The Epidemiology of Accidents Among the Navajo Indians

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ACCIDENTS are the leading cause of death among the Navajo Indians of the Southwestern United States and are considered to be one of the most important public health problems of all American Indians. Despite the importance of accidents as a leading cause of morbidity and mortality on the reservation, no epidemiologic investigation of their occurrence among this population has been reported. Our study was conducted in an attempt to define the nature and extent of accidents among the Navajos.

Background

The Navajo Indian Reservation is a vast 25,000-square-mile area that lies within the States of Arizona, New Mexico, and Utah. The Navajo population totals approximately 109,000; it is the largest of the American Indian tribes. Aptly called America's last real frontier, the Navajo country is semi-arid desert, mesas, canyons, and arroyas on the southern portion of a plateau, with elevation ranges from 3,000 to 10,000 feet. The climate, which is temperate in summer and cold in winter, has a wide diurnal variation in temperature.

The population, with an average density of four persons per square mile, is widely scattered over the reservation. Most Navajo families still live in small cabins or in the traditional hogan—a one-room, windowless, mud and log hut—several miles from their nearest neighbors. Larger groups settle around missions, government stations, and the tribal headquarters. Although the Navajos have retained, to a large extent, their traditional culture and language, the social structure of the tribe is rapidly changing. Sheepherding is still a major form of livelihood, but the old pastoral economy is giving way to industrial development and tourism. There are 892 miles of paved roads on the reservation. The pickup truck has replaced the horse-drawn wagon as the chief means of transportation.

The pattern of life and health of the Navajos is comparable in some respects to that of the people in the developing countries of Asia, Africa, and South America. Acculturation with

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the general population of the United States, however, is touching all phases of Navajo life, and environmental health standards are gradually improving.

Medical Care

The Navajo Area Indian Health Service in Window Rock Ariz., part of the Public Health Service, is responsible for the health and medical care of the Navajos. The following 11 Public Health Service medical facilities served the Navajo Indian Reservation at the time of the study. In addition, two mission hospitals are on the reservation at Ganado, Ariz., and Goulding, Utah. The location of these facilities is shown on the map.

Medical facilities

Hospitals:	*Number of beds*
Gallup, N. Mex	200
Fort Defiance, Ariz	110
Shiprock, N. Mex	75
Tuba City, Ariz	75
Crownpoint, N. Mex	56
Winslow, Ariz	50
Keams Canyon, Ariz	38
Sage Memorial (mission) Hospital, Ganado, Ariz	45
Monument Valley (mission) Hospital, Goulding, Utah	24
Total	673

Health centers: Chinle and Kayenta, Ariz., and Tohatchi and Fort Wingate, N. Mex.

The Keams Canyon Hospital is situated on the eastern boundary of the Hopi Indian Reservation, but 75 percent of the patients seen at this hospital are Navajos; therefore it was included in the study. Outpatient records at the Monument Valley Hospital and at the health centers in Tohatchi and Fort Wingate, N. Mex., were not available for review and were excluded from the study.

Collection of Data

Seldom has it been possible in accident research to carry out descriptive epidemiologic studies of accidents in a known homogeneous population living in a defined geographic area. The Navajo reservation gave us the opportunity to conduct such a study. The mid-year population on the reservation and on Indian-alloted land immediately adjacent to the reservation during the study period November 1, 1966, through October 31, 1967, was 109,378 (*1*).

