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Five-Year Cancer Survival Rates in Oklahoma from 1997 to 2008

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Abstract

Introduction—This study evaluated the five-year observed survival rates of American Indians/Alaskan Native, African American, and white cancer patients among various demographic characteristics in Oklahoma focusing on lung and bronchus, colon and rectum, female breast, and prostate for the cancer patients diagnosed between 1997 and 2008.

Methods—The five-year observed survival rates were calculated for overall cancer and specific cancer sites, using Kaplan-Meier method with data from the Oklahoma Central Cancer Registry.

Results—Overall, 51.5% patients diagnosed with cancer survived for five years. For specific sites we found: 79.2% for female breast cancer survived; 77.5% for prostate cancer; 12.9% for lung and bronchus cancer; and 49.9% for colorectal cancer.

Conclusions—The five-year observed survival rates in Oklahoma were consistent with national trends. Overall, cancer survival seems to be improving over time, but there remains disparity with the AA and AI/AN populations in contrast to whites in Oklahoma.

INTRODUCTION

Cancer survival is a complex combination of prevention, screening, and treatment. Increased survival is only positive when it is accompanied by decreased burden of disease.[1] Improved survival can also occur as a result of increased disease burden, which may occur with increased screening resulting in diagnosing cancer at an earlier stage as seen with mammography for breast cancer. Increased survival may also be seen as a result of improved

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treatment or improved management of co-morbid conditions such as diabetes or heart disease.[1] Five-year survival may be seen as an important indicator of potential disparities within a population. Cancer is the second most common cause of death in the United States (US) and Oklahoma.[2] In 2012, Oklahoma ranked 5th highest in cancer mortality with an age-adjusted rate of 193.8 per 100,000 compared to 166.8 per 100,000 in the US.[3] Oklahoma had a population of around 3.8 million in 2013, out of which, 13.2% were American Indian or Alaskan Native (AI/AN) race alone or in combination with one or more other races and 8.8% were African American (AA) race alone or in combination with one or more other races.[4]

The patterns of cancer occurrence among AI/AN populations and AA populations are distinctive because of the unique characteristics of history, culture, geographic location, and access to healthcare facilities.[5-7] The AI/AN population is comprised of hundreds of tribes and linguistic groups, offering great diversity in culture.[5] Among the major risk factors for cancer, the abuse of commercial tobacco and alcohol, lower physical activity levels, and high levels of obesity have been observed at greater rates in AA and AI/AN populations.[5,8,9] The cancer mortality rate is also influenced by the stage at which the cancer is diagnosed in addition to access to healthcare. The primary healthcare in AI/AN populations is provided by the Indian Health Service (IHS) or other tribally operated programs.[11] Specialty care services, including cancer treatment, are only accessible through non-Federal Purchased/ Referred Care (PRC) services with IHS.[5] Health services are available only to those who are enrolled members of tribal nations or otherwise eligible, and therefore, treatment becomes very difficult and unaffordable to those who do not fulfill eligibility requirements or do not have access to PRC services.[5] Among AAs, there are also unique histories of segregation and lack of access to health. Both AI/AN and AA populations generally have lower socioeconomic status and less access to healthcare than whites.[10] Many studies have reviewed segregation issues, historical trauma, racism, institutional racism, intergenerational poverty and the lack of access to care among AA and AI/AN populations.[8,11-14]

Multiple studies have identified disparities in cancer survival in the US.[11,15-23] A few studies have focused specifically on the burden of cancer incidence, mortality and survival among the AA and AI/AN populations.[11,15-26] These studies have demonstrated that the survival of cancer patients in AA and AI/AN populations is lower than that of the white population.[24,25,27] However, cancer survival among AA and AI/AN populations in Oklahoma has not yet been studied.

The goal of this study was to evaluate the five-year observed survival rates among AI/AN, AA, and white populations in Oklahoma. This study focused on overall as well as site-specific five-year survival rates for lung and bronchus, colon and rectum, female breast, and prostate cancers diagnosed between 1997 and 2008. This study was approved by the institutional review boards at the University of Oklahoma Health Sciences Center and the Oklahoma State Department of Health.

MATERIALS AND METHODS

Study Population

The data for this study was obtained from the Oklahoma Central Cancer Registry (OCCR) and included all patients diagnosed with cancer (n=220,816) between 1997 and 2008 in Oklahoma. Cases were excluded if they met the following exclusion criteria: benign or borderline behavior codes (n=1,811), death certificate only as the reporting source (n=5,225), autopsy only as the reporting source (n=93), zero survival time or fewer than zero days survival (n=3,796). With these exclusions, the total sample size was 209,891. Vital status on each case was ascertained through November 1, 2014. OCCR does not participate in active follow-up, however, the OCCR periodically conducts follow-up of those included in the registry, along with linkage with the Oklahoma Mortality Data, the Social Security Death Index, and the National Death Index (NDI) to identify those who are deceased.[28] Therefore, the presumed alive assumption for those not listed as dead was used.[29]

Data Source

The data used in this study were from the OCCR, a population-based public health surveillance database that includes information on all cases of reportable cancers diagnosed or treated in Oklahoma. The OCCR started collecting information on cancer cases from January 1, 1997. The OCCR was a gold certified registry from the North American Association of Central Cancer Registries (NAACCR) for the years of this study.[30]

Cancer stage at diagnosis was determined using the SEER Summary Stage 2000 for cases diagnosed in from 1997 through 2003, and using the derived SEER Summary Stage 2000 for cases diagnosed in 2004 through 2008. Cancer stage at diagnosis was determined using the standard SEER definition, in situ, localized, regional, distant, and unstaged. Participants' age, race, date of diagnosis, date of last contact, cancer stage, sex, survival time, primary payer at diagnosis, marital status, county of residence at diagnosis, and vital status were either extracted from the OCCR or calculated based on the available information. An individual's race was determined using the OCCR primary race variable for all racial groups except AI/ANs, whose race was determined using the IHS link variable in combination with the primary race. The rural/urban continuum 2000 was used to classify patients county of residence at diagnosis as either metropolitan or non-metropolitan.[31]

Misclassification of race had been a major issue in the past in central cancer registries particularly for correctly identifying the AI/AN population. Cancer registries generally extract race and ethnicity from medical records. Several studies reported misclassification of race that varied by region and resulted in significantly lowered cancer rates in AI/AN populations.[5,32,33] To address this issue, the US cancer registry systems have been enhanced by record linkages to reduce racial misclassification.[32] In this study, the AI/AN population included those reported as primary race of AI/AN in addition to those who linked with IHS records (regardless of primary race). The IHS linkage procedures for AI/AN population are explained in detail in other studies.[32] AA and white population have been coded from the primary race variable excluding those who linked to IHS.

Survival time was calculated by subtracting date of diagnosis from date of death for patients who died and dividing the outcome by 365.24 to get survival time in years. If patients remained alive as of last contact or November 1, 2014, their survival times were considered as censored. For those dates of diagnosis that were missing, standard SEER methods were used.[34] To reduce overestimation or underestimation of survival due to missing day or month in the date variables, the following imputation method was implemented.[34] For missing days the midpoint of the month was used; for those with missing months and days, January 1 for the given year was used. For those that lacked the day but had the year and month, the 15th day of the month was assigned. for those with missing months and days, January 1 for the given year was used. For those missing the last date of contact it was assumed they were alive and the November 1, 2014 date was used.

