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Cancer among American Indians – Identifying Priority Areas in Oklahoma

Sydney A. Martinez, PhD, **Amanda E. Janitz, PhD**, **Julie Erb-Alvarez, MPH, CPH**, **Dana S. Mowls, MPH**, **Janis E. Campbell, PhD**, and **Tom Anderson, MPH**

Abstract

Background—We describe and compare cancer incidence and mortality among American Indians (AI/ANs) and whites in nine Indian Health Service (IHS) Service Units in Oklahoma.

Methods—Using data from the Oklahoma Central Cancer Registry and the web-based OK2SHARE database, we obtained age-adjusted cancer incidence rates from 1997 to 2012 and cancer mortality rates from 1999 to 2009 for AI/ANs and whites in Oklahoma. We examined differences in primary site, percentage of late stage diagnoses, and trends over time.

Results—AI/ANs consistently had higher cancer incidence and mortality compared to whites in Oklahoma. The magnitude of disparity for cancer incidence and mortality varied by IHS Service Unit and by gender. The top three cancer sites were the same for all Service Units. The percentage of late stage diagnosis also varied by region.

Conclusions—We identify priority areas where cancer disparity challenges exist among AI/ANs in Oklahoma.

Keywords

Indians; North American; Neoplasms; Registries; Health Policy; Health Status Disparities

BACKGROUND

Racial disparities in cancer exist, demonstrated by differences in incidence, stage of diagnosis, survival, and mortality.[1–3] American Indians and Alaska Natives (AI/ANs) often bear higher rates of cancer incidence and mortality compared to whites, and this racial disparity has been shown to vary widely by geographic region and cancer site.[4–18] Measures of cancer disparities faced by AI/ANs have historically been underestimated due largely to high rates of racial misclassification in cancer registries and death records.[19–21] Recent data indicate racial misclassification has been reduced through Indian Health Service (IHS) patient registration record linkages. Subsequently, significant disparities in cancer incidence

Correspondence to: Sydney Martinez, PhD, MPH, Department of Biostatistics and Epidemiology, College of Public Health, University of Oklahoma Health Sciences Center, 801 N.E. 13th Street, Room 309, Oklahoma City, OK 73104, t(405) 271-2229, f(405)271-2068 Sydney-Martinez@ouhsc.edu.

DISCLOSURES

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and mortality have been identified among AI/ANs for malignant cancers in the Northern Plains and Southern Plains regions.[14]

Oklahoma ranks second of the 50 states for the largest AI/AN population for both count and proportion with nearly half a million people and 12.8% of the population reporting AI/AN race alone or in combination with one or more other races in 2013.[22] From 2005 to 2009, AI/ANs in Oklahoma had a significantly higher age-adjusted cancer incidence rate compared to whites (629.8/100,000 vs 503.3/100,000).[23] The difference in cancer incidence between AI/ANs and whites has been found to vary nationally across six geographic regions[14] as well as within the nine Oklahoma City Area IHS Service Units in the State of Oklahoma.[23] However, it is unclear whether geographic variations in the disparity between AI/ANs and whites exist by gender, cancer site, or over time. Aggregate estimates of cancer incidence across large geographic areas often mask differences at the state and local level. Exploring regional differences, as well as differences over time, in the cancer disparity between AI/ANs and whites is key to identifying priority areas to address and reduce health disparities in the State of Oklahoma.

The purpose of this study was to examine the geographic variation and trends over time of racial disparities in cancer for AI/ANs residing in Oklahoma. Using the nine Service Units in the State of Oklahoma as geographic boundaries defined by IHS, we describe regional differences in age-adjusted cancer incidence from 1997 to 2012 and cancer mortality from 1999 to 2009. We also examine regional differences in health disparities among AI/ANs compared to whites. Differences by race in the percentage of late stage diagnosis of breast, colorectal, melanoma, and cervical cancers were also compared across regions. In addition, we examined temporal trends in geographic and racial disparities in cancer incidence from 1997 to 2012.

METHODS AND MATERIALS

Cancer Incidence

We obtained data from the Oklahoma Central Cancer Registry (OCCR) for residents diagnosed with cancer between January 1, 1997 and December 31, 2012. The OCCR has been a member of the National Program of Cancer Registries since 1997 and abides by standards set by the North American Association of Central Cancer Registries. We classified cancers according to the SEER site recodes.[24] We classified lymphomas as Hodgkin's and non-Hodgkin's lymphomas and mesothelioma and Kaposi sarcoma were classified separately from other tumors. We excluded any benign/borderline conditions, including those with brain/CNS tumors. Malignant and in situ bladder cancers were combined into a single malignant category.[25] We included cases classified as white or AI/AN in our analysis. To reduce misclassification of AI/ANs, records in the OCCR were linked with IHS patient registration files.[19] Cases classified as either AI/AN through the primary race variable in OCCR or linkage with IHS records were classified as AI/AN.

