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Cancer Profiles of Two American Indian Tribes

JAMES W. JUSTICE

ABSTRACT

The relative distribution of primary cancers as well as incidence rates by type were found to be significantly different between the Oglala Sioux from the Northern Plains and the Tohono O'Odham from the Southwestern desert. The Oglala had higher mortality rates for lung, cervix, and breast cancer, and the Tohono O'Odham had higher mortality rates for gallbladder, breast, and stomach cancer compared to the mortality rates for the same cancers in the all-United States Indians. Multiple myeloma rates were increased for both tribes.

Cancer rates among Indian peoples are usually reported by ethnic groups. For American Indians, these groups are usually combined, and rates are reported under the heading *Indians*. It appears that if regional tumor registries for Native Americans were to be developed, then distinctive patterns might be expected, proving that individual tribal cancer patterns may vary as much as observed patterns for other ethnic groups of European or Asian origin in the United States.

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INTRODUCTION

There are a number of registries that contain data about cancer incidence in American Indians. Since 1969, the SEER programs (Surveillance, Epidemiology, and End Results programs of the National Cancer Institute [NCI]) have compiled cancer statistics for Native Americans in six states (Arizona, New Mexico, Connecticut, Hawaii, Utah, and Iowa) and four urban areas (Atlanta, Detroit, San Francisco, and Seattle). The most recent data for American Indians reported from all twenty-three SEER programs for both incidence and mortality by primary cancer sites, 1978 through 1981, were published by the NCI [1]. However, these data lend a bias in favor of Southwestern tribes, since over 75 percent of these cancers were from tribes in New Mexico and Arizona. Incidence and prevalence data for neoplasms are categorized by the NCI as *Native Americans*. Of the SEER project areas, only the New Mexico SEER project (includes American Indians in Arizona) can retrieve cancer rates by specific ethnic groups but not by specific tribe (i. e., specific ethnic groups are Apache, Navajo, Pueblo, etc.; however, the Apache, for example, can be subdivided into four separate tribes: Mescalero, Jicarilla, San Carlos, and White Mountain). In time, this program will provide incidence and mortality comparisons between Navajo, Apache, and several Pueblo groups, but not data about specific tribes. Currently, Navajo account for about 75 percent of the total database in the New Mexico SEER program.

In addition to the New Mexico SEER program and tumor registry established for Indians in 1974 (which includes data back-loaded since 1966 [2]), only two other sources can provide enough data to compare decade changes in incidence of cancer in Native Americans. One is the tumor registry established by the Arctic Investigations Laboratory of the Public Health Services Centers for Disease Control, which has collected data from 1960 to the present [3,4,5] and has categorized the data into the three groups: Indians, Aleuts, and Eskimos. The only other long-term tumor registry, which was established from records dating from 1961, is for the Tohono O'odham people (formerly named Papago) of southern Arizona. This registry contains cases from 1961 through 1984, when it was discontinued. This latter registry was the only tumor registry that categorized cancers for a specific tribal group [6].

Because of the way these statistics are compiled, some researchers have, unfortunately, tended to assume that findings relevant

to Southwestern tribes may be applicable to all Native American groups. Statements such as "These observations confirm previous reports of reduced mortality from lung cancer in American Indians of both sexes" [7], which are based on comparisons of only Southwestern tribes, appear from time to time in the literature. Until more tribes are studied and the results reported, generalizations should not be made about whether the "all Indians" cancer incidence rate is more, less, or equal to rates for other races in the United States.

The purpose of the present study was to compare one tribe from the Southwestern group (the Tohono O'Odham) with a tribe from the Northern Plains (the Oglala Lakota Sioux, hereafter referred to as Oglala) for the purpose of discovering the distribution of primary cancers in two tribes from very different cultural, genetic, and environmental backgrounds (see table 1 and table 2). While the Tohono O'Odham comprise a generally homogeneous population that has experienced very little intermarriage with Europeans and with other tribes, the Oglala, in contrast, have a minority of "pure bloods" as a result of intermarriage with Europeans and members of other tribal groups. If these two specific tribes or any other Indian ethnic groups had a similar overall incidence of cancer and similar proportions of specific primary site cancers, then it would make sense to report them together as *Indians*. However, we believe the evidence presented in this paper supports the view that each cancer pattern of each tribe or ethnic group may be unique.

METHODS

The location of records for patients with diagnosed neoplasms was facilitated for both tribes by the IHS computerized health record system. Printout lists were retrieved of all hospitalized patients as well as all outpatient visits where a neoplasm code [8] was recorded (I. C. D. 9, 8th or 9th edition, 140.0 to 239.0). Contract care records were also studied, as well as all death certificates (coded to all underlying causes of death) of persons listed as American Indian and resident in localities on or near Pine Ridge, South Dakota, or Sells, Arizona. Tribal rolls were used when the ethnic identity was in doubt. In addition, the newly established tumor registries at Rapid City, South Dakota, and the Arizona Health Sciences Center of the University of Arizona in Tucson

TABLE 1
Cause of Death Compared for Two Tribes (1975-1977),
Three-Year Mean, per 100,000 Population

Cause	Oglala		Tohono O'Odham		All U. S. Indian
	Number	Rate	Number	Rate	Rate
Accidents	76	221.4	68	165.6	159.9
Cirrhosis	20	58.3	33	80.4	44.7
Heart disease	69	201.0	34	82.8	127.6
Neoplasms	27	78.7	29	70.6	68.4
Influenza/ Pneumonia	31	90.3	13	31.7	36.3
Diabetes	3	8.7	8	19.5	20.1
Cerebro- Vascular	22	64.2	10	24.4	36.2
Homicide	25	72.8	8	19.5	21.5
Suicide	9	26.2	11	26.8	23.9
Ill-defined	16	46.6	33	80.4	-
All others	102	297.2	97	236.2	-
TOTALS	405	1,180.0	344	837.7	751.2

From Selected Vital Statistics for Indian Health Service Areas and Service Units, 1972-1977. Not age-adjusted.

