

Cancer Incidence in the Zuni Indians of New Mexico

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The total age-adjusted incidence of cancer in the Zuni Indians of New Mexico was significantly lower than that of the New Mexico Anglo population during the period 1969-1982. Specific sites at which the Zunis had a significantly lower number of cases than expected, based on the rates for Anglos, are: colon, rectum and anus, lung, breast, endometrium, melanoma of the skin, pancreas, and the leukemias. Sites at which the Zunis had a higher number of cases than expected are stomach and gallbladder. The Zunis have a pattern of occurrence of cancer that is similar to other American Indians of New Mexico (Navajo, Apache, and Pueblo); however, rates of lung, colonic, and pancreatic cancer among the Zunis are significantly lower. The occurrence and anatomic distribution of cancer among the Zunis may be the result of cultural and environmental conditions or genetic influences. Further studies may clarify the risk factors which contribute to this pattern of disease.

Several studies have shown a lower incidence of cancer in American Indians compared with whites in the United States and Canada [1-5]. Furthermore, the age-adjusted cancer mortality for American Indians is about two-thirds the national overall rate for non-Indians living in the United States [6]. Studies dealing specifically with New Mexico's American Indian population show lower rates of cancer of the skin, lung, breast, endometrium, colon, and rectum and anus, and higher cancer rates for the gallbladder, stomach, and cervix [1,7,8]. The Zuni tribe, one of the Pueblo tribes in New Mexico, is genetically distinct from the Anglo¹ population and is culturally isolated from Hispanics and Anglos in the state. Less assimilated into Anglo culture than American Indians in the larger towns and cities of New Mexico, the Zunis may have cancer incidence rates which provide a sharper contrast to the rates for Anglos than do those of American Indians as a group. Future studies at Zuni could therefore provide clues or hypotheses about what environmental or hereditary risk factors may be contributing to unusually high or low incidence rates for particular sites.

Zuni is located in northwestern New Mexico, approximately 125 miles west of Albuquerque. The 7,300 Zuni Indians² who occupy the reservation receive all health services from the Zuni Public Health Services (PHS) Hospital. Among the Zunis, cancer is the third leading cause of death, following accidents and alcoholism [9].

The Zuni population is readily accessible to a study of cancer incidence because the Zuni PHS Hospital is registered with the New Mexico Tumor Registry (NMTR), which participates in the National Cancer Institute Surveillance, Epidemiology and End-Results (SEER) program. NMTR requires reporting of all malignant and *in situ*

¹The term Anglo is colloquial but used locally to designate anyone who is Caucasian and not of Spanish or Mexican heritage.

²1982 census data from the Zuni tribal board

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neoplasms, as well as data on the extent of the disease at the time of diagnosis, diagnostic procedures used in determining cancer type and site, tumor-directed therapy, and patient survival information. In addition, NMTR registry abstractors based in Albuquerque travel to the Zuni PHS Hospital periodically to review charts in order to assure uniformity of case registration, provide follow-up information, and facilitate computerization and quality control.

METHODS

The Zuni Service Unit 1982 annual report from NMTR, which was issued in July 1983, was used for this study. The report included a cumulative list of all cancer patients reported through the Zuni PHS Hospital from 1969–1982. Although 21 percent of the cases reported through Zuni PHS Hospital were Navajo, only Zuni cases were tallied. Zuni cancer patients reported through other hospitals, such as Gallup Indian Medical Center and Albuquerque Indian Hospital, were also included in the study.

Because the population profiles for Anglos and Zunis are different, all expected numbers of cases were age-adjusted for accurate comparison. The proportion of the population in the higher cancer risk age group (over 45 years old) is smaller in Zunis than that group in the Anglo population: 14 percent of the Zuni population is over 45, whereas 25 percent of the Anglo population is over 45 years of age.

Information on cancer among Anglos in New Mexico was obtained from SEER Monograph 57 (1973–1977) [2]. Tables 42 A, B, and C were used to determine numbers of malignant and *in situ* cases diagnosed in 1973–1977 by primary site, age group, and gender. Using census information (Monograph 57, 1973–1977, Table 44) [2], Anglo incidence by age group was calculated for all cancers combined and for each type of cancer found in Zunis. Population data from the Zuni tribal board were used to age-adjust the cancer incidence in Anglos in order to arrive at an expected number of cases among the Zunis. Tribal population figures are considered by members of the tribal board to be more accurate than U.S. census information and were therefore used for the study. The age distribution of Zunis was observed to be constant from the period 1969–82, as calculated by percentage of the population in ten-year age groups during each of the years.

