

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

*Supplement to Cancer*

# Prostate Cancer Incidence Among American Indian and Alaska Native Men, US, 1999–2004

**Jeffrey A. Henderson, MD, MPH<sup>1</sup>**  
**David K. Espey, MD<sup>2</sup>**  
**Melissa A. Jim, MPH<sup>2</sup>**  
**Robert R. German, DrPH, MPH<sup>2</sup>**  
**Kate M. Shaw, MS<sup>2</sup>**  
**Richard M. Hoffman, MD, MPH<sup>3</sup>**

<sup>1</sup> Black Hills Center for American Indian Health, Rapid City, South Dakota.

<sup>2</sup> Division of Cancer Prevention and Control, Centers for Disease Control and Prevention, Atlanta, Georgia.

<sup>3</sup> University of New Mexico Cancer Center, Albuquerque, New Mexico.

This supplement was sponsored by Cooperative Agreement Number U50 DP424071-04 from the Centers for Disease Control and Prevention, Division of Cancer Prevention and Control.

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

Address for reprints: Jeffrey Henderson, MD, MPH, Black Hills Center for American Indian Health, 701 St. Joseph Street, Suite 204, Rapid City, SD 57701; Fax (605) 348-6990; E-mail: jhenderson@bhcaih.org

\*This article is a US Government work and, as such, is in the public domain in the United States of America.

Received May 5, 2008; accepted June 3, 2008.

Published 2008 by the American Cancer Society\*  
 DOI 10.1002/cncr.23739  
 Published online 20 August 2008 in Wiley InterScience (www.interscience.wiley.com).

**BACKGROUND.** American Indian and Alaska Native (AI/AN) men experience lower incidence of prostate cancer than other race/ethnic populations in the US, but racial misclassification of AI/AN men threatens the validity of these estimates. To the authors' knowledge, little is known concerning prostate-specific antigen (PSA) testing in AI/AN men.

**METHODS.** The authors linked cancer registry data with Indian Health Service enrollment records to improve race classification. Analyses comparing cancer incidence rates and stage at diagnosis for AI/AN and non-Hispanic white (NHW) men for 6 geographic regions focused on counties known to have less race misclassification. The authors also used Behavioral Risk Factors Surveillance System data to characterize PSA testing in AI/AN men.

**RESULTS.** Prostate cancer incidence rates were generally lower in AI/AN than in NHW men for all regions combined (rate ratio of 0.68). However, regional variation was noted among AI/AN men, with incidence rates (per 100,000 population) ranging from 65.7 in the Southwest to 174.5 on the Northern Plains. The rate of distant stage disease was somewhat higher among AI/AN (7.8) than NHW (6.2) men. Nationally, AI/AN men were less likely than NHW men to have undergone recent PSA testing (48.4% vs 58.0%), with prominent regional variation in screening rates noted.

**CONCLUSIONS.** Prostate cancer incidence rates and the proportion of men with recent PSA testing were lower for AI/AN men than for NHW men. However, incident rates and rate of distant stage varied by region more for AI/AN than for NHW. Further research is needed among AI/AN men to evaluate strategies for better understanding the causes of the regional variation in prostate cancer incidence. *Cancer* 2008;113(5 suppl):1203–12. Published 2008 by the American Cancer Society.\*

**KEYWORDS:** prostate cancer, cancer, incidence, American Indian, Alaska Native, misclassification, National Program of Cancer Registries (NPCR), Surveillance, Epidemiology, End Results (SEER), US, health disparity.

**P**rostate cancer is an important health issue for men in the US,<sup>1</sup> including American Indian/Alaska Native (AI/AN) men.<sup>2</sup> It is the second-leading cause of cancer death for men of all races combined and for AI/AN men.<sup>3</sup> Largely because of race misclassification, the accuracy of prostate cancer incidence and stage data among AI/AN men has been uncertain; prior publications on the subject focused on specific geographic regions<sup>4,5</sup> and thus were not generalizable to other AI/AN populations. Furthermore, the association between can-

cer incidence and prostate-specific antigen (PSA) testing among AI/AN men has not been well described.

The purpose of the current study was to better estimate prostate cancer incidence and stage at diagnosis in AI/AN men, using techniques to minimize race misclassification. We present these data by geographic region and for all regions combined. We also described patterns of PSA testing among AI/AN men, identified the demographic and behavioral factors associated with testing, and evaluated ecologic associations of PSA testing with prostate cancer incidence.

## MATERIALS AND METHODS

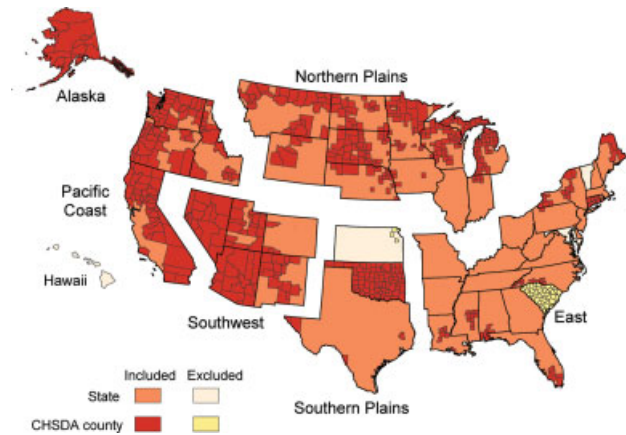
Detailed descriptions of the data sources and methods used for this analysis are found elsewhere in this supplement.<sup>6</sup>