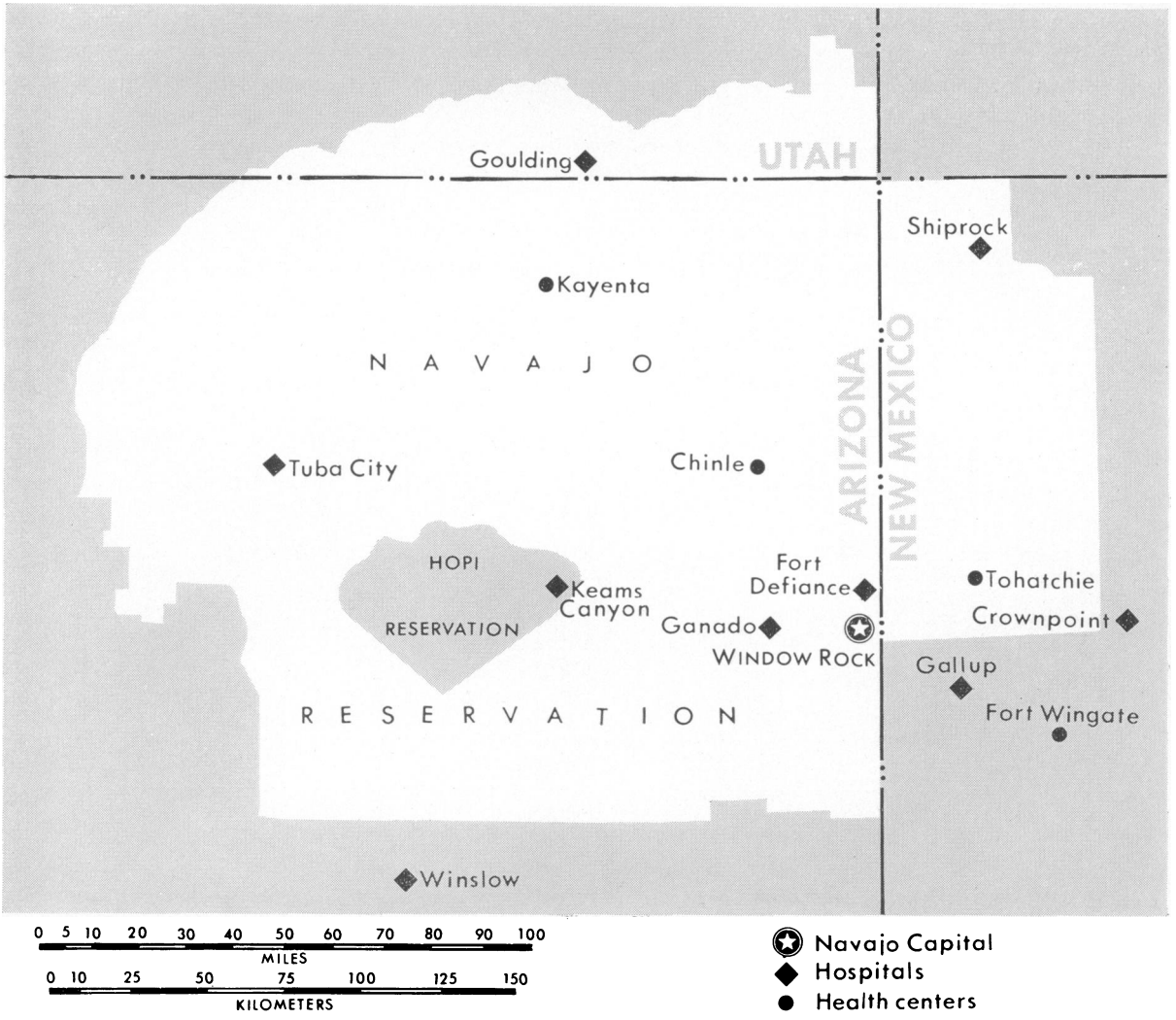
Data on accident cases were obtained by reviewing emergency room records, outpatient records, and hospital charts of all medical facilities serving the Navajo reservation. As no private medical practitioners were on the reservation, all accident patients requiring immediate medical attention probably were attended at one of the facilities listed. Information on the cases recorded during the study period, involving Navajos living on the reservation or on feder-

Table 1. Distribution of accident cases among Navajos, by age and sex, with incidence rates per 1,000 population, Navajo Indian Reservation, Window Rock, Ariz., Nov. 1, 1966–Oct. 31, 1967

Age group (years) at last birthday	Males			Females			Both sexes			Ratio of males to females
	Population [1]	Cases	Rate	Population [1]	Cases	Rate	Population [1]	Cases	Rate	
0–4	8, 242	419	50. 8	8, 147	297	36. 4	16, 389	716	43. 7	1. 40
5–14	16, 022	955	59. 6	16, 655	544	32. 7	32, 677	1, 499	45. 9	1. 82
15–24	10, 991	619	56. 3	11, 118	261	23. 5	22, 109	880	39. 8	2. 40
25–34	7, 373	457	62. 0	7, 880	171	21. 7	15, 253	628	41. 2	2. 86
35–44	4, 561	246	53. 9	4, 835	116	24. 0	9, 396	362	38. 5	2. 24
45–54	2, 928	152	51. 9	2, 956	71	24. 0	5, 884	223	37. 9	2. 16
55–64	2, 107	88	41. 8	2, 065	53	25. 7	4, 172	141	33. 8	1. 63
65 and over	1, 937	105	54. 2	1, 561	59	37. 8	3, 498	164	46. 9	1. 43
Total	54, 161	[2] 3, 093	57. 1	55, 217	[2] 1, 618	29. 3	109, 378	[3] 4, 803	43. 9	1. 95

[1] Office of Information and Statistics: Estimated population of Navajo residents for July 1, 1967. Bureau of Indian Affairs, U.S. Department of the Interior, Navajo Area Office, Window Rock, Ariz., 1967.
[2] Includes 52 males and 46 females for whom age was not recorded.
[3] Includes 190 cases for which age or sex was not recorded.

