An Update on Cancer in American Indians and Alaska Natives, 1999-2004

Supplement to ***Cancer***

Cancer in American Indian and Alaska Native Young Adults (Ages 20–44 Years): US, 1999–2004

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BACKGROUND. An examination of cancer incidence patterns in American Indians and Alaska Native (AI/AN) young adults may provide insight into their present and future cancer burden.

METHODS. To reduce racial misclassification, incidence data were linked with the Indian Health Service (IHS) patient services database. Age-adjusted cancer incidence rates per 100,000 (AAR) and corresponding rate ratios (RR) for young adults (ages 20-44 years) were compared across IHS regions and for selected cancers within Contract Health Service Delivery Area counties by race (AI/AN vs non-Hispanic whites [NHW]) and sex.

RESULTS. The all-sites cancer incidence rate was lower for AI/ANs (AAR of 83.8) than for NHWs (AAR of 111.2) (RR of 0.75) but varied by IHS regions. Among the leading cancers in AI/AN females the risk was elevated for stomach (RR of 3.22), colorectal (RR of 1.30), uterine (RR of 1.61), and kidney (RR of 1.39) cancers and was lower for breast (RR of 0.70) and thyroid (RR of 0.71) cancers. Among AI/AN young adult males the risk was elevated for stomach (RR of 2.62), liver (RR of 1.89), and kidney (RR of 1.59) cancers and lower for testicular germ cell cancer (RR of 0.64) and lymphoma (RR of 0.60). The risk for these and other cancers varied across IHS regions.

CONCLUSIONS. Many of the cancer patterns that characterize the AI/AN population overall are apparent among young adults. Compared with NHW young adults, the overall cancer burden among AI/AN young adults was lower but varied for selected cancers and across IHS regions. Cancer control and research strategies are needed to address the unique genetic, social, cultural, and lifestyle aspects of AI/AN young adults. ***Cancer* 2008;113(5 suppl):1153–67.** *Published 2008 by the American Cancer Society.**

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Health disparities have persisted for many years among the American Indian/Alaska Native (AI/AN) populations and other racial and ethnic populations in the US.[1-3] Although the overall cancer burden appears lower in the AI/AN population than in other racial and ethnic groups, the incidence and death rates for selected cancers, and within specific geographic regions of the US, are higher,[4-7] overall cancer survival rates are lower,[8,9] and cancer death rates may be increasing for selected cancers.[6,9] With more than 560 federally

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recognized tribes throughout the US, each with its own genetic makeup, social customs, culture, and lifestyles, these differences may reflect unique exposure opportunities and genetic predispositions.

There are several compelling reasons for examining the cancer burden in young adults between the ages of 20-44 years. An examination of incidence patterns in this age group may foretell the future cancer burden (because of unique and changing exposure opportunities of young adulthood) and provide insight into etiologic relations (because the time since exposure and diagnosis may be somewhat shorter in young adults than for older adults).[10-12] In particular, an analysis of incidence patterns among the AI/AN young adult population compared with the non-Hispanic white (NHW) young adult population may provide insight into the present and future disease burden in the AI/AN population and serve as a critical first step toward describing, monitoring, and eventually eliminating health disparities.

Past efforts to characterize the burden of cancer in the AI/AN population accurately have been hindered by incomplete population coverage and racial misclassification, thus leading to the under–reporting of cancer incidence in the AI/AN population. Through the efforts of the 2 federal cancer surveillance programs, the Centers for Disease Control and Prevention (CDC)'s National Program of Cancer Registries (NPCR) and the National Cancer Institute (NCI)'s Surveillance, Epidemiology, and End Results (SEER) program, there are now population-based cancer registries operating in all 50 states and the District of Columbia. The combined coverage of the 2 federal programs now allows us to better monitor the burden of cancer in racially, ethnically, and geographically diverse populations throughout the US, including the many diverse AI/AN populations.[13]

The standard cancer registration practice of abstracting race information directly from medical records appears to underestimate the cancer burden in the AI/AN population, and special methods such as the linkage of cancer registry data to the Indian Health Service (IHS) patient services database are therefore required to obtain more precise estimates.[2,4,14] The IHS provides medical services to AI/AN persons who are eligible members of federally recognized tribes. Services are provided to residents of Contract Health Service Delivery Areas (CHSDA), counties specifically served by the IHS. Linkage of cancer registry data to IHS records and analyses restricted to CHSDA counties have helped address issues related to the misclassification of race in the AI/AN population.[4,14]

The purpose of this report is to describe cancer incidence in the AI/AN young adult population (ages 20-44 years) and to compare it with that among NHW young adults. This analysis is part of a larger effort to characterize the cancer burden in the AI/AN population as a whole by IHS regions. We anticipate that our findings will inform cancer control planners about the needs of this population and stimulate research into the causes and management of cancers in AI/AN young adults.

MATERIALS AND METHODS

Detailed descriptions of the data sources and methods used for this analysis are found in another article in this supplement.[14]

Cancer Cases

Cancer incidence data for the period 1999 through 2004 were analyzed from 47 population-based registries that participate in either or both of the 2 federal cancer surveillance programs, provided permission for use of their data, and met data quality criteria (see footnote in Table 1). Data were collected and reported by use of standards established by the North American Association of Central Cancer Registries (NAACCR).[15] Primary site and histology were coded according to the *International Classification of Diseases for Oncology* (ICD-O) edition in use at the time of diagnosis and converted to the third edition.[16] For this report, cancers were categorized according to the SEER site recodes and the SEER modification of the third edition of the *International Classification of Childhood Cancer* (ICCC-3) groupings.[17] Because pediatric cancers tend to be disseminated at the time of diagnosis, the ICCC was developed to better characterize these cancers by using primarily histologic information.[18] The SEER site recodes were developed to categorize adult cancers by primary site in the body in which the cancer arose (eg, digestive system, respiratory system, etc). Cancers in adolescents and young adults include cancers that could be characterized by both of these coding systems.[19,20] Therefore, a combination of the 2 systems was used to identify and categorize selected cancers by use of SAS software (version 9.1; SAS Institute Inc, Cary, NC)[21] (for details see Supplementary Table 1 at www.cdc/cancer-URL to be determined). Cancers defined mainly on the basis of histology (eg, leukemia, lymphoma, melanoma, sarcoma, etc) were put into their respective ICCC-3 categories first; the remaining cancers, which were primarily carcinomas, were then classified by the appropriate SEER site recodes. When possible, can-

TABLE 1
All Cancers Combined Incidence by Indian Health Service Region for American Indians/Alaska Natives[a] and Non-Hispanic Whites, Ages 20-44 Years, US, 1999-2004