### Cancer Cases

We identified cancer cases using data collected by the National Program of Cancer Registries of the Centers for Disease Control and Prevention (CDC) and the Surveillance, Epidemiology, and End Results (SEER) Program of the National Cancer Institute (NCI).<sup>7</sup> Registries coded primary cancer site and histology data according to the third edition of the International Classification of Diseases for Oncology (ICD-O).<sup>8</sup> We used data regarding invasive cancers (ICD-O-3 C619) to calculate incidence rates. Included cases are from state registries that agreed to participate in this project and met the US Cancer Statistics standards for high-quality data.<sup>7</sup>

We classified race by combining information from 2 sources: 1) data linkages with Indian Health Service (IHS) patient registration records and 2) the multiple race fields in cancer registry records. The IHS provides medical services to AI/AN persons who are members, or descendants of members, of federally recognized tribes. To reduce race misclassification, states linked all case records with the IHS patient registration database to identify AI/AN cases misclassified as some other racial group. Further details about coding rules for multiple races are described elsewhere in this supplement.<sup>6</sup>

To further improve race classification, we focused analyses on Contract Health Service Delivery Area (CHSDA) counties (Fig. 1), which generally contain federally recognized tribal lands or are adjacent to tribal lands. The proportions of AI/AN in relation to total population are higher in CHSDA counties than in non-CHSDA counties, and data indicate less race misclassification for AI/AN in these counties.<sup>9</sup> Approximately 56% of the US AI/AN population resides in



**FIGURE 1.** State and Contract Health Service Delivery Area (CHSDA) counties used in cancer incidence analyses for the American Indian and Alaska Native population are shown by Region.

CHSDA counties. This proportion varies by IHS region: Alaska: 100%; East: 13.1%; Northern Plains: 59.0%; Southern Plains: 64.1%; Pacific Coast: 55.6%; and Southwest: 87.5% (in each region, the proportion of AI/AN in CHSDA counties to AI/AN in all counties.) In addition, our analyses stratified incidence rates by IHS regions (Alaska, Pacific Coast, Northern Plains, Southern Plains, Southwest, and East) to evaluate the geographic variation of cancer incidence in the AI/AN population (Fig. 1). Additional details concerning CHSDA and IHS are provided elsewhere.<sup>6</sup>

Stage of disease data spanned changes in SEER summary stage coding. Stage was coded according to SEER Summary Stage 1977 rules for diagnosis years 1999 to 2000 and according to SEER summary stage 2000 rules for diagnosis years 2001 to 2003; collaborative stage data, first reported for 2004, were not available for analysis. We reported stage data for 2001 to 2003 because of significant changes in coding local and regional stage disease between the 2 staging systems.<sup>10,11</sup>

### Population Estimates

The NCI makes further refinements to population estimates produced by the CDC and the Census Bureau regarding race and county geographic codes; the estimates for the period 1999 to 2004 were used as denominators for the rate calculations in this report.<sup>12</sup>

### PSA Testing and Demographic, Health, and Socioeconomic Indicators

We used data from the Behavioral Risk Factor Surveillance System (BRFSS) to characterize PSA testing in the AI/AN and NHW populations and to evaluate

**TABLE 1**  
Prostate Cancer Incidence by Indian Health Service Region for American Indians/Alaska Natives<sup>a</sup> and Non-Hispanic Whites, US, 1999-2004

IHS Region	CHSDA Counties						All Counties					
	AI/AN Count	AI/AN Rate <sup>b</sup>	95% CI for AI/AN Rate	NHW Rate <sup>b</sup>	Rate Ratio (AI/AN:NHW)	95% CI for Rate Ratio	AI/AN Count	AI/AN Rate <sup>b</sup>	95% CI for AI/AN Rate	NHW Rate <sup>b</sup>	Rate Ratio (AI/AN:NHW)	95% CI for Rate Ratio
Northern Plains	499	174.5	157.8-192.4	162.2	1.08	0.97-1.19	651	133.6	122.2-145.7	161.7	0.83 <sup>c</sup>	0.76-0.90
Alaska <sup>d</sup>	124	78.3	63.7-95.0	180.7	0.43 <sup>c</sup>	0.35-0.53	124	78.3	63.7-95.0	180.7	0.43 <sup>c</sup>	0.35-0.53
Southern Plains	834	156.7	145.7-168.3	146.5	1.07	0.99-1.15	930	126.6	118.1-135.6	147.8	0.86 <sup>c</sup>	0.80-0.92
Pacific Coast	447	83.2	74.9-92.0	160.8	0.52 <sup>c</sup>	0.47-0.57	586	60.6	55.4-66.2	161.6	0.38 <sup>c</sup>	0.34-0.41
East	114	83.9	68.1-102.0	155.9	0.54 <sup>c</sup>	0.44-0.65	646	63.8	58.6-69.3	149.7	0.43 <sup>c</sup>	0.39-0.46
Southwest	457	65.7	59.5-72.2	133.8	0.49 <sup>c</sup>	0.44-0.54	492	63.6	57.8-69.7	146.9	0.43 <sup>c</sup>	0.39-0.47
Total	2475	105.6	101.2-110.1	154.4	0.68 <sup>c</sup>	0.66-0.71	3429	83.5	80.5-86.6	153.4	0.54 <sup>c</sup>	0.52-0.56

IHS indicates Indian Health Service; CHSDA, Contract Health Service Delivery Areas; AI/AN, American Indian/Alaska Native; 95% CI, 95% confidence interval; NHW, non-Hispanic white.

<sup>a</sup> AI/AN race is reported by National Program of Cancer Registries and Surveillance, Epidemiology, and End Results registries or through linkage with the IHS patient registration database. AI/AN persons of Hispanic origin are included.