To calculate cancer incidence rates, we used the population estimates from 1997–2012 in Oklahoma based on US Census estimates from 2013, which were available for both AI/AN and white populations by age, sex, and county.[26] To calculate age-adjusted incidence rates

(AAIR) by the direct method, we used the 2000 standard population for 19 age groups from SEER.[27] All rates were calculated per 100,000 population. Using SAS v. 9.4, we additionally calculated rate ratios of American Indians compared to the white population and 95% confidence intervals (CI) around the incidence rates and rate ratios (RR). To evaluate differences in the incidence rates of cancer by region, we grouped Oklahoma counties into the IHS Service Units in Oklahoma, which are part of the Oklahoma City Area of the IHS (Figure 1).[28] The operation of the IHS health services delivery system is managed through local administrative units called Service Units. A Service Unit is the basic health organization for a geographic area served by the IHS program, just as a county or city health department is the basic health organization in a State health department. We also identified the top 10 cancers based on the AAIR for each IHS Service Unit and compared the incidence RR (calculated as AAIR among AI/AN compared to whites) by IHS Service Unit for the top 10 cancers.

Stage at Diagnosis

For staging comparisons among cancer sites with commonly available screening tests, we compared late (regional and distant) to early (in situ and localized) using the SEER Summary Stage variable[29] after excluding staging based on death certificates (n=7,920) and autopsy (n=108) only. We compared the percent of late stage cancers for cervical, colorectal, female breast, melanoma, lung and bronchus, and prostate cancers by Service Unit and race. We used Chi-Square Tests to determine differences in the percent late stage between the AI/AN and the white populations. For categories with small numbers (<25% of categories having an expected count <5), we used Fisher's Exact Tests.

Time Trends

We examined variations in time trends of cancer incidence from 1997 to 2012 by race, gender, and region using joinpoint regression analyses. Joinpoint regression uses weighted least squares log-linear regression and joined line segments to identify time points with significant differences in incidence rates.[30] We fit joinpoint regression models with a maximum of three joinpoints. The Annual Percent Change (APC) and corresponding 95% CI was calculated overall and for each population subgroup and differences were considered significant with an alpha level of 0.05. Statistical analyses were conducted using the Joinpoint Regression Program Version 4.2.0.[31]

Cancer Mortality

We obtained mortality rates per 100,000 population in the State of Oklahoma and for each of the nine IHS Service Units using the Oklahoma State Department of Health's web-based query system, Oklahoma Statistics on Health Available for Everyone (OK2SHARE).[32] We examined mortality rates for AI/ANs and whites overall and by gender for all malignant neoplasms combined. Mortality rates were age-adjusted by the direct method using the 2000 US standard population. To reduce racial misclassification, we used IHS-linked data, which was only available for the years 1999 to 2009 for mortality. Using the age-adjusted mortality rates (AAMR) obtained from OK2SHARE, we calculated age-adjusted mortality RRs to compare AI/ANs and whites overall and by gender.

RESULTS

Cancer Incidence

From 1997 to 2012, there were 298,339 cases of cancer diagnosed in Oklahoma, with AI/ANs accounting for 7.6% (n=22,588) of cases and whites accounting for 85.1% (n=253,870) of cases. The overall AAIR was 598.5 per 100,000 for the AI/AN population and 479.5 per 100,000 for the white population in Oklahoma. AI/ANs in the state had a significantly higher overall cancer incidence than whites, with a RR of 1.25 (95% CI: 1.23, 1.27).

For the entire State of Oklahoma, the AI/AN population had a 25% higher rate of cancer compared to whites (95% CI: 1.23, 1.27) (Table 1). The lowest AAIR for AI/ANs occurred in the Lawton Service Unit (AAIR: 494.8 per 100,000; 95% CI: 466.6, 522.9 per 100,000) while the highest AAIR occurred in the Tahlequah Service Unit (AAIR: 642.4 per 100,000; 95% CI: 622.3, 662.6 per 100,000). Among the white population, the Talihina Service Unit had the lowest AAIR of 443.8 per 100,000 (95% CI: 436.1, 451.5 per 100,000) and the Shawnee Service Unit had the highest with an AAIR of 497.2 per 100,000 (95% CI: 493.5, 500.9 per 100,000). The Tahlequah Service Unit had the highest RR of AI/AN compared to whites (RR: 1.43, 95% CI: 1.38, 1.48), but the cancer incidence rate was higher among AI/ANs compared to whites for all IHS Service Units. The lowest RR among all IHS Service Units was in the Lawton Service Unit, where AI/ANs had a 7% higher cancer incidence compared to whites (95% CI: 1% to 13% higher).

Similar to the overall RRs, the RRs for both males and females were significantly higher among the AI/AN males and females compared to white males and females, respectively, with the exception of males in the Lawton Service Unit (Table 1). Of note, while not significantly higher, RRs for females were generally stronger than RRs for males, with the exception of the Shawnee and Wewoka Service Units.

Primary Site

We ranked the top ten primary cancer sites in each of the nine IHS Service Units for AI/ANs and whites. The top three specific cancers from 1997 to 2012 in Oklahoma were cancers of the lung and bronchus, breast (excluding in situ), and prostate, although the order differed slightly in the Lawton and Wewoka Service Units (Table 2). The highest incidence rates for cancer of the lung and bronchus among AI/ANs were found in the Claremore and Tahlequah Service Units, which were also the only two Service Units with significant disparities for all three top primary sites. Lung cancer was significantly higher among AI/ANs compared to whites in the majority of Service Units, with the exception of the Lawton, Talihina, and Wewoka Service Units. Due to small counts, we only report AI/AN site specific rates for the top three cancer sites.