Expected numbers of cases at Zuni, based on the incidence in New Mexico's American Indian population, were calculated similarly, using Monograph 57, Tables 41 A, B, and C [2]. Zuni cases were subtracted from the pooled American Indian cases for all cancers combined and for each site studied, and the 1973–1977 Zuni populations were subtracted from the census data from those years.

RESULTS

Table 1 shows the four most common types of cancer in Zunis, American Indians, and Anglos in New Mexico with incidence rates per 100,000. The five most common sites in Zuni males are prostate, stomach, gallbladder, liver, and kidney. Likewise, for all American Indian males prostate is the most common, followed by stomach; however, the third and fourth most common sites in this group are lung and colon, two cancers rarely seen in Zuni males. The most common site for Anglo males is the lung, followed by prostate, colon, and urinary bladder.

For all three groups of females the cervix is the most common site. For Zuni females the gallbladder is the next most common site, followed by breast and ovary. For

TABLE 2
Observed Versus Expected Numbers of Cases in Zunis (1969–1982) Based on Incidences in Anglos
and American Indians in New Mexico (1973–1977)

| | Observed | Zuni vs. Anglo | | Zuni vs. Indian | |
|---------------------------------|----------|----------------|-----------|-----------------|----------|
| | | O/E | 95%CI | O/E | 95%CI |
| Males | | | | | |
| All sites (malignant only) | 52 | 0.5 | 0.4–0.7* | 1.1 | 0.8–1.4 |
| Prostate | 18 | 0.9 | 0.5–1.4 | 1.5 | 0.8–2.2 |
| Stomach | 11 | 4.6 | 1.9–7.3* | 1.5 | 0.6–2.4 |
| Primary site unknown | 4 | 1.4 | 0.0–2.7 | 1.1 | 0.0–2.2 |
| Gallbladder | 3 | 14.3 | 0.0–30.5 | 2.2 | 0.0–4.7 |
| Liver | 3 | 3.7 | 0.0–7.9 | 3.7 | 0.0–7.8 |
| Kidney | 3 | 1.1 | 0.0–2.3 | 1.5 | 0.0–3.1 |
| Lung | 1 | 0.1 | 0.0–0.2* | 0.3 | 0.0–1.0* |
| Colon | 0 | 0.0 | 0.0–0.5* | 0.0 | 0.0–1.5 |
| Females | | | | | |
| All sites (malignant and CIS) | 55 | 0.6 | 0.5–0.8* | 0.8 | 0.6–1.1 |
| All sites (malignant only) | 31 | 0.5 | 0.3–0.6* | 0.7 | 0.5–1.0* |
| Cervix (malignant and CIS) | 25 | 1.2 | 0.7–1.7 | 0.9 | 0.6–1.3 |
| Cervix (malignant only) | 3 | 0.8 | 0.0–1.8 | 0.6 | 0.0–1.3 |
| Gallbladder (malignant and CIS) | 8 | 25.8 | 7.9–43.7* | 2.7 | 1.1–4.3* |
| Gallbladder (malignant only) | 6 | 19.4 | 3.9–34.8* | 2.2 | 0.7–3.7 |
| Breast | 3 | 0.2 | 0.0–0.3* | 0.6 | 0.0–1.4 |
| Ovary | 3 | 0.9 | 0.0–2.0 | 1.1 | 0.0–2.2 |
| Endometrium | 2 | 0.4 | 0.0–0.9* | 2.0 | 0.0–4.8 |
| Lung | 0 | 0.0 | 0.0–0.8* | 0.0 | 0.0–4.4 |
| Colon | 0 | 0.0 | 0.0–0.6* | 0.0 | 0.0–1.5 |
| Males and Females | | | | | |
| Leukemias | 2 | 0.4 | 0.0–0.8* | 0.5 | 0.0–1.2 |
| Pancreas | 2 | 0.4 | 0.0–1.0* | 0.4 | 0.0–1.0* |
| Rectal/anal | 2 | 0.4 | 0.0–0.9* | 0.6 | 0.0–1.4 |
| Colon | 0 | 0.0 | 0.0–0.3* | 0.0 | 0.0–0.8* |
| Melanoma | 0 | 0.0 | 0.0–0.7* | 0.0 | 0.0–8.2 |

*Indicates statistical significance

American Indian females the breast is the second most common site, followed by gallbladder and ovary. For Anglo females breast cancer ranks second, colon ranks third, and lung ranks fourth.

Table 2 shows the number of cases observed in Zunis versus the expected number of cases based on age-specific incidence reported in Anglos in males and females and for both sexes combined. Also given is the ratio of the observed to expected (O/E), and the 95 percent confidence interval (95% CI).