(1) Lakota population 3-year mean = 11441; Papago = 13,689.

(2) Total population served by all IHS areas = 626,888. DHEW Publication No. (HSA) 79-1005.

TABLE 2
Oglala Lakota and T. O. N.* Tribes Compared for Cultural,
Demographic, and Environmental Factors

Factor	Tribe	
	Oglala Lakota	Tohono O'Odham
Culture:		
Origin	Migration from Minnesota to Dakotas, 1700s	Present location in Southern Arizona for 10,000 years
Language	Teton dialect of Siouxan	Pimian subgroup of Uto-Aztecan
Society	Patriarchal, hunter-warrior	Patriarchal, agricultural
Ceremonies	Sun Dance, sacred pipe tradition	Rain Dance, cactus wine tradition
History:		
European contacts	English, French, 1790 to present	Spanish, 1687-1776
Events	General Custer, Little Bighorn battle, 1876; Wounded Knee, 1892, 1973	U. S. Army scouts, Apache wars, 1860s; Pancho Villa's raids, 1918
Demography:		
Location	Southwest South Dakota	West of Tucson, Arizona
Population (1980)	14,500	17,600
Median age	17.5 years	21.0 years
Live traditional lifestyle	40 percent	65 percent
Live off reservation	30 percent	25 percent
Full-blood	48 percent	87 percent
Per capita visits to M. D., 1975	5.7	3.8

TABLE 2 (cont'd)
**Oglala Lakota and T. O. N.* Tribes Compared for Cultural,
 Demographic, and Environmental Factors**

Factor	Tribe	
	Oglala Lakota	Tohono O'Odham
Demography (cont'd):		
Percent within 30 minutes travel time to hospital	100	43
Number of villages on reservation	28	74
Population density, square mile	2.4	2.0
Environment:		
Altitude, feet	3,200	2,400
Life zone	Great Plains	Sonoran Desert
Precipitation	17 inches/year	9 inches/year
Background radiation estimated millirems per year	115	170
Water source	Surface and ground; some chlorinated	Deep ground; not chlorinated
Mean yearly temperature	47° F	67.5° F
Mean yearly days sunshine	250 (68 percent)	314 (86 percent)
Genetics: Red cell antigens	[11]	[21]
A	.38	.06
B	.03	.00
O	.56	.93
AB	.08	.00
Rh "negative"	.02	.00

*Tohono O'Odham Nation, hereinafter referred to as T. O. N.

were consulted. Diagnoses of Tohono O'Odham cases were obtained from three IHS hospitals, four private hospitals, and two Veterans Administration facilities located in Arizona. For the Oglala, records were retrieved and reviewed from eighteen hospitals scattered from Portland, Oregon, to the Mayo Clinic in Minnesota, including the IHS hospitals in Pine Ridge, Rosebud, and Rapid City.

Population figures for Pine Ridge were provided by the Oglala Tribal Council and the IHS. For the Tohono O'Odham tribe, the population register of all patients in a special computer database developed by the IHS Office of Research and Development was used, plus population estimates from the tribal rolls and United States census for those living in surrounding Arizona towns and cities [9].

A population pyramid comparison of these two tribes was made (not shown). Although the median age is greater for the Tohono O'Odham (21.0 years, compared to 17.5 years for Oglala), they have proportionately less population in the older age group (28 percent over age twenty-five) than the Oglala (38 percent over age twenty-five) (see table 2). The distribution of age by sex was similar for each tribe. Age adjustments were made by the direct method, in which various standard populations are used depending upon the desired comparisons [10].

For the comparison of red cell and Rh antigens shown in table 2, a survey was conducted of the first one hundred newborn records where the mother's blood type was recorded at the Pine Ridge Indian Hospital [11]. These deliveries had occurred during 1964 through 1966 and were assembled by Dr. Niswander of the genetics branch of the National Institute of Dental Health for the purpose of a survey of congenital defects and other birth data. This data was used instead of that collected by G. A. Matson [12] in 1938 from Sioux peoples whose exact residence was not listed. Environmental health records maintained by the IHS on the Pine Ridge and Tohono O'Odham Indian reservations were used to compare water sources for nitrates, arsenic, lead, other substances, and radiation levels.

The method of case certification is shown in table 3. Only four cases were included based on the death certificate alone. Tissue confirmation of cancer was 87 percent for the Oglala and 78 percent for the Tohono O'Odham. All persons not known to have died were located and were known to be alive at the end of 1979. Three cancer cases diagnosed for residents of the Pine Ridge

TABLE 3

Method of Case Confirmation for Oglala and Tohono O'Odham Tribes, Diagnosed during 1970 to 1979

Method	Tribe			
	Oglala		Tohono O'Odham	
	Number	Percent	Number	Percent
Tissue Reports				
<i>Autopsy</i>	15	9.6	23	20.4
<i>Biopsy</i>	79	50.6	38	33.6
<i>Surgical pathology</i>	42	26.9	27	23.9
<i>Subtotal</i>	136	87.2	88	77.9
Surgical findings (Tissue reports not found)	2	1.3	4	3.5
Clinical, x-ray findings	12	7.7	10	8.8
Health records only	5	3.2	8	7.1
Death certificates only	1	0.6	3	2.7
TOTALS	156	100.0	113	100.0

service area and seven for the Sells service area were excluded, because their tribal identity was other than that of the two groups in this study. In addition, five cases of skin cancer (I. C. D. 9, 173.0) in the Oglala and eight in the Tohono O'Odham were excluded from the following tables because of the difficulty of comparisons with other population statistics where these nonmelanotic neoplasms are also excluded. For the same reason, cancers in situ of

the cervix were also excluded in both tribes. Six neoplasms (pituitary adenoma, astrocytoma [grade II], meningioma, chordoma, mesothelioma, and thyroid adenoma) of "uncertain behavior" or classified by I. C. D. 9 as benign were excluded for the Oglala, although two of the six were listed as the cause of death.

