Years of Potential Life Lost Among a Native American Population

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Synopsis

The determination of years of potential life lost (YPLL) can aid in monitoring changes in premature mortality among various population groups. While premature mortality has been shown to differ among blacks and whites, patterns of YPLL have not been well established among other racial groups.

The Seneca Nation of Indians (SNI) is a Native American group residing primarily in western New York State (NYS). A review of SNI necrology records revealed that 55 percent (510 of 924) of the deaths between 1955 and 1984 occurred before 65 years of age. The proportion of premature deaths among males exceeded the proportion in females. SNI males demonstrated an increased risk of premature death (odds ratio = 1.43) relative to SNI females. Both the percentage of premature deaths and the number of YPLL per death were greater among SNI members compared with NYS residents. Almost one-half of all YPLL among the SNI were attributable to accidents and injuries. Heart disease, digestive diseases, and malignant neoplasms also represented important contributors to YPLL for both SNI males and females.

This investigation identifies important causes of premature death among a Native American population and underscores the preventable nature of premature loss of life.

THE CALCULATION OF YEARS of potential life lost (YPLL) can be a useful index for determining the relative importance of various causes of premature death among population groups (*1,2*). Analyses of YPLL can assist in prioritizing the allocation of public health resources, monitoring temporal shifts in premature mortality, and evaluating the effectiveness of intervention programs (*3*). Studies of premature mortality can also aid in assessing the impact of mortality among persons in younger age groups.

Premature mortality has been shown to differ among racial groups in the United States. Blacks have an increased risk of premature mortality relative to whites, with males of both races accounting for a majority of years of potential life lost (*3*). Leading causes of premature death (by ranking) have generally been accidents and injuries, malignant neoplasms, and heart disease (*1–6*).

Previous investigations have not adequately described premature mortality among racial groups other than whites and blacks (*7*). Whites represent the largest subgroup among the general population; therefore reports from previous studies of premature mortality in the overall United States population are most generalizable to this group. The relative ranking of specific causes of premature mortality in racial groups other than whites remains unknown. We have identified one report which compared YPLL among whites, blacks, and Native Americans; however, that report presented only YPLL due to alcohol-associated causes of premature death during 1980 (*7*). This investigation will report YPLL among the Seneca Nation of Indians (SNI) between 1955 and 1984. Leading causes of premature mortality among this Native American group will be compared with those reported in other populations.

Table 1. Percentage of premature deaths [1] and average YPLL [2] in the Seneca Nation of Indians (SNI) compared with New York State (NYS), by sex and time period

Time period	Males		Females	
	SNI	NYS	SNI	NYS
1955–64				
Number of deaths	167	...	121	...
Percent premature	62.3	36.6	60.3	25.2
Average YPLL	26.3	15.4	22.4	15.9
1965–74				
Number of deaths	161	...	115	...
Percent premature	57.8	37.7	47.8	25.5
Average YPLL	20.6	15.4	16.5	15.6
1975–84				
Number of deaths	211	...	149	...
Percent premature	56.9	33.8	43.6	21.0
Average YPLL	19.9	15.5	17.5	14.1

[1] Deaths between ages 1 and 65. [2] Years of potential life lost.

Methods

Study population. Members of the Seneca Nation of Indians reside primarily in western New York State (NYS). The Nation maintains annual roll books containing demographic information for all tribal members. Since more than 90 percent of SNI enrollees reside within NYS, this investigation included only deaths among SNI members who were identified as NYS residents.

A review of annual necrology listings and annuity roll books maintained by the Nation identified 1,045 SNI members as having died in NYS between 1955 and 1984. Death certificates were obtained for 937 persons (89.7 percent). Vital records were reviewed to obtain information on age at death, sex, year of death, and underlying cause of death. To maintain comparability over time, cause of death listed on death certificates was transmuted to the ninth revision of the International Classification of Diseases (*8*). Mortality data for both New York State and the Seneca Nation were transmuted using the same method.