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

<sup>c</sup> Rate ratio is statistically significant ( $P < .05$ ).

<sup>d</sup> Rates and rate ratios for Alaska in the CHSDA Counties section is the same as those in the All Counties section because all counties in Alaska are CHSDA counties.

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

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%.

the influence of demographic, health, and socioeconomic factors on PSA testing. BRFSS is a cross-sectional telephone survey conducted by all state health departments and the District of Columbia. PSA testing questions were part of the BRFSS core module in 2001, 2002, 2004, and 2006. Respondents were asked if they had ever had a PSA test and the time since their last test. BRFSS data presented here include data from all counties of the 50 states and the District of Columbia (ie, are not limited to CHSDA counties). More detailed methodology regarding the BRFSS has been published in this supplement and elsewhere.<sup>13,14</sup>

### Statistical Analyses

Two sets of basic descriptive statistics are provided for AI/AN and NHW men: 1) data from CHSDA counties in all states that meet quality criteria and 2) data from all counties in all states that meet cancer registry data quality criteria (referred to as 'All Counties'). In addition, CHSDA and All Counties data are provided for each IHS region. The results described in the text refer to persons who resided in CHSDA counties, unless otherwise noted. Additional information regarding cases and population coverage is available elsewhere in this supplement.<sup>6</sup>

For AI/AN and NHW populations, prostate cancer incidence rates are expressed per 100,000 and age-adjusted to the 2000 US standard population using 19 age groups (Census P25-1130). In addition, we per-

formed a stratified analysis by 4 age groups (<50, 50-64, 65-74, and 75 + years) based on screening recommendations,<sup>15</sup> and the provision of Medicare benefits for those aged  $\geq 65$  years. Age-group specific rates are also age-adjusted within each age category. Stage-specific rates and percent distributions of stage of disease at diagnosis are also age-adjusted. Age-adjusted rates were generated using SEER\*Stat Software (version 6.3.6).<sup>16</sup> For all analyses, exact counts were suppressed when the category of interest contained 5 or fewer cases.

Using the age-adjusted incidence rates, standardized rate ratios (RRs) were calculated for AI/AN men using NHW rates for comparison. Confidence intervals (CIs) for age-adjusted rates and standardized RRs were calculated based on methods described by Tiwari et al<sup>17</sup> using SEER\*Stat 6.3.6.<sup>16</sup>

We report the proportions and 95% CIs for PSA testing within the last year for all male AI/AN and NHW BRFSS respondents aged 50 to 75 years, overall and stratified by region. We also report the proportions and 95% CIs of those with recent PSA testing by key demographic, socioeconomic, and health behavior factors. The BRFSS data presented herein are not restricted to CHSDA counties.

### RESULTS

In CHSDA and All Counties, the prostate cancer incidence rate for all regions combined for AI/AN men was lower than the rate for NHW men (Table 1). The

**TABLE 2**  
**Prostate Cancer Invasive Incidence Rates<sup>a</sup> and Rate Ratios<sup>b</sup> by Age and Indian Health Service Region for American Indians/Alaska Natives<sup>c</sup> and Non-Hispanic Whites, CHSDA Counties, US, 1999 to 2004**

IHS Region	<50 Years				50-64 Years				65-74 Years				75+ Years			
	AI/AN Rate <sup>a</sup>	NHW Rate <sup>a</sup>	RR <sup>b</sup>	95% CI	AI/AN Rate <sup>a</sup>	NHW Rate <sup>a</sup>	RR <sup>b</sup>	95% CI	AI/AN Rate <sup>a</sup>	NHW Rate <sup>a</sup>	RR <sup>b</sup>	95% CI	AI/AN Rate <sup>a</sup>	NHW Rate <sup>a</sup>	RR <sup>b</sup>	95% CI
CHSDA counties																
Northern Plains	5.1	4.3	1.19	0.73-1.81	257.6	303.4	0.85 <sup>b</sup>	0.73-0.98	893.7	953.3	0.94	0.80-1.09	1212.6	839.5	1.44 <sup>b</sup>	1.19-1.74
Alaska	2.0	4.6	0.43	0.11-1.11	162.1	313.7	0.52 <sup>b</sup>	0.39-0.68	297.5	1043.1	0.29 <sup>b</sup>	0.20-0.40	545.3	1017.3	0.54 <sup>b</sup>	0.35-0.80
Southern Plains	2.3	3.6	0.63	0.33-1.08	237.6	249.6	0.95	0.84-1.08	879.5	830.7	1.06	0.94-1.18	1016.7	854.6	1.19 <sup>b</sup>	1.03-1.37
Pacific Coast	1.6	4.2	0.39 <sup>c</sup>	0.20-0.67	133.8	305.2	0.44 <sup>c</sup>	0.37-0.51	521.4	929.9	0.56 <sup>c</sup>	0.48-0.65	455.8	838.7	0.54 <sup>c</sup>	0.43-0.68
East	2.9	4.6	0.64	0.21-1.46	172.5	301.5	0.57 <sup>c</sup>	0.43-0.75	399.5	901.9	0.44 <sup>c</sup>	0.30-0.62	489.4	792.6	0.62 <sup>c</sup>	0.39-0.92
Southwest	0.9	4.0	0.24 <sup>c</sup>	0.10-0.46	92.8	273.4	0.34 <sup>c</sup>	0.28-0.40	358.8	769.0	0.47 <sup>c</sup>	0.40-0.54	453.8	648.8	0.70 <sup>c</sup>	0.58-0.83
Total CHSDA	2.1	4.2	0.51 <sup>c</sup>	0.39-0.65	165.2	295.1	0.56 <sup>c</sup>	0.52-0.60	578.1	892.5	0.65 <sup>c</sup>	0.61-0.69	681.1	798.6	0.85 <sup>c</sup>	0.79-0.92

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

IHS indicates Indian Health Service; CHSDA, Contract Health Service Delivery Areas; AI/AN, American Indian/Alaska Native; NHW, non-Hispanic white; RR, rate ratio.