Statistical Methods

We calculated descriptive statistics using percentages of overall cancer and each cancer site diagnosed by sex, age group, race, ethnicity (Hispanic and non-Hispanic), year of diagnosis group, marital status, primary payer at diagnosis, and stages of cancer. For race-specific analyses, we evaluated those classified as white, AA, or AI/AN. The age variable was categorized into five groups: younger than 40, 40-49, 50-59, 60-69 and 70 years and older. The stages of cancer were grouped into five categories: in situ, localized, regional, distant, and unstaged. The diagnosis years were categorized into three groups: 1997-2000, 2001-2004 and 2005-2008. Marital status was classified as single, married, separated, divorced, widowed and unknown for the overall analysis, but was categorized into three groups: married, single and unknown for race-specific analyses. Primary payer at diagnosis status was categorized as uninsured, insured, Medicaid, Medicare, Medicare/Medicaid, Veterans Affair (VA)/TRICARE/Military, IHS, and unknown. The five-year observed survival rates and their 95% confidence intervals (CI) were calculated for overall cancer and specific cancer sites, stratified by sex, age group, race, ethnicity, year of diagnosis group, marital status, primary payer at diagnosis, and stages of cancer using Kaplan-Meier method.[35] Difference in survival function between groups, such as the differences between the three main racial groups stratified by sex, age group and stages of cancer, were assessed by the log-rank test (two-sided), at 0.05 alpha level of significance.[35] If the overall log-rank test was significant, pair-wise log-rank test using the Šidák method performed with whites as the control group.[36] All the analyses were performed using SAS 9.4 version (SAS Institute, Cary, NC).

RESULTS

All Cancers

Overall, 51.5% patients diagnosed with cancer survived for five years (all groups were significant at a $p<0.0001$ **(Table 1)**. There was a relatively small but statistically significant improvement in overall five-year survival from 1997-2000, to 2001-2004 and 2005-2008 at 48.3%, 51.6%, and 54.0% respectively. The trend for overall cancer survival was as expected with younger age groups having had higher survival rates in contrast to those in older age groups. Those aged 40 years or younger had the highest percentage of survival at 77.2% in contrast to those aged 70 years and older at only 38.3% with the intervening age groups

being between those two extremes. Women were significantly more likely to survive five years with 55.3% compared to men at 47.7%. Those individuals living in non-metropolitan counties were slightly but significantly less likely to survive five years with 48.8% compared to those in metropolitan counties 53.3%. Those who were married were significantly more likely to survive five years after diagnosis at 56.7% in contrast to those that were single at 49.7% or whose marital status was unknown at 42.5%.

Primary payer at diagnosis was an important indicator of potential access to screening and early diagnosis as an approximation for socio-economic status (SES). There was a statistically significant difference between those insured and those with other primary payer sources **(Table 1)**. Sixty nine percent (68.6%) of those insured survived five years contrasted with 33.0% for those on both Medicare and Medicaid, 40.0% uninsured at diagnosis, 43.6% with Medicaid at diagnosis, 44.1% with Medicare at diagnosis, and 49.1% with VA/TRICARE/Military at diagnosis. Among those with IHS as the primary payer at diagnosis, 55.7% survived at least five years, which was significantly worse than insured, but better than those on other public payer sources (VA/TRICARE/Military, Medicare, Medicaid and Medicare/Medicaid) **(Table 1)**.

As expected, as the stage of diagnosis worsened so did the survival, with the five-year observed survival being: 84.8% for those diagnosed at in situ; 72.0% for those diagnosed at localized; 48.9% for those diagnosed at regional; 18.5% for those diagnosed at distant stage; and 31.1% for those unstaged at diagnosis **(Table 1)**.

Overall, whites and AI/ANs had similar five-year survival at 51.6% and 50.9% in contrast to 47.1% among AAs. Those identified as Hispanic had a significantly higher survival at 60.1% compared to non-Hispanics at 51.3% **(Table 1)**. Consistent with overall cancer survival trends, similar trends were observed by race for each of the demographic characteristics **(Table 2)**. However, the study also showed two vital trends. First, observed survival among AA was consistently worse than that in whites or AI/ANs, with the exception of those with primary payer of Medicaid and VA/TRICARE/Military and among those who were diagnosed at in situ or localized stage **(Table 2)**. Overall observed survival was lower for AA in contrast to AI/AN with the exception of years 2005-2008, among those aged 40-49, 50-59, and 60-69, among males, married and single, uninsured, Medicaid, Medicare/Medicaid, VA/TRICARE/Military, in situ, localized and regional **(Table 2)**. The second important trend was that while AI/ANs had similar overall observed survival compared to whites, the trends were inconsistent. The most recent years 2005-2008 were trending toward being worse for AI/AN populations compared to whites at 50.1% and 54.5% (p=0.07) respectively **(Table 2)**. Additionally, each age group and males had lower observed survival compared to the same demographic groups among whites **(Table 2)**. For primary payer, when compared to whites, AI/ANs had lower five-year survival among those uninsured (34.5% vs 40.3%, p=0.07) and those with Medicare (42.5% vs 44.4%, p<0.0001), however, had higher survival with unknown primary payer (55.1% vs 48.0%, p<0.0001). Moreover, those AI/ANs with distant stage had increased observed survival at 20.9% in contrast to 18.3% for whites, although not significantly different (p=0.09).

Female Breast Cancer

Overall, 79.2% of women diagnosed with breast cancer survived for five years (all groups were significant at a $p<0.0001$ unless stated otherwise; **Table 1**). There was a small but statistically significant improvement in overall observed survival for women diagnosed from 1997-2000, to 2001-2004 and 2005-2008 at 76.4%, 79.9%, and 81.1% respectively. Women aged 70 years and older were less likely to survive five years at 66.8% compared to all other age groups. Women living in non-metropolitan counties at diagnosis were slightly less likely to survive five years at 77.2% compared to those in metropolitan counties at 80.3%. Married women were significantly more likely to survive five years 85.7% compared to single women at 77.5% or whose marital status was unknown at 67.8%.

The percentage of women surviving breast cancer for five years decreased as stage of diagnosis worsened: 92.9% of those diagnosed at in situ; 85.9% diagnosed at localized stage; 74.4% diagnosed at regional stage; 24.0% diagnosed at distant stage; and those unstaged at diagnosis had 54.4% five-year survival **(Table 1)**.

There was a statistically significant difference in observed survival based on primary payer sources **(Table 1)**. Women with VA/TRICARE/Military as their primary payer at diagnosis had the highest survival at 91.4% followed closely by women with insurance at 89.3%. Among those with both Medicare and Medicaid as their primary payer at diagnosis, only 57.8% survived five years.

Whites and AI/AN women had similar five-year observed survival at 79.4% and 80.2%, in contrast to 73.4% of AA women who survived five years ($p<0.0001$). Trends in survival for each of these demographic characteristics of women diagnosed with female breast cancer by race were consistent with the overall survival within each racial group. There was one overarching and disconcerting trend: observed survival for AA women was consistently worse than white or AI/AN women, with the exception of a few very specific groups, including among those with Medicare and Medicaid at diagnosis and those diagnosed at the in situ stage. While there was no significant differences among women younger than 40 years, survival remained lower for AA women at 81.0% in contrast to 84.3% for AI/AN women and 84.8% for white women **(Table 3)**. Among women ages 40-49 and 50-59, both AI/ANs and AAs were significantly lower than whites ($p<0.0001$). Among women ages 60-69, AI/ANs and AAs were also significantly worse ($p=0.005$ and $p<0.0001$, respectively). Additionally, among women ages 70 and older, AI/ANs and AAs were also significantly worse ($p=0.005$ and $p<0.0001$ respectively).

Furthermore, AA women living in both metropolitan ($p<0.0001$) and non-metropolitan ($p=0.006$) areas had lower observed survival in contrast to white women, whereas AI/AN women did not **(Table 3)**. Married AA women (78.1%) had significantly decreased observed survival in contrast to white women (85.9%) ($p<0.0001$), although there were no differences among single women **(Table 3)**. AI/AN women had significantly higher survival (86.9%) than white women ($p=0.03$). Among those who were insured at diagnosis, 84.0% of AAs survived five years in contrast to 89.7% of white women ($p<0.0001$). Again, AI/AN women had significantly higher survival (90.2%) than white women ($p=0.02$). AA women with Medicare had an observed survival of 65.4% in contrast to white women at 72.5%

(p=0.0003) **(Table 3)**. Finally, women who were diagnosed at in situ or localized stage showed no significant differences by race **(Table 3)**. However, AA women (67.6%) who were diagnosed at regional stage had poorer five-year survival compared to white women (74.9%) (p<0.0001). Finally, AA women (12.6%) who were diagnosed at distant stage had poorer five-year survival compared to white women (24.4%) and they were lower than AI/AN women (30.2%) (p=0.004).