For the Tohono O'Odham, five single cases diagnosed as mixed parotid tumor, ependyoma of spinal cord, pituitary adenoma, ovarian teratoma, and ocular teratoma, and two patients with craniopharyngiomas were similarly excluded.

RESULTS

Comparison of Incidence

Incidence rates by age for all cancers were higher in the Oglala than in the Tohono O'Odham (table 4). Average annual incidence rates compared with other United States ethnic groups are shown in table 5 and are age-adjusted to the United States all races standard population of 1970. Incidence curves by sex and age group for each tribe show the expected increase of cancer with age and correspond to the shape of the curve for all races.

The males from each tribe are very similar in their age-specific rates. Tohono O'Odham males have higher rates of cancer than United States males all races for ages 20–34, but substantially lower rates for every age group younger than 20 and older than 35 [13] (not shown in tables). Oglala male rates are higher than the United States males all races rate for the 25–34 age group but are lower for all age groups younger than 24 and older than 35. The Oglala female rate is consistently higher for almost every age group when compared to either males or females of either tribe. The Oglala females aged 30 to 39 years, 75 to 79, and 85 years and older have higher incidence rates than the United States all races rate for the same age groups.

The age-adjusted average annual incidence rates for each type of primary cancer in both tribes are listed in table 6 for males and table 7 for females. The Oglala and Tohono O'Odham were compared to each other by reference to a table of 95 percent confidence limits for a Poisson-Distributed variable by Haenszel [14]. The column for all races is derived by combining the incidence of cancers from the ten SEER reporting areas from 1973–76 [13]. Possible unstable rates based on three cases or less over the ten-

TABLE 4
Cancer: Mean Annual, Crude, and Age-Adjusted Incidence Rates,
per 100,00 Population Compared for Tohono O'Odham and
Oglala Indians by Age and Sex
1970-1979

Tribe Age/Sex	Tohono O'Odham		Oglala	
	M	F	M	F
0-4	0	0	0	31.6
5-9	0	0	0	0
10-14	0	0	0	14.2
15-19	16.1	0	19.8	0
20-24	38.4	0	0	0
25-29	44.1	41.9	40.2	36.9
30-34	55.9	24.5	53.5	122.4
35-39	67.3	65.6	45.4	292.2
40-44	36.2	173.0	49.6	193.1
45-49	57.1	92.6	169.8	210.9
50-54	168.5	418.9	491.4	499.0
55-59	517.2	299.4	202.7	491.4
60-64	720.0	507.3	794.9	838.1
65-69	555.6	681.8	1,025.2	630.6
70-74	1,216.2	685.0	909.3	1,247.4
75-79	1,521.7	888.9	647.4	2,086.3
80-84	526.3	357.1	1,863.9	1,201.2
85+	1,428.6	588.2	2,820.2	2,316.6
Total population (1975)	5,556.0	5,790.0	5,319.0	5,487.0
Number cases	59.0	54.0	71.0	84.0
Total rate: crude	106.2	93.3	144.3	165.5
Age adjusted to U. S. 1970 standard population	181.9	149.5	187.6	288.2

TABLE 5
Malignant Neoplasm, Average Annual Incidence Rates by Tribe, Ethnic Group, and Sex Compared, 1970 to 1979, Age- and Sex-Adjusted [39]

	Tribe		New Mexico	Black (U. S.)	White (U. S.)
Sex	Oglala	Tohono O'Odham	S.E.E.R.*	S.E.E.R.	S.E.E.R.
Male	187.6	182.0	158.9	435.9	361.1
Female	288.2	149.5	177.5	280.2	297.4

To U. S. Standard 1970 population.

*Includes Navajo, Apache, Pueblo tribes in Surveillance, Epidemiology, and End Results Study, University of New Mexico.

year study period are indicated by parenthesis.

Table 11 compares the frequency distribution for each tribe of primary neoplasms and reveals a distinctively different profile for each tribe. Proportionately, the Oglala males experience more cancers of the lung, pancreas, penis, and bladder than the Tohono O'Odham males. Male Tohono O'Odham patients had proportionately more stomach, liver, and testicular cancer.

The lung cancer rates for the Oglala at Pine Ridge (table 7) represent the highest rates reported for any American Indian tribe. As indicated in table 7, the Oglala female lung cancer mortality rates (34.6/100,000) may be the highest for females in the world. (The NIH publication, *Cancer Rates and Risks*, lists the highest rate of this cancer in the world in females in Hong Kong, where the rate is 30.4 per 100,000 [15]). The rates for male stomach cancers, liver, and biliary cancer, and possibly for multiple myeloma cancers in both sexes among the Tohono O'Odham, are ranked within the first ten countries in the world, although the rate for multiple myeloma is based on only three cases in females and one in males. Compared with males, all United States races, both tribes had significant deficits in colorectal, lung, prostate, and bladder cancers.