Stage at diagnosis

In our analyses of the percent of cancers diagnosed at late stage, we observed no differences between the AI/AN and white populations living in the Ada, Pawnee, and Shawnee Service Units (Table 3). In the Claremore, Tahlequah, and Wewoka Service Units, AI/AN females

had a significantly higher percentage of late stage breast cancer than white females (Claremore: 37.3% v. 31.5%, p<0.0001; Tahlequah: 37.7% v. 32.2%, p=0.01; Wewoka: 47.5% v. 28.1%, p=0.002). In the Clinton and Lawton Service Units, AI/ANs had a higher percentage of colorectal cancers diagnosed at late stage compared to whites (Clinton: 71.6% v. 56.3%, p=0.004; Lawton: 67.2% v. 57.8%, p=0.03). Diagnosis with prostate cancer at late stage was significantly higher among AI/AN males (20.6%) compared to white males (15.2%) in the Tahlequah Service Unit (p=0.01). Late stage melanoma was significantly higher among AI/ANs (25.0%) compared to whites (13.1%) in the Talihina Service Unit (p=0.04).

When comparing the regional variation of the percent of cancers diagnosed at late stage among AI/ANs only, the Clinton Service Unit has the highest proportion of cervical and colorectal cancers diagnosed late stage. In the Clinton Service Unit, 71.6% of AI/ANs with colorectal cancer and 77.8% of AI/AN females with cervical cancer were diagnosed late stage. The percent of late stage breast cancer among AI/AN females ranged from 30–38% for most Service Units; however, nearly half (47.5%) of all breast cancer cases among AI/AN females in the Wewoka Service Unit were diagnosed late stage.

Time Trends

In the years 1997 to 2007, the AAIR in the State of Oklahoma increased significantly for AI/AN males (APC: 2.1%; 95% CI: 0.4, 3.8%) and AI/AN females (APC: 2.4%; 95% CI: 1.4, 3.5%); the AAIR remained stable for white males (Table 4, Figure 2). Cancer incidence decreased significantly from 2007 to 2012 for AI/AN males (APC: −4.9%; 95% CI: −8.8, −0.8%) and white males (APC: −3.7; 95% CI: −5.1, −2.3%). During the same time frame, AI/AN females did not experience significant declines. White females experienced an increase (APC: 1.2%; 95% CI: 0.9, 1.6%) in cancer incidence from 1997 to 2006 followed by a decrease (APC: −2.5%; 95% CI: −4.2, −0.8%) in incidence from 2006 to 2010 with no change between 2010 and 2012.

When looking at geographic variations in trends over time, the joinpoint regression models were fit with no joinpoints for the Ada, Claremore, Clinton, and Wewoka Service Units for both races and sexes, indicating no significant changes in trends throughout the study period (1997 to 2012). Of these four Service Units, significant increases in cancer incidence were found among AI/AN females in the Ada (APC: 2.7%, 95% CI: 0.6, 4.8%) and Wewoka (APC: 4.2%: 95% CI: 0.5, 8.0%) Service Units during the entire period. The data suggests white males were more likely to experience significant declines in cancer incidence, with declines primarily occurring from 2007 to 2012. White male trends indicated a significant decline in cancer incidence in the Ada, Lawton, Pawnee, Shawnee, Tahlequah, and Talihina Service Units. White females in the Pawnee and Shawnee Service Units experienced an increase in cancer incidence during the first half of the study period, but rates remained stable or decreased during the second half of the study period. AI/AN females in the Talihina Service Unit experienced a significant increase in cancer incidence from 1997 to 2009 (APC: 4.2%; 95% CI: 1.5, 6.9%).

Cancer Mortality

From 1999 to 2009, the AAMR in Oklahoma was 239.2 deaths per 100,000 for AI/ANs and 193.3 deaths per 100,000 for whites (Table 5). Looking across the nine Service Units, the AAMR ranged from 176.0 to 205.0 deaths per 100,000 for whites and 222.3 to 271.5 deaths per 100,000 for AI/ANs. The Wewoka Service Unit had the highest AAMR for both whites and AI/ANs. Mortality rates were significantly higher for AI/ANs in the state as well as each of the nine IHS Service Units. The Claremore Service Unit had the greatest disparity in cancer mortality for AI/ANs compared to whites, with a RR of 1.39 (95% CI: 1.33, 1.46).

Males had a higher AAMR compared to females for both races in all Service Units (Table 4). Among males, the greatest disparity in cancer mortality between AI/ANs and whites was found in the Clinton Service Unit (RR: 1.52, 95% CI: 1.19, 1.86). AI/AN males had significantly higher cancer mortality rates compared to white males in the Ada, Claremore, Clinton, Lawton, Tahlequah, and Wewoka Service Units. The differences in the Pawnee, Shawnee, and Talihina Service Units were not significant. Among females, the highest RR comparing AI/AN cancer mortality to whites was in the Tahlequah Service Unit (RR: 1.45, 95% CI: 1.30, 1.59). Differences between AI/AN and white females were significant in all Service Units except for Clinton and Wewoka.