Prostate Cancer

Overall, 77.5% of men diagnosed with prostate cancer survived for five years (all groups were significant at a p<0.0001 unless stated otherwise; **Table 1**). The proportion of AA men diagnosed with prostate cancer was 7.4% in contrast to 5.4% of those diagnosed with prostate cancer overall. There was a small, but statistically significant improvement in overall survival for men diagnosed with prostate cancer from 1997-2000, to 2001-2004 and 2005-2008 at 75.0%, 77.2%, and 80.0% respectively. Those who reported Hispanic ethnicity had a higher five-year survival at 84.3% compared to non-Hispanic ethnicity at 77.4%. Those aged 70 years and older were less likely than other age groups to survive for five years. Men living in non-metropolitan counties at diagnosis were less likely to survive five years at 75.0% compared to those in metropolitan counties at 79.2%. Those who were married were significantly more likely to survive five years at 82.5% in contrast to those who were single at 74.9% or whose marital status was unknown at 63.6%.

Also, there were significant differences between men who were insured and those with other primary payer sources **(Table 1)**. Those with insurance as their primary payer at diagnosis had the highest five-year survival at 90.8% in contrast to those with VA/TRICARE/Military at 82.0%, those with Medicare at 73.3%, those with Medicare and Medicaid 67.1%, those with Medicaid at 59.0%, those who were uninsured at 56.1%, and those with unknown primary payer at 71.4%.

Regarding stage, there were no differences in observed survival between in situ at 81.3%, localized at 83.1%, and regional at 84.2%. However, those diagnosed at distant stage had lower survival (22.5%) compared to those diagnosed with in situ tumors **(Table 1)**. Those with unstaged cases had 51.7% five-year survival.

White and AI/AN men had similar five-year observed survival at 77.5% and 77.7% respectively in contrast to 75.2% among AA men (p=0.0002) **(Table 1)**. Among older age groups, AA men had increased disparities compared to whites: aged 50-59 years at 88.9% compared to 92.6% for whites (p<0.0001); aged 60-69 years at 81.6% compared to 87.4% for whites (p<0.0001); aged 70 years and older at 52.5% compared to 65.6% for whites (p<0.0001). AA men living in both metropolitan areas (76.6%) (p=0.002) and non-metropolitan areas (70.2%) (p=0.06) had slightly lower observed survival compared to white men (79.4%) and (75.0%) respectively **(Table 4)**. Among AAs who had Medicare as their primary payer at diagnosis, 68.8% survived five years compared to 73.4% among white men (p=0.003). AI/AN men (79.6%) whose diagnosis was reported at regional stage had worse five-year survival compared to white men (84.1%) (p=0.005). AI/AN men (64.9%) whose diagnosis was reported at an unknown stage had marginally better five-year survival compared to white men (50.7%) (p=0.07).

Lung and Bronchus Cancer

Overall, 12.9% of those diagnosed with lung and bronchus cancer survived for five years (all groups were significant at a p<0.0001 unless stated otherwise; **Table 1**). There was a small, but statistically significant improvement in overall survival for individuals diagnosed with lung and bronchus cancer from 1997-2000, to 2001-2004 and 2005-2008 at 11.4%, 12.9%, and 14.4 % respectively **(Table 1)**. Those younger than 40 years were 3.7 times more likely to survive five years (33.9%) in contrast to those aged 70 years or older (9.2%). Those living in non-metropolitan counties at diagnosis were slightly less likely to survive five years with 12.3% in compared to metropolitan counties at 13.4%. Those who were married were significantly more likely to survive five years at 14.7% in contrast to those that were single at 12.6% or whose marital status was unknown at 10.0%. There was a statistically significant difference between those insured and those with other primary payer sources. However, 9.4% of those who were uninsured, 10.8% for those with Medicaid, 11.6% for those with Medicare, 9.6% for those with both Medicare and Medical, 12.5% for those with VA/TRICARE/Military and 11.2% for those with unknown primary payer were all less likely to survive five years in contrast to those with primary payer at insurance (19.3%).

As expected, as stage of diagnosis became later, the percentage surviving lung and bronchus cancer at five years declined: 29.6% of those diagnosed at in situ; 34.0% of those diagnosed at localized; 16.2% of those diagnosed at regional; and 3.5% of those diagnosed at distant stage **(Table 1)**. Those unstaged at diagnosis had 8.0% five-year survival.

Among those diagnosed with lung and bronchus cancer, fewer disparities by race were observed compared to other cancer sites. AI/ANs diagnosed with lung cancer in 1997-2000 (13.9%) had a marginally higher observed survival in contrast to whites (11.4%) (p=0.08). AI/ANs diagnosed with lung cancer in 2005-2008 (11.5%) had lower observed survival in contrast to whites (14.5%) (p=0.01), but there was no difference by race in 2001-2004. Among those aged 60-69 years, AAs (9.8%) diagnosed with lung cancer were less likely to survive five years compared to whites (15.6%) (p=0.01). Married AAs diagnosed with lung and bronchus cancer (11.5%) showed a slight but marginally significant decreased observed survival compared to whites (14.7%) (p=0.06) but no difference among those reported as single. There was no significant difference based on race for sex, rural/urban continuum, primary payer, or stage at diagnosis **(Table 5)**.

Colon and Rectum Cancer

Overall, 49.9% of those diagnosed with colorectal cancer survived for five years (all groups were significant at a p<0.0001 unless stated otherwise; **Table 1**). There was a small, but significant improvement in overall survival for individuals diagnosed with colorectal cancer from 1997-2000, to 2001-2004 and 2005-2008 at 46.5%, 50.6%, and 52.8%, respectively. Those aged 70 years and older were less likely to survive five years at 41.6% in contrast to those in all other age groups. Furthermore, there was a small, but significant difference in observed survival between men at 48.8% and women at 51.0% (p=0.003). Those living in non-metropolitan counties were slightly less likely to survive five years with 48.2% compared to those in metropolitan counties at 51.2%. Additionally, those who were married were significantly more likely to survive five years at 56.3% in contrast to those that were

single at 47.7% or whose marital status was unknown at 40.2%. Those with insurance as their primary payer at diagnosis had the highest survival at 63.8%. Those with the following primary payer sources were less likely to survive five years than those with insurance: Medicare and Medicaid at 36.3%, those uninsured at 40.1%, those with Medicaid at 40.1%, those with Medicare at 46.3%, those with IHS at 49.2%, those with VA/TRICARE/Military at 51.1%, and those with unknown primary payer at 44.9%. As expected, as stage of diagnosis increased, the percentage surviving colorectal cancer at five years worsened: 78.0% of those diagnosed at in situ; 69.2% of those diagnosed at localized; 53.3% of those diagnosed at regional; and 11.3% of those diagnosed at distant stage. Those unstaged at diagnosis had 26.5% five-year survival.

Survival from colorectal cancer indicated disparities between AAs (43.1%) and whites (50.5%), with AI/ANs in between at 47.6% (p=0.0001) **(Table 1)**. While the percent surviving five years increased during the periods 2001-2004 for whites and AAs, there was no substantial change for AI/ANs **(Table 6)**. Among AAs diagnosed with colorectal cancer in 1997-2000 35.3% survived five years compared to whites at 47.2% (p=0.006). Additionally, among AAs in 2005-2008, 46.4% survived five years compared to whites at 53.7% (p=0.006). Among AI/AN in 2005-2008, 47.6% survived five years compared to whites at 53.7% (p=0.01). All age groups had significant differences between AA and whites except the youngest age groups (aged 40-49 p=0.0006, aged 50-59 p=0.003, aged 60-69 p=0.004 and aged 70 years and older p<0.0001). Additionally, survival for all age groups significantly differed between AI/ANs and whites except the youngest age groups (40-49 p=0.0004, 50-59 p=0.007, 60-69 p=0.008 and 70 and older p=0.003). AA and AI/AN men had lower observed survival at 40.5% (p=0.0002) and 44.4% (p=0.008), respectively, compared to whites at 49.6%. AAs living in both metropolitan areas (43.9%) (p=0.008) and non-metropolitan areas (40.3%) (p=0.0007) had lower observed survival in contrast to whites at 51.8% in metropolitan and 48.8% in non-metropolitan counties. AI/ANs living in both non-metropolitan areas at 44.3% had lower observed survival compared to whites at 48.8% (p=0.03) **(Table 6)**. Married AAs (48.7%) had significantly decreased observed survival compared to whites (56.7%) (p=0.02). Furthermore, AAs and AI/ANs who had Medicare at diagnosis had a five-year survival rate of 35.9% and 42.5% compared 47.0% among whites (p<0.0001 and p=0.0002 respectively). There was no significant difference among racial groups based on stage at diagnoses **(Table 6)**.