The Oglala females (table 11) had significantly more lung,

TABLE 6
Male Cancer Mean Annual Incidence Rates per 100,000
for Oglala, Tohono O'Odham, and All U. S. Races,
1970 to 1979, per 100,000
Age-Adjusted to 1970 U. S. Standard

Primary Site	I.C.D.A.	Oglala	Tohono O'Odham	U. S. All Races
Stomach	151.0	16.6	38.1	14.2
Colon	153.0	10.8	6.7	35.6
Rectum	154.0	6.6	5.6	18.7
Liver	155.0	(2.7)	16.8*	3.0
Gallbladder	156.0	4.5	8.6	1.0
Pancreas	157.0	14.3	0*	12.1
Lung	162.0	46.9	13.7	76.1
Prostate	185.0	19.4	16.4	65.4
Testes	186.0	0	10.5*	3.1
Penis	187.0	10.7	0*	0.9
Bladder	188.0	7.8	0	25.4
Kidney	189.0	18.7	11.6	9.0
Leukemia	204.0-207.0	(5.6)	6.1	12.4
Lymphomas	200.0-202.0	(5.8)	(3.6)	13.7
Myeloma	203.0	(6.7)	(1.9)	4.5

() = Rate based on less than three cases.

*P = 0.05 or less, tribes compared to each other, beyond 95 percent C. L.

I.C.D.A. = International Classification of Diseases Adapted for Use in the United States. Eighth revision USDHEW P.H.S. Publication No. 1693, 1969.

TABLE 7
Female Cancer Mean Annual Incidence Rates per 100,000 for Oglala,
Tohono O'Odham, and All U. S. Races, 1970 to 1979 per 100,000
Age-Adjusted to 1970 U. S. Standard

Primary Site	I.C.D.A.	Oglala	Tohono O'Odham	U. S. All Races
Stomach	151.0	21.4	(5.7)*	6.4
Colon	153.0	14.5	0	30.4
Rectum	154.0	0	(2.6)	11.6
Liver	155.0	(3.5)	(5.7)	1.3
Gallbladder	156.0	(6.7)	27.3*	1.8
Pancreas	157.0	10.3	(3.7)	7.9
Lung	162.0	34.6	0	21.1
Breast	174.0	47.5	23.3*	84.9
Cervix	180.0	46.9	15.0*	12.6
Uterus	182.0	9.8	10.4	30.0
Bladder	188.0	0	0	6.9
Kidney	189.0	0	(6.8)	4.3
Leukemia	204.0-207.0	11.4	0*	7.3
Lymphomas	200.0-202.0	(6.6)	0	10.0
Myeloma	203.0	(3.1)	7.1	3.2
Melanoma	172.0	0	9.8*	5.3

() = rate based on less than three cases.

*P = 0.05 or less, tribes compared to each other, beyond 95 percent C. L.

I.C.D.A. = International Classification of Diseases Adapted for Use in the United States.
 Eighth revision USDHEW P.H.S. Publication No. 1693, 1969.

stomach, colon, pancreas, breast, leukemia, and cervical cancer than Tohono O'Odham females. The Tohono O'Odham females had excess cancer of the gallbladder, ovaries, and melanoma of skin. Compared to females from all races (table 7), the Oglala lung cancer, cervical cancer, and stomach cancer incidence appears unusually high. The Tohono O'Odham showed only a comparatively high rate for cancer of the gallbladder ($p = .01$ by chi square test). Females from both tribes had a relative deficit in colorectal, breast, uterine, and bladder cancers compared to all races.

Incidence by year of diagnosis showed no obvious pattern over time. Proportionately fewer cases were diagnosed among the Tohono O'Odham every year (except for 1976) than among the Oglala. An average of 11.4 cases per year were diagnosed among the Tohono O'Odham and an average of 15.6 cases per year among the Oglala. This difference was not statistically significant by the chi square test.

Mortality Compared

Table 8 compares mortality rates for these tribes with all American Indians, whites, and Blacks. Eight Oglala and eleven Tohono O'Odham deaths were from neoplasms diagnosed before 1970. Their death rates from 1970 to 1979 were age-adjusted to two different United States standard populations to take advantage of the published rates for twenty years in the *Atlas of Cancer Mortality* [16] as well as the rates published by SEER. The apparent increase in the relative rates for the two tribes when age-adjusted to the United States standard populations for 1960 and 1970 is an artifact reflecting the increased proportion of the elderly in the United States from 1960 to 1970.

A closer comparison of deaths from certain cancers is shown in table 9, in which each tribe is compared with the expected number of deaths when calculated using age- and sex-specific death rates for Native Americans (i. e., Navajo, Apache, Pueblo tribes) in the New Mexico Tumor Registry, 1973–77, as reported by Young et al. [13]. The cancer profiles become more specific when the Standard Mortality Ratios (SMRs) are calculated by dividing the observed numbers by the expected number and then are tested for statistical significance by the chi square test.

Based on these calculations, Oglala males and females are at a significantly greater risk of dying from lung cancer ($p = .001$ and

TABLE 8
Mean Annual Cancer Mortality Rates, Age-Adjusted, Oglala and Tohono O’Odham Compared to Other U. S. Ethnic Groups

Rate per 100,000

Age-Adjusted to 1970 U. S. Standard

	Oglala		Tohono O’Odham		S.E.E.R.		1973–1976	I.H.S. Data-base
	No.	Rate	No.	Rate	White	Black		U. S. Indian
Male	53	171	55	174	209	288		N.A.
Female	67	219	44	137	136	159		N.A.

Age-Adjusted to 1960 U. S. Standard

	Oglala		Tohono O’Odham		Atlas U.S. Non-White 1950–1969 [16]		U.S. Indian
	No.	Rate	No.	Rate	White	Black	
Male		157		162	174	189	100
Female		204		113	130	142	110

.0001) than New Mexico Indians. Oglala females are at greater risk of dying from stomach ($p < .001$), cervical ($p = .001$), and blood cancers ($p = .01$) than the New Mexico Indian population. The male Tohono O’Odham are at greater mortality risk from stomach ($p = .05$), liver, and biliary system cancers ($p = .001$) and multiple myeloma ($p = .05$). Females from this tribe are at greater mortality risk from breast cancer ($p = .05$).