DISCUSSION

In Oklahoma, health disparities exist between AI/ANs and whites for overall cancer mortality and incidence. While AI/ANs in each IHS Service Unit had higher cancer mortality and incidence rates than whites, the magnitude of cancer disparities faced by AI/ANs varied geographically. AI/AN cancer incidence rates ranged from a 7% higher incidence rate in the Lawton Service Unit to a 43% higher incidence rate in the Tahlequah Service Unit. Cancer mortality rates were also higher among AI/ANs compared to whites, ranging from 13% higher in the Talihina Service Unit to 39% higher in the Claremore Service Unit.

Geographic variations in cancer mortality and incidence differed by gender, with higher incidence and mortality rates among AI/AN males in the Wewoka Service Unit and AI/AN females in the Claremore Service Unit. Although males had higher cancer incidence and mortality rates compared to females in nearly every Service Unit for both AI/ANs and and whites, AI/AN females often faced significant disparities. The greatest disparities in cancer incidence, measured by RRs, were found in the Tahlequah Service Unit for both males and females. This Service Unit, along with the Claremore Service Unit, experienced the largest disparities in incidence for the top three primary cancer sites, which included cancers of the lung, breast, and prostate. The Wewoka Service Unit experienced the greatest increase in cancer incidence among AI/AN females during the study period.

Compared to whites, AI/AN females had a significantly higher percentage of late stage breast cancer in the Claremore and Tahlequah Service Units, which also have the greatest disparities in mortality. Nearly half (47.5%) of the AI/AN females diagnosed with breast cancer in the Wewoka Service Unit were diagnosed late stage, although the disparities in

cancer mortality between AI/ANs and whites were not as high in this Service Unit compared to other regions.

There are limitations to this study that warrant discussion. We used a large time period (1999 to 2009 for cancer mortality; 1997 to 2012 for cancer incidence) in order to examine differences in cancer for AI/ANs in small geographic regions by gender and by specific cancer sites. One limitation to aggregating incidence over a large number of years is there may have been changes in reporting quality over time as well as changes in reporting requirements or categorization, primarily changes in staging. However, we used the SEER summary stage which is fairly consistent across the study period.[29] Moreover, any misclassification due to changes in reporting differences over time are thought to be non-differential because these changes would have affected both AI/ANs and whites similarly. Although we attempted to account for racial misclassification using data linked with IHS patient registrations, there is likely some level of misclassification remaining. Not all AI/ANs utilize IHS services during their lifetime, and may continue to have their race reported incorrectly as white or other races. Another limitation is there may have been some incident cases missing from the registry that were not reported. IHS, tribal, or urban facilities are not required to report by law; however, it is believed that all facilities voluntarily participate in reporting. Many AI/AN cancer patients are diagnosed or treated through Purchased and Referred Care in non-Indian health facilities or pathology labs, which would consistently report cancer diagnoses. Therefore, the number of missing cases is likely to be small.

A final issue that needs to be addressed is that these data reflect statewide population-based information. They do not represent tribal health services or the IHS user population thus does not reflect on the quality of care provided by tribal health services, tribal programs or IHS. Each area has a unique set of circumstances that include access to care and services and this study is not a review of the impact of these services. In fact, we know that females in Oklahoma who use IHS as their primary payer are as likely as those with private insurance to receive standard of care for their localized breast cancer.[33] Thus our conclusion represent geographic variation at a population level that may assist in priority setting and may suggest increases in needs or services to a specific geographic areas, but does not suggest that existing programs are ineffective.

CONCLUSION

We found geographic variations in cancer mortality and incidence among AI/ANs and differences in the magnitude of cancer disparities in Oklahoma. These findings are important, as they will aid in identifying priority areas to address and reduce health disparities in the State of Oklahoma. Geographic variation in cancer incidence may reflect differences in health risk behaviors, environmental exposures, utilization of screening tests, access to care, or underlying differences in disease occurrence.[3] It remains unclear from this study what underlying differences exist across Service Units that could explain the differences observed in cancer incidence, mortality, and late stage diagnosis. Additional studies should consider sociodemographic, behavioral, and environmental differences by region that might explain these differences in cancer burden across Oklahoma.

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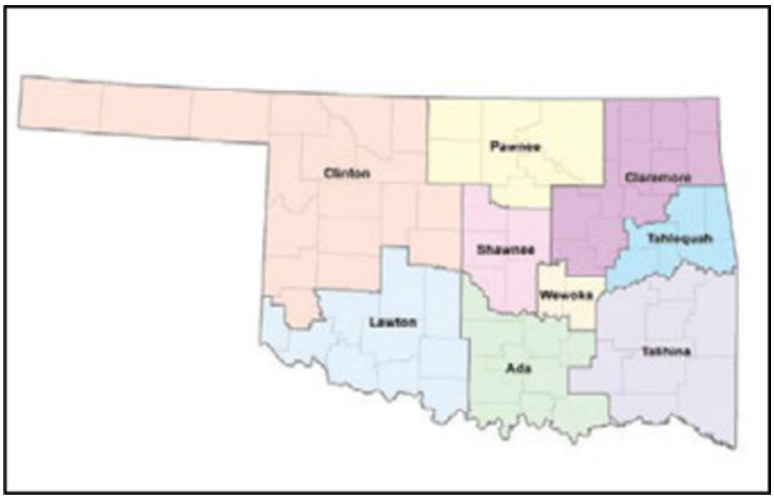