DISCUSSION

In this study, the five-year observed survival rates in Oklahoma were consistent with national trends.[37] Overall, cancer survival seems to be improving over time, but there remains serious disparity with AA population compared to whites in Oklahoma. To a lesser extent, there were also disparities in survival between AI/ANs and whites in Oklahoma, which is consistent with previous studies indicating AI/ANs have poorer survival in other parts of the US.[24,25,37]

In some cases, the percentage surviving five years for a specific demographic group were as much as 2.4 times worse for AAs compared to whites, but this trend was not consistent. The few instances where AA survival was higher than whites or AI/ANs were notable for their

rarity. While this is consistent with national trends, it is still important to note and to highlight the work that still needs to be done to reduce these long standing and critical disparities in the US and in Oklahoma.[37] Future analytical studies should identify and control for confounding and determine whether effect modification is present in order to better understand racial disparities in Oklahoma.[6,8,11,13,29,38]

Overall, older aged patients had lower survival. This was to be expected given that only observed survival or all-cause survival was used. Those with primary payer as Medicare also indicated lower overall observed survival. As reported nationally, males tend to have decreased survival compared to females.[37] Individuals who lived in non-metropolitan counties also tended to have lower survival compared to those living in metropolitan areas at diagnosis. Further research is recommended using smaller spatial areas (such as census tracts), as county-based categories may be too geographically heterogeneous to show true disparities.

This study also suggested an important disparity by marital status at diagnosis. For the most part, those married at diagnosis were more likely to survive five years. This was true for all racial groups and for each specific cancer and suggests the importance of support for cancer patients. However, further analytic research is recommended controlling for confounding factors such as age, race, SES to determine if this remains important.

Primary payer at diagnosis is a complicated factor that has been shown to be important for cancer surivival.[39] Generally when the primary payer at diagnosis was private insurance, survival was better. In a few strata VA/TRICARE/Military also indicated improved survival. Often those on Medicaid and those who were uninsured had poorer survival. Again, further research controlling for confounding factors such as age, race, and SES is extremely important as these factors impact insurance coverage. It will also be interesting to follow trends in insurance coverage over time with the implementation of the Affordable Care Act in 2010, which has reduced the numbers of the uninsured population from 20.3% in 2012 to 13.2% in 2015.[40]

One note that deserves further attention is the lack of dramatic disparity in observed survival among the racial groups for lung cancer. While previous studies indicated significant lung and bronchus cancer disparities by race, the disparities observed – particularly in the early years of 1997-2001, those aged 60-69 years and those who were married – were not nearly as dramatic as in other cancers.[41,42] A more intense review of racial disparities in lung and bronchus cancer is recommended with the hope to begin observing an end to disparities in survival of this very fatal cancer, which was also observed in a study of US Veteran population.[43]

As mentioned above, there appear to be disparities in survival between AI/ANs and whites in Oklahoma consistent with previous studies.[24,25,37] However, this disparity is evident primarily in overall cancer survival and in colorectal cancer but not consistently in other specific cancers. Therefore, analysis of additional cancers is needed to determine whether the overall differences between AI/ANs and whites were due to rarer cancers that cannot as easily be treated by IHS or Tribal Health Facilities. Finally, the primary payer among

AI/ANs is often complicated by the confusion of health facility staff as well as those providing insurance, because many AI/AN with IHS or Tribal Health coverage are rarely asked to provide this information if seeking medical help at an IHS or Tribal Health Facility. This is evidenced throughout this study as AI/ANs typically have the highest percentage of unknown primary payer.

An important topic to keep in mind for future studies is the issue of increasing individual who report they are multiple races. Oklahoma is unique in the 5.9% who report they are two or more races in the census.[4] In fact, not a great deal of work has been done with people who report multiple races and how this affects their health outcomes. The complex issues of race, racism, access to care, cultural differences and genetic distribution none of which we understand in detail. Further exploration of the differences in survival for specific geographic areas is recommended as there are dramatic differences between and among tribal nations regarding risk factors, treatment, and access to care. Action should be taken at tribal, local, state as well as federal level, as cancer is a major problem among AI/AN population in Oklahoma and the US.[5,25,44-48] 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. It is important to note that in some cancers that have been a focus of tribal health services, female breast cancer in this study, shows no significant difference between AI/AN and whites. We have seen this is other studies and it does suggest that focused screening and treatment programs may be beginning to show successes.[49,50]

STRENGTHS AND LIMITATIONS

There were several strengths to this study: the large database, the high quality data, the death linkages, and the presumed alive methodology. The OCCR data set is the only large data set of cancer patients for Oklahoma and it allowed us to make reasonable cancer survival estimates that can be generally applicable to the population in Oklahoma.[28]

Nonetheless, there were several limitations encountered while performing this study. First, the most important limitation in the study was that OCCR does not conduct active follow-up of the patients or NDI linkage every year and therefore, survival may still be overestimated. However, according to a recent review of central cancer registry data, the presumed alive methodology results in minimal underestimation.[28,29] This underestimation would most likely occur among Hispanic and Asian populations primarily due to the higher proportion of emigrants in these populations and due to small sample size were not reviewed in detail for this study.[29] Of concern is that NDI linkage is not completed each year at OCCR. The large majority of cases will be updated with Oklahoma Mortality Data and the Social Security Death Index to identify those who are deceased. There may be an artificial inflation of the rates for recent years. We will continue to review these in future years.

A second limitation of this study was the use of crude observed survival, rather than one of the other methods such as relative survival, cause-specific survival, age-adjusted survival, or median survival.[37,51] For cancers with dismal survival rates such as lung cancer, five-year

observed survival may not be the optimal survival measure. The decision of which survival methods to use in a cancer study is complex.[28,29,51-53] Observed survival is the proportion of people with a particular cancer who are alive at a certain point in time after their diagnosis, thus includes deaths from causes other than the specific cancer. Therefore, a confounding factor may be co-morbidity and competing causes of death, such as in diabetes among AI/AN and AA populations. This can be particularly true when looking at groups that have disparities in death from many causes. For this study, observed survival was the best choice as the study was descriptive.[53]

A third limitation of this study was not accounting for incidence, mortality or screening. Improved survival is only a strength when it is accompanied by decreased burden of disease.[1] Apparent improved survival can occur when disease burden is increased due to certain biases including lead time (the systematic error of apparent increased survival from detecting disease in an early stage), length (the systematic error from detecting disease with a long latency or pre-clinical period), referral (the systematic error from detecting disease in persons who have a tendency to seek health care) and detection (the detection of insignificant disease) being introduced, and without incidence, mortality and screening data, true survival differences cannot be known.

A fourth limitation of this study was potential confounding and effect modification. As this study was descriptive in nature, these potential effects were not evaluated. Differences by the demographic variables often contribute to confounding as well as behavioral factors not typically collected by cancer registries. A multivariate or stratified analysis is recommended to further explore and account for these factors.

Fifth, biases are often associated with cancer registry data collection including “immortal” cancer patients who have a diagnosis but are immediately lost to follow-up due to moving outside of the US where the NDI or other methods would not identify their death. This may explain the higher percentage of survival among Hispanics in our study. To control for this, those who had zero days or less than zero days of survival in our study were eliminated.

Finally, the percent of missing data was concerning for some variables, namely marital status with 28% unknown, primary payer at diagnosis with 8.8% missing and stage at diagnosis with 12.3% missing or unknown. Missing data were analyzed as a unique category for each of the variables. As discussed above, cases with zero days or less than zero days of survival were deleted in our study with 1.7% of the total study.