For males at all sites combined, the number of observed cases is significantly lower than expected (52 percent). Stomach cancer is significantly higher (5×) in Zuni than Anglo males. A significantly lower number of cases are seen in cancer of the lung (5 percent) and colon (0 percent). For females at all sites combined, the number of observed cases is significantly lower than expected: 45 percent for malignant only and 62 percent for malignant plus carcinoma *in situ* (CIS). Cancer at the following sites is significantly lower among Zuni females: colon (0 percent), lung (0 percent), breast (15

percent), and endometrium (36 percent). The only site for which cancer is significantly higher for Zuni females is the gallbladder ($19\times$ expected for malignant cases and $25\times$ expected for malignant plus CIS).

For both sexes combined, cancer of all sites combined is significantly lower in Zunis than Anglos. All malignant plus *in situ* neoplasms are 60 percent of expected, and malignant neoplasms only are 52 percent of expected. The sites for which significantly higher number of Zuni cases were reported than expected are stomach ($3.4\times$ expected) and gallbladder ($15\times$ expected for malignant and $18\times$ expected for malignant plus carcinoma *in situ*). The sites at which significantly fewer Zuni cases were reported than expected are colon (0 percent), rectum (37 percent), lung (5 percent), melanoma (0 percent), and the leukemias (35 percent). For all other sites O/E did not differ significantly from unity with 95 percent confidence.

Also shown in Table 2 is the number of cases observed at Zuni versus the expected number of cases based on the age and sex-specific incidence rates for the non-Zuni American Indian population of New Mexico. For both sexes and for males and females taken separately, the total observed number of malignant plus CIS cancer cases for all sites combined is not significantly different from the expected number of cases (O/E, both 0.95, O/E, males = 1.07, O/E, females = 0.84).

For Zuni females the total number of observed malignant cases is significantly lower than the expected number based on the incidence in other American Indian females (O/E = 0.7). For males there is a significant deficit of lung cancers (30 percent of expected), and for females there is a significant excess of malignant plus CIS tumors of the gallbladder (O/E = 2.7). When both sexes are combined, the sites for which the Zunis differ significantly from other New Mexico Indians are colon (0 percent of expected), lung (30 percent), and pancreas (40 percent).

DISCUSSION

For all cancers combined the Zunis have a much lower incidence than the Anglos of New Mexico. Since the Anglo population in New Mexico has incidence rates similar to whites in the United States for all cancers combined and for the common sites [1], the Zunis differ similarly from the U.S. population in terms of both overall incidence and incidence for the major sites.

This study has the limitation of small numbers, which yield unstable incidence rates. The advantages of studying a culturally and genetically distinct group such as the Zunis for elucidation of the cancer risk factors may outweigh the disadvantages of the small number of cases. Despite the small numbers, several of the differences were of sufficient magnitude to achieve conventional levels of statistical significance. Under-reporting of cases at Zuni could potentially give deceptively low cancer rates for Zunis; however, this source of bias could not explain the dramatic increases found for cancers of the stomach and gallbladder. Very few of the cases (4 out of 107, or 3.7 percent) were diagnosed with primary site unknown, and detection of carcinoma of the cervix *in situ* has been high (over 85 percent), suggesting that a high percentage of the cancer cases at Zuni come to medical attention.

The pattern of cancer occurrence in the Zunis shares several features with that of other American Indians in New Mexico: high stomach and gallbladder cancer relative to Anglos and low lung, colon, rectal, breast, and endometrial cancers relative to Anglos. On the other hand the results of this study indicate that there are some distinct differences. Most notably, the incidences of colon and lung cancer among Zunis are

significantly lower than the incidences of these cancers in other New Mexico Indians. The incidence of pancreatic cancer was also significantly lower, whereas the incidence of tumors of the gallbladder was significantly higher for Zuni females than for other Indians in New Mexico. These differences are perhaps attributable to the fact that the Zunis are relatively more isolated from changing environmental and cultural conditions than are other American Indians in New Mexico.

American Indians in New Mexico have less than one-fourth the incidence of lung cancer compared to Anglos in New Mexico [1], and results from this study show that the incidence among Zunis is about one-third that of other American Indians in New Mexico. The simplest explanation for the differential lung cancer incidence in these three populations would be different smoking patterns, yet precise data have not been gathered. According to Black and Key, few American Indians smoke, and those who do so smoke only a few cigarettes per day [1]. Similarly, the clinical impression among staff members at the Public Health Services Hospital at Zuni is that habitual smoking of greater than five to ten cigarettes per day is unusual. In addition to smoking, other environmental variables may also be important. For example, the increased incidence of lung cancer among Navajo uranium miners [10] may contribute to the increased incidence of lung cancer in the group of other American Indians in New Mexico compared to Zunis, who are currently not employed in the uranium mines.