Figure 1.
Indian Health Service (IHS) Service Units in Oklahoma

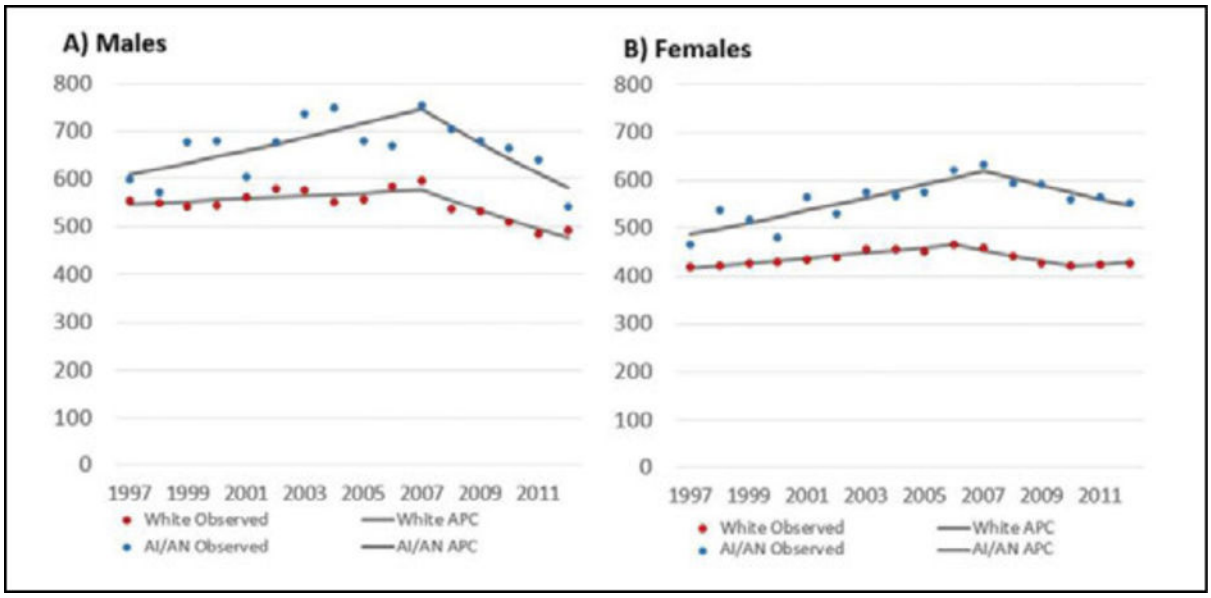

Figure 2.
Oklahoma trends in cancer incidence by race using joinpoint regression, 1997–2012

Table 1

Age-adjusted cancer incidence rates (AAIR) per 100,000, rate ratios, and 95% confidence intervals (CI) by IHS Service Unit for American Indian/Alaska Native and White Oklahomans, 1997 to 2012

	American Indian/Alaska Native			White								
	Overall	Male	Female	Overall	Male	Female	Overall		Male		Female	
	AAIR	AAIR	AAIR	AAIR	AAIR	AAIR	Rate Ratio[a] (95% CI)	p-value	Rate Ratio[a] (95% CI)	p-value	Rate Ratio[a] (95% CI)	p-value
Overall	598.5	664.8	560.2	479.5	545.2	437.1	1.25 (1.23, 1.27)	**<0.0001**	1.22 (1.19, 3.46)	**<0.0001**	1.28 (1.26, 3.67)	**<0.0001**
Ada	578.9	668.9	528.7	489.5	568.8	435.0	1.18 (1.13, 1.24)	**<0.0001**	1.18 (1.10, 3.48)	**<0.0001**	1.22 (1.14, 3.60)	**<0.0001**
Claremore	634.7	698.7	597.6	480.1	536.5	445.6	1.32 (1.29, 1.36)	**<0.0001**	1.30 (1.25, 3.82)	**<0.0001**	1.34 (1.30, 3.96)	**<0.0001**
Clinton	626.1	710.0	592.8	485.8	558.1	438.2	1.29 (1.19, 1.39)	**<0.0001**	1.27 (1.12, 4.04)	**0.0002**	1.35 (1.22, 4.28)	**<0.0001**
Lawton	494.8	491.6	509.2	464.0	523.0	427.0	1.07 (1.01, 1.13)	**0.03**	0.94 (0.85, 2.82)	**0.21**	1.19 (1.11, 3.55)	**<0.0001**
Pawnee	573.9	631.5	544.9	462.1	531.9	414.6	1.24 (1.17, 1.32)	**<0.0001**	1.19 (1.09, 3.58)	**0.0002**	1.31 (1.21, 4.03)	**<0.0001**
Shawnee	584.2	665.2	530.2	497.2	568.6	452.5	1.17 (1.13, 1.22)	**<0.0001**	1.17 (1.11, 3.41)	**<0.0001**	1.17 (1.11, 3.40)	**<0.0001**
Tahlequah	642.4	710.9	602.9	449.9	511.5	408.9	1.43 (1.38, 1.48)	**<0.0001**	1.39 (1.32, 4.23)	**<0.0001**	1.47 (1.40, 4.59)	**<0.0001**
Talihina	530.6	587.0	497.7	443.8	507.8	396.4	1.20 (1.14, 1.26)	**<0.0001**	1.16 (1.07, 3.42)	**0.0001**	1.26 (1.17, 3.77)	**<0.0001**
Wewoka	597.4	741.4	505.2	496.1	589.3	432.1	1.20 (1.10, 1.32)	**<0.0001**	1.26 (1.11, 3.99)	**0.0004**	1.17 (1.03, 3.67)	**0.02**