CONCLUSION

In conclusion, this study provides information on observed survival rates for all cancers combined and for specific cancer sites in Oklahoma. This is the first known population-based race-specific study on cancer survival rates in Oklahoma. The cancer survival rates were poorer among the AA population and, to a lesser extent, among the AI/AN population in Oklahoma. Additional research is encouraged to clarify survival in Oklahoma including relative survival, cause-specific survival and multivariable analysis. There are numerous opportunities to address disparities in cancer, such as patient navigation, physician

education, and health literacy, and this should be the focus of future analyses and interventional studies.[54] Addressing such issues would influence better understanding of the burden and survival of cancer among Oklahomans.

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Table 1

Number (N), five-year observed survival, 95% confidence intervals and log-rank p-values for all cancers, female breast, prostate, lung and bronchus, and colorectal cancer by selected demographic characteristics, Oklahoma 1997-2008 Oklahoma Central Cancer Registry

	All Cancers			Female Breast			Prostate			Lungs and Bronchus			Colon and Rectum		
	N	**Observed Survival**	**95% CI**	**N**	**Observed Survival**	**95% CI**	**N**	**Observed Survival**	**95% CI**	**N**	**Observed Survival**	**95% CI**	**N**	**Observed Survival**	**95% CI**
Overall		51.5	(51.2, 51.7)		79.2	(78.8, 79.6)		77.5	(77.0, 78.0)		12.9	(12.6, 13.3)		49.9	(49.2, 50.6)
Race			*p<0.0001*			*p<0.0001*			*P=0.0002*			*p<0.0001*			*p=0.0001*
White	181,189	51.6	(51.4, 51.9)	30,317	79.4	(79.0, 79.9)	24,056	77.5	(77.0, 78.1)	30,543	13.0	(12.6, 13.4)	16,134	50.5	(49.7, 51.3)
African-American	11,285	47.1	(46.2, 48.0)	1,925	73.4	(71.3, 75.3)	2,066	75.2	(73.3, 77.0)	1,770	11.4	(9.9, 12.9)	1,139	43.1	(40.2, 46.0)
AI/AN	15,239	50.9	(50.1, 51.7)	2,425	80.2	(78.5, 81.7)	1,728	77.7	(75.7, 79.6)	2,425	12.7	(11.5, 14.1)	1,383	47.6	(44.9, 50.2)
Asian/Pacific Islander	1,349	57.4	(54.8, 60.0)	271	83.4	(78.4, 87.3)	123	85.4	(77.8, 90.5)	165	21.8	(15.9, 28.4)	128	55.5	(46.4, 63.6)
Missing	829			129			132			55			55		
Ethnicity			*p<0.0001*			*p=0.001*			*p<0.0001*			*p=0.01*			*p=0.01*
Non-Hispanic	205,566	51.3	(51.1, 51.5)	34,242	79.1	(78.7, 79.5)	27,660	77.4	(76.9, 77.9)	34,516	12.9	(12.6, 13.3)	18,496	49.8	(49.1, 50.6)
Hispanic	4,324	60.1	(58.6, 61.5)	825	81.9	(79.1, 84.4)	445	84.3	(80.5, 87.3)	442	15.4	(12.2, 18.9)	343	53.9	(48.5, 59.0)
Missing	<5														
Years			*p<0.0001*			*p<0.0001*			*p<0.0001*						
1997-2000	64,379	48.3	(47.9, 48.7)	11,180	76.4	(75.6, 77.1)	8,729	75.0	(74.0, 75.9)	11,149	11.4	(10.8, 12.0)	6,379	46.5	(45.3, 47.8)
2001-2004	70,571	51.6	(51.3, 52.0)	11,959	79.9	(79.2, 80.6)	9,488	77.2	(76.3, 78.0)	11,716	12.9	(12.3, 13.6)	6,443	50.6	(49.3, 51.8)
2005-2008	74,941	54.0	(53.7, 54.4)	11,928	81.1	(80.4, 81.8)	9,888	80.0	(79.2, 80.8)	12,093	14.4	(13.7, 15.0)	6,017	52.8	(51.5, 54.1)
Age Group (years)			*p<0.0001*			*p<0.0001*			*p<0.0001*			*p<0.0001*			*p<0.0001*
<40	10,313	77.2	(76.4, 78.0)	1,456	84.1	(82.2, 85.9)	14	85.7	(53.9, 96.2)	242	33.9	(28.0, 39.9)	396	64.4	(59.5, 68.9)
40-49	17,684	68.8	(68.1, 69.5)	5,201	87.5	(86.5, 88.3)	570	93.5	(91.2, 95.3)	1,657	18.8	(17.0, 20.7)	1,086	62.2	(59.2, 65.0)
50-59	36,381	62.4	(61.9, 62.9)	8,072	86.4	(85.7, 87.2)	4,348	92.0	(91.1, 92.7)	5,422	17.2	(16.2, 18.2)	2,656	61.6	(59.7, 63.4)
60-69	54,247	55.7	(55.3, 56.1)	8,587	83.5	(82.7, 84.3)	9,686	87.0	(86.3, 87.6)	10,570	15.4	(14.7, 16.0)	4,357	58.1	(56.6, 59.5)
≥70	91,266	38.3	(38.0, 38.6)	11,751	66.8	(65.9, 67.6)	13,487	65.3	(64.5, 66.1)	17,067	9.2	(8.8, 9.7)	10,344	41.6	(40.7, 42.6)
Sex			*p<0.0001*									*p<0.0001*			*p=0.00*
Male	106,034	47.7	(47.4, 48.0)	N/A			28,105			20,030	10.9	(10.5, 11.4)	9,475	48.8	(47.8, 49.8)
Female	103,852	55.3	(55.0, 55.6)	35,067			N/A			14,928	15.6	(15.0, 16.2)	9,364	51.0	(50.0, 52.0)
Missing	5														