In the combined category of liver and biliary tumors, there were two deaths from primary hepatomas (one male, one female) among the Oglala compared with five deaths among Tohono O’Odham males and two deaths among females (seven total). Only two Oglala females died from primary gallbladder cancer, compared with seven Tohono O’Odham females who died from

this cancer. There were no male gallbladder deaths among the Oglala but three such deaths among the Tohono O'Odham. Blood cancers listed in table 9 exclude multiple myeloma. If all blood cancers were combined for Oglala females, then the rate would be significantly higher statistically ($p = .02$) than the all-United States Indian females rate.

Deaths from specific cancer of greatest interest are listed in table 10, which compares the cancer death rates in these two tribes to those of other ethnic groups after adjusting cancer death rates for each sex by age. The similarities and differences shown here suggest that when the Oglala cancer rates depart from the New Mexico Indian pattern, they move closer to the rates for whites and Blacks than for all United States Indians (except for cervical cancer). This result possibly could have been predicted by the data listed in table 1 relative to distribution of major blood genotypes, history of contact with Europeans, and degree of Indian heritage. Conversely, rates for cancer deaths for the Tohono O'Odham, whose gene pool is relatively homogeneous, are considerably different from those of the whites, Blacks, and all United States Indians in all categories of cancer except for breast cancer rates.

DISCUSSION

In spite of the small numbers and relatively short duration of ten years, it does appear that the two study tribes present different cancer incidence and mortality patterns from each other, from the all-New Mexico Indian patterns, and from United States Blacks and whites [13, 16]. It is therefore of interest to ask whether these two very different tribes possibly could be representative of any other Native American groups or whether the alternative hypothesis, that each is a relatively isolated population, is more correct.

A good argument can be made that the Tohono O'Odham patterns may be representative of only one other closely related tribe—the Pima—because both share a similar history, language, desert environment, and blood gene alleles [17]. These two tribes are markedly different from the other Southwestern tribes such as Navajo, Apache, and Pueblo tribes for the above characteristics. The blood alleles of the Pima and the Tohono O'Odham are closer to those of the Pueblo groups than they are to other Southwestern tribes, but the Pima and Tohono O'Odham are closer to the Yaqui tribe (in southern Arizona and northern Sonora, Mexico) in physi-

TABLE 9
Standard Mortality Ratios for Deaths by Primary Neoplasms, Oglala and T.O.N. Tribes
Compared with New Mexico Indians

Site	Oglala			Tohono O'Odham				
	Number Observed	Number Expected**	SMR	P	Number Observed	Number Expected**	SMR	P
Male:								
Stomach	7	6.6	1.1	NS	12	6.7	1.8	<.050
Colon-Rectal	3	3.1	1.0	NS	4	3.0	1.3	NS
Liver & Biliary	2	2.6	0.7	NS	10	2.4	4.2	<.001
Lung	9	2.7	3.4	<.001	5	2.9	1.7	NS
Prostate	5	7.9	0.6	NS	5	5.1	1.0	NS
Pancreas	4	1.8	2.2	NS	0	1.6	-	NS
Blood*	2	1.7	1.2	NS	4	2.0	2.0	NS
Myeloma	2	0.9	2.2	NS	3	0.9	3.3	<.050
Female:								
Stomach	4	0.8	4.7	<.001	3	1.5	2.0	NS
Colon-Rectal	3	1.7	1.8	NS	0	1.9	-	NS
Liver & Biliary	2	5.3	0.4	NS	11	6.8	1.6	NS
Pancreas	3	3.3	0.9	NS	1	3.2	0.3	NS
Lung	8	0.4	20.0	<.0001	0	0.3	-	NS
Breast	7	3.5	2.0	NS	8	4.1	2.0	<.050
Cervix	9	2.4	3.7	<.001	4	3.1	1.3	NS
Blood*	7	2.4	2.9	<.01	0	2.4	-	NS
Myeloma	1	0.7	1.4	NS	3	1.2	2.6	NS

*Myeloma (I.C.D. 203) not included in category of blood, above.

**Young (1981) SEER Statistics, New Mexico, pp. 564, 566 [13].

NS = not statistically significant difference, probability greater than 0.05.

P = probability values from chi square test.

cal measurements than they are to the Zuni, Navajo, and Hopi peoples [18].

Carraher [19] has published the mortality rates for cancer by primary site in the Pima resident on one reservation, and these rates are almost identical to the rates for the Tohono O'Odham listed in tables 10 and 11. Blood alleles in Yaqui have not been determined; however, based on preliminary studies, the frequency distribution of cancers among the Yaqui appear to be very different from the distribution in the Tohono O'Odham [6]. This may in part be attributed to intermarriage between Yaqui and other peoples over the last century.

However, the situation for the Oglala may be much different. Their history indicates close contact with many other bands collectively called Sioux in addition to the Cheyenne, Arapaho, Pawnee, Kiowa, and other tribes of the northern and southern Plains [20]. Planned intertribal marriages as well as the capture of wives occurred, and intermarriage with English and French are also documented. Red cell antigen studies do not show a distinctive pattern for the residents of Pine Ridge as compared to other tribes of the Plains [12,21].

There is some evidence that lung cancer death rates are higher among Great Plains tribes from the Dakotas, Montana, and Oklahoma, compared with other tribes in the Southwest, Southeast, North, and Northwest IHS administrative areas. Breast cancer death rates were also highest in the IHS areas serving the Dakotas that are populated primarily by Sioux and Chippewa tribal groups [22].