AAIR: Age-adjusted incidence rate

[a]Rate Ratios compare the American Indian/Alaska Native AAIR to the white AAIR

Boldface indicates statistical significance (p-value <0.05)

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Table 2

Age-adjusted cancer incidence rates (AAIR) per 100,000, rate ratios, and 95% confidence intervals (CI) by IHS Service Unit for American Indian/Alaska Native and white Oklahomans, 1997 to 2012 for the top three primary cancer sites

		AI/AN AAIR	White AAIR	Rate Ratio[a] (95% CI)	p-value
Ada	Lung and bronchus	97.8	87.1	1.13 (1.01, 1.26)	**0.03**
	Breast (females)	79.8	71.6	1.12 (0.98, 1.25)	0.08
	Prostate	71.1	58.5	1.21 (1.05, 1.38)	**0.0047**
Claremore	Lung and bronchus	112.7	78.0	1.44 (1.36, 1.53)	**<0.0001**
	Breast (females)	97.7	81.7	1.20 (1.12, 1.27)	**<0.0001**
	Prostate	73.8	56.1	1.32 (1.22, 1.41)	**<0.0001**
Clinton	Lung and bronchus	90.1	71.7	1.26 (1.01, 1.51)	**0.03**
	Breast (females)	86.5	78.6	1.10 (0.90, 1.30)	0.31
	Prostate	76.7	69.0	1.11 (0.88, 1.35)	0.33
Lawton	Breast (females)	78.1	75.9	1.03 (0.88, 1.17)	0.71
	Lung and bronchus	71.5	81.5	0.88 (0.74, 1.01)	0.09
	Prostate	37.5	52.4	0.72 (0.57, 0.86)	**0.0017**
Pawnee	Lung and bronchus	99.7	72.2	1.38 (1.19, 1.57)	**<0.0001**
	Breast (females)	85.2	72.9	1.17 (1.00, 1.34)	**0.03**
	Prostate	65.7	61.2	1.07 (0.89, 1.25)	0.42
Shawnee	Lung and bronchus	91.5	75.9	1.21 (1.09, 1.32)	**<0.0001**

		AI/AN AAIR	White AAIR	Rate Ratio[a] (95% CI)	p-value
	Breast (females)	90.9	88.4	1.03 (0.94, 1.12)	0.55
	Prostate	69.9	66.2	1.06 (0.94, 1.17)	0.32
Tahlequah	Lung and bronchus	111.4	85.8	1.30 (1.19, 1.41)	**<0.0001**
	Breast (females)	93.4	64.4	1.45 (1.32, 1.58)	**<0.0001**
	Prostate	76.7	52.1	1.47 (1.32, 1.62)	**<0.0001**
Talihina	Lung and bronchus	92.1	85.8	1.07 (0.95, 1.20)	0.25
	Breast (females)	71.8	63.3	1.13 (0.98, 1.29)	0.07
	Prostate	63.7	51.8	1.23 (1.05, 1.41)	**0.0052**
Wewoka	Lung and bronchus	101.9	91.3	1.12 (0.87, 1.36)	0.33
	Prostate	89.4	64.0	1.40 (1.07, 1.73)	**0.0063**
	Breast (females)	65.4	69.2	0.94 (0.70, 1.19)	0.69

AAIR: Age-adjusted incidence rate

[a]Rate Ratios compare the American Indian/Alaska Native AAIR to the white AAIR

Boldface indicates statistical significance (p-value <0.05)

Table 3

Number and percent late stage cancer by IHS Service Unit by race Oklahoma 1997 to 2012