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	All Cancers			Female Breast			Prostate			Lungs and Bronchus			Colon and Rectum		
	N	**Observed Survival**	**95% CI**	**N**	**Observed Survival**	**95% CI**	**N**	**Observed Survival**	**95% CI**	**N**	**Observed Survival**	**95% CI**	**N**	**Observed Survival**	**95% CI**
Rural/Urban Continuum			*p<0.0001*			*p<0.0001*			*p<0.0001*			*p<0.0001*			*p<0.0001*
Metropolitan	124,485	53.3	(53.0, 53.6)	22,234	80.3	(79.8, 80.9)	16,545	79.2	(78.6, 79.8)	19,962	13.4	(13.0, 13.9)	10,725	51.2	(50.3, 52.2)
Non-Metropolitan	85,404	48.8	(48.5, 49.1)	12,833	77.2	(76.4, 77.9)	11,560	75.0	(74.2, 75.8)	14,996	12.3	(11.8, 12.8)	8,113	48.2	(47.1, 49.2)
Missing	<5												<5		
Marital Status			*p<0.0001*			*p<0.0001*			*p<0.0001*			*p<0.0001*			*p<0.0001*
Married	114,367	56.7	(56.4, 57.0)	19,130	85.7	(85.2, 86.2)	18,903	82.5	(82.0, 83.1)	18,514	14.7	(14.1, 15.2)	10,045	56.3	(55.3, 57.2)
Single	35,051	49.7	(49.2, 50.3)	5,827	77.5	(76.4, 78.6)	2,838	74.9	(73.2, 76.4)	6,467	12.6	(11.8, 13.5)	2,875	47.7	(45.8, 49.5)
Unknown	60,473	42.5	(42.2, 42.9)	10,110	67.8	(66.9, 68.7)	6,364	63.6	(62.4, 64.8)	9,977	10.0	(9.4, 10.6)	5,919	40.2	(39.0, 41.5)
Primary Payer			*p<0.0001*			*p<0.0001*			*p<0.0001*			*p<0.0001*			*p<0.0001*
Uninsured	13,369	40.0	(39.1, 40.8)	1,981	68.0	(65.9, 70.0)	1,008	56.1	(52.9, 59.1)	2,644	9.4	(8.3, 10.5)	1,143	40.1	(37.2, 42.9)
Insured	61,424	68.6	(68.2, 69.0)	14,371	89.3	(88.8, 89.8)	7,798	90.8	(90.1, 91.4)	7,141	19.3	(18.4, 20.2)	4,669	63.8	(62.5, 65.2)
Medicaid	8,980	43.6	(42.6, 44.6)	1,684	70.2	(68.0, 72.4)	441	59.0	(54.2,63.4)	1,711	10.8	(9.4, 12.3)	534	40.1	(35.9, 44.2)
Medicare	96,354	44.1	(43.8, 44.4)	13,225	72.2	(71.5, 73.0)	14,921	73.3	(72.6, 74.0)	17,943	11.6	(11.1, 12.0)	10,218	46.3	(45.3, 47.2)
Medicare/Medicaid	3,251	33.0	(31.7, 35.0)	424	57.8	(52.9, 62.3)	231	67.1	(60.6, 72.7)	732	9.6	(7.6, 11.8)	358	36.3	(31.4, 41.3)
VA/Tricare/Military	6,225	49.1	(47.8, 50.3)	500	91.4	(88.6, 93.5)	1,074	82.0	(79.6, 84.2)	1,469	12.5	(10.9, 14.3)	466	51.1	(46.4, 55.5)
Indian Health Services	1,902	55.7	(53.5, 57.9)	370	82.4	(78.2, 85.9)	183	84.2	(78.0, 88.7)	286	15.0	(11.2, 19.4)	118	49.2	(39.9, 57.8)
Unknown	18,386	48.4	(47.7, 49.1)	2,512	73.3	(71.6, 75.0)	2,449	71.4	(69.5, 73.1)	3,032	11.2	(10.1, 12.4)	1,333	44.9	(42.2, 47.5)
Stage			*p<0.0001*			*p<0.0001*			*p<0.0001*			*p<0.0001*			*p<0.0001*
In Situ	11,858	84.8	(84.2, 85.4)	5,285	92.9	(92.2, 93.6)	16	81.3	(52.5, 93.5)	27	29.6	(14.1, 47.0)	777	78.0	(74.9, 80.7)
Localized	85,504	72.0	(71.7,72.3)	17,272	85.9	(85.4, 86.4)	21,619	83.1	(82.6, 83.6)	6,773	34.0	(32.9, 35.2)	6,433	69.2	(68.0, 70.3)
Regional	40,112	48.9	(48.4, 49.4)	8,736	74.4	(73.5, 75.3)	2,437	84.2	(82.7, 85.6)	8,107	16.2	(15.4, 17.0)	6,708	53.3	(52.1, 54.5)
Distant	46,651	18.5	(18.2, 18.9)	1,772	24.0	(22.1, 26.1)	1,190	22.5	(20.2, 24.9)	15,649	3.5	(3.2, 3.8)	3,493	11.3	(10.3, 12.4)
Unstaged	25,766	31.1	(31.1, 32.2)	2,002	54.4	(52.2, 56.6)	2,843	51.7	(49.9, 53.5)	4,402	8.0	(7.2, 8.8)	1,428	26.5	(24.2, 28.8)

Table 2

Five-year observed survival, 95% confdence intervals and log-rank p-values for all cancers by selected demographic characteristics, Oklahoma, 1997-2008, Oklahoma Central Cancer Registry

	American Indian/ Alaskan Native		White		African American		
	Observed Survival	95% CI	Observed Survival	95% CI	Observed Survival	95% CI	p-value
Years							
1997-2000	50.8	(49.3, 52.3)	48.3	(47.9, 48.8)	42.2	(40.6, 43.9)	<0.0001
2001-2004	52.0	(50.6, 53.3)	51.7	(51.3, 52.1)	47.7	(46.1, 49.3)	0.0002
2005-2008	50.1	(48.8, 51.4)	54.5	(54.1, 54.9)	50.5	(49.0, 52.1)	<0.0001
Age Group (years)							
<40	74.2	(71.7, 76.5)	78.6	(77.7, 79.5)	68.3	(64.9, 71.5)	<0.0001
40-49	63.8	(61.5, 66.0)	70.0	(69.2, 70.7)	61.6	(58.9, 64.2)	<0.0001
50-59	56.7	(54.9, 58.4)	63.4	(62.9, 64.0)	55.2	(53.2, 57.2)	<0.0001
60-69	52.1	(50.6, 53.7)	56.4	(56.0, 56.9)	49.0	(47.2, 50.8)	<0.0001
≥70	36.4	(35.1, 37.8)	38.6	(38.3, 39.0)	32.0	(30.5, 33.4)	<0.0001
Sex							
Male	45.9	(44.7, 47.0)	47.9	(47.5, 48.2)	45.2	(44.0, 46.5)	<0.0001
Female	55.4	(54.4, 56.5)	55.5	(55.2, 55.9)	49.1	(47.8, 50.4)	<0.0001
Rural/Urban Continuum							
Metropolitan	53.2	(52.0, 54.4)	53.5	(53.2, 53.8)	48.7	(47.7, 49.8)	<0.0001
Non-Metropolitan	49.0	(47.9, 50.1)	48.9	(48.6, 49.3)	41.1	(39.2, 43.1)	<0.0001
Marital Status							
Married	55.9	(54.7, 57.1)	56.8	(56.5, 57.1)	53.4	(51.9, 54.9)	<0.0001
Single	48.4	(46.8, 50.1)	50.0	(49.4, 50.6)	47.6	(46.0, 49.3)	0.04
Unknown	45.3	(43.9, 46.7)	42.4	(41.9, 42.8)	37.9	(36.2, 39.6)	<0.0001
Primary Payer							
Uninsured	34.5	(31.3, 37.8)	40.3	(39.4, 41.2)	37.6	(34.5, 40.7)	0.01
Insured	68.0	(66.4, 69.5)	68.9	(68.5, 69.3)	63.7	(62.1, 65.3)	<0.0001
Medicaid	46.1	(43.1, 49.0)	43.3	(42.1, 44.4)	42.8	(39.8, 45.7)	0.05
Medicare	42.5	(41.2, 43.8)	44.4	(44.0, 44.7)	39.0	(37.5, 40.5)	<0.0001
Medicare/ Medicaid	31.6	(26.9, 36.4)	33.3	(31.4, 35.2)	32.8	(28.4, 37.3)	0.12
VA/Tricare Military	48.9	(43.2, 54.3)	48.4	(47.1, 49.8)	50.6	(46.8, 54.2)	0.28
Indian Health Services	55.5	(53.2, 57.8)	55.9	(45.7, 64.9)			0.42
Unknown	55.1	(52.6, 57.6)	48.0	(47.2, 48.8)	39.1	(35.6, 42.5)	<0.0001
Stage							
In Situ	84.9	(82.0, 87.3)	84.6	(83.9, 85.3)	86.7	(83.3, 89.5)	0.62

	American Indian/ Alaskan Native		White		African American		
	Observed Survival	**95% CI**	**Observed Survival**	**95% CI**	**Observed Survival**	**95% CI**	**p-value**
Localized	71.9	(70.7, 73.1)	71.9	(71.6, 72.2)	72.0	(70.6, 73.3)	0.86
Regional	49.2	(47.5, 50.9)	49.0	(48.4, 49.5)	46.0	(43.9, 48.0)	0.11
Distant	20.9	(19.5, 22.2)	18.3	(17.9, 18.6)	15.2	(13.9, 16.5)	<0.0001
Unstaged	33.8	(31.7, 35.9)	31.4	(30.7, 32.0)	26.9	(24.6, 29.2)	0.0004

Table 3

Five-year observed survival, 95% confdence intervals and log-rank p-values for female breast cancer by selected demographic characteristics, Oklahoma,1997-2008, Oklahoma Central Cancer Registry