<sup>a</sup> Rates are per 100,000 persons and are age-adjusted to the 2000 US standard population (19 age groups, Census P25-1130).

<sup>b</sup> Rate ratios are calculated in SEER\*Stat prior to rounding of rates and may not equal rate ratios calculated from rates presented in the table.

<sup>c</sup> Rate ratio is statistically significant ( $P < .05$ ).

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

rate of prostate cancer in AI/AN men residing in CHSDA counties was higher than the AI/AN rate for All Counties for 5 of 6 regions and for all regions combined. Little variation was noted between CHSDA and All Counties for NHW men. AI/AN incidence rates in CHSDA counties varied widely by region and ranged from 65.7 (per 100,000 males) in the Southwest to 174.5 in the Northern Plains, whereas NHW rates ranged from 133.8 in the Southwest to 180.7 in Alaska. AI/AN rates were highest in the Plains regions, where they were similar to NHW men, but nearly 2-fold or more higher than the rates for AI/AN men in the remaining regions.

When examined by age group, among those residing in CHSDA counties, AI/AN men in the 50 years to 64 years and 65 years to 74 years age groups had lower incidence rates compared with NHW men, except in the Northern and Southern Plains, in which the rates were similar (Table 2). For the age group  $\geq 75$  years, AI/AN men in the Northern Plains and Southern Plains had higher incidence rates than NHW men (RR of 1.44 [95% CI, 1.19-1.74] and RR of 1.19 [95% CI, 1.03-1.37], respectively).

For AI/AN males, 67.5% of prostate cancers were diagnosed at the localized stage versus 76.4% for NHW men (Table 3). Conversely, for AI/AN men, 7.4% of prostate cancers were diagnosed at the dis-

tant stage compared with 4.0% for NHW men; the differences in incidence rates of late stage disease were not as marked (7.8 vs 6.2) and were mostly because of a high rate among AI/AN in the Northern Plains. The distributions of cancers diagnosed at the regional stage were similar between AI/AN and NHW men. Finally, the percentage of unstaged cancers was greater in AI/AN men (16.0%) than in NHW men (10.0%).

Table 4 presents the prevalence in the 50 states and the District of Columbia and by region of PSA testing by demographics and measures of socioeconomic status and access to care. For all regions combined, the prevalence of recent PSA testing was higher for NHW than for AI/AN men (58.0% and 48.4%, respectively). AI/AN men in the Southern Plains had the highest prevalence (54.9%), whereas those in Alaska had the lowest (28.7%). Overall, increasing age was associated with a higher prevalence of recent PSA testing for NHW and AI/AN men. However, among AI/AN men, there was no consistent relation noted between age and testing within regions. Having healthcare coverage; having higher levels of both educational attainment and income; being current with colorectal cancer screening; being married; reporting excellent, very good, or good health status; being a nonsmoker; and being employed or retired were all

**TABLE 3**  
**Prostate Cancer Invasive Incidence Counts, Rates,<sup>a</sup> and Age-Adjusted Percent Distributions by Stage at Diagnosis<sup>b</sup> and Indian Health Service Region for American Indians/Alaska Natives and Non-Hispanic Whites, US, 2001 to 2003, CHSDA Counties**