		CHSDA Counties							All Counties						
IHS Region	Sex	AI/AN Count	AI/AN Rate[b]	95% CI For AI/AN Rate	NHW Count	NHW Rate[b]	Rate Ratio[c] (AI/AN:NHW)	95% CI For Rate Ratio	AI/AN Count	AI/AN Rate[b]	95% CI For AI/AN Rate	NHW Count	NHW Rate[b]	Rate Ratio[c] (AI/AN:NHW)	95% CI For Rate Ratio
Northern Plains	Both sexes	500	105.5	96.4-115.2	16,897	106.7	0.99	0.90-1.08	698	78.6	72.9-84.7	86,447	109.6	0.72[d]	0.66-0.77
	Males	187	79.7	68.6-92.1	6258	78.7	1.01	0.87-1.17	259	57.9	51.0-65.4	32,150	81.3	0.71[d]	0.63-0.80
	Females	313	129.8	115.7-145.0	10,639	134.8	0.96	0.86-1.08	439	98.9	89.8-108.6	54,297	138.1	0.72[d]	0.65-0.79
Alaska[e]	Both sexes	249	114.9	101.1-130.1	1080	104.1	1.10	0.96-1.27	249	114.9	101.1-130.1	1080	104.1	1.10	0.96-1.27
	Males	80	74.3	58.9-92.5	434	80.8	0.92	0.71-1.17	80	74.3	58.9-92.5	434	80.8	0.92	0.71-1.17
	Females	169	154.9	132.4-180.1	646	129.1	1.20[d]	1.01-1.42	169	154.9	132.4-180.1	646	129.1	1.20[d]	1.01-1.42
Southern Plains	Both sexes	760	120	111.5-128.8	5841	103.6	1.16[d]	1.07-1.25	876	89.9	84.0-96.1	32,337	110.3	0.81[d]	0.76-0.87
	Males	257	82.2	72.4-93.0	2182	77	1.07	0.93-1.22	292	59.3	52.7-66.6	12,504	85.1	0.70[d]	0.62-0.78
	Females	503	155.7	142.4-170.0	3659	130.4	1.19[d]	1.09-1.31	584	119.9	110.4-130.1	19,833	135.7	0.88[d]	0.81-0.96
Pacific Coast	Both sexes	524	65.3	59.8-71.1	32,552	113.4	0.58[d]	0.53-0.63	679	44.9	41.6-48.5	62,842	114.6	0.39[d]	0.36-0.42
	Males	202	50.7	43.9-58.2	12,670	87.7	0.58[d]	0.50-0.66	268	35	30.9-39.5	24,857	89.6	0.39[d]	0.34-0.44
	Females	322	79.5	71.0-88.6	19,882	139.4	0.57[d]	0.51-0.64	411	55	49.8-60.6	37,985	140.4	0.39[d]	0.35-0.43
East	Both sexes	104	55.6	45.5-67.4	21,608	116.8	0.48[d]	0.39-0.58	513	36.9	33.8-40.2	222,841	114.8	0.32[d]	0.29-0.35
	Males	34	35.7	24.7-49.9	8028	87.3	0.41[d]	0.28-0.57	182	25.6	22.0-29.6	82,953	85.8	0.30[d]	0.26-0.35
	Females	70	76.2	59.4-96.3	13,580	146.2	0.52[d]	0.41-0.66	331	48.5	43.5-54.1	139,888	143.6	0.34[d]	0.30-0.38
Southwest	Both sexes	704	65.4	60.7-70.5	12,766	107.8	0.61[d]	0.56-0.66	760	60.2	56.0-64.7	24,717	107.7	0.56[d]	0.52-0.60
	Males	246	46.2	40.5-52.4	4871	81	0.57[d]	0.50-0.65	268	42.5	37.5-47.9	9383	80.5	0.53[d]	0.46-0.60
	Females	458	83.5	76.0-91.5	7895	135.3	0.62[d]	0.56-0.68	492	77.1	70.4-84.3	15,334	135.7	0.57[d]	0.52-0.62
Total	Both sexes	2841	83.8	80.8-87.0	90,744	111.2	0.75[d]	0.73-0.78	3775	60.5	58.5-62.4	430,264	112.9	0.54[d]	0.52-0.55
	Males	1006	59.9	56.2-63.7	34,443	84	0.71[d]	0.67-0.76	1349	42.7	40.5-45.1	162,281	85	0.50[d]	0.48-0.53
	Females	1835	106.7	101.9-111.7	56,301	138.7	0.77[d]	0.73-0.81	2426	78.1	75.0-81.2	267,983	140.9	0.55[d]	0.53-0.58

Source: Cancer registries in the Centers for Disease Control and Prevention's National Program of Cancer Registries and/or the National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER) program.

IHS indicates Indian Health Service; AI/AN, American Indians/Alaska Natives; 95% CI, 95% confidence interval; NHW, non-Hispanic whites.

[a] AI/AN race is reported by National Program of Cancer Registries and SEER registries or through linkage with the IHS patient registration database. AI/AN persons of Hispanic origin are included.

[b] Rates are per 100,000 persons and are age-adjusted to the 2000 US standard population (19 age groups-Census P25-1130).

[c] Rate ratios are calculated in SEER*Stat prior to rounding of rates and may not equal the rate ratio calculated from rates presented in the table.

[d] Rate ratio is statistically significant ($P < .05$).

[e] Rates and rate ratios for Alaska in the Contract Health Service Delivery Areas (CHSDA) counties section are the same as those in the "All Counties" section because all counties in Alaska are CHSDA counties.

Years of data and registries used: 1999-2004 (41 states and the District of Columbia): Alabama,* Alaska,* Arkansas, Arizona,* California,* Colorado,* Connecticut,* Delaware, District of Columbia, Florida,* Georgia, Hawaii, Idaho,* Illinois, Indiana,* Iowa,* Kentucky, Louisiana,* Maine,* Massachusetts,* Michigan,* Minnesota,* Missouri, Montana,* Nebraska,* Nevada,* New Hampshire, New Jersey, New Mexico,* New York,* North Carolina,* Ohio, Oklahoma,* Oregon,* Pennsylvania,* Rhode Island,* Texas,* Utah,* Washington,* West Virginia, Wisconsin,* and Wyoming*; 1999 and 2002-2004: North Dakota*; 2001-2004: South Dakota*; 2003-2004: Mississippi* and Virginia; 2004: Tennessee. *States with at least 1 county designated as CHSDA.Percent regional coverage of AI/AN in CHSDA counties to AI/AN in all counties: Alaska: 100%; East: 13.1%; Northern Plains: 59.0%; Southern Plains: 64.1%; Pacific Coast: 55.6%; Southwest: 87.5%.

cers were grouped by systems (eg, digestive, genital, endocrine, urinary, etc) and by specific cancer type within these systems.

In this report, incidence data referred to invasive cancers, with the exception of cancer of the urinary bladder (bladder), which included both in situ and invasive cancers. It should also be noted that cancer registries throughout North America coded all pilocytic astrocytoma (ICD-O-3 9421) as invasive. For consistency across the period of analysis (1999-2004), those cancers newly classified as malignant, beginning in 2001 with the introduction of ICD-O-3, were excluded. Additional changes in ICD-O-3 applied to low malignant potential tumors of the ovary, which were no longer coded as malignant beginning in 2001. These cancers were also excluded.

Race and Population Data and Geographic Coverage

In this report, cancer patients were classified as "American Indian" or "Alaska Native" (AI/AN) if they were identified as such in the medical record or through linkage with the IHS patient services database. As described in detail elsewhere,[4] linkages between cancer registries and IHS records were conducted by use of Link Plus,[22] a probabilistic linkage software program developed by the CDC.