	American Indian/ Alaskan Native		White		African American		
	Observed Survival	95% CI	Observed Survival	95% CI	Observed Survival	95% CI	p-value
Years							
1997-2000	77.4	(74.2, 80.4)	76.7	(75.8, 77.5)	68.6	(64.5, 72.3)	<0.0001
2001-2004	82.0	(79.2, 84.5)	80.0	(79.3, 80.8)	73.8	(70.3, 77.0)	0.01
2005-2008	80.6	(77.9, 83.0)	81.5	(80.7, 82.3)	76.7	(73.4, 79.6)	0.0001
Age Group (years)							
<40	84.3	(77.9, 89.1)	84.8	(82.5, 86.8)	81.0	(73.9, 86.4)	0.21
40-49	82.8	(79.0, 86.0)	88.3	(87.3, 89.3)	84.0	(80.0, 87.2)	<0.0001
50-59	87.2	(84.3, 89.5)	87.1	(86.3, 87.9)	76.9	(72.8, 80.4)	<0.0001
60-69	83.9	(80.6, 86.6)	83.9	(83.1, 84.7)	75.4	(70.8, 79.4)	<0.0001
≥70	65.8	(61.8, 69.5)	67.2	(66.3, 68.1)	57.3	(52.8, 61.5)	<0.0001
Rural/Urban Continuum							
Metropolitan	82.2	(79.9, 84.3)	80.7	(80.1, 81.2)	74.5	(72.2, 76.5)	<0.0001
Non-Metropolitan	78.3	(75.9, 80.4)	77.3	(76.6, 78.1)	68.6	(63.5, 73.1)	<0.0001
Marital Status							
Married	86.9	(84.8, 88.7)	85.9	(85.4, 86.5)	78.1	(74.8, 81.0)	<0.0001
Single	77.6	(73.7, 81.0)	77.7	(76.4, 78.9)	76.6	(73.3, 79.6)	0.66
Unknown	71.5	(68.2, 74.6)	67.7	(66.7, 68.7)	63.5	(59.4, 67.3)	0.0003
Primary Payer							
Uninsured	68.3	(58.4, 76.3)	68.5	(66.2, 70.6)	61.3	(53.0, 68.6)	0.14
Insured	90.2	(87.9, 92.0)	89.7	(89.1, 90.2)	84.0	(81.3, 86.3)	<0.0001
Medicaid	75.4	(68.9, 80.7)	70.2	(67.6, 72.7)	65.7	(58.7, 71.8)	0.12
Medicare	72.4	(68.9, 75.5)	72.5	(71.7, 73.3)	65.4	(61.2, 69.3)	0.0005
Medicare/ Medicaid	75.0	(56.2, 86.6)	53.8	(48.1, 59.1)	67.1	(54.8, 76.8)	0.14
VA/Tricare Military	88.2	(60.6, 96.9)	91.9	(88.8, 94.2)	86.4	(72.1, 93.6)	0.37
Indian Health Services	83.0	(78.5, 86.6)	77.4	(58.4, 88.5)	suppressed		0.92
Unknown	74.6	(68.5, 79.6)	73.8	(71.8, 75.6)	61.2	(50.8, 70.1)	0.0003
Stage							
In Situ	92.9	(89.7, 95.2)	92.8	(92.1, 93.6)	93.9	(90.5, 96.1)	0.77
Localized	87.9	(85.8, 89.7)	85.8	(85.2, 86.3)	85.9	(83.2, 88.1)	0.22
Regional	74.0	(70.6, 77.1)	74.9	(73.9, 75.9)	67.6	(63.7, 71.2)	<0.0001

	American Indian/ Alaskan Native		White		African American		
	Observed Survival	**95% CI**	**Observed Survival**	**95% CI**	**Observed Survival**	**95% CI**	**p-value**
Distant	30.2	(22.4, 38.3)	24.4	(22.3, 26.7)	12.6	(7.9, 18.4)	<0.0001
Unstaged	64.9	(56.7, 71.9)	53.3	(50.9, 55.6)	46.1	(36.8, 54.9)	0.0006

Table 4

Five-year observed survival, 95% confdence intervals and log-rank p-values for prostate cancer by selected demographic characteristics, Oklahoma, 1997-2008, Oklahoma Central Cancer Registry

	American Indian/ Alaskan Native		White		African American		
	Observed Survival	95% CI	Observed Survival	95% CI	Observed Survival	95% CI	p-value
Years							
1997-2000	76.3	(72.2, 79.8)	75.2	(74.2, 76.1)	70.4	(66.7, 73.8)	0.0004
2001-2004	76.8	(73.3, 79.9)	77.3	(76.4, 78.2)	75.0	(71.6, 78.1)	0.16
2005-2008	79.8	(76.4, 82.8)	79.9	(79.0, 80.8)	79.5	(76.4, 82.2)	0.58
Age Group (years)							
<40	suppressed		81.8	(44.7, 95.1)	100.0		0.40
40-49	86.7	(68.3, 94.8)	93.4	(90.7, 95.4)	96.8	(90.4, 99.0)	0.29
50-59	88.2	(84.1, 91.4)	92.6	(91.7, 93.4)	88.9	(85.7, 91.5)	<0.0001
60-69	87.1	(84.3, 89.4)	87.4	(86.7, 88.1)	81.6	(78.6, 84.2)	<0.0001
≥70	64.8	(61.2, 68.1)	65.6	(64.7, 66.5)	58.5	(55.0, 61.9)	<0.0001
Rural/Urban Continuum							
Metropolitan	80.1	(77.0, 82.8)	79.4	(78.7, 80.0)	76.6	(74.4, 78.6)	0.003
Non-Metropolitan	76.0	(73.2, 78.5)	75.0	(74.1, 75.8)	70.2	(65.7, 74.3)	0.07
Marital Status							
Married	83.2	(80.7, 85.4)	82.5	(81.9, 83.0)	82.4	(80.1, 84.5)	0.49
Single	78.3	(72.8, 82.9)	74.5	(72.6, 76.3)	74.5	(70.2, 78.4)	0.73
Unknown	65.9	(61.4, 70.0)	63.4	(62.1, 64.7)	58.1	(53.6, 62.4)	0.004
Primary Payer							
Uninsured	63.2	(49.3, 74.2)	55.3	(51.9, 58.6)	54.3	(43.7, 63.7)	0.25
Insured	89.6	(86.0, 92.2)	90.9	(90.1, 91.5)	90.6	(88.0, 92.6)	0.02
Medicaid	52.0	(37.4, 64.7)	58.4	(52.5, 63.8)	64.1	(53.4, 73.0)	0.50
Medicare	73.4	(70.3, 76.2)	73.4	(72.7, 74.2)	68.8	(65.4, 71.8)	0.007
Medicare/ Medicaid	78.6	(58.4, 89.8)	62.5	(54.3, 69.7)	71.8	(54.9, 83.3)	0.97
VA/Tricare Military	86.0	(72.9, 93.1)	81.6	(78.7, 84.1)	82.4	(76.7, 86.8)	0.83
Indian Health Services	86.8	(80.2, 91.2)	66.7	(44.3, 81.7)	85.7	(33.4, 97.9)	0.08
Unknown	74.3	(66.9, 80.2)	71.9	(69.9, 73.8)	58.4	(50.7, 65.3)	<0.0001
Stage							
In Situ	suppressed		81.3	(52.5, 93.5)	suppressed		NA
Localized	82.5	(80.4, 84.5)	83.1	(82.5, 83.6)	83.5	(81.5, 85.2)	0.05
Regional	79.6	(72.4, 85.1)	84.1	(82.5, 85.6)	88.8	(82.9, 92.7)	0.003

	American Indian/ Alaskan Native		White		African American		
	Observed Survival	**95% CI**	**Observed Survival**	**95% CI**	**Observed Survival**	**95% CI**	**p-value**
Distant	21.5	(13.3, 31.1)	23.0	(20.4, 25.7)	19.1	(13.1, 26.0)	0.46
Unstaged	66.3	(59.0, 72.6)	50.7	(48.7, 52.7)	40.9	(34.2, 47.5)	<0.0001

Table 5

Five-year observed survival, 95% confdence intervals and log-rank p-values for lung and bronchus cancer by selected demographic characteristics, Oklahoma, 1997-2008, Oklahoma Central Cancer Registry