Medical facilities on the Navajo Indian Reservation, 1966–67



ally alloted land immediately adjacent to the reservation, included type of accident, nature of injury, time and place of occurrence, and age and sex of the persons injured.

The collection of data was limited to true cases of accidents—the unexpected occurrence of physical or chemical damage to a human being. Traumatic injury secondary to assault, intentional self-inflicted injury, homicide, suicide, and attempted suicide were excluded.

Analysis of Data and Results

On completion of our study, we coded the collected data, using the World Health Organization classification of diseases and injuries. We then tabulated and analyzed the coded data by data-processing equipment to give a descriptive epidemiologic view of accidents in this population.

Age and sex distribution of cases. During the 1-year period of study, 4,863 accidental injuries were reported for 4,803 patients, with an annual incidence rate of 43.9 per 1,000 population. Of the 4,803 patients 114 (2.4 percent) died as a result of the accidents, 3,106 (64.6 percent) were treated as hospital outpatients, and 1,583 (33 percent) were treated as hospital inpatients. Males had 64.5 percent of the accidents, females had 33.6 percent, and sex was unspecified in 1.9 percent.

Table 1 shows incidence rates by age and sex. Incidence rates for males ranged from a low of

41.8 per 1,000 population in the age group 55–64 years to a high of 62 per 1,000 in the age group 25–34 years. Incidence rates were higher for males than for females in every age group; for the total series the incidence rate for males was 1.95 times that for females. Incidence rates for females ranged from a low of 21.7 per 1,000 population in the age group 25–34 years to a

Table 2. Distribution of accident cases among Navajos, by type of accident and sex, Nov. 1, 1966–Oct. 31, 1967

Type of accident	Number of cases			Percent of total cases			Incidence rate per 1,000			Ratio of males to females
	Males	Females	Both sexes	Males	Females	Both sexes	Males	Females	Both sexes	
Falls	619	359	1,000	20.0	22.2	20.8	11.43	6.50	9.1	1.75
Pedestrian-motor vehicle	597	344	943	19.3	21.4	19.6	11.02	6.23	8.6	1.77
Cutting or piercing objects or instruments	354	201	598	11.4	12.4	12.5	6.54	3.64	5.5	1.80
Collision with object, person, animal	312	101	413	10.1	6.2	8.6	5.76	1.83	3.8	3.22
Animal bites	137	93	230	4.4	5.7	4.8	2.53	1.68	2.1	1.47
Contact with hot liquid or object	97	73	178	3.1	4.5	3.7	1.79	1.32	1.6	1.38
Machinery and nonmotor vehicle	105	44	152	3.4	2.7	3.2	1.94	.80	1.4	2.38
Inhalation or ingestion of toxic substance	67	55	125	2.2	3.4	2.6	1.24	1.00	1.1	1.20
Athletic or sports events	79	12	96	2.6	.7	2.0	1.46	.22	.9	7.50
Fire or explosion	54	36	96	1.7	2.2	2.0	1.00	.65	.9	1.66
Other [1]	672	300	972	21.8	18.6	20.2	12.41	5.43	8.9	2.30
Total	3,093	1,618	[2] 4,803	100	100	100	57.11	29.30	43.9	1.96

[1] Includes drowning, exposure, firearms, lifting or exertion, snakebite, and unknown types.
[2] Includes 92 cases for which sex was not specified.

Table 3. Distribution of accidents among Navajos, by type of accident and clinical nature of injury, Nov. 1, 1966–Oct. 31, 1967