County-level population estimates produced by the US Census Bureau were used as denominators in the rate calculations. To manage multiple race data collected beginning in 2000, a technique of bridging multiple race categories into single-race annual population estimates was developed by the CDC's National Center for Health Statistics, in collaboration with the Census Bureau.[23] The NCI made further refinements regarding race and county geographic codes and provided public access to these estimates[24] through its SEER*Stat statistical analysis software.[25]

Analyses

Averaged annual age-adjusted incidence rates per 100,000 population and 95% confidence intervals (95% CIs) for the period 1999 through 2004 were calculated by use of SEER*Stat software (version 6.3.6)[25] by race and ethnicity (AI/AN, NHW), sex (males and female), IHS regions (Alaska, East, Northern Plains, Pacific Coast, Southern Plain, and Southwest), and within CHSDA counties (Fig. 1). Rates were adjusted to the 2000 US standard population by use of 5-year age groups (20-24, 25-29, 30-34, 35-39, and 40-44 years). Rates based on case counts of <5 cases for the entire period were italicized, and the corresponding case counts and rate ratios (RRs) were suppressed. CIs were constructed by use of the modified gamma method to ensure proper coverage for small case counts, low incidence rates, and populations with age distributions that differ from the standard age distribution.[26]

RRs and rate differences were calculated for the purpose of comparing incidence rates between AI/AN and NHW populations. RRs were calculated as the age-adjusted incidence rate among the AI/AN population divided by the age-adjusted incidence rate among the NHW population. *P* values for rate ratios used the method developed by Fay and Feuer.[27] Rate differences, which reflected either the higher or lower rates of cancer incidence in the AI/AN population compared with the NHW population, were calculated by subtracting the NHW rate from the AI/AN rate.

RESULTS

A total of 3775 incident cancer cases were diagnosed among the AI/AN young adult population (ages 20-44 years) in participating cancer registries during the period between 1999 and 2004 (Table 1). A majority of these cases (ie, 2841) representing 75.3% of all incident cases were diagnosed among AI/AN residents of CHSDA counties. Cancer incidence rates among AI/AN young adult CHSDA residents were uniformly higher than rates based on AI/AN residents of all counties combined (except in Alaska, where all counties are designated as CHSDA). In contrast, there was little difference in NHW rates noted between CHSDA counties and all counties combined. These findings are consistent with improved classification of AI/AN cancer cases within CHSDA counties, which increased rates for AI/AN but had minimal effect on rates for NHW. Because AI/AN incidence rates for residents of CHSDA counties provide a more valid estimate of incidence rates for AI/AN populations than do rates for all counties combined, the remaining portion of this report will focus solely on rates calculated for residents of CHSDA counties.

Age-adjusted incidence rates for all cancers combined were higher in females than for males in both the AI/AN and NHW young adult populations (Table 1). Rates among AI/AN young adult females varied most across IHS regions, from a low of 76.2 per 100,000 females (East) to a high of 155.7 per 100,000 females (Southern Plains), compared with rates among AI/AN young adult males, which ranged from 35.7 (East) to 82.2 per 100,000 males (Southern Plains). There was relatively little variation in rates for NHW young adults noted across regions.

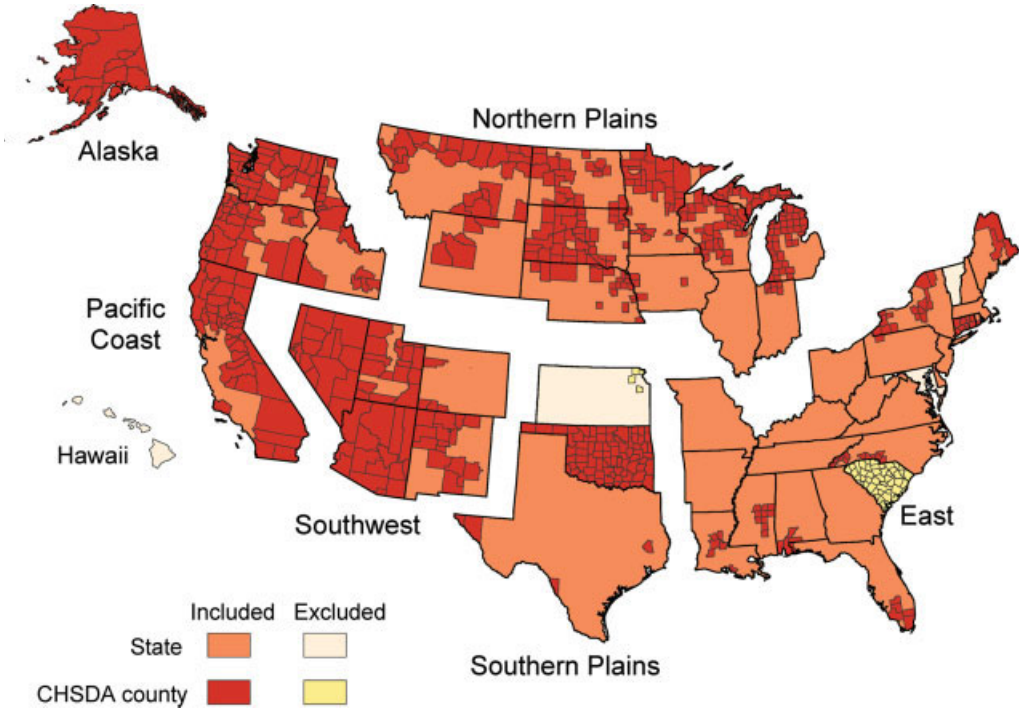

FIGURE 1. States and Contract Health Service Delivery Areas (CHSDA) counties by Indian Health Service region.

Compared with NHW young adults, AI/AN young adult males and females had lower all sites combined incidence rates, with significantly reduced RRs (RRs of 0.71 and 0.77, respectively), with the Pacific Coast, East, and Southwest regions having the lowest RRs (Table 1). In Alaska and the Southern Plains, AI/AN young adult females had elevated cancer incidence rates compared with NHW young adult females. AI/AN young adult males had cancer incidence rates that were similar to the NHW young adult population in Alaska, the Northern Plains, and the Southern Plains, as did AI/AN young adult females in the Northern Plains.

Table 2 shows case counts, age-adjusted incidence rates, and corresponding RRs for major cancer groups and for specific cancers within all IHS regions combined. Among all cancers diagnosed in AI/AN young adult males (n = 1006), 4 cancers accounted for approximately 60% of all diagnoses: cancers of the digestive system (20%), the male genital system (18%), lymphomas (12%), and cancers of the urinary system (9%). Cancers of the digestive system were the leading cancers among AI/AN young adult males in all but the Pacific Coast, where cancers of the male genital system were most common, followed by cancers of the digestive system (data not shown). Among all cancers diagnosed in AI/AN young adult females (n = 1835), 4 cancers accounted for nearly 75% of all diagnoses: breast cancer (29%), cancers of the female genital system (21%), the endocrine system (12%), and the digestive system (10%). Breast cancer was the leading cancer among AI/AN young adult females in all IHS regions (data not shown). Although melanoma ranked third in NHW females and second in NHW males, accounting for 13% of cancers in males and females combined, it was much less common in AI/AN young adults (<4% of incident cancers).