Calculation of YPLL. Years of potential life lost were calculated using life expectancy remaining at the predetermined age limit of 65 years (*1,6*). Only deaths occurring after 1 year of age and before age 65 were considered. This cutoff age of 65 years was selected as a conservative estimate of potential years of life lost among the SNI based on observations of increased premature mortality among groups other than whites (*3,9*). While life expectancy tables for Native Americans are available from the Indian Health Service (IHS), use of the life table method would have resulted in little difference in the cause-specific distribution of YPLL. Moreover, the use of age 65, rather than remaining life expectancy, as an end point in the calculation of YPLL is widely reported by both the IHS and the Centers for Disease Control.

The method of calculation used in this investigation expressed the number of YPLL for an individual dying at age X as being equal to $[65-(X+0.5)]$. (Note that a slight adjustment is made for deaths occurring at different times during each calendar year.) Both neonatal and infant deaths were excluded from this analysis since deaths under 1 year of age are generally attributable to specific causes not characteristic of deaths at later ages (*1*). Further, the inclusion of any deaths under 1 year in this type of analysis is thought to overestimate the impact of the death, since it would account for twice as many YPLL when compared to a death occurring at age 35, particularly within categories with a small number of premature deaths.

To evaluate any temporal shifts in patterns of premature mortality over time, the 30-year study period was subdivided into three 10-year periods (1955–64, 1965–74, 1975–84). Sex- and cause-specific YPLL were added up for each of the three periods to obtain period-specific totals of YPLL. NYS mortality data were obtained from annual summaries of age- and sex-specific mortality among NYS residents (exclusive of New York City) for the years 1960, 1970, and 1980. These 3 years represent the mid-points of each of the three 10-year periods and are thought to reflect mortality patterns during each period while allowing the analyses to be simplified.

Mortality data for NYS did not include data from the New York City area since inhabitants of New York City are demographically distinct from the rest of the State, partly because of the high level of urbanization. (In this paper, all references to NYS exclude the New York City area.)

Since these mortality tables reported data in 5-year age intervals, it was necessary to select the midpoint of each age interval when calculating estimates of YPLL among NYS residents. The midpoint of the age interval was subtracted from 65 with the resultant value multiplied by the number of persons who had expired within a particular age interval. Interval-specific YPLL were summed up across all age categories to obtain sex- and period-specific estimates of YPLL among NYS residents. These estimates of YPLL among NYS

Table 2. Percentage distribution of YPLL [1] among the Seneca Nation of Indians for selected causes of death, for three periods

Cause [2]	1955–64		1965–74		1975–84		1955–84	
	Number of deaths	Percent of YPLL	Number of deaths	Percent of YPLL	Number of deaths	Percent of YPLL	Number of deaths	Percent of YPLL
Accidents and injuries (800–899)	60	48.2	48	51	56	51.8	164	50.1
Circulatory (390–459)	43	11.7	37	17.6	46	16.3	126	14.8
Digestive (520–579)	16	9.3	19	9.7	19	6.1	54	8.3
Malignant neoplasms (140–208)	14	7.8	18	7.5	29	7.0	61	7.5
Respiratory (460–519)	7	5.9	5	3.2	6	5.6	18	5.1
Endocrine and blood (240–289)	14	6.4	10	3.8	11	3.9	35	4.9
All other ICD codes [3]	23	10.7	11	7.2	18	9.3	52	9.3
Totals	177	100.0	148	100.0	185	100.0	510	100.0

[1] Years of potential life lost.
[2] International Classification of Diseases, ninth revision; for males and females combined.
[3] 001–139, 209–239, 290–389, and 580–799.