Type of accident	Lacerations and contusions		Fractures and dislocations		Head injuries		Burns		Poisoning		Other injuries		Total	
	Number	Percent of total accidents	Number	Percent of total accidents	Number	Percent of total accidents	Number	Percent of total accidents	Number	Percent of total accidents	Number	Percent of total accidents	Number	Percent
Falls	458	9.4	378	7.8	115	2.4	24	0.5	0	0	30	0.6	1,005	20.7
Pedestrian—motor vehicle	520	10.7	248	5.1	118	2.4	3	.1	0	0	49	1.0	938	19.3
Cutting or piercing objects or instruments	556	11.4	3	.1	18	.4	0	0	0	0	4	.1	581	11.9
Collision with object, person, animal	268	5.5	61	1.2	57	1.2	1	0	0	0	22	.4	409	8.4
Animal bites	165	3.4	27	.6	6	.1	0	0	25	.5	7	.1	230	4.7
Contact with hot liquid or object	1	0	0	0	0	0	165	3.4	0	0	0	0	166	3.4
Machinery and nonmotor vehicle	105	2.2	52	1.0	8	.2	0	0	0	0	0	0	165	3.4
Inhalation or ingestion of toxic substance	0	0	0	0	0	0	0	0	125	2.6	1	0	126	2.6
Athletic or sports events	42	.9	50	1.0	9	.2	0	0	0	0	5	.1	106	2.2
Fire or explosion	1	0	0	0	0	0	84	1.7	0	0	0	0	85	1.7
All other injuries [1]	482	9.9	221	4.5	166	3.4	20	.4	2	0	161	3.3	1,052	21.6
Total [1]	2,598	53.4	1,040	21.3	497	10.3	297	6.1	152	3.1	279	5.6	[2] 4,863	100.0

[1] Including unknown types.
[2] Does not include accidental deaths or patients with no apparent injury. The 4,863 injuries exceeds the 4,803 patients because some types of accidents resulted in more than one injury to a patient.

Table 4. Distribution of accident cases among Navajos, by place of occurrence on reservation, Nov. 1, 1966–Oct. 31, 1967

Place of occurrence	Distribution	
	Number	Percent
Home premises	1, 408	29. 3
Highway	1, 048	21. 8
School or public place	426	8. 9
Work	131	2. 7
Unknown or not recorded	1, 790	37. 3
Total	4, 803	100. 0

Table 5. Distribution of accident cases among Navajos, by season of the year, Nov. 1, 1966–Oct. 31, 1967

Season	Number	Percent of total	Incidence rate per 1,000 population
March, April, May 1967	1, 128	23. 5	10. 31
June, July, August 1967	1, 405	29. 2	12. 84
September, October 1967, November 1966	1, 292	26. 9	11. 81
December 1966, January, February 1967	978	20. 4	8. 94
Total	4, 803	100. 0	43. 90

high of 37.8 per 1,000 population among persons aged 65 years and older. When data for both sexes were combined, the highest rate was noted in the age group 65 and older—46.9 per 1,000 population. In 46 percent, or 2,215, of the total cases, the persons injured were under 15 years old.

Types of cases. Incidence rates and distribution of accident cases by types are tabulated in table 2. The largest number of injuries occurred from falls, pedestrian-motor vehicle accidents, and cutting or piercing objects or instruments. Of the total number of cases attributed to falls, 175 (18 percent) were a result of falling or being thrown from a horse. The 943 injuries involving pedestrians and motor vehicles resulted from a total of 802 traffic accidents.

Nature of injuries. Lacerations and contusions were recorded most frequently, accounting for more than 50 percent of the total number of injuries sustained by this population. Fractures and dislocations accounted for another 21 percent of the total number of injuries. Percent distribution by type of accident and clinical nature of injury is given in table 3.

Places of occurrence. The high proportion of cases for which place of occurrence was not recorded or was unknown detracted from the results of this category. Nearly one-third of the recorded accidents occurred on the home premises; that is, within the dwelling place or on the surrounding grounds. The results are summarized in table 4.

Seasonal occurrences. Distribution of cases by seasons of the year is shown in table 5. The number was minimal during the winter months, gradually increased to a maximum during the summer, and then decreased during the fall. The incidence of accident cases during the summer season was significantly higher than during the winter season when tested statistically with Duncan's multiple range test (*2*).

Fatal accidents. Distribution of the 114 accidental deaths is shown by type of accident in table 6 and by age and sex in table 7. Pedestrian-motor vehicle accidents were the major source of accidental deaths among the Navajos, accounting for nearly 50 percent. During the study period, 87 males and 27 females

Table 6. Accidental deaths among Navajos, by type of accident, Nov. 1, 1966–Oct. 31, 1967

Type of accident	Number of deaths	Percent of all accidents	Incidence rate per 100,000 population
Pedestrian-motor vehicle	55	48. 2	50. 3
Drowning	15	13. 1	13. 7
Fire or explosion	14	12. 3	12. 8
Exposure, freezing	11	9. 6	10. 0
Falls	2	1. 8	1. 8
Collision with object, person, animal	2	1. 8	1. 8
Collision with railway train	2	1. 8	1. 8
Struck by lightning	2	1. 8	1. 8
Firearms	1	. 9	. 9
Salicylate ingestion	1	. 9	. 9
Contact with hot object	1	. 9	. 9
Unknown	8	7. 0	7. 3
Total	114	100. 0	104. 2

died; sex-specific mortality rates were 160.6 for males and 48.9 for females per 100,000 population. For purposes of comparison, accident mortality rates for the general population of the United States for the year 1966 also are shown in table 7.