Specific cancers found to have statistically significantly higher incidence rates in the AI/AN young adult population (Table 2) included: male and female digestive system cancers (RR of 1.26), including male and female stomach cancer (RR of 2.86); female colorectal cancer (CRC) (RR of 1.32); male hepatic (liver) cancer (RR of 1.89); female genital system cancers (RR of 1.15), including corpus uteri (uterine) cancer (RR of 1.61); and male and female urinary system cancers (RR of 1.28), including renal (kidney) cancer (RR of 1.50). The largest excess, as measured by rate differences, occurred for cancers of the digestive system and urinary cancers in males and females and genital cancers in females.

Specific cancers found to have statistically significantly lower incidence rates in the AI/AN young

TABLE 2
Cancer Incidence for American Indians/Alaska Natives[a] and Non-Hispanic Whites, Ages 20-44 Years, CHSDA Counties, US, 1999-2004

Site	Sex	AI/AN Count[b]	AI/AN Rate[c]	95% CI For AI/AN Rate	NHW Count[b]	NHW Rate[c]	Rate Ratio[d] (AI/AN:NHW)	95% CI For Rate Ratio	Rate Difference (AI/AN-NHW)
All sites combined	Both sexes	2841	83.8	80.8-87.0	90,744	111.2	0.75[d]	0.73-0.78	-27.4
	Male	1006	59.9	56.2-63.7	34,443	84.0	0.71[d]	0.67-0.76	-24.1
	Female	1835	106.7	101.9-111.7	56,301	138.7	0.77[d]	0.73-0.81	-32.0
Oral cavity and pharynx	Both sexes	72	2.2	1.7-2.7	2114	2.6	0.85	0.66-1.07	-0.4
	Male	46	2.9	2.1-3.9	1418	3.4	0.85	0.62-1.14	-0.5
	Female	26	1.5	1.0-2.2	696	1.7	0.87	0.56-1.28	-0.2
Digestive system	Both sexes	388	11.7	10.6-12.9	7550	9.2	1.28[d]	1.15-1.42	2.5
	Male	198	12.3	10.6-14.1	4218	10.2	1.20[d]	1.04-1.39	2.1
	Female	190	11.2	9.7-12.9	3332	8.1	1.38[d]	1.18-1.60	3.1
Esophagus	Both sexes	11	0.3	0.2-0.6	322	0.4	0.88	0.44-1.58	−0.1
	Male	9	0.6	0.3-1.1	269	0.6	0.89	0.40-1.70	0.0
	Female	~	*0.1*		53	0.1			
Stomach	Both sexes	60	1.8	1.4-2.3	523	0.6	2.86[d]	2.15-3.73	1.2
	Male	32	2.0	1.4-2.8	313	0.8	2.62[d]	1.76-3.77	1.2
	Female	28	1.7	1.1-2.4	210	0.5	3.22[d]	2.09-4.78	1.2
Colon and rectum	Both sexes	219	6.6	5.7-7.5	4764	5.8	1.14	0.99-1.30	0.8
	Male	97	6.0	4.9-7.3	2510	6.1	0.99	0.80-1.21	−0.1
	Female	122	7.2	6.0-8.6	2254	5.5	1.30[d]	1.08-1.56	1.7
Anus, anal canal and anorectum	Both sexes	13	0.4	0.2-0.7	439	0.5	0.75	0.39-1.28	−0.1
	Male	6	0.4	0.1-0.8	209	0.5	0.71	0.26-1.57	−0.1
	Female	7	0.4	0.2-0.9	230	0.6	0.77	0.31-1.59	−0.2
Hepatic carcinoma	Both sexes	28	0.8	0.5-1.2	437	0.5	1.55[d]	1.02-2.28	0.3
	Male	23	1.4	0.9-2.1	312	0.7	1.89[d]	1.17-2.88	0.7
	Female	~	*0.3*		125	0.3			
Pancreas	Both sexes	28	0.9	0.6-1.2	638	0.8	1.12	0.74-1.63	0.1
	Male	17	1.1	0.6-1.7	383	0.9	1.17	0.67-1.89	0.2
	Female	11	0.7	0.3-1.2	255	0.6	1.06	0.52-1.92	0.1
Respiratory system	Both sexes	110	3.4	2.8-4.1	3745	4.5	0.76[d]	0.62-0.91	−1.1
	Male	63	4.0	3.1-5.1	1919	4.6	0.88	0.67-1.13	−0.6
	Female	47	2.8	2.1-3.7	1826	4.4	0.64[d]	0.47-0.85	−1.6
Larynx	Both sexes	12	0.4	0.2-0.6	359	0.4	0.87	0.45-1.53	0.0
	Male	8	0.5	0.2-1.0	238	0.6	0.92	0.39-1.81	−0.1
	Female	~	*0.2*		121	0.3			
Lung and bronchus	Both sexes	97	3.0	2.4-3.6	3373	4.0	0.74[d]	0.60-0.90	−1.0
	Male	54	3.4	2.6-4.5	1674	4.0	0.86	0.64-1.12	−0.6
	Female	43	2.6	1.9-3.5	1699	4.1	0.63[d]	0.45-0.85	−1.5
Bones and joints	Both sexes	19	0.5	0.3-0.8	554	0.7	0.75	0.44-1.18	−0.2
	Male	8	0.4	0.2-0.9	321	0.8	0.56	0.23-1.12	−0.4
	Female	11	0.6	0.3-1.1	233	0.6	1.00	0.49-1.84	0.0
Soft tissue and other extraosseous sarcoma	Both sexes	114	3.2	2.7-3.9	2581	3.2	1.02	0.84-1.23	0.0
	Male	60	3.4	2.6-4.4	1476	3.6	0.93	0.71-1.21	−0.2
	Female	54	3.1	2.3-4.0	1105	2.8	1.13	0.84-1.48	0.3

(*continued*)

TABLE 2
(*continued*)