Table 3. Average YPLL [1] per event for selected causes of mortality among the Seneca Nation of Indians, by sex and time period

Cause [2]	Males						Females					
	1955–64		1965–74		1975–84		1955–64		1965–74		1975–84	
	Number of deaths	Average YPLL	Number of deaths	Average YPLL	Number of deaths	Average YPLL	Number of deaths	Average YPLL	Number of deaths	Average YPLL	Number of deaths	Average YPLL
Malignant neoplasms (140–208)	6	34.8	10	9.7	13	7.2	8	16.5	8	14.3	16	9.7
Endocrine and blood (240–289)	6	24.3	6	12.5	7	14.8	8	16.6	4	7.8	4	8.8
Circulatory (390–459)	27	10.5	22	14.7	31	13.8	16	14.3	15	11.4	15	10.0
Digestive (520–579)	8	31.6	11	17.6	12	11.5	8	19.0	8	10.1	7	10.8
Accidents and injuries (800–999)	46	34.2	34	29.0	38	31.8	14	38.0	14	32.5	18	34.5
All other ICD codes [3]	104	26.3	93	20.6	120	19.9	73	22.4	55	16.5	65	17.5

[1] Years of potential life lost.
[2] International Classification of Diseases, ninth revision.
[3] 001–139, 209–239, 290–389, 460–519, and 580–799.

residents were compared with YPLL among SNI members.

Statistical considerations. Risk of premature death among SNI males and females was calculated for each 10-year period and expressed as an odds ratio. Chi-square tests for trend were performed to assess temporal shifts in premature mortality among both SNI males and females. A Mantel-Haenszel chi-square test was used to test for sex differences in premature mortality while controlling for time (*10*). Ninety-five percent confidence intervals (CI) are provided for each risk estimate.

Results

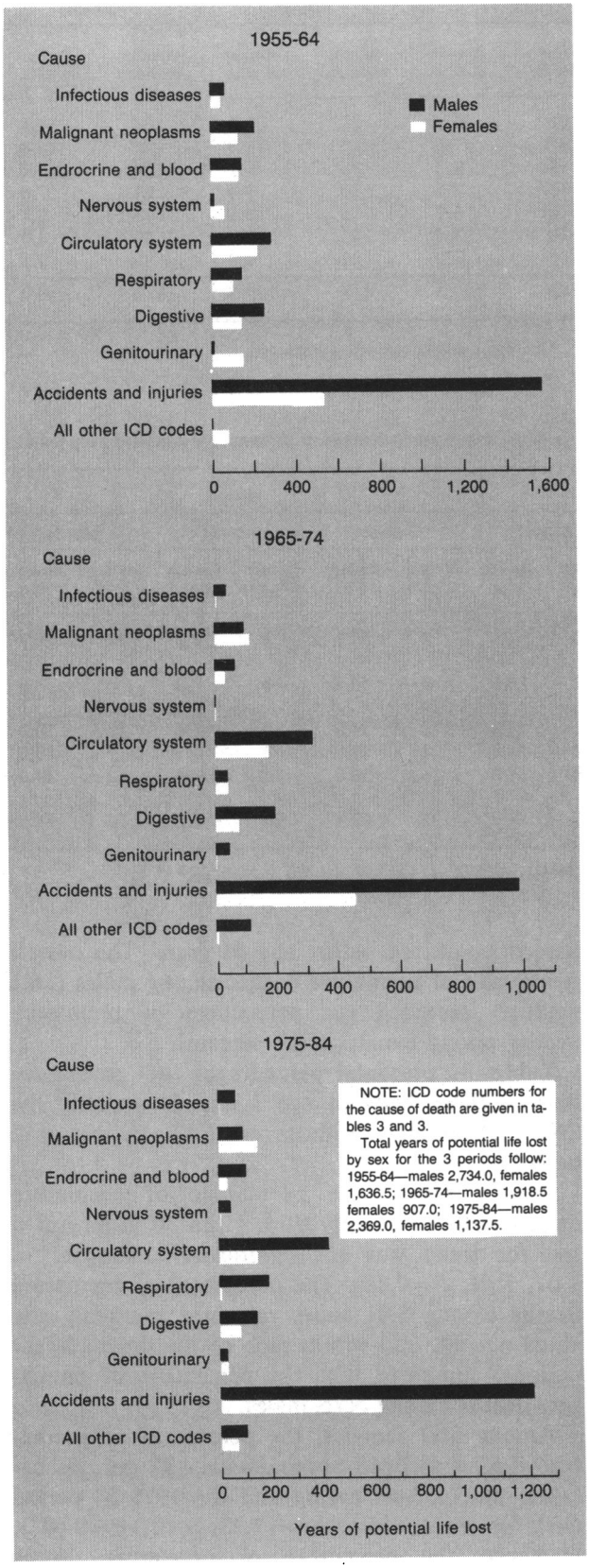
Death certificates were obtained for 924 members of the SNI who died between 1955 and 1984. (This total excludes the deaths of 13 infants of less than 1 year that occurred during the period of study.) During the entire 30-year period, 510 deaths (55.2 percent) occurred before age 65 years. The overall percentage of premature deaths among males (58.8 percent) exceeded the percentage of premature deaths among females (50.1 percent).

Table 1 presents percentages of premature deaths—those between age 1 and 65—among the SNI and among residents of NYS by sex and period.

Among males, the percentage of premature deaths declined slightly during the 30 years but a test for trend was not significant (chi-square = 1.07, 1 df, $P=0.30$). The percentage of premature deaths among SNI males remained markedly elevated overall, and within each of the three 10-year periods, compared with the percentage of premature deaths among NYS males.

Among SNI females, the percentage of premature deaths declined approximately 27 percent between the 1955-64 period and the 1975-84 period (test for trend, chi-square = 7.23, 1 df, $P=0.007$). However, the percentage of premature deaths

Figure 1. Years of potential life lost before age 65 among the Seneca Nation of Indians, by sex



among SNI females remained almost twice that of females in NYS during the period of study.

There were no significant differences in premature mortality between Seneca Nation males and females during either of the two earlier periods. While a greater proportion of deaths of males did occur during each period, odds ratios were not statistically significant, probably due to small numbers in some cells. During the most recent period (1975–84), however, SNI males demonstrated an increased risk of premature mortality relative to SNI females (odds ratio = 1.70, 95 percent CI (1.09–2.66)). A Mantel-Haenszel test for sex differences in premature mortality was performed, controlling for time. Results indicated an overall increased risk of death prior to age 65 for SNI males (odds ratio = 1.43 (1.09–1.87)).

Table 1 also presents the average number of YPLL for all causes of premature death among the SNI and among NYS residents for each of the three periods.

During all periods and for both males and females, the average number of years of potential life lost per premature death was greater among SNI members compared with NYS residents. SNI males demonstrated an additional 10 years of YPLL per premature death compared to NYS males during the 1955–64 period. This decreased to slightly more than a 4-year difference between SNI and NYS males for average YPLL during the 1975–84 period.

SNI females exhibited an average of 6 1/2 additional potential years of life lost per premature death compared to NYS females in the earliest decade, 1955–64. However, differences in the number of YPLL per premature event between SNI and NYS females were less marked during each of the following periods.

Among SNI members, the average number of YPLL per premature death was higher among males in each of the three periods. While average YPLL for premature deaths among males and females in NYS showed no changes across time, the average number of YPLL per SNI premature death declined among both males and females.

Figure 1 presents the distribution of YPLL by sex and cause for the three periods. During all three, the largest proportion of YPLL among males and females was attributable to accidents and injuries. Other important contributors to YPLL included circulatory diseases, digestive diseases, and malignant neoplasms. There were no marked differences in patterns of YPLL between SNI males and females.

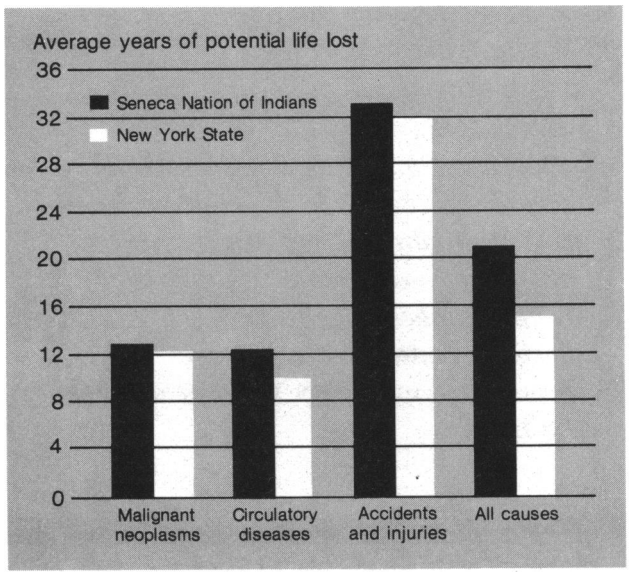
As shown in table 2, the proportion of YPLL due to accidents and injuries increased slightly (48.2 percent to 51.4 percent) between the 1955–64 and 1975–84 periods. The proportion of YPLL due to circulatory diseases also increased from 11.7 percent to 16.3 percent between these two periods. The proportion of YPLL due to digestive diseases decreased (9.3 percent to 6.1 percent), while the proportion of YPLL due to malignant neoplasms showed little change over time (7.8 percent to 7.0 percent).

The average number of YPLL among the SNI for selected causes of death was compared across each of the three time frames for both males and females to assess temporal shifts in age at death for specific causes of premature mortality. "Average" YPLL per death were obtained by dividing the sum of the cause-, sex-, and period-specific number of YPLL by the corresponding number of events which resulted in each subtotal. This process yields the average age at which premature events are occurring rather than the proportion of YPLL due to specific causes.

As shown in table 3, among both males and females, accidents and injuries continued to account for between 29 and 38 years of potential life lost per episode with little change observed over the 30-year period. The average number of YPLL per episode of fatal digestive and malignant disease appears to have declined among both males and females. A similar decline was noted for endocrine and blood-related causes of premature mortality in both males and females during the 30 years. The average number of YPLL per circulatory disease death increased slightly among males over the period of study, but among females the average number of YPLL per episode of fatal circulatory disease decreased slightly. It must be noted that the average YPLL among the SNI for several causes of death are based on a small number of observations and should be interpreted cautiously.

It was possible to compare average YPLL among the SNI with average YPLL in the NYS population for three common causes of death. The average number of YPLL among SNI members did not differ appreciably from that observed among NYS residents for premature deaths due to cancer, circulatory disease, and accidents or injuries (fig. 2). However, when all causes of death are considered, SNI members experience, on average, an additional 5.6 YPLL per premature death compared with NYS residents. This observation suggests that excess YPLL among the SNI is occurring from causes of death other than these three causes.

Figure 2. Average years of potential life lost before age 65 for selected causes of death, Seneca Nation of Indians and New York State, 1965-84



Discussion

Aggregate data from the Centers for Disease Control (CDC) indicate that the three leading causes of YPLL among both males and females in the United States during the early 1980s were accidents and injuries (30.2 percent), malignant neoplasms (15.3 percent), and heart disease (13.3 percent) (*3–6*). Together, these three categories represented 58.8 percent of premature deaths in the United States population. NYS mortality data for 1980 indicate that 80.5 percent of all YPLL were attributable to these three causes (accidents and injuries—35.4 percent, heart disease—22.9 percent, malignant disease—22.2 percent). During the 1975–84 period these three categories also represented the leading causes of YPLL among the SNI. The ranking and the percentage of deaths due to each cause, however, differed slightly, with 49.4 percent due to accidents and injuries, 16.3 percent due to circulatory diseases, and 7.0 percent due to malignant diseases. When combined, these three categories represented 75.1 percent of premature deaths among the SNI between 1975 and 1984.

The choice of 65 years as a cut-off for premature mortality may result in an increased likelihood of observing a large proportion of YPLL due to accidental causes. Almost half of all YPLL among both male and female SNI members during each of the three eras was attributed to accidental causes. Native American groups have been shown to be at increased risk of dying as the result of motor

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vehicle accidents and other accidental causes when compared with white, black, Hispanic, and Asian groups (*11–13*).

The number of YPLL per accidental event among the SNI does not seem to differ from that observed among NYS residents, suggesting that although there may be proportionately more premature accidental deaths among the SNI, these accidental deaths are occurring at ages similar to those observed in the NYS population. The rural locations of the SNI reservations may partially explain the increased risk of premature fatalities attributable to motor vehicles since it has been demonstrated that residents of rural areas are at increased risk of such events (*14*). Baker and coworkers (*14*) have suggested several determinants which may increase the risk of involvement in and mortality resulting from motor vehicle accidents, including the greater rate of speed on rural roadways, increased use of off-road or utility vehicles, deficient maintenance of rural roads, decreased seatbelt usage, and reduced or delayed access to trauma treatment centers.

We are unable to provide an explanation for the marked decline in the average number of YPLL per premature death among the SNI between the 1955–64 and 1965–74 periods. Such a rapid and dramatic decline is not likely to be explained simply by an aging of the population. Few social or environmental changes have been identified among the SNI that may help to explain this decline. Expansion of on-reservation health care services did not occur until the mid-1970s; consequently, we would have expected to have observed this drop during the last period. No changes in the average number of YPLL were noted among NYS residents during the study period.

A health survey conducted among the SNI has demonstrated a 26.5 percent prevalence of diabetes among tribal members (*15*). However, diabetes was not observed to be responsible for a large number of YPLL among the SNI. The broad categories of endocrine and blood diseases, which are composed primarily of diabetes deaths, represent less than 5 percent of the YPLL, suggesting that either diabetes is not a cause of death prior to age 65 among the SNI or the sequelae associated with this disease result in death due to causes other than diabetes.

Almost 15 percent of YPLL were due to circulatory diseases. These cardiovascular deaths seem to have occurred between 50 and 55 years of age, suggesting the occurrence of some pathologic change, possibly related to diabetes mellitus, occurring in the vascular tissue of the heart or related vessels or both.

During the 30-year study period, 8.3 percent of all YPLL among the SNI were due to digestive disorders. Although this is a broad disease grouping (including appendicitis, hernia, intestinal obstruction, cirrhosis, and gallbladder disease) it was the third most common cause of YPLL. More than one-third of these premature digestive disease deaths were due to cirrhosis. Excess cirrhosis mortality has been reported in other Native American populations (*12,13*). In addition, Native American populations in the Southwest have demonstrated elevated rates of gallbladder disease (*16,17*) that may be indicative of difficulty in metabolizing a westernized diet.

Some of the decline in proportion of YPLL ascribed to digestive disorders between the 1965–74 and 1975–84 periods may be attributable to increased use of on-reservation health care services. Such services and related health care programs first became available in the 1970s.

Both the SNI and other Native American populations have demonstrated deficits of mortality due to malignant diseases (*12,13,18,19*). The present investigation has indicated that less than 8 percent of YPLL among the SNI were attributable to malignant diseases. During the most recent period this percentage was less than the percentage of cancer-specific YPLL observed in the United States population (*3–6*). While this observation may reflect lower overall cancer mortality among this Native population, it may also be the result of premature deaths due to causes other than cancer, thereby diminishing the number of individuals at risk of prematurely developing a fatal malignancy.

Also, SNI members with diagnosed malignancies may expire beyond the cut-off age of 65 years selected for this study.

Conclusion

The determination of YPLL provides a broad overview of the relative importance of major causes of premature deaths among various population groups. While this measure emphasizes the social impact of death at younger ages, it fails to address adequately the economic impact of these premature events. However, investigations of this type allow an appreciation for the broad impact of premature deaths. Additionally, the quantification of YPLL provides for the focus of health planning to shift to preventive measures. As Perloff and coworkers (*2*) have suggested, these types of analyses indicate (*a*) that most premature deaths are preventable, (*b*) premature death is often linked to the interaction of an individual's lifestyle and environment, and (*c*) these analyses can assist in the efficient allocation of limited health care resources.

Among the SNI almost one-half of all YPLL were attributable to accidents and injuries. Premature deaths due to heart disease, digestive diseases, and malignant neoplasms also represent important contributors to YPLL. Having identified problematic yet largely preventable causes of premature death, it becomes necessary to proceed with the design of interventions since premature mortality will not diminish by itself.

References

1. Romeder, J. M., and McWhinnie, J. R.: Potential years of life lost between ages 1 and 70: an indicator of premature mortality for health planning. Int J Epidemiol 6: 143–151 (1977).
2. Perloff, J. D., et al: Premature death in the United States: years of life lost and health priorities. J Public Health Policy 5: 167–184 (1984).
3. Centers for Disease Control: Premature mortality helps set public health priorities. Oncology Times 9: 4,8,13, Feb. 15, 1987.
4. Centers for Disease Control: Changes in premature mortality—United States, 1984–1985. MMWR 36: 55–57, Feb. 6, 1987.
5. Centers for Disease Control: Changes in premature mortality—United States, 1982–1983. MMWR 34: 17–18, Jan. 18, 1985.
6. Centers for Disease Control: Changes in premature mortality—United States, 1983–1984. MMWR 35: 27,29–31, Jan. 17, 1986.
7. Centers for Disease Control: Alcohol-associated premature mortality—United States, 1980. MMWR 34: 493–494, Aug. 16, 1985.
8. Manual of the international statistical classification of diseases, injuries, and causes of death, ninth revision. World Health Organization, Geneva, 1977.
9. Vital Statistics of the United States, 1970. Vol. II—sec 5, life tables. PHS Publication No. (HRA) 75-1101, Hyattsville, MD, 1974.
10. Mantel, N., and Haenszel, W.: Statistical aspects of the analysis of data from retrospective studies of disease. J NCI 22: 719–748 (1959).
11. Waller, J. A.: Injury: conceptual shifts and preventive implications. Ann Rev Public Health 8: 21–49 (1987).
12. New Mexico vital statistics report: New Mexico standardized mortality ratios 1985. New Mexico State Center for Health Statistics, Santa Fe, February 1985.
13. Mao, Y., Morrison, H., Semenciw, R., and Wigle, D.: Mortality on Canadian Indian reserves 1977–1982. Can J Public Health 77: 263–268 (1986).
14. Baker, S. P., Whitfield, R. A., and O'Neill, B.: Geographic variations in mortality for motor vehicle crashes. N Engl J Med 316: 1384–1387 (1987).
15. Seneca Nation of Indians Health Department: 1985 annual report. Salamanca, NY, September 1985.
16. Morris, D. L., Buechley, R. W., Key, C. R., and Morgan, M. V.: Gallbladder disease and gallbladder cancer among American Indians in tricultural New Mexico. Cancer 42: 2472–2477 (1978).
17. Lowenfels, A. B., Lindstrom, C. G., Conway, M. J., and Hastings, P. R.: Gallstones and risk of gallbladder cancer. J NCI 75: 77–80 (1985).
18. Cregan, E. T., and Fraumeni, J. F.: Cancer mortality among American Indians, 1950–1967. J NCI 49: 959–967 (1972).
19. Surveillance, epidemiology and end results: incidence and mortality data, 1973–1977. NCI Monogr No. 57, NIH Publication No. 81-2330, Bethesda, MD, 1981.