Discussion

Gordon and co-workers' classic report of a field study in the Punjab, India (*3*), pointed the way for epidemiologic investigations of accidents in rural areas. Waller (*4*) recently stressed the importance of accidents in present-day rural America. Our study is a logical first step to public health control of accidents among a unique rural population, the Navajos, largest of the American Indian tribes. Haddon and associates (*5*) have called attention to several deficiencies in the use of hospital cases in accident research. The inherent deficiences that tend to detract from hospital studies, such as under-reporting of numerator data and unknown composition of denominator data, are obviated to a great extent in our study in that the population at risk is known and well defined. Because of the absence of private medical practitioners in the tribal area, it is necessary for any person seeking medical care for an accident to be treated at one of the facilities listed. Therefore, all types of accidents that were severe enough to need medical attention entered into the study.

The results of this study attest to the formidable public health problem of accidents in the Navajo population. The observed accident mortality rate is one of the highest in the United States—nearly double that of the general population. Comparison of age-specific accident mortality rates for the year 1966 (table 7) shows that they are much higher for the Navajos in every age group than for the corresponding group in the general U.S. population.

Our study identified Navajo males as the most susceptible to accidental injury. Those in the age group 25–34 years had the highest incidence rate; thus they were at greatest risk for having an accident. For the total series of 4,803 patients, the very young and the very old also represented high-risk age groups. The highest incidence rates were in the age groups 0–4, 5–14, and 65 and older, as noted in table 1. Apparently the elderly Navajos also had the more serious accidents, as indicated by the high age-specific mortality rate of 228.7 per 100,000 population for the age group 65 and older. The high proportion (46 percent) of accident cases among persons under 15 years old probably reflected the age distribution of the Navajo population.

The large number of accidents that occurred in and about the home may have reflected the substandard dwellings and overcrowding. A survey of housing among the Navajos, conducted by Bosch (*6*), indicated that the average number of persons per house was 6.1 in the communities surveyed; 79.7 percent of the homes had only one room and 13.6 percent sheltered eight or more persons per room. In

Table 7. Accident mortality rates per 100,000 population of Navajos and general U.S. population, by age and sex, Nov. 1, 1966–Oct. 31, 1967

Age group (years)	Males		Females		Both sexes		U.S. rate [1]
	Number	Rate	Number	Rate	Number	Rate	
0–4	11	133.5	9	110.5	20	122.0	42.9
5–14	15	93.6	4	24.0	19	58.1	19.8
15–24	15	136.5	2	18.0	17	76.9	67.1
25–34	17	230.6	4	50.8	21	137.7	51.9
35–44	11	241.2	5	103.4	16	170.3	47.9
45–54	7	239.1	1	33.8	8	136.0	55.8
55–64	4	189.8	1	48.4	5	119.8	67.3
65 and over	7	361.4	1	64.1	8	228.7	156.3
Total	87	160.6	27	48.9	114	104.2	58.0

[1] U.S. National Center for Health Statistics: Vital statistics of the United States, 1966: Mortality, pt. A, vol. II. U.S. Public Health Service, Washington, D.C., 1967, p. I-28.

categorizing accidents by place of occurrence, the term "home premises," rather than "home," was used. The Navajos spent much of their time on the immediate premises around the family dwelling in raising sheep, horses, and cattle, and in subsistence farming.

During the summer season the mobility of the Navajos increased by travel to tribal dances and ceremonials. Many Navajos also migrated during the warmer months to a summer hogan. The added travel and outside activities probably accounted for the higher incidence of accidents during the summer season.

Horses, a source of great pride to the Navajo, are found in abundance on the reservation. Navajo children learn to ride at an early age, and horses are used extensively in sheepherding and during the summer rodeos. Thus a high proportion of injuries from falls related to the frequent use of horses.