Despite the dramatically diminishing incidence of stomach cancer in the United States, the incidence rates among American Indians in New Mexico [1], the Hohokam (Pima-Papago) Indians of Arizona [11], and the Zunis remain high. All of the cases at Zuni have appeared among men and represent an exaggeration of the typical pattern in areas of high stomach cancer incidence such as Japan, where the incidence of stomach cancer in men is twice that in women [12].

No cases of colonic cancer, the third most common site of cancer in Anglo males and females, were diagnosed among Zunis from 1969 to 1982. In addition, the number of rectal/anal cancers is one-third the expected number of cases. These results are consistent with the pattern of high stomach/low colorectal cancer among southwestern American Indians [1]. Unlike first-generation migrants from countries with high stomach/low colorectal cancer (e.g., Japan, Poland) who have experienced increased colorectal cancer upon immigrating to the U.S. [13], the Zunis do not have significant colorectal cancer.

Carcinoma of the gallbladder accounts for 0.8 percent of all cancers in U.S. males and 1.2 percent of all cancers in U.S. females [14], compared with 6 percent and 15 percent in Zuni males and females, respectively. The high incidence of gallbladder cancer among Zunis is consistent with a high incidence among American Indians in New Mexico [1,8,15]. Moreover, significantly elevated gallbladder cancer incidences have been found in British Columbia Indians [16], Alaska natives [17], and the Ojibwa Indians in Ontario [4]. Since the frequency of cholelithiasis and altered bile chemistry are elevated among American Indians [18,19,20], the increased risk of biliary tract neoplasms may be part of a spectrum of gallstone-related diseases endemic to this population.

Because some human neoplasms, particularly cancers of the alimentary tract, are felt to be influenced by dietary variables [21,22], it is tempting to draw correlations between Zuni dietary patterns and cancer incidence. Unfortunately, dietary parameters of this population are difficult to assess. Data are currently unavailable on qualitative or quantitative consumption of fiber, fat, smoked meat or fish, ascorbic acid, retinoids, coffee, or any of the substances currently under investigation for a

possible role in carcinogenesis. Few Zunis or workers at the Public Health Service Hospital at Zuni have been willing to speculate about an "average Zuni diet," although some have raised questions about the high fat content of Zuni bread, the use of chewed Jimson weed, and "Zuni tea," which grows wild locally. Further investigation of possible diet-cancer associations would have to involve standard epidemiologic methods for assessing dietary intake such as food diaries, interviews about previous food intake, or questionnaires in which people assign consumption frequency to a selected list of foods [23].

Although Sievers and Fisher have noted that the relative deficit for malignant neoplasms in Indians in North America is largely confined to males [5], this observation does not seem to hold true for Zuni females, in whom invasive cancers are 45 percent of expected and malignant plus *in situ* cases are 62 percent of expected. This finding is largely due to significantly lower rates of breast and endometrial cancer among Zuni women and to cervical cancer rates which are not substantially higher than expected based on the Anglo population. The low incidence of endometrial cancer among Zuni females is consistent with the low incidence of this cancer in all American Indians [1]. However, given the high incidence of risk factors such as obesity and diabetes mellitus, the low incidence in Zuni females is remarkable. Information on Zuni reproductive patterns is not available, so that it is not currently possible to evaluate the extent to which the low incidence of cancer of the breast and endometrium may be explained in terms of factors such as parity, menopausal status, and age at first full-term pregnancy.

According to Black and Key [1], the incidence of cervical cancer in American Indians is "substantially" higher than that of Anglos in New Mexico. In contrast, the incidence of cervical cancer in Zuni females is not significantly different from expected. O/E for malignant plus CIS cases is 1.2 (95 percent CI = 0.7 – 1.7); for invasive cases O/E = 0.8 (95 percent CI = 0.0 – 1.8). Because over 85 percent of the cervical cancer cases at Zuni were diagnosed *in situ*, mortality from cervical cancer probably does not pose a significantly higher risk for Zunis than for Anglos.

The Zunis are a population within the United States which has a dramatically different pattern of cancer incidence from that of Caucasian Americans. Unlike racial and ethnic groups which have immigrated to the U.S., and assumed cancer rates which approach those in the U.S., the Zunis of New Mexico have a cancer pattern which remains distinct. Especially provocative for further study are the cancers which are presumably environmentally influenced, such as cancers of the stomach, colon, breast, endometrium, and lung. Investigation of such factors as diet, reproductive variables, smoking, and alcohol consumption among the Zuni should help to clarify the basis for the pattern of cancer incidence found in this study of the Zuni Indians.

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