IHS Region	Localized			Regional			Distant			Unstaged			All							
	Count	Rate <sup>a</sup>	Cases, % <sup>c</sup>	Count	Rate <sup>a</sup>	Cases, % <sup>c</sup>	Count	Rate <sup>a</sup>	Cases, % <sup>c</sup>	Count	Rate <sup>a</sup>	Cases, % <sup>c</sup>	Count	Rate <sup>a</sup>	Cases, % <sup>c</sup>					
American Indian/Alaska Native																				
Northern Plains	191	110.2	93.8-128.3	27	16.0	9.9-24.0	9.3	17	13.4	7.2-21.9	7.8	38	32.7	22.3-45.7	19.0	273	172.2	150.2-196.2	100	
Alaska	52	62.9	45.1-84.7	5	4.3	1.4-10.5	4.9	4	7.7	1.6-19.8	8.9	9	12.1	4.6-24.3	13.9	70	86.9	65.1-113.0	100	
Southern Plains	322	111.9	99.4-125.4	34	10.7	7.4-15.1	6.8	24	9.8	6.1-14.6	6.2	59	24.6	18.4-32.0	15.7	439	157.0	141.9-173.2	100	
Pacific Coast	158	58.4	48.9-68.9	34	10.4	6.9-14.8	12.2	15	6.1	3.1-10.4	7.2	20	10.0	5.9-15.6	11.8	227	84.9	73.2-97.7	100	
East	36	48.1	32.9-67.4	6	7.2	2.4-16.1	10.2	1	1.3	0.0-7.2	1.8	8	14.2	5.7-27.8	20.1	51	70.7	51.4-94.3	100	
Southwest	150	40.8	34.3-48.1	32	7.6	5.1-10.8	11.4	24	6.9	4.3-10.3	10.4	33	11.3	7.7-15.9	17.0	239	66.6	58.0-75.9	100	
Total CHSDA	909	71.6	66.7-76.6	138	9.8	8.1-11.7	9.2	85	7.8	6.1-9.7	7.4	167	17.0	14.3-19.9	16.0	1,299	106.1	100.0-112.4	100	
Non-Hispanic White																				
Northern Plains	14,412	121.8	119.8-123.8	1,893	15.6	14.9-16.3	9.5	671	6.0	5.6-6.5	3.7	2,266	20.2	19.4-21.1	12.3	19,242	163.7	161.3-166.0	100	
Alaska	605	123.5	112.8-135.0	78	12.8	9.9-16.3	6.8	25	7.8	4.6-12.0	4.2	157	43.0	35.7-51.2	23.0	865	187.2	173.2-201.8	100	
Southern Plains	4,996	109.3	106.3-112.4	535	11.4	10.5-12.5	7.7	327	7.8	7.0-8.7	5.2	827	20.3	19.0-21.8	13.6	6,685	149.0	145.4-152.6	100	
Pacific Coast	26,750	124.5	123.0-126.0	4,232	19.1	18.5-19.6	11.9	1,498	7.2	6.8-7.6	4.5	1,908	9.5	9.1-9.9	5.9	34,388	160.3	158.6-162.0	100	
East	18,798	126.3	124.5-128.1	786	17.32	11.5	10.9-12.0	7.2	808	5.6	5.2-6.0	3.5	2,506	17.3	16.6-18.0	10.8	23,844	160.6	158.6-162.7	100
Southwest	10,752	101.3	99.4-103.3	741	14.44	13.3	12.6-14.0	9.7	418	4.2	3.8-4.7	3.1	1,746	17.9	17.0-18.8	13.1	14,360	136.7	134.5-139.0	100
Total CHSDA	76,313	119.4	118.5-120.2	76.4	9.914	15.1	14.8-15.4	9.7	3,747	6.2	6.0-6.4	4.0	9,410	15.6	15.3-16.0	10.0	99,384	156.3	155.3-157.3	100

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

CHSDA indicates Contract Health Service Delivery Areas; IHS, Indian Health Service; 95% CI, 95% confidence interval.

<sup>a</sup> Rates are per 100,000 persons and are age-adjusted to the 2000 US standard population (19 age groups, Census P25-1130).

<sup>b</sup> Based on SEER Summary Stage 2000.

<sup>c</sup> Percent stage distribution is age-adjusted to the 2000 US standard population and may not add to 100.0% due to rounding.

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

**TABLE 4**  
**Percentage of American Indian/Alaska Native and Non-Hispanic White Men Aged 50 to 75 Years Who Have Had Prostate-Specific Antigen Testing Within the Previous Year, by Health and Socioeconomic Indicators and by Indian Health Service Region; Behavioral Risk Factor Surveillance System, 2001, 2002, 2004, and 2006<sup>a</sup>**