		American Indian/Alaska Native	White	
Service Unit	**Cancer Type**	**N (%)**	**N (%)**	**p-value**
Ada	Cervical	10 (58.8)	66 (45.5)	0.30
	Colorectal	123 (58.6)	1083 (58.2)	0.92
	Female Breast	99 (37.6)	828 (34.0)	0.24
	Melanoma	9 (23.7)	94 (14.3)	0.11
	Lung and Bronchus	221 (78.4)	2301 (79.8)	0.56
	Prostate	20 (9.7)	295 (14.5)	0.06
Claremore	Cervical	50 (51.0)	248 (49.6)	0.80
	Colorectal	404 (55.5)	3585 (54.5)	0.60
	Female Breast	415 (37.3)	3574 (31.5)	**<0.0001**
	Melanoma	38 (19.9)	421 (14.8)	0.06
	Lung and Bronchus	843 (79.5)	7819 (78.1)	0.31
	Prostate	107 (15.6)	1099 (14.6)	0.48
Clinton	Cervical	7 (77.8)	95 (54.0)	0.19*
	Colorectal	63 (71.6)	1291 (56.3)	**0.004**
	Female Breast	37 (33.0)	1076 (30.8)	0.61
	Melanoma	<5 (10.0)	148 (14.1)	1.00*
	Lung and Bronchus	68 (82.9)	2351 (78.8)	0.36
	Prostate	10 (13.2)	392 (12.9)	0.94
Lawton	Cervical	9 (27.3)	68 (40.5)	0.15
	Colorectal	92 (67.2)	1170 (57.8)	**0.03**
	Female Breast	70 (37.4)	933 (30.6)	0.05
	Melanoma	<5 (12.5)	119 (15.4)	1.00*
	Lung and Bronchus	112 (78.3)	2360 (77.9)	0.91
	Prostate	12 (14.6)	288 (13.9)	0.84
Pawnee	Cervical	12 (48.0)	52 (39.4)	0.42
	Colorectal	79 (59.9)	988 (50.7)	0.04
	Female Breast	60 (33.3)	816 (30.5)	0.42
	Melanoma	<5 (6.9)	141 (20.7)	0.07
	Lung and Bronchus	142 (84.0)	1903 (78.3)	0.08
	Prostate	17 (13.0)	282 (12.1)	0.78
Shawnee	Cervical	20 (51.3)	239 (43.5)	0.34
	Colorectal	200 (59.5)	3575 (56.3)	0.25
	Female Breast	156 (31.3)	3400 (29.4)	0.35
	Melanoma	8 (13.8)	460 (16.0)	0.65
	Lung and Bronchus	338 (81.8)	7294 (78.2)	0.08
	Prostate	53 (16.1)	1172 (13.8)	0.23

		American Indian/Alaska Native	White	
Service Unit	**Cancer Type**	**N (%)**	**N (%)**	**p-value**
Tahlequah	Cervical	21 (41.2)	67 (54.5)	0.11
	Colorectal	223 (59.6)	692 (57.2)	0.40
	Female Breast	223 (37.7)	566 (32.2)	**0.01**
	Melanoma	21 (19.4)	74 (16.6)	0.48
	Lung and Bronchus	397 (74.9)	1630 (75.7)	0.71
	Prostate	80 (20.6)	204 (15.2)	**0.01**
Talihina	Cervical	12 (48.0)	64 (50.4)	0.83
	Colorectal	108 (63.9)	737 (59.9)	0.32
	Female Breast	66 (30.0)	584 (34.4)	0.19
	Melanoma	10 (25.0)	56 (13.1)	**0.04**
	Lung and Bronchus	195 (79.6)	1617 (77.9)	0.53
	Prostate	25 (14.0)	214 (14.9)	0.76
Wewoka	Cervical	8 (66.7)	12 (66.7)	1.00*
	Colorectal	38 (63.3)	157 (55.3)	0.25
	Female Breast	29 (47.5)	110 (28.1)	**0.002**
	Melanoma	<5 (33.3)	12 (14.1)	0.23*
	Lung and Bronchus	64 (83.1)	399 (80.8)	0.62
	Prostate	5 (6.9)	45 (11.5)	0.24

Table 4

Joinpoint Regression results by Race and Gender for Oklahoma Overall and by Region

	Trend 1		Trend 2		Trend 3	
	Years	**APC (95% CI)**	**Years**	**APC (95% CI)**	**Years**	**APC (95% CI)**
Oklahoma						
AI/AN Males	1997–2007	2.1 (0.4, 3.8)^	2007–2012	−4.9 (−8.8, −0.8)^		
White Males	1997–2007	0.5 (−0.0, 1.0)	2007–2012	−3.7 (−5.1, −2.3)^		
AI/AN Females	1997–2007	2.4 (1.4, 3.5)^	2007–2012	−2.5 (−5.0, 0.1)		
White Females	1997–2006	1.2 (0.9, 1.6)^	2006–2010	−2.5 (−4.2, −0.8)^	2010–2012	0.9 (−2.7, 4.6)
Ada						
AI/AN Males	1997–2012	0.3 (−1.6, 2.3)				
White Males	1997–2012	−1.0 (−1.8, −0.1)^				
AI/AN Females	1997–2012	2.7 (0.6, 4.8)^				
White Females	1997–2012	0.1 (−0.5, 0.6)				
Claremore						
AI/AN Males	1997–2012	0.1 (−1.4, 1.5)				
White Males	1997–2012	−0.1 (−0.9, 0.7)				
AI/AN Females	1997–2012	0.9 (−0.2, 1.9)				
White Females	1997–2012	0.1 (−0.3, 0.5)				
Clinton						
AI/AN Males	1997–2012	−0.4 (−4.5, 3.9)				
White Males	1997–2012	(−0.4 (−1.2, 0.3)				
AI/AN Females	1997–2012	−0.4 (−3.5, 2.7)				
White Females	1997–2012	0.7 (−0.2, 1.6)				
Lawton						
AI/AN Males	1997–2012	1.5 (−1.1, 4.2)				
White Males	1997–2007	−0.1 (−1.0, 0.8)	2007–2012	−3.3 (−5.7, −0.8)^		
AI/AN Females	1997–2012	−0.3 (−2.0, 1.5)				