Site	Sex	AI/AN Count[b]	AI/AN Rate[c]	95% CI For AI/AN Rate	NHW Count[b]	NHW Rate[c]	Rate Ratio[d] (AI/AN:NHW)	95% CI For Rate Ratio	Rate Difference (AI/AN-NHW)
Kaposi sarcoma	Both sexes	26	0.8	0.5-1.1	403	0.5	1.53	0.98-2.27	0.3
	Male	25	1.5	1.0-2.2	390	1.0	1.55	0.99-2.32	0.5
	Female	~	*0.1*		13	0.0			
Melanoma	Both sexes	104	3.0	2.5-3.6	12,192	15.1	0.20[d]	0.16-0.24	−12.1
	Male	40	2.4	1.7-3.2	5149	12.6	0.19[d]	0.13-0.26	−10.2
	Female	64	3.6	2.8-4.6	7043	17.6	0.21[d]	0.16-0.26	−14.0
Breast	Female	534	31.8	29.2-34.6	18,619	45.3	0.70[d]	0.64-0.77	−13.5
Female genital system	Female	394	23.0	20.8-25.4	8048	19.9	1.15[d]	1.04-1.28	3.1
Cervix	Female	187	10.8	9.3-12.4	3888	9.7	1.11	0.95-1.29	1.1
Corpus uteri	Female	122	7.3	6.0-8.7	1847	4.5	1.61[d]	1.33-1.94	2.8
Ovary cancer	Female	62	3.6	2.8-4.6	1565	3.8	0.95	0.72-1.22	−0.2
Male genital system	Male	181	10.1	8.7-11.7	6373	15.7	0.64[d]	0.55-0.75	−5.6
Prostate	Male	13	0.9	0.5-1.4	708	1.7	0.51[d]	0.27-0.87	−0.8
Testicular germ cell	Male	163	8.9	7.6-10.4	5585	13.8	0.64[d]	0.55-0.75	−4.9
Urinary system	Both sexes	147	4.5	3.8-5.3	2884	3.5	1.28[d]	1.08-1.51	1.0
	Male	94	5.9	4.8-7.2	1835	4.4	1.34[d]	1.07-1.64	1.5
	Female	53	3.1	2.3-4.1	1049	2.6	1.22	0.91-1.61	0.5
Renal cancer	Both sexes	120	3.7	3.0-4.4	2016	2.4	1.50[d]	1.24-1.80	1.3
	Male	75	4.7	3.7-5.9	1230	3.0	1.59[d]	1.24-2.00	1.7
	Female	45	2.7	2.0-3.6	786	1.9	1.39[d]	1.01-1.88	0.8
Brain and other nervous system	Both sexes	97	2.7	2.2-3.3	3325	4.1	0.66[d]	0.53-0.81	−1.4
	Male	58	3.3	2.5-4.3	1935	4.8	0.69[d]	0.52-0.90	−1.5
	Female	39	2.2	1.5-3.0	1390	3.5	0.62[d]	0.44-0.86	−1.3
Astrocytoma	Both sexes	52	1.5	1.1-1.9	1795	2.2	0.66[d]	0.49-0.88	−0.7
	Male	31	1.8	1.2-2.5	1065	2.6	0.68[d]	0.46-0.97	−0.8
	Female	21	1.2	0.7-1.8	730	1.8	0.65[d]	0.40-1.00	−0.6
Endocrine system	Both sexes	238	6.8	5.9-7.7	8256	10.2	0.66[d]	0.58-0.75	−3.4
	Male	26	1.5	1.0-2.3	1618	4.0	0.39[d]	0.25-0.57	−2.5
	Female	212	11.9	10.3-13.6	6640	16.6	0.71[d]	0.62-0.82	−4.7
Thyroid	Both sexes	237	6.7	5.9-7.7	8157	10.1	0.67[d]	0.58-0.76	−3.4
	Male	26	1.5	1.0-2.3	1556	3.8	0.40[d]	0.26-0.59	−2.3
	Female	211	11.8	10.3-13.5	6601	16.5	0.71[d]	0.62-0.82	−4.7
Lymphoma	Both sexes	201	5.8	5.0-6.7	8464	10.5	0.55[d]	0.48-0.64	−4.7
	Male	123	7.3	6.0-8.7	4932	12.1	0.60[d]	0.50-0.72	−4.8
	Female	78	4.4	3.4-5.4	3532	8.8	0.49[d]	0.39-0.62	−4.4
Hodgkin lymphoma	Both sexes	53	1.4	1.0-1.8	3359	4.2	0.33[d]	0.25-0.44	−2.8
	Male	33	1.8	1.2-2.5	1801	4.5	0.40[d]	0.27-0.56	−2.7
	Female	20	1.0	0.6-1.6	1558	4.0	0.26[d]	0.16-0.40	−3.0
Non-Hodgkin lymphoma	Both sexes	131	3.9	3.3-4.6	4586	5.6	0.69[d]	0.58-0.82	−1.7
	Male	79	4.9	3.8-6.1	2753	6.7	0.72[d]	0.57-0.91	−1.8
	Female	52	3.0	2.2-3.9	1833	4.5	0.66[d]	0.49-0.87	−1.5

(*continued*)

TABLE 2
(*continued*)

Site	Sex	AI/AN Count[b]	AI/AN Rate[c]	95% CI For AI/AN Rate	NHW Count[b]	NHW Rate[c]	Rate Ratio[d] (AI/AN:NHW)	95% CI For Rate Ratio	Rate Difference (AI/AN-NHW)
Leukemia	Both sexes	116	3.2	2.7-3.9	2543	3.1	1.04	0.85-1.25	0.1
	Male	63	3.6	2.7-4.6	1419	3.5	1.03	0.78-1.33	0.1
	Female	53	2.9	2.2-3.8	1124	2.8	1.05	0.78-1.39	0.1
Lymphoid	Both sexes	36	0.9	0.7-1.3	794	1.0	0.97	0.67-1.36	−0.1
	Male	22	1.2	0.7-1.8	514	1.3	0.93	0.57-1.43	−0.1
	Female	14	0.7	0.4-1.2	280	0.7	1.06	0.57-1.83	0.0
Acute myeloid	Both sexes	45	1.3	0.9-1.7	1146	1.4	0.91	0.66-1.23	−0.1
	Male	22	1.3	0.8-2.0	564	1.4	0.94	0.58-1.44	−0.1
	Female	23	1.3	0.8-1.9	582	1.5	0.88	0.55-1.34	−0.2
Chronic myeloproliferative Disease	Both sexes	29	0.8	0.6-1.2	468	0.6	1.46	0.97-2.13	0.2
	Male	16	1.0	0.5-1.6	276	0.7	1.41	0.79-2.33	0.3
	Female	13	0.7	0.4-1.3	192	0.5	1.56	0.81-2.72	0.2
Other	Both sexes	126	3.8	3.1-4.5	3494	4.3	0.88	0.73-1.05	−0.5
	Male	46	2.8	2.0-3.7	1830	4.4	0.63[d]	0.46-0.84	−1.6
	Female	80	4.7	3.7-5.8	1664	4.1	1.14	0.90-1.43	0.6

Source: Cancer registries in the Centers for Disease Control and Prevention's National Program of Cancer Registries (NPCR) and/or the National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER) program.

CHSDA indicates Contract Health Service Delivery Areas; AI/AN, American Indians/Alaska Natives; 95% CI, 95% confidence interval; NHW, non-Hispanic whites.

[a] AI/AN race is reported by NPCR and SEER registries or through linkage with the Indian Health Service patient registration database. AI/AN persons of Hispanic origin are included.

[b] Rates based on counts ≤5 are presented in italics.

[c] Rates are per 100,000 persons and are age-adjusted to the 2000 US standard population (19 age groups-Census P25-1130).

[d] Rate ratio is statistically significant ($P < .05$).

~Counts <6 are suppressed; if no cases were reported, then rates could not be calculated.