	US NHW		US AI/AN		Northern Plains <sup>b</sup>		Alaska <sup>c</sup>		Southern Plains <sup>d</sup>		Pacific Coast <sup>e</sup>		East <sup>f</sup>		Southwest <sup>g</sup>	
	% <sup>h</sup>	(95% CI)	%	(95% CI)	%	(95% CI)	%	(95% CI)	%	(95% CI)	%	(95% CI)	%	(95% CI)	%	(95% CI)
Total	58.0	(57.6-58.5)	48.4	(43.0-53.7)	44.9	(35.5-54.7)	28.7	(19.4-40.2)	54.9	(44.3-65.0)	49.0	(35.2-62.9)	49.7	(42.9-56.6)	41.5	(33.7-49.7)
Age group, y																
50-54	41.8	(40.9-42.8)	43.3	(34.1-53.1)	32.6	(18.7-50.5)	22.3	(10.2-42.0)	i		52.9	(29.6-75.1)	42.9	(30.6-56.1)	21.6	(14.2-31.6)
55-64	56.7	(55.9-57.4)	49.9	(42.1-57.8)	55.5	(41.0-69.2)	35.1	(23.4-48.9)	55.4	(42.9-67.3)	45.1	(26.2-65.5)	51.0	(41.3-60.7)	43.3	(30.6-57.0)
65-75	69.2	(68.4-69.9)	51.0	(41.8-60.1)	43.3	(28.6-59.3)	i		52.7	(35.7-69.1)	66.6	(47.9-81.2)	51.6	(39.5-63.5)	54.0	(39.4-68.0)
Healthcare coverage																
Yes	59.7	(59.2-60.2)	50.1	(44.4-55.8)	44.7	(35.2-54.5)	33.2	(22.8-45.4)	57.3	(45.9-67.9)	50.4	(36.0-64.8)	52.6	(45.0-60.0)	41.8	(33.7-50.4)
No	32.8	(30.1-35.6)	36.6	(24.1-51.2)	43.2	(21.9-67.3)	i		i		i		31.5	(18.7-48.0)	34.0	(16.2-57.9)
Education																
≤High school graduate	51.1	(50.4-51.9)	43.6	(36.4-51.1)	42.8	(30.9-55.7)	26.3	(16.5-39.3)	47.1	(32.4-62.4)	48.6	(29.3-68.3)	43.7	(34.6-53.2)	32.5	(22.7-44.2)
Some college/technical school	58.4	(57.4-59.3)	54.3	(44.1-64.2)	47.0	(31.0-63.8)	i		68.5	(53.0-80.8)	41.1	(24.3-60.3)	61.1	(48.4-72.5)	51.8	(38.4-64.9)
College graduate	64.2	(63.4-64.9)	54.8	(43.0-66.2)	51.4	(33.4-69.0)	i		57.9	(40.8-73.3)	51.7	(27.1-75.5)	54.9	(41.6-67.6)	59.7	(44.4-73.3)
Annual household income																
<\$35K	48.4	(47.5-49.3)	45.1	(37.7-52.7)	35.7	(24.4-48.8)	21.2	(10.7-37.6)	49.8	(34.9-64.7)	52.9	(35.0-70.1)	44.0	(35.1-53.2)	34.3	(25.8-44.0)
\$35K-<\$75K	59.8	(59.0-60.5)	51.2	(40.7-61.7)	55.2	(43.7-66.2)	i		77.0	(61.8-87.4)	35.2	(16.9-59.3)	62.8	(49.2-74.6)	44.8	(29.3-61.3)
≥\$75K	65.8	(64.8-66.8)	56.4	(43.4-68.6)	i		i		i		i		46.8	(31.8-62.4)	i	
Unknown	58.2	(56.7-59.6)	54.5	(41.0-67.3)	81.0	(61.1-92.0)	i		i		i		48.8	(33.5-64.4)	i	
Colorectal cancer screening																
Yes	72.3	(71.8-72.9)	65.6	(57.4-72.9)	76.2	(64.1-85.2)	41.8	(27.0-58.3)	65.8	(50.9-78.2)	62.0	(39.2-80.4)	66.1	(55.7-75.1)	66.4	(53.5-77.2)
No	40.9	(40.2-41.7)	33.3	(27.3-39.9)	28.9	(20.4-39.3)	16.4	(9.2-27.5)	47.7	(34.0-61.8)	37.8	(24.9-52.7)	29.2	(21.8-38.0)	26.3	(17.7-37.0)
Marital status																
Married	60.3	(59.8-60.8)	54.9	(48.5-61.2)	50.7	(38.1-63.2)	37.6	(24.8-52.5)	56.7	(44.1-68.5)	57.1	(40.0-72.7)	57.2	(48.9-65.0)	45.2	(35.9-54.9)
Not married	49.6	(48.7-50.6)	38.8	(31.3-46.8)	33.6	(23.3-45.7)	13.5	(7.5-23.3)	50.4	(35.2-65.6)	43.4	(30.7-57.1)	38.0	(28.7-48.2)	32.2	(19.8-47.8)
Health status																
Excellent, very good, good	58.8	(58.3-59.3)	48.4	(42.1-54.8)	50.9	(39.3-62.5)	32.4	(21.2-46.0)	57.7	(44.6-69.7)	44.0	(26.6-63.0)	48.4	(39.8-57.0)	41.9	(32.5-51.8)
Fair, poor	55.1	(54.1-56.1)	48.7	(39.8-57.6)	36.7	(24.0-51.6)	19.9	(9.1-38.3)	44.5	(32.8-56.9)	53.2	(32.7-72.6)	52.5	(42.3-62.4)	39.3	(28.6-51.1)
Smoker <sup>k</sup>																
Current	46.2	(45.0-47.4)	38.4	(29.6-48.0)	35.0	(22.9-49.4)	21.9	(12.1-36.5)	48.4	(32.6-64.5)	26.1	(14.2-43.1)	43.8	(31.1-57.4)	47.0	(29.3-65.5)
Nonsmoker (former and never)	60.4	(59.9-60.9)	52.8	(46.4-59.1)	51.3	(38.9-63.4)	29.9	(19.1-43.7)	54.8	(43.1-66.0)	54.9	(38.5-70.3)	54.1	(45.6-62.3)	38.9	(30.6-48.0)
Employment																
Employed	57.3	(56.5-58.1)	49.3	(41.3-57.3)	45.1	(31.4-59.5)	33.5	(19.4-51.5)	55.2	(37.0-72.0)	42.4	(26.9-59.6)	49.5	(39.3-59.7)	42.3	(27.4-58.6)
Unemployed	47.3	(44.9-49.6)	46.6	(35.1-58.5)	53.7	(37.7-69.0)	8.7	(4.1-17.6)	43.9	(28.2-61.0)	i		54.2	(40.5-67.3)	18.4	(9.0-33.7)
Homemaker/student/retired	62.9	(61.8-64.1)	51.0	(37.3-64.6)	46.4	(30.0-63.6)	52.5	(30.5-73.6)	48.7	(35.9-61.6)	46.6	(20.7-74.5)	63.9	(52.3-74.0)	48.5	(31.8-65.6)

(continued)

**TABLE 4**  
(continued)

NHW indicates non-Hispanic white; AI/AN, American Indians/Alaska Natives 95% CI, 95% confidence interval.

<sup>a</sup> Data are from 50 US states and the District of Columbia. Hawaii did not participate in 2004.

<sup>b</sup> AI/AN in Illinois, Indiana, Iowa, Michigan, Minnesota, Montana, Nebraska, North Dakota, South Dakota, Wisconsin, and Wyoming.

<sup>c</sup> AI/AN in Alaska.

<sup>d</sup> AI/AN in Kansas, Oklahoma, and Texas.

<sup>e</sup> AI/AN in California, Idaho, Oregon, Washington, and Hawaii.

<sup>f</sup> AI/AN in Alabama, Arkansas, Connecticut, Delaware, Florida, Georgia, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Mississippi, Missouri, New Hampshire, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Rhode Island, South Carolina, Tennessee, Vermont, Virginia, West Virginia, and District of Columbia.

<sup>g</sup> AI/AN in Arizona, Colorado, Nevada, New Mexico, and Utah.

<sup>h</sup> Weighted estimates, age adjusted to 2000 US population.