	Trend 1		Trend 2		Trend 3	
	Years	APC (95% CI)	Years	APC (95% CI)	Years	APC (95% CI)
White Females	1997–2006	1.7 (0.4, 3.1)^	2006–2012	−2.4 (−4.8, 0.1)		
Pawnee						
AI/AN Males	1997–2012	1.7 (−0.4, 3.8)				
White Males	1997–2007	0.8 (−0.5, 2.2)	2007–2012	−4.5 (−8.2, −0.7)^		
AI/AN Females	1997–2012	1.4 (−0.2, 3.0)				
White Females	1997–2003	3.4 (0.4, 6.5)^	2003–2012	−0.8 (−2.3, 0.7)		
Shawnee						
AI/AN Males	1997–2012	−0.4 (−2.8, 2.1)				
White Males	1997–2006	0.6 (−0.5, 1.7)	2006–2012	−2.8 (−4.7, −0.9)^		
AI/AN Females	1997–2012	1.5 (−0.3, 3.3)				
White Females	1997–2004	1.8 (0.4, 3.3)^	2004–2012	−1.8 (−2.9, −0.7)^		
Tahlequah						
AI/AN Males	1997–2012	−0.8 (−1.9, 0.3)				
White Males	1997–2007	−0.1 (−1.9, 1.7)	2007–2012	−6.1 (−11.0, −1.0)^		
AI/AN Females	1997–2012	−0.3 (−1.8, 1.2)				
White Females	1997–2012	−0.4 (−1.1, 0.2)				
Talihina						
AI/AN Males	1997–2012	−0.7 (−2.7, 1.3)				
White Males	1997–2007	−0.0 (−1.2, 1.1)	2007–2012	−6.9 (−10.1, −3.6)^		
AI/AN Females	1997–2009	4.2 (1.5, 6.9)^	2009–2012	−16.4 (−31.9, 2.5)		
White Females	1997–2008	0.4 (−0.3, 1.1)	2008–2012	−5.1 (−8.3, −1.8)^		
Wewoka						
AI/AN Males	1997–2012	−0.8 (−3.5, 2.0)				
White Males	1997–2012	−1.4 (−2.8, 0.0)				
AI/AN Females	1997–2012	4.2 (0.5, 8.0)^				
White Females	1997–2012	0.5 (−1.1, 2.1)				

^ The Average Annual Percent Change (APC) was significantly different from zero at alpha =0.05.

Table 5

Age-adjusted cancer mortality rates (AAMR) per 100,000, rate ratios, and 95% confidence intervals (CI) by Indian Health Service (IHS) Service Unit for American Indian/Alaska Native and white Oklahomans, 1999 to 2009

	American Indian/Alaska Native			White								
	Overall	Male	Female	Overall	Male	Female	Overall		Male		Female	
	AAMR	AAMR	AAMR	AAMR	AAMR	AAMR	Rate Ratio[a] (95% CI)	p-value	Rate Ratio[a] (95% CI)	p-value	Rate Ratio[a] (95% CI)	p-value
Overall	239.2	312.5	214.1	193.3	241.8	159.7	1.24 (1.20, 1.27)	**<0.0001**	1.29 (1.25, 1.34)	**<0.0001**	1.34 (1.29, 1.39)	**<0.0001**
Ada	261.3	364.0	207.3	195.3	243.5	160.7	1.34 (1.22, 1.46)	**<0.0001**	1.49 (1.31, 1.68)	**<0.0001**	1.29 (1.12, 1.46)	**0.0002**
Claremore	266.3	322.0	229.1	191.0	235.0	161.0	1.39 (1.33, 1.46)	**<0.0001**	1.37 (1.28, 1.46)	**<0.0001**	1.42 (1.33, 1.52)	**<0.0001**
Clinton	233.5	330.9	180.9	176.0	217.2	147.5	1.33 (1.11, 1.54)	**0.0008**	1.52 (1.19, 1.86)	**0.0003**	1.23 (0.93, 1.53)	0.1085
Lawton	240.2	297.7	210.7	203.3	258.1	165.3	1.18 (1.06, 1.30)	**0.0015**	1.15 (0.98, 1.32)	**0.03**	1.27 (1.09, 1.46)	**0.0010**
Pawnee	231.8	275.1	198.8	189.1	238.0	154.3	1.23 (1.09, 1.36)	**0.0003**	1.16 (0.98, 1.33)	0.0589	1.29 (1.08, 1.49)	**0.0019**
Shawnee	227.4	258.7	202.6	186.1	235.2	153.6	1.22 (1.13, 1.31)	**<0.0001**	1.10 (0.99, 1.21)	0.0645	1.32 (1.18, 1.46)	**<0.0001**
Tahlequah	266.4	271.9	188.4	195.2	247.2	157.3	1.36 (1.27, 1.46)	**<0.0001**	1.32 (1.19, 1.44)	**<0.0001**	1.45 (1.30, 1.59)	**<0.0001**
Talihina	222.3	271.9	188.4	197.0	250.1	157.0	1.13 (1.03, 1.23)	**0.0077**	1.09 (0.95, 1.22)	0.1813	1.20 (1.04, 1.36)	**0.0061**
Wewoka	271.5	378.0	198.6	205.0	256.3	169.8	1.32 (1.11, 1.54)	**0.0009**	1.47 (1.15, 1.79)	**0.0006**	1.17 (0.88, 1.46)	0.2343

AAMR: Age-adjusted mortality rate

[a]Rate Ratio compares the American Indian/Alaska Native AAMR to white AAMR