Years of data and registries used: 1999-2004 (41 states and the District of Columbia): Alabama,* Alaska,* Arkansas, Arizona,* California,* Colorado,* Connecticut,* Delaware, District of Columbia, Florida,* Georgia, Hawaii, Idaho,* Illinois, Indiana,* Iowa,* Kentucky, Louisiana,* Maine,* Massachusetts,* Michigan,* Minnesota,* Missouri, Montana,* North Carolina,* Nebraska,* Nevada,* New Hampshire, New Jersey, New Mexico,* New York,* Ohio, Oklahoma,* Oregon,* Pennsylvania,* Rhode Island,* Texas,* Utah,* Washington,* West Virginia, Wisconsin,* and Wyoming*; 1999 and 2002-2004: North Dakota*; 2001-2004: South Dakota*; 2003-2004: Mississippi* and Virginia; 2004: Tennessee. *States with at least 1 county designated as CHSDA.

adult population (Table 2) included: female respiratory cancer (RR of 0.64), including cancer of the lung and bronchus (RR of 0.63); male and female melanoma (RR of 0.20); female breast cancer (RR of 0.70); male genital cancers (RR of 0.64), including prostate cancer (RR of 0.51) and testicular germ cell cancer (RR of 0.64); male and female brain and other nervous system cancers (RR of 0.66), including astrocytoma (RR of 0.66); male and female endocrine cancers (RR of 0.66), including thyroid cancer (RR of 0.67); and male and female lymphoma (RR of 0.55), including Hodgkin lymphoma (RR of 0.33) and non-Hodgkin lymphoma (NHL) (RR of 0.69). The largest deficits, as measured by rate differences, occurred for female breast cancer, melanoma, testicular germ cell cancers, and lymphoma and thyroid cancer.

Figures 2a and 2b graphically display statistically significant log RRs from Table 2 for selected cancers within CHSDA counties by IHS region for AI/AN young adult males and females compared with NHW young adult males and females.

- In Alaska, the cancer burden in AI/AN females was higher for breast cancer and lower for melanoma.
- In the East, the cancer burden for AI/AN females was higher for uterine cancer and lower for breast and thyroid cancer; for AI/AN males, it was lower for melanoma, stomach cancer, and testicular germ cell tumors (testis).
- In the Northern Plains, the cancer burden in both AI/AN males and females was higher for stomach and CRC cancer and lower for melanoma.
- In the Pacific Coast, the cancer burden was higher for Kaposi sarcoma in AI/AN males and lower for melanoma in both males and females, NHL and testis cancer in males, and breast and thyroid cancer in females.
- In the Southern Plains, the cancer burden was higher for cervix and CRC cancers in AI/AN females and for kidney cancer, stomach cancer, and leukemia in males; the cancer burden was lower for melanoma in males and females and for testis cancer in males.
- In the Southwest, the cancer burden was higher for kidney cancer in males and stomach and uterine cancers in AI/AN females, and lower for breast, cervix, melanoma, thyroid, and lung cancer in females, and melanoma, NHL, testis, and lung cancer in males.

For all other cancers, the rate ratios among the AI/AN and NHW young adult populations were not statistically significantly different or data were insufficient to identify statistically significant differences.

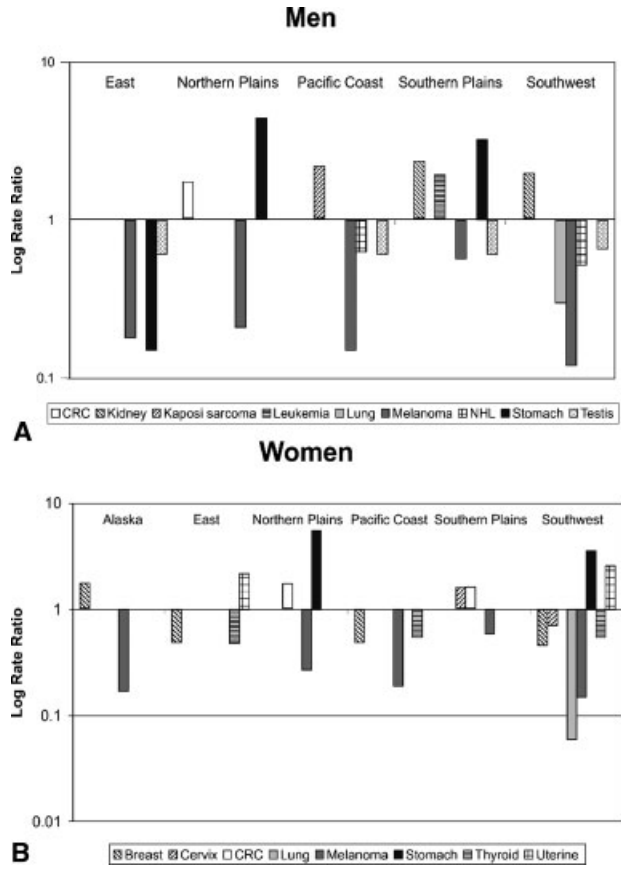

FIGURE 2. (a and b) Statistically significant rate ratios ($P < .05$) to explain the cancer burden in the American Indian/Alaskan Native young adult population compared with the cancer burden in the non-Hispanic white population by sex and Indian Health Service regions in individuals ages 20 to 44 years in the US Contract Health Service Delivery Areas (CHSDA) counties, 1999 through 2004. CRC indicates colorectal cancer; NHL, non-Hodgkin lymphoma. Source: Cancer registries in the Centers for Disease Control and Prevention's National Program of Cancer Registries and/or the National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER) program. Years of data and registries used: 1999-2004 (41 states and the District of Columbia): Alabama,* Alaska,* Arizona,* Arkansas, California,* Colorado,* Connecticut,* Delaware, District of Columbia, Florida,* Georgia, Hawaii, Idaho,* Illinois, Indiana,* Iowa,* Kentucky, Louisiana,* Maine,* Massachusetts,* Michigan,* Minnesota,* Missouri, Montana,* Nebraska,* Nevada,* New Hampshire, New Jersey, New Mexico,* New York,* North Carolina,* Ohio, Oklahoma,* Oregon,* Pennsylvania,* Rhode Island,* Texas,* Utah,* Washington,* West Virginia, Wisconsin,* and Wyoming*; 1999 and 2002-2004: North Dakota*; 2001-2004: South Dakota*; 2003-2004: Mississippi* and Virginia; 2004: Tennessee. *States with at least 1 county designated as CHSDA.

DISCUSSION

Our analyses support earlier findings that there were pronounced disparities in the cancer burden among AI/AN populations and between the AI/AN and NHW population,[4] and that many of these disparities

were also apparent in the young adult population. For example, the burden in AI/AN young adults residing in CHSDA counties was higher for cancers of the stomach, liver, and kidney; and lower for all sites combined, NHL, melanoma, and cancers of the breast, thyroid, prostate, testis, and brain. However, these summary estimates can be misleading, as they missed disparities that were evident only in specific IHS regions. Because regional differences were likely a function of the heterogeneity of AI/AN populations with respect to genetic, social, cultural, and lifestyle aspects, some of which are known to vary by region,[6,7,28] future analyses would benefit from routinely including region-specific data.