<sup>i</sup> Estimates are not reportable because  $n < 50$ .

<sup>j</sup> Fecal occult blood test within 1 year or endoscopy within past 5 years.

<sup>k</sup> Smoked at least 100 cigarettes (5 packs) in entire life.

associated with increased PSA testing for NHW and AI/AN men, both nationally and regionally.

## DISCUSSION

There are several findings to emphasize from the current study. First, the prostate cancer incidence rate for AI/AN men for all regions combined is lower than for NHW men living in the same counties; however, the rate is higher than reported previously,<sup>18-22</sup> although differences in age standardization of rates may make the comparison difficult. Second, as with other cancer types,<sup>23</sup> AI/AN men demonstrate marked regional variation in prostate cancer incidence rates in comparison with NHW men. Third, our data indicate that AI/AN men experience slightly higher rates and percentages of distant stage disease than NHW men. Finally, our data also demonstrate lower rates of PSA testing in AI/AN men than in NHW men in all regions.

There are several possible explanations for the lower prostate cancer incidence rates noted among AI/AN men. First, PSA screening primarily detects early-stage cancers.<sup>24</sup> Many screen-detected early stage prostate cancers are indolent, non-life-threatening lesions that would not have become clinically apparent in the absence of screening.<sup>25</sup> Therefore, a lower prevalence of prostate cancer screening will result in lower incidence rates.<sup>26</sup> The BRFSS data presented herein demonstrated that PSA screening rates are lower for AI/AN men in every region when compared with NHW men, often markedly so. Much of the difference observed in prostate cancer incidence rates between AI/AN and NHW men may be explained by differences in PSA screening in the population.

Second, an increasing body of evidence points to an inverse correlation between type 2 diabetes mellitus and prostate cancer.<sup>27-33</sup> AI/AN men (and women) have the highest prevalence of type 2 diabetes mellitus of any race/ethnic group in the US.<sup>34-38</sup> Diabetes-related hypoinsulinemia and low androgenicity are hypothesized to reduce the risk for prostate cancer.<sup>39</sup> Other hypotheses for this apparent protective effect include decreased testosterone levels, a common finding in males with type 2 diabetes<sup>32,40,41</sup>; the potential beneficial effects of drugs used to treat diabetes or other conditions<sup>42,43</sup>; and the possible role of renal failure.<sup>44</sup> The role that diabetes may play in prostate cancer in AI/AN men is unclear and is likely to have much less influence on overall rates than PSA screening.

The current study data also demonstrate a striking regional variation in AI/AN prostate cancer incidence

rates, exceeding that noted among NHW men. The rates for AI/AN men living on either the Northern or Southern Plains approach and even surpass those for NHW men, and are approximately double the rates reported for AI/AN men in all other regions. By contrast, the NHW rates reveal at most 35% regional variation. This marked degree of regional variation in prostate cancer rates noted among AI/AN men mirrors that reported for rates of other leading cancer types among both men and women.<sup>3,23,45-47</sup> Although this variation in prostate cancer incidence modestly tracks differences in self-reported BRFSS prevalence of PSA testing among AI/AN men, differences in testing alone are not likely to explain all the variation. For 1 reason, our BRFSS data demonstrate an inconsistent correlation between PSA testing prevalence and prostate cancer incidence, including localized stage disease, among the AI/AN men in our 6 different regions. Beyond the possible effects of screening differences and the few obviously tobacco-related cancers—notably lung and urinary bladder—we really cannot explain this variation noted for multiple cancer types. These data emphasize the need for etiologic studies designed to elucidate regional variation in prostate cancer incidence and other cancers that can assist in prioritizing future cancer control efforts.

Although routine screening with PSA is not recommended by the US Preventive Services Task Force nor by most other major health organizations, it is still widely used by clinicians. Therefore, the differences in PSA testing between AI/AN and NHW men may reflect similar disparities in health access as noted for other cancers, such as breast and colorectal, for which screening recommendations are widely accepted.<sup>44,49</sup> Cultural issues may play a role in the limited use of PSA screening tests in AI/AN populations. Several studies, involving only AI/AN females, have examined relations between cultural beliefs and practices, or “traditionality,” and receipt of breast and/or cervical cancer screening.<sup>50-55</sup> Although the results of these and other studies were generally mixed, future research regarding the influences of traditionality on receipt of cancer screening tests (eg, for colorectal cancer) or seeking care when symptoms develop should include AI/AN men.

The current study has several important strengths. We used the most current, complete, and accurate data available regarding prostate cancer incidence and stage at diagnosis for AI/AN males. Specifically, few previous studies have reached the broad coverage achieved in this analysis. In addition, our ability to conduct data linkages and to restrict our analyses to CHSDA counties has likely improved the classification of AI/AN race in participating cancer registries. Finally,

our study includes BRFSS prostate cancer test receipt data on AI/AN men analyzed by 6 geographic regions.

The current study has several important limitations. First, the analyses presented here for AI/AN populations are based on residents of CHSDA counties and excluded many AI/AN residents in urban areas not part of CHSDA counties; therefore, the findings do not represent all AI/AN populations in the US or in individual IHS regions, particularly the East.<sup>6</sup> There may be significant differences in cancer risk-related and screening behaviors between the AI/AN and NHW men who live in these selected counties and those not living in those counties. Second, although linkage with IHS patient registration databases improves the race classification for AI/AN cases, AI/AN persons who are not eligible for IHS services are not represented in the IHS database. Third, BRFSS data are limited by being self-reported, by selection bias related to the sampling strategy and the relatively low response rate,<sup>56</sup> by the small numbers of AI/AN participants, and perhaps most importantly in this case, by the fact that these data were not limited to CHSDA counties. Finally, we did not provide comparable prostate cancer mortality data among AI/AN and NHW men in the CHSDA counties. Other reports have noted that prostate cancer mortality in AI/AN men in the Plains regions for time periods similar to our incidence analyses exceeds that of NHW men.<sup>45,57</sup> Future analyses could determine whether there is an association between lack of PSA testing, presenting at advanced stage, and mortality. In addition, linking mortality data with cancer registry data linked to the IHS patient registration database could reveal stage-specific mortality rates for AI/AN and NHW men, and be able to evaluate whether survival differences were related to access to/receipt of treatment.