Causes for these distinctive cancer patterns have not been elucidated. Cigarette smoking may be an important factor in the incidence of lung cancer among the Oglala. Tobacco has been of cultural and religious importance for many years among the Great Plains tribes [23], and eighteen of the twenty-one lung cancer cases had histories of consuming more than one pack of cigarettes per day. Histologically, ten patients had squamous cell carcinoma, four had adenocarcinoma, two had oat cell cancer, one had large cell carcinoma, and three had cancers not specified by cell type (one was not tested). None had any history of working in uranium mines, and mining has never been an important occupation for the Pine Ridge Sioux. Conversely, Tohono O'Odham reservation residents generally have not been observed to use cigarettes. Their ceremonial use of tobacco has been mentioned, but social use was "practically universal among older Tohono O'Odham and Pima men, less common among women, and practically forbidden for

TABLE 10
Age, Sex-Adjusted Mean Annual Mortality Rates for Selected Cancers in Oglala and T.O.N.
Compared to All U.S. Indians, Blacks & Whites (Rates per 100,000 Population)

Cancer Site	I.C.D.9	Sex	1970-1979		1970		1973-1976			1950-1969		
			Number	Crude Rate	Adjusted Rate	Total U.S. Rates			Age-Adjusted, 1960			
						White	Black	Indian	White	Black	Indian	
Lakota:												
Lung	(162)	M	9	18.3	25.2	64.3	79.8	13.0	38.0	38.0		
	F	8	17.7	34.7	15.0	15.0	4.6	6.3	6.3			
Urinary Tract	(188-189)	M	5	10.2	13.0	NA	NA	5.9	10.6	7.8		
Breast	(174)	F	7	13.8	25.9	27.0	26.2	10.5	25.6	22.0		
Cervix	(180)	F	9	21.7	38.0	4.2	11.8	17.1	7.8	10.6		
Colon	(153)	F	3	11.2	19.9	16.5	17.1	7.3	16.5	17.1		
T.O.N.:												
Liver & Biliary	(155-156.9)	M	10	18.0	30.3	NA	NA	8.0	6.0	8.0		
	F	11	19.0	36.7	NA	NA	13.2	6.0	5.2			
Stomach	(151)	M	12	21.6	33.6	9.0	17.3	14.4	15.2	24.2		
Multiple Myeloma	(203)	M	3	5.4	7.6	2.9	6.6	2.5	1.8	2.8		
	F	3	5.2	10.6	2.1	4.6	1.5	1.2	1.9			
Breast	(174)	F	8	13.8	24.8	27.0	26.2	10.5	25.6	22.0		

Cancer incidence and mortality in the U. S.; 1973-76.

N.A. = rates not available for combined category.

Atlas of Cancer Mortality among the U. S. Non-White 1950-69. Oglala and T.O.N. rates adjusted to 1960 U.S. population drop from 8 to 12 percent below the 1970 age-adjusted rates.

TABLE 11
Frequency Distribution of Cancer by Primary Site,
Three Native American Ethnic Groups Compared

Sex	Males			Females		
	Oglala	T.O.N.*	Alaska Native[5]	Oglala	T.O.N.	Alaska Native[5]
Ethnicity	Percent	Percent		Percent	Percent	
Type Primary						
() ICD 8th Number						
Salivary Glands (142)	0	0	1.1	0	0	3.2
Nasopharynx (147)	0	0	4.8	0	0	1.9
Esophagus (150)	2.8	0	3.2	1.2	0	0.6
Stomach (151)	10.0	20.3	5.3	5.7	3.6	3.8
Colon (153)	2.8	3.4	11.1	4.8	0	13.9
Rectum (154)	2.8	1.7	7.4	0	1.8	6.3
Liver (155)	1.4	8.5	4.2	1.2	3.6	0.6
Gallbladder & ducts (156)	4.3	5.1	2.1	2.3	19.9	7.6
Pancreas (157)	4.2	0	3.7	4.8	1.8	3.2
Lung (162)	15.3	1.7	17.5	11.9	0	4.4
Bone (170)	0	0	1.6	0	0	0.6
Melanoma (172)	0	0	0	0	7.1	0.6
Breast (174)	0	0	0	28.6	17.9	13.9
Prostate/Cervix (185/180)	11.4	8.5	8.5	16.1	10.9	5.1
Testes/Uterus (186/182)	0	5.1	2.6	3.4	7.1	2.5
Penis/Ovary (187/183)	5.6	0	NR	1.2	3.6	4.4
Bladder (188)	4.2	0	3.2	1.2	0	1.3
Kidney (189)	7.1	8.5	4.2	1.1	3.6	5.1
Brain CNS (191, 2)	1.4	0	1.6	2.4	0	3.2
Thyroid (193)	1.4	0	0	1.2	1.8	5.7
Unspecified Site (195-199)	8.6	10.2	6.3	9.2	5.5	5.7
Lymphoma (200-2)	2.8	1.7	3.2	2.4	0	0.6
Myeloma (203)	2.8	1.7	0	1.2	5.4	0
Leukemia (204-7)	2.8	5.1	2.6	7.1	0	1.3
Total Cancers	72	59	189	84	56	158
Total Patients	71	58	189	83	55	158

NR = not reported

* = Tohono O'Odham nation

young men" [24]. Only 5.4 percent of hospitalized Tohono O'Odham patients during 1961 to 1965 gave histories of smoking more than one pack per day, compared to 26 percent of "non-Southwestern" tribal patients. This latter group included many members from the Plains tribes [25].

Cigarette usage may also account for the male bladder cancers in the Oglala and their total absence in the Tohono O'Odham [26]. However, laryngeal cancer, which is often associated with smoking and alcohol use, was low in both tribes; only one case was reported during this period in each tribe.

The Oglala have been large consumers of meat. The Tohono O'Odham eat red meat infrequently, which is a possible reason accounting for the higher rate of colon cancer among the Oglala. The excess stomach cancer among the Tohono O'Odham cannot be explained by environmental factors as currently known. Nitrates in drinking water are low for both tribes. While alcohol abuse is very high, it is very high for both tribes and is ranked as their number one health problem by tribal health planners. Nutrition surveys of the Tohono O'Odham have mentioned lack of vitamin A as well as fresh vegetables in their diet [27]. A number of investigators have discussed the relationship between stomach cancer and blood group A [28]. However, only 6 percent of this population have blood group A (see table 2).