To our knowledge, the current analysis is the first to systematically describe the cancer burden among AI/AN young adults between the ages of 20 and 44 years. As such, several limitations need to be acknowledged when interpreting these results, especially as they relate to the regional data. First, although linking cancer registry data to the IHS patient services database and focusing the analysis on IHS CHSDA appears to have reduced racial misclassification,[4,14] such strategies could not correct for misclassification among AI/AN individuals who were not members of federally recognized tribes and as such were not eligible for IHS services, or who did not access IHS services. Second, because analyses were restricted to CHSDA counties, the results cannot be generalized to AI/AN individuals who lived outside CHSDA, often in predominately urban areas, and who were therefore not represented in these rates.[14] Third, the AI/AN population was small, accounting for approximately 1% of the total US population,[29] and a diagnosis of cancer in a young adult was a rare event. Therefore, the total number of incident cases in AI/AN young adults in this study was small, resulting in low statistical power to detect differences in the cancer burden. Thus, our ability to examine regional differences by cancer type was limited. Future analyses would benefit from expanding coverage to include more diagnosis years and more population-based cancer registries.

Describing the cancer burden is an essential first step toward eliminating these disparities. There are 2 perspectives by which to view the cancer burden: a cancer control perspective and a surveillance research perspective. Of particular interest to cancer control planners should be the identification of cancers that accounted for the majority of cancers diagnosed in the AI/AN young adult population (female breast cancer, lymphoma, and cancers of the female and male digestive, genital, and endocrine systems). Of particular interest to researchers should be the finding that the relative burden of selected cancers (female breast, Kaposi sarcoma, leukemia, and cancers of the digestive, genital, respiratory, and urinary systems) differed among the AI/AN populations, as defined by IHS regions, as well as when compared with the NHW young adult population. The leading cancers and those with statistically significant rate differences are discussed below.

Digestive System

Cancers of the digestive system accounted for approximately 14% of all cancers diagnosed in AI/AN young adults. Compared with NHW young adults, the AI/AN population was at increased risk for stomach and CRC in males and females and liver cancer in males. Other studies have reported an elevated risk for stomach cancer among the AI/AN population[3,30,31] and the incidence of stomach cancer may be increasing in the AI/AN population as a whole.[3] The present study confirmed an elevated risk for stomach cancer among AI/AN young adult males in the Northern and Southern Plains and identified reduced risk in the East (Fig. 2a). Among AI/AN young adult females, risk was elevated in the Northern Plains and the Southwest (Fig. 2b). Risk factors for stomach cancer include infection with *Helicobacter pylori*[32] and a diet low in fruits and vegetables and high in red meat consumption.[33,34] Five-year survival after a diagnosis of stomach cancer in the AI/AN population was approximately 14%.[8]

The present study also found that AI/AN young adult females had elevated risk for CRC in the Northern and Southern Plains. This finding is consistent with a concurrent study that demonstrated wide variability in incidence rates across IHS regions, including higher incidence rates in both AI/AN adult males and females in Alaska and in the Northern and Southern Plains.[35] Incidence rates were also high among younger (age <50 years) males and females compared with older males and females, suggesting a greater susceptibility to CRC in younger ages among the AI/AN population than among the NHW population.[35] The incidence of CRC appears to be increasing in the AI/AN population[4,36] and risk factors thought to increase risk include personal and family history of polyps, inflammatory bowel syndrome, cigarette smoking, alcohol consumption, physical inactivity, and a diet high in animal fats and low in fruits and vegetables.[30] Infection with *H. pylori*[37] and diabetes[38] are emerging as potential additional risk factors for CRC. The extent to which these risk factors can explain the variability of CRC incidence in AI/AN young adults will require further

research. Five-year survival after a diagnosis of CRC in the AI/AN population was approximately 50%.[8]

AI/AN young adult males had a higher risk of hepatic (liver) cancer than NHW young adult males; however, the case counts were too small to allow calculation of regional incidence rates. Elevated risk for liver and intrahepatic bile duct cancers in the AI/AN population has been reported elsewhere.[39-41] Risk factors for liver cancer include chronic inflammation (cirrhosis) because of excessive alcohol consumption[32] or infection with hepatitis B and C (HBV and HCV, respectively)[32,42]; more recently, diabetes is emerging as a possible risk factor.[43,44] In the early 1980s, infection with HBV was implicated as a leading cause of liver cancer in Alaska Native children and adolescents, and an HBV immunization program was instituted. As these immunized children become young adults, rates of liver cancer may decline.[45] However, more recently, liver cancer incidence has been reported to be increasing in the general population, attributed primarily to increased prevalence of individuals chronically infected with the HCV.[42] Monitoring of incidence rates among AI/AN young adults may help elucidate the relationship between liver cancer and known and suspected risk factors. Five-year survival after a diagnosis of liver cancer in the AI/AN population was approximately 10%.[8]

Female Breast Cancer

Breast cancers accounted for approximately 30% of all cancers diagnosed in AI/AN young adult women, and breast cancer was the leading cancer diagnosed in AI/AN women across all IHS regions. Although the overall burden of breast cancer was lower in AI/AN than for NHW young adult women, the burden was not uniformly distributed across all IHS regions: the burden was lower in the Pacific Coast, East, and Southwest and elevated in Alaska. This distribution is consistent with a concurrent study that has shown wide variability in the breast cancer burden in AI/AN women across IHS regions.[46] Of particular interest is the finding that breast cancer incidence rates have been increasing for several decades in Alaska among AI/AN women but not among white women.[47] Differences in cancer burden among AI/AN women across IHS regions suggest the need for research into the role that screening, genetic factors, reproductive histories (eg, parity, breast feeding, age at first full–term pregnancy, etc), health behaviors (eg, diet and physical activity) and environmental exposures play in them.[46] Five-year survival after a diagnosis of breast cancer in the AI/AN population was approximately 75%.[8]

Genital System

Cancers of the genital system accounted for approximately 14% of all cancers diagnosed in AI/AN young adults. Cancer of the cervix uteri (cervix) accounted for approximately 50% of all female genital system cancers. Compared with the risk for NHW young adult women, the risk for cancer of the cervix was higher in the Southern Plains and lower in the Southwest. Screening for cancer of the cervix by use of the Papanicolaou (Pap) test is recommended for women of all ages who have been sexually active. Virtually all cancers of the cervix are now believed to be associated with infection with the human papillomavirus (HPV).[32] An HPV vaccine has recently been approved for use in the US for women ages 9 to 26 years[30] and the vaccine offers hope for future reduction in the incidence of cancer of the cervix. In the meantime, current incidence patterns likely reflect differences in the prevalence of persistent HPV infection and screening activity across the IHS regions. Prevalence estimates for recommended screening (including the Pap test) were the lowest in the Southern Plains,[48] the region with elevated cervical cancer risk. Close surveillance of cervical cancer will be necessary to ensure that high-risk populations are reached by both screening and vaccination programs. Five-year survival after a diagnosis of cervical cancer in the AI/AN population was approximately 70%.[8]

Uterine cancer accounted for approximately 30% of all female genital tract cancers. AI/AN young adult women were at increased risk for corpus uteri (uterine) cancer in the East and Southwest. Risk factors for uterine cancer include elevated or prolonged exposure to unopposed estrogen, including estrogen replacement therapy, obesity, early menarche, nulliparity, and a history of polycystic ovary syndrome.[30] The finding that AI/AN young adult women were at elevated risk for uterine cancer is somewhat inconsistent with an earlier study that showed that AI/AN women of all ages had lower uterine cancer risk than NHW females in New Mexico.[49] The extent to which this finding reflects the geographic variability in uterine cancer risk or represents a new and increasing risk of uterine cancer in the AI/AN population requires further investigation. Five-year survival after a diagnosis of uterine cancer in the AI/AN population was approximately 77%.[8]

Malignant germ cell tumors of the testis accounted for approximately 90% of all male genital cancers in this age group. The risk was uniformly lower among AI/AN young adult males than among NHW young adult males. Apart from a history of undescended testicle, few if any modifiable risk factors have been identified for testis cancer.[50] Testis

cancer is often curable, as evidenced by the finding that 5-year relative survival in AI/AN males was 90%.[8]

The overall burden of prostate cancer was lower in AI/AN young adult males than in NHW young adult males; however, the case counts were too small to allow calculation of regional incidence rates.