In conclusion, AI/AN men have a generally lower prostate cancer incidence than NHW men and lower rates of PSA testing. The current study data also demonstrate marked regional variation in cancer incidence rates among AI/AN persons. Future research should include data regarding prostate cancer mortality for AI/AN men to better correlate factors with disease stage, treatment decisions, and outcomes. In addition, future research among AI/AN men should also examine the role of diabetes status and duration as well as other patient factors on prostate cancer screening, incidence, and outcomes.

## REFERENCES

1. Penson DF, Chan JM. Prostate cancer. *J Urol.* 2007;177:2020-2029.

2. Gronberg H. Prostate cancer epidemiology. *Lancet*. 2003; 361:859-864.
3. Espey DK, Wu XC, Swan J, et al. Annual report to the nation on the status of cancer, 1975–2004, featuring cancer in American Indians and Alaska Natives. *Cancer*. 2007;110: 2119-2152.
4. Gilliland FD, Key CR. Prostate cancer in American Indians, New Mexico, 1969 to 1994. *J Urol*. 1998;159:893-897; discussion 897-898.
5. Snyder OB, Kelly JJ, Lanier AP. Prostate cancer in Alaska Native men, 1969–2003. *Int J Circumpolar Health*. 2006;65: 8-17.
6. Espey DK, Wiggins C, Jim MA, Miller BA, Johnson C, Becker TM. Methods for improving cancer surveillance data in American Indian and Alaska Native populations. *Cancer*. 2008; 113(5 suppl):1120-1130.
7. U.S. Cancer Statistics Working Group. United States cancer statistics: 2004 incidence. Atlanta, GA: Department of Health and Human Services, Centers for Disease Control and Prevention and National Cancer Institute; 2007.
8. Fritz A, Percy C, Jack A. International classification of diseases of oncology. Geneva: World Health Organization; 2000.
9. Jim MA, Espey DK, Wiggins C, Cobb N, Wingo PA. Racial Misclassification of American Indians Residing Near IHS Facilities. Poster P-47, Final Program and Abstracts. Presented at the North American Association of Central Cancer Registries Conference, Regina, Saskatchewan, Canada. June 2006.
10. Howe HL, Jamison M, Havener L, Chen VW, Ries L and members of the North American Association of Central Cancer Registries Collaborative Research Work Group. Site-specific Comparison of Summary Stage 1977 and Summary Stage 2000 Coding. North American Association of Central Cancer Registries 2005. Available at: [http://www.naacr.org/filesystem/pdf/EOD\\_SS\\_All](http://www.naacr.org/filesystem/pdf/EOD_SS_All). Accessed on December 17, 2007.
11. Phillips J. Summary stage: data effects of the changes in 2000. Available at: <http://www.naacr.org/filesystem/pdf/Summary%20Stage%20Report%201-21-04b.pdf> 2000. Accessed on December 17, 2007.
12. National Cancer Institute. Surveillance, Epidemiology, and End Results (SEER) program. Statistical resources. U.S. population data 1969–2004. Available at: <http://seer.cancer.gov/resources>. Accessed on December 17, 2007.
13. Steele CB, Cardinez CJ, Richardson LC, Tom-Orme L, Shaw K. Surveillance for health behaviors of American Indians and Alaska Natives—findings from the Behavioral Risk Factor Surveillance System, 2000–2006. *Cancer*. 2008;113(5 suppl): 1131-1141.
14. Mokdad AH, Stroup DF, Giles WH. Public health surveillance for behavioral risk factors in a changing environment. Recommendations from the Behavioral Risk Factor Surveillance Team. *MMWR Recomm Rep*. 2003;52:1-12.
15. Agency for Healthcare Research and Quality. What's New From the U.S. Preventive Services Task Force: An Overview of Recommendations—Screening for Prostate Cancer. AHRQ Pub. No. APPIP03–0003. Rockville, MD: Agency for Healthcare Research and Quality; 2002. Available at: <http://www.ahrq.gov/clinic/3rduspstf/prostatescr/prostatwh.htm>. Accessed on December 17, 2007.
16. Surveillance Research Program. SEER\*Stat software. Bethesda, MD: National Cancer Institute, Division of Cancer Control and Population Sciences, Surveillance Research Program, Cancer Statistics Branch; 2007. Available at: <http://www.seer.cancer.gov/seerstat>. Accessed on December 17, 2007.
17. Tiwari RC, Clegg LX, Zou Z. Efficient interval estimation for age-adjusted cancer rates. *Stat Methods Med Res*. 2006;15: 547-569.
18. American Cancer Society. Cancer facts & figures 2007. Atlanta, GA: American Cancer Society; 2007.
19. Nutting PA, Freeman WL, Risser DR, et al. Cancer incidence among American Indians and Alaska Natives, 1980 through 1987. *Am J Public Health*. 1993;83:1589-1598.
20. Paltoo DN, Chu KC. Patterns in cancer incidence among American Indians/Alaska