The Tohono O'Odham have the lowest rates for colon and rectal cancers but the highest death rates for stomach and gallbladder cancers, compared to all other tribal groups served by IHS administrative areas [22]. Gallbladder cancer was found to be concentrated within one dialect group (the Kuk) of the Tohono O'Odham living in one (Chukut Kuk) of the eleven districts of the main reservation. None of the twenty-six cases diagnosed from 1961 through 1979 were consanguineous. Nevertheless, a strong genetic factor is still suspected, because this was the only primary cancer among either tribe that was concentrated geographically within one district of their reservations. Contrary to expectations, this group of Tohono O'Odham had the lowest rate for symptomatic gallstones compared with the other dialect groups (village communities), although Tohono O'Odham generally experience a high rate of reported symptomatic cholelithiasis (1 percent for males and 5 percent for females, fifteen years of age and older).

There were four cases of melanoma among female Tohono O'Odham, but no cases reported for the Oglala. This finding was not unexpected, since the former tribe has, theoretically, greater

exposure to ultraviolet radiation than South Dakota residents. The white population of southern Arizona has been reported to have one of the highest melanotic and nonmelanotic skin cancer rates in the world due to the combination of high solar radiation, low humidity, and less atmospheric ozone [29]. The female white population of New Mexico also has a high melanoma rate, 10.7/100,000 per year, compared with 6.0/100,000 per year for all females in all sites reported by SEER [13]. However, the incidence rate of 9.8 per 100,000 of nonmelanotic skin cancer among the Tohono O'Odham is five times that of the other Southwestern tribes (1.8 per 100,000) in the New Mexico SEER Tumor Registry [13]. Therefore, other factors must be of importance, because the tribes in New Mexico are also heavily exposed to dry climate, elevation, and sunshine. One factor may be the number of pigmented nevi (moles) counted in Tohono O'Odham people. When Gabel [18] examined the Tohono O'Odham in 1938, he found absence of nevi in only 4 percent of the people compared with the relative absence of nevi in the Yaqui (41 percent), Zuni (55 percent), Hopi (65 percent), and Navajo (50 percent).

Little information is available regarding factors that may explain the higher death rate from cervical cancer among the Oglala compared with the Tohono O'Odham. Both tribes experience high fertility rates (Tohono O'Odham = 102 and Oglala = 189 per 1,000 female population, 15–44 years). Both have similar rates of teenage pregnancies (26 percent), and women from both tribes are exposed to uncircumcised males. Both tribes have had routine cervical cytology examinations as part of their health programs at least since 1970. Ten cases of cancer in situ were found for the Oglala (for a ratio of 0.6:1 in situ to invasive cases). Sixteen in situ cases were diagnosed for the Tohono O'Odham for a ratio of 2.7:1 in situ to invasive. The mean age of diagnosis for Oglala with invasive cancer of the cervix was 55.4 years, compared to 48.3 years for the Tohono O'Odham. These facts suggest that the screening programs may have been more effective in reaching the Tohono O'Odham women at a younger age.

The relatively high incidence of breast cancers in both tribes was surprising, since others have commented on the uncommonness of this type of primary tumor among American Indians [30] as compared to Blacks and whites in the United States. The usual factors suspected for a high risk of breast cancer were not present in patients from either tribe, i. e., null parity, unmarried status, and absence of breast feeding. Tumors were more common in the left

breast for the Oglala (56 percent) than in the Tohono O'Odham (50 percent). The most common histological type for both tribes was invasive ductal adenocarcinoma. There was also a difference in the age of onset. Thirty-one percent of the sixteen Oglala tumors occurred before age forty-four (menopause), but only the sarcoma of the breast occurred in a premenopausal Tohono O'Odham woman (10 percent). All nine adenocarcinoma occurred in Tohono O'Odham patients who were forty-four years or over at time of diagnosis. Fibroadenomas and fibrocystic disease were stated by clinicians to be uncommon in both groups. Indeed, this diagnosis could not be found in the computer databases for either tribe.

The occurrence of multiple myeloma in both tribes conforms to past observations of a higher incidence of this cancer in general among agricultural workers. Ranching and farming are the principal occupations for those employed in both tribes. None of the members of either tribe are exposed to suspected high risk occupations such as leather-making or tool and dye-making [31].

Multiple myeloma may have increased during the 1970s. Only three (0.4 percent) cases were diagnosed from among 693 American Indian cancer specimens studied by pathologists at the NCI over a fifteen-year period from 1950 through 1965 [30]. The NIH study included all Native Americans from undisclosed locations and tribal affiliations in the database for the NCI. The total population represented by these tissue samples from 693 tumors is unknown. Therefore, rates cannot be compared. On an annual basis, the six deaths among the Tohono O'Odham from multiple myelomas (proportionate to all their cancer deaths) during the 1970s means that this cancer is fourteen times more common in the Tohono O'Odham than among the NCI Indian population.

Comparisons with Other Tribal Groups and with the United States Population at Large

Although studies of certain specific types of cancers occurring in American Indians have been reported sporadically, few studies have been conducted of the distribution of cancers in specific tribes over an extended time period. Lanier et al. [3] and Blot et al. [32] have studied cancers in the Alaska Native population, composed of six ethnic groups, over a twenty-year period during which changes in primary cancer sites over time have been reported. However, these changes in both populations lacked statis-

tical significance because of the extremely small number of cases involved. In Alaska Natives, Lanier [5] reported increases in lung, liver, prostate, and cervical cancers over a fourteen-year period (see table 11). Lung cancer increases since the 1950–65 era were also reported by Schaefer et al. [33] for Canadian Eskimos from 1966 through 1974.