	American Indian/ Alaskan Native		White		African American		
	Observed Survival	95% CI	Observed Survival	95% CI	Observed Survival	95% CI	p-value
Years							
1997-2000	13.9	(11.3, 16.7)	11.4	(10.8, 12.0)	8.0	(5.9, 10.5)	0.004
2001-2004	13.4	(11.1, 15.9)	12.9	(12.3, 13.6)	11.3	(9.0, 13.9)	0.58
2005-2008	11.5	(9.6, 13.5)	14.5	(13.9, 15.2)	14.3	(11.7, 17.2)	0.02
Age Group (years)							
<40	50.0	(30.6, 66.6)	31.3	(24.7, 38.1)	25.9	(11.5, 43.1)	0.07
40-49	15.3	(10.4, 21.1)	19.8	(17.7, 22.0)	13.3	(8.3, 19.6)	0.15
50-59	16.5	(13.3, 20.1)	17.1	(16.0, 18.2)	18.2	(14.6, 22.2)	0.99
60-69	14.8	(12.4, 17.4)	15.6	(14.9, 16.4)	9.8	(7.4, 12.6)	0.02
≥70	7.9	(6.3, 9.6)	9.3	(8.9, 9.8)	7.8	(5.9, 9.9)	0.09
Sex							
Male	10.5	(8.9, 12.2)	11.0	(10.6, 11.5)	9.4	(7.7, 11.2)	0.60
Female	15.4	(13.4, 17.6)	15.6	(15.0, 16.2)	14.3	(11.8, 17.0)	0.88
Rural/Urban Continuum							
Metropolitan	13.1	(11.1, 15.2)	13.5	(12.9, 14.0)	11.9	(10.2, 13.7)	0.57
Non-Metropolitan	12.5	(10.8, 14.3)	12.3	(11.8, 12.9)	9.6	(7.0, 12.7)	0.14
Marital Status							
Married	14.0	(12.0, 16.1)	14.7	(14.2, 15.3)	11.5	(9.3, 14.1)	0.04
Single	12.8	(10.2, 15.6)	12.4	(11.6, 13.4)	12.9	(10.4, 15.8)	0.38
Unknown	10.7	(8.5, 13.1)	9.9	(9.3, 10.6)	9.2	(6.9, 12.0)	0.34
Primary Payer							
Uninsured	6.7	(3.4, 11.4)	9.1	(7.9, 10.3)	12.8	(8.5, 18.0)	0.05
Insured	21.3	(17.4, 25.5)	19.3	(18.3, 20.3)	16.9	(13.3, 20.8)	0.21
Medicaid	11.5	(7.1, 17)	10.3	(8.7, 12.0)	13.4	(9.0, 18.7)	0.24
Medicare	10.7	(9.0, 12.6)	11.7	(11.2, 12.2)	9.2	(7.2, 11.5)	0.17
Medicare/ Medicaid	6.7	(2.5, 13.8)	10.2	(7.9, 12.9)	4.5	(1.2, 11.4)	0.10
VA/Tricare Military	12.3	(5.8, 21.5)	12.6	(10.9, 14.5)	10.5	(6.2, 16.1)	0.89
Indian Health Services	14.3	(10.5, 18.8)	28.6	(8.8, 52.4)	suppressed		0.88
Unknown	13.3	(9.1, 18.4)	11.3	(10.1, 12.5)	4.5	(1.5, 10.2)	0.11
Stage							

	American Indian/ Alaskan Native		White		African American		
	Observed Survival	**95% CI**	**Observed Survival**	**95% CI**	**Observed Survival**	**95% CI**	**p-value**
In Situ	suppressed		31.8	(14.2, 51.1)	50.0	(0.6, 91.0)	0.17
Localized	34.6	(30.3, 38.9)	34.0	(32.8, 35.2)	31.5	(26.1, 37.1)	0.56
Regional	15.4	(12.6, 18.5)	16.1	(15.3, 17.0)	16.3	(13.0, 20.1)	0.37
Distant	3.3	(2.3, 4.5)	3.5	(3.2, 3.8)	3.9	(2.8, 5.3)	0.35
Unstaged	8.2	(5.6, 11.5)	7.9	(7.1, 8.8)	5.8	(3.1, 9.5)	0.94

Table 6

Five-year observed survival, 95% confdence intervals and log-rank p-values for colorectal cancer by selected demographic characteristics, Oklahoma, 1997-2008, Oklahoma Central Cancer Registry

	American Indian/ Alaskan Native		White		African American		
	Observed Survival	95% CI	Observed Survival	95% CI	Observed Survival	95% CI	p-value
Years							
1997-2000	46.8	(41.7, 51.6)	47.2	(45.9, 48.5)	35.3	(30.5, 40.1)	0.0006
2001-2004	48.2	(43.7, 52.6)	50.9	(49.5, 52.2)	47.6	(42.5, 52.6)	0.16
2005-2008	47.6	(43.2, 51.8)	53.7	(52.3, 55.1)	46.4	(41.3, 51.4)	0.01
Age Group (years)							
<40	57.9	(44.1, 69.5)	66.0	(60.2, 71.1)	57.5	(40.8, 71.0)	0.75
40-49	56.0	(46.5, 64.5)	64.2	(60.8, 67.3)	51.8	(42.1, 60.7)	0.001
50-59	55.6	(49.0, 61.7)	63.1	(61.0, 65.1)	53.2	(46.4, 59.6)	0.005
60-69	52.7	(47.4, 57.7)	59.1	(57.5, 60.7)	50.9	(44.8, 56.7)	0.006
≥70	39.1	(35.3, 43.0)	42.3	(41.3, 43.3)	31.4	(27.4, 35.5)	<0.0001
Sex							
Male	44.4	(40.6, 48.1)	49.6	(48.5, 50.7)	40.5	(36.4, 44.5)	0.0004
Female	50.6	(46.8, 54.2)	51.3	(50.2, 52.4)	45.7	(41.5, 49.7)	0.08
Rural/Urban Continuum							
Metropolitan	52.0	(47.9, 56.0)	51.8	(50.7, 52.8)	43.9	(40.6, 47.2)	0.002
Non-Metropolitan	44.3	(40.8, 47.7)	48.8	(47.6, 50.0)	40.3	(34.3, 46.2)	0.001
Marital Status							
Married	53.8	(49.8, 57.7)	56.7	(55.7, 57.8)	48.7	(44.0, 53.2)	0.02
Single	45.5	(39.8, 51.0)	48.3	(46.2, 50.4)	45.1	(39.7, 50.3)	0.72
Unknown	40.8	(36.4, 45.2)	40.4	(39.1, 41.8)	33.8	(28.9, 38.8)	0.01
Primary Payer							
Uninsured	35.3	(25.3, 45.4)	41.1	(38.0, 44.3)	33.3	(24.1, 42.8)	0.91
Insured	66.0	(60.0, 71.4)	64.0	(62.5, 65.4)	59.6	(54.1, 64.6)	0.17
Medicaid	44.0	(33.3, 54.3)	39.6	(34.6, 44.6)	35.8	(24.6, 47.2)	0.39
Medicare	42.5	(38.6, 46.3)	47.0	(46.0, 48.0)	35.9	(31.6, 40.1)	<0.0001
Medicare/ Medicaid	31.6	(17.7, 46.4)	36.3	(30.6, 42.1)	35.7	(21.7, 49.9)	0.34
VA/Tricare Military	34.6	(17.5, 52.5)	52.6	(47.5, 57.5)	45.3	(31.6, 58.0)	0.19
Indian Health Services	50.0	(40.5, 58.8)	25.0	(0.9, 66.5)	suppressed		0.40
Unknown	50.4	(41.6, 58.5)	44.6	(41.7, 47.5)	37.1	(25.3, 48.9)	0.04
Stage							

	American Indian/ Alaskan Native		White		African American		
	Observed Survival	**95% CI**	**Observed Survival**	**95% CI**	**Observed Survival**	**95% CI**	**p-value**
In Situ	65.3	(50.3, 76.8)	78.9	(75.6, 81.8)	75.6	(60.2, 85.6)	0.43
Localized	66.6	(62.0, 70.8)	69.4	(68.2, 70.6)	65.7	(60.5, 70.4)	0.66
Regional	53.2	(48.7, 57.4)	53.5	(52.2, 54.8)	49.5	(44.3, 54.4)	0.59
Distant	11.3	(7.8, 15.4)	11.5	(10.3, 12.6)	7.5	(4.8, 11.1)	0.11
Unstaged	27.6	(20.1, 35.7)	26.4	(23.9, 28.9)	22.2	(14.9, 30.4)	0.51