bx^2}$ (Weighted)	$Y=ae^{-bx}$ (Weighted)	$Y=ae^{-bx}$ (Unweighted)	$Y=a+bx+cx^2$ (Unweighted)
Total Accidents, All ages	102.29	29.49	33.85	12.84
Ages 45-54	11.66	2.86	2.88	2.14
75+ Females	1.42	.35	.35	.47
Unemployed	.87	1.43	1.49	.95
Ages 25-34, $3000-$5000 Income	.90	.64	.79	.72
Moving Motor Vehicle	3.49	.86	.95	.79
Cutting or Piercing Instrument	18.89	6.58	7.35	2.51
Falls	8.11	2.89	3.81	1.69
Struck by Moving Object	4.14	.94	1.05	.48
Lifting or Exertion	7.42	1.24	1.48	1.51
Total Injuries	NC*	15.39	NC	15.63
Fractures and Dislocations	NC	1.19	NC	.90
Sprains	NC	3.79	NC	4.76
Lacerations	NC	3.86	NC	4.38
Contusions and Superficial Injuries	NC	5.86	NC	7.38

*Not computed

The results of the MSE analysis are shown in Tables 2 and 3 for selected types of accidents and injuries, respectively. The estimate of the number of persons injured or the number of injuries are shown for 5 recall periods along with the relative squared bias, the relative variance and the relative mean square error. The relative squared bias and relative variance components are additive and can be compared to one another to assess their contribution to the relative MSE. For the eleven types of accidents and injuries shown, the 2-week recall period was optimum (smallest relative MSE) in 7 of the 11 cases and the 4-week recall period was optimum for the remaining cases. Similar analysis for certain subdomains of the population was conducted and the results indicated that either the 2 or 4-week recall period was optimum in almost all cases. In general, the relative bias remained about the same for the subdomains while the relative variance increased. Thus, as the subdomain becomes smaller the more likely a longer recall period will become optimum. The squared bias for recall periods longer than 4 weeks was so large relative to the variance, however, that the optimum recall period was longer than 4 weeks in only one case.

Conclusions

The major conclusion drawn from this analysis is that the optimum recall period for collecting and analyzing accidental injury data is either a 2-week or 4-week period depending on the detail of the analysis. The memory bias for longer recall periods is quite large and totally unacceptable by NCHS standards. The study revealed several possible biases associated with the standard 2-week recall period used by HIS and additional research is planned. This study does provide additional evidence, however, that the 2-week reference

Table 2. Components of the Relative Mean Square Error of the Annual Number of Persons Injured by Type of Accident and Recall Period

Type of Accident	Recall Period				
	2 weeks	4 weeks	8 weeks	13 weeks	26 weeks
TOTAL ACCIDENTS					
Estimate (in thousands)	67,812	61,199	55,161	50,716	43,129
Rel-Bias^2 (%)	.086	.707	3.160	7.043	11.541
Rel-Var (%)	.086	.036	.019	.013	.006
Rel-MSE (%)	.172	.743	3.179	7.056	11.547
MOVING MOTOR VEHICLE					
Estimate (in thousands)	4,859	4,604	4,381	4,232	3,709
Rel-Bias^2 (%)	.023	.191	.897	2.153	4.894
Rel-Var (%)	.966	.392	.303	.156	.056
Rel-MSE (%)	.989	.583	1.200	2.309	4.950
CUTTING OR PIERCING INSTRUMENT					
Estimate (in thousands)	5,585	4,748	4,329	3,910	3,364
Rel-Bias^2 (%)	.119	.971	4.268	9.243	13.094
Rel-Var (%)	.980	.395	.180	.091	.049
Rel-MSE (%)	1.099	1.366	4.448	9.334	13.143
FALLS					
Estimate (in thousands)	4,919	4,434	4,059	3,822	3,468
Rel-Bias^2 (%)	.064	.520	2.289	4.971	7.135
Rel-Var (%)	1.339	.345	.176	.109	.051
Rel-MSE (%)	1.403	.865	2.465	5.080	7.186
STRUCK BY MOVING OBJECT					
Estimate (in thousands)	4,204	3,909	3,744	3,381	2,987
Rel-Bias^2 (%)	.042	.351	1.614	3.753	7.470
Rel-Var (%)	1.410	.646	.335	.175	.092
Rel-MSE (%)	1.452	.997	1.949	3.928	7.562
LIFTING OR EXERTION					
Estimate (in thousands)	5,444	5,245	4,638	4,327	3,534
Rel-Bias^2 (%)	.057	.480	2.236	5.300	11.438
Rel-Var (%)	.822	.413	.177	.115	.044
Rel-MSE (%)	.879	.893	2.413	5.415	11.482

Table 3. Components of the Relative Mean Square Error of the Annual Estimate of Injuries by Type of Injury and Recall Period

Type of Injury	Recall Period				
	2 Weeks	4 Weeks	8 Weeks	13 Weeks	26 Weeks
TOTAL INJURIES					
Estimate (in thousands)	71,844	65,418	59,219	54,544	46,481
Rel-Bias^2 (%)	.080	.667	3.091	7.286	15.359
Rel-Var (%)	.084	.034	.019	.013	.006
Rel-MSE (%)	.164	.701	3.110	7.299	15.365
FRACTURES AND DISLOCATIONS					
Estimate (in thousands)	7,130	7,133	6,750	6,264	5,884
Rel-Bias^2 (%)	.020	.167	.794	1.946	4.804
Rel-Var (%)	.703	.281	.136	.097	.043
Rel-MSE (%)	.723	.448	.930	2.043	4.847
SPRAINS					
Estimate (in thousands)	16,482	14,820	13,661	12,672	10,847
Rel-Bias^2 (%)	.071	.596	2.770	6.550	14.001
Rel-Var (%)	.363	.112	.058	.045	.021
Rel-MSE (%)	.434	.708	2.828	6.595	14.022
LACERATIONS					
Estimate (in thousands)	19,606	17,673	16,181	15,157	12,992
Rel-Bias^2 (%)	.071	.591	2.740	6.460	13.603
Rel-Var (%)	.338	.150	.070	.044	.022
Rel-MSE (%)	.409	.741	2.810	6.504	13.625
CONTUSIONS AND SUPERFICIAL INJURIES					
Estimate (in thousands)	13,659	12,393	10,657	9,634	7,635
Rel-Bias^2 (%)	.122	1.020	4.746	11.238	24.146
Rel-Var (%)	.368	.163	.066	.037	.020
Rel-MSE (%)	.490	1.183	4.812	11.275	24.166

period used to collect information on acute conditions in the HIS survey is close to optimum. A final check that was made to help determine the validity of the results obtained in this study was a comparison of the MSE's for motor vehicle accidents with the MSE's obtained in a previous NCHS study (4). The comparisons were quite favorable for all comparable recall periods.

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