Urinary System

Cancers of the urinary system accounted for approximately 5% of all cancers diagnosed in AI/AN young adults. Compared with NHW young adult males, AI/AN males were at elevated risk for renal (kidney) cancer. Other studies have reported elevated risks for kidney cancer among the AI/AN population,[3,30] with some analyses reporting that the AI/AN population as a whole has the highest rates of kidney and renal pelvis cancers in the US.[51] The current study found that AI/AN young adult males had an elevated risk for kidney cancer in the Southern Plains and Southwest. This finding is consistent with a concurrent study that has shown wide variability in incidence rates for kidney cancer across IHS regions.[52] Cigarette smoking and obesity are well-documented risk factors for kidney cancer, whereas diets that include fruits and vegetables and physical activity may decrease risk.[30] Five-year survival after a diagnosis of kidney cancer in the AI/AN population was approximately 66%.[8]

Endocrine Cancer

Cancers of the endocrine system accounted for approximately 12% of all cancers diagnosed in AI/AN young adult females and approximately 3% of cancers diagnosed in AI/AN young adult males. Essentially all endocrine cancers in AI/AN young adults were thyroid cancers. Incidence rates were uniformly lower in AI/AN young adult females than for NHW females. To our knowledge, apart from exposure to ionizing radiation, little is known about risk factors for thyroid cancer. Recent increases in thyroid cancer incidence throughout the US may be because of increased detection of subclinical papillary thyroid cancer, rather than to a true increase in the incidence of the cancer.[53] Additional research is required for knowing whether the lower cancer burden in the AI/AN young adult population reflects lower incidence of thyroid cancer or lower detection of subclinical cancers and, as such, was related to access to healthcare. Five-year survival after a diagnosis of thyroid cancer in the AI/AN population was greater than 90%.[8]

Lymphoma

Lymphomas accounted for less than 1% of all cancers diagnosed in AI/AN young adults, and NHL accounted for the majority (65%) of these lymphomas. Compared with the NHW young adult population, the overall burden of lymphoma, including Hodgkin lymphoma and NHL, was lower in AI/AN young adults. AI/AN young adult males had a lower risk of NHL in the Pacific Coast and Southwest. Risk factors for NHL include immune suppression and exposure to certain infectious agents (eg, human immunodeficiency virus [HIV], *H. pylori,* etc) and chemicals.[30] Five-year survival after a diagnosis of NHL in the AI/AN population was approximately 46%.[8]

Other Cancers

The overall burden of melanoma was uniformly lower in AI/AN young adults than for NHW young adults. Likewise, the overall burden of respiratory cancers appeared lower in the AI/AN young adult population than for the NHW young adult population despite the finding that the prevalence of smoking was higher overall in the AI/AN population.[48] The majority of respiratory system cancers in AI/AN young adults (88%) were cancers of the lung and bronchus (lung). The Southwest had a statistically significant lower lung cancer burden both in young males and females. This finding supports the observation that current smoking prevalence estimates (cigarette smoking being a well-established risk factor for lung cancer[30]) were lower in this region than in other IHS regions.[48]

The burden of leukemia was elevated among AI/AN young adult males in the Southern Plains. Risk factors for leukemia include genetic abnormalities (eg, Down syndrome), cigarette smoking, exposure to chemicals, including benzene, and ionizing radiation.

Kaposi sarcoma accounted for <1% of all cancers diagnosed in AI/AN young adults. Risk was elevated for AI/AN young adult males in the Pacific Coast. Kaposi sarcoma is associated with infection with HIV.[32] HIV infection was higher in AI/AN young adults than in NHW young adults.[54]

Living With Cancer

The 5-year relative survival rates for many cancers of primary importance in the AI/AN population, including breast cancer and cancers of the digestive, genital, and urinary systems, are lower than the rates in the NHW population.[8] This finding suggests that AI/AN males and females may have limited access to diagnostic services or evidenced-based treatments[9] including clinical trails. AI/AN males and females also have reportedly lower participation in clinical trials.[55] Participants in clinical trials have higher edu-

cation and income,[56] whereas the AI/AN populations as a whole have less educational attainment, lower incomes, less insurance coverage, and less access to personal healthcare providers.[48] Even for those cancers with higher survival rates in the AI/AN population (thyroid, testis, uterine), the consequence of such a diagnosis can be great. These young males and females have most of their potential years of life ahead of them and, as a consequence of their diagnosis, may spend decades living with the physical, reproductive, social, emotional, and spiritual effects of a cancer diagnosis and treatment or have their lives tragically shortened.[10,11,57] A diagnosis of cancer in a young adult is rare and healthcare practitioners need to be aware of the unique cancer burden in this population so that they can respond promptly and appropriately to the first signs and symptoms of disease.

Many of the cancer patterns that characterize the AI/AN population overall are apparent among young adults. Elevated risk may result from the higher prevalence of known and suspected risk factors. Data from the Behavioral Risk Factor Surveillance System (BRFSS) suggests that AI/AN populations as a whole have high prevalence of diabetes and obesity (colorectal, kidney, liver, and uterine cancers) and excessive alcohol (colorectal and liver cancer) and tobacco (colorectal, kidney, and liver cancer)[48] consumption. In addition, the AI/AN population may be at greater risk for infection and/or it may be infected at an earlier age with HBV, HCV, HIV, and *H. pylori* than other racial groups.[53,58,59] How these risk factors operate individually or synergistically within the genetic composition of the AI/AN population is an area for research. In the meantime, cancer control planners should continue to address modifiable risk factors in the AI/AN population and in particular the young adult population as changes in the cancer burden because of changes in risk factor prevalence may first become apparent in this population. In particular, AI/AN adolescent girls and young adult females should be receiving HPV immunization and Pap screening, as indicated, as part of routine prevention healthcare. Strategies for accomplishing this and other cancer control measures must address the unique social, cultural, and lifestyle aspects of the AI/AN young adult population.[60]

Several cancers described in this report (CRC in the Southern and Northern Plains, and Kaposi sarcoma in the Pacific Coast) may denote sentinel events and foretell an increasing cancer burden in the AI/AN young adult population. The extent to which these findings reflect the geographic variability in cancer risk, or represent a new and increasing risk of cancer in the AI/AN population, requires further investigation. Monitoring of incidence rates among AI/AN young adults may help elucidate the relation between these cancers and known and suspected risk factors, and such monitoring will be necessary to ensure that high-risk populations are being reached by cancer control efforts.

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