The National Cancer Center Institute *Atlas for Cancer Mortality among United States Non-Whites* [16] has provided the first rates for cancer mortality by primary site for all American Indians in the United States during a twenty-year period (1950–1969). Previously, cancer deaths for a few specific reservation communities could be compared to Blacks, whites, or all races but not to “all Indians”; now comparisons could be made with American Indians as a group. Because the Navajo are the largest tribe in the United States and account for 18 percent of the total population identified as Native American (they also accounted for approximately 19 percent of the deaths from cancer during 1969), these two sources are unavoidably overly influenced by this one ethnic group.

The most striking differences between Native American cancer rates and that of the United States all races population have arisen from the comparisons between tribes (or ethnic Native American cultures) for certain primary cancers. Some tribes show extremely high rates for cancers that are rarely seen either in other Native American groups or in non-Indians.

For example, Alaska Natives (table 11) have one of the highest rates for nasopharyngeal cancer in the world—age-adjusted at 9.8 per 100,000 per year [5]. This cancer site ranks as their eighth most frequent invasive cancer, with 3.5 percent of the total cancer for over fifteen years. Of the 290 invasive cancers reported during twenty-five years among the Tohono O’Odham, only one case of nasopharyngeal cancer was reported. Even more striking differences between Alaska Natives and Arizonan desert dwellers were seen for cancer of the lungs and colon, representing 12 percent each of all cancers reported for Alaska Natives [5] compared with 1.4 percent each of all Tohono O’Odham cancers [6]. On the other hand, the Tohono O’Odham have one of the highest incidence rates (27 per 100,000 per year, females, age-adjusted) in the world for primary cancer of the gallbladder, which is their highest ranked cancer (15 percent). Stomach cancer, ranked number two, accounted for 11 percent of all cancers for the Tohono O’Odham, 6.3 percent of all cancers in the Oglala, but only 4.6 percent of all

Alaska Native cancers. (See table 11.) According to Lanier [5], the cancer frequency rates in the Alaska Native population vary among the three composite ethnic groups: Eskimos, Aleuts, and Indians.

Overall, the incidence rates for Native Americans for all cancers are usually less than corresponding rates for all races, or for whites or Blacks. The NCI reported an age- and sex-adjusted incidence rate of 164 cancers per 100,000 per year for Native Americans in the SEER programs, compared with rates of 335 and 373 for whites and Blacks, respectively [1]. Mortality rates from neoplasms are also generally lower than the United States all races rate. The Oklahoma tribes' mortality rates for cancer for both sexes were 58 percent less than the reported Oklahoma white cancer death rates [34].

These comparisons may be misleading, because cancer incidence has been reported for only a few tribes other than three of the major Southwestern cultures (Navajo, Tohono O'Odham, and Pueblo). Lanier [5] reported age-adjusted rates of incidence of 314 per 100,000 for both sexes of Native Alaskans, much higher than the SEER Indian rates reported by Baquet and Ringer [1] and not statistically significantly different from the rates for whites and for all races.

Comparisons of Indian cancer rates with other ethnic groups within the same ecological zones (and therefore somewhat similar environments) have rarely been reported except for those at the University of New Mexico's SEER program. According to Black and Key [35], "the incidence rates for nearly every major cancer are either markedly lower or higher for Indians than for Anglos [*Anglo* is a local word referring to peoples of northern European extraction]. Hispanics always occupy an intermediate position between the two, suggesting 'dose response' relationships" [35]. (*Dose response* in this context refers to the admixture of Spanish and Native Mexican-American bloodlines in New Mexico). However, this data is biased, because Navajo account for 75 percent of the Indians reported by this data source, and therefore these statistics are not applicable for all Indians.

CONCLUSIONS

From the results of this study of the patterns of cancer observed among the Oglala Sioux and the Tohono O'Odham, it appears that specific tribal patterns may vary as much from the total cancer

patterns for all American Indians as specific European ethnic group cancer patterns differ from the total races pattern in the United States [36,37]. This result is to be expected when considering the profound differences in the history, environment, genetics, and culture of the various groups and tribes.

This brief review of the incidence, prevalence, and mortality from neoplasms in Native Americans justifies a few generalizations at present. Exceptions to each of the following may occur as knowledge expands:

1. The proportion of each type of primary neoplasm for any given ethnic group of Native Americans will vary considerably, as much or more between tribal groups as between European ethnic societies, and will probably vary more than rates among third-generation European stock residents in the United States.
2. Total cancer rates in Native Americans will usually be lower than age- and sex-adjusted rates for whites or Blacks in the United States. This seems to be especially true for childhood cancer rates in Southwestern tribes [38].
3. All rates are statistically unstable, because they have large confidence intervals as a result of the small numbers of cancer cases in each tribe, and both completeness of reporting as well as accuracy of diagnosis may vary considerably from tribe to tribe.
4. Total cancer rates seem to be increasing for those few tribes where adequate studies have been repeated over two or more decades [5,6]. A number of primary types rarely or never diagnosed before 1975 have been seen for the first time in a few tribes during the period 1975-85 (e. g., uterine, lung, kidney).
5. With the exceptions of cancer of the cervix, survival time after cancer diagnosis seems not to have improved and remains less than United States whites for most primary neoplasms. However, missing information about stage (or extent) of the tumor at the time of diagnosis makes these comparisons difficult.
6. Several different tribal ethnic groups have shown a pattern of gastrointestinal cancer quite different from those in whites. These groups have an excess of cancers primary to the gall-

bladder (3 to 7 times, based on adjusted rates of whites) and stomach (3 to 200 times more), but a striking deficit (except for Alaska Natives) of only from 0 to 10 percent of white rates in esophageal, colon, and rectal neoplasms. Only a few tribes (Alaskan tribes) studied to date have shown colorectal cancer rates approaching parity with white rates.

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