Pedestrian-motor accidents were the greatest threat to life and limb of the Navajos. Several factors contributed to the high incidence and fatality rates of pedestrian-motor vehicle accidents in this population: alcoholic intoxication, a high proportion of unlicensed drivers, lack of driver education, poor roads in large sections of the reservation, and lax enforcement of the law. The purpose of our study was primarily a descriptive one, but it would be interesting to carry out, at a future date, an analytical study to test the hypotheses of contributing factors to this important category of accidents. Significantly, motor vehicle accidents were responsible for 48.2 percent of the deaths but only 19.3 percent of the injuries, indicating that morbidity data must be considered in any evaluation of the injury problem.

Analysis of the results concerning falls and fires or explosions revealed interesting findings. Although falls were the most frequently occurring type of accident on the Navajo reservation, they accounted for only two accidental deaths. Fires or explosions, on the other hand, represented only 2 percent of the total cases but resulted in 12.3 percent of the accidental deaths. This result indicates the serious nature of burn cases and possibly of delay in therapy because of transportation problems on the reservation.

The results of this study have several implications in the environmental control of accidents among the Navajo population. For example, motor vehicle accidents should be more amenable to control in a relatively stable geographic and political entity like the Navajo reservation than in the areas of general U.S. population. Stricter enforcement of traffic laws by the police and better use of the police, insistence upon examination and licensing for all drivers, punishment of chronic offenders, and education of the driver are at least theoretically easier to accomplish in a somewhat controlled social environment like Indian reservations and military installations than in the environment of the general U.S. population.

The greatest hope for decreasing the high accident rates in this population lies in the public health discipline of health education. The results of our study point to the areas where health education efforts should be directed. School-age children had a high rate of accidents; the greatest proportion occurred among those in the age group 5 to 14 years, part of whom are in a sense a captive audience because of the system of government boarding schools on the reservation.

Accident prevention could easily be incorporated into the school program. Accidents occurring in and around the home could be alleviated through educational efforts by public health nurses and sanitarians. However, more detailed information regarding home-premises accidents would be helpful in identifying the type of health education program most applicable to this particular category of accidents.

Summary

All accident cases occurring between November 1, 1966, and October 31, 1967, to Navajos living on the Navajo Indian Reservation and recorded in emergency room records, outpatient records, and hospital charts of the medical facilities serving the reservation were investigated for type of accident, nature of injury, time and place of occurrence, and age and sex of the persons involved.

The data were tabulated and analyzed to give a descriptive epidemiologic picture of accidents in this population. A total of 4,863 accidental injuries to 4,803 patients was reported, with an annual incidence rate of 43.9 per 1,000 popu-

lation; 114 (2.4 percent) of the patients died. The mortality rate of 104.2 per 100,000 was nearly double that of the general population of the United States for the year 1966.

The study identified Navajo males as having an incidence rate twice that of the Navajo females. School-age and preschool children accounted for 46 percent of the total accident cases. Highest incidence rates for the total series were noted in the age groups 0–4, 5–14, and 65 and older. The mortality rate was highest in the age group 65 and older (228.7 per 100,000 population).

Falls and pedestrian-motor vehicle accidents occurred most frequently; pedestrian-motor vehicle accidents accounted for nearly 50 percent of the accident fatalities. Lacerations, contusions, fractures, and dislocations accounted for 75 percent of the injuries sustained by this population. The incidence of accident cases was highest in the summer months and lowest during the winter; most accidents (29.3 percent) occurred on the home premises. Health education techniques that are properly used are probably the best means of reducing the mortality and morbidity from accidents in the Navajo population.

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Tearsheet Requests

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Mass X-ray Program for Coal Miners

The approximately 90,000 underground coal miners now working in the United States are being given chest X-rays. The mass X-ray program—authorized under the new Coal Mine Health and Safety Act—will identify miners affected with coal workers' pneumoconiosis, or "black lung." Black lung is a crippling and sometimes fatal respiratory disease caused by inhaling coal dust. The X-ray program is to be completed by June 30, 1971.

The primary purpose of this program is to warn miners who show X-ray evidence of significant pneumoconiosis. In such cases, the law provides that affected miners can be transferred from underground work to a less dusty environment to prevent the disease from becoming worse.

The X-ray program, as provided under law, is being financed by the coal mine operators, who are contracting with private physicians throughout the country to take the X-rays and classify them.

The physicians are required either to demonstrate proficiency in taking, reading, and classifying X-ray films or to complete a federally approved short course on the subject.

A course by the American College of Radiology, approved by the Bureau of Occupational Safety and Health, Environmental Health Service, was given June 13–14, 1970, in Washington, D.C. Additional courses will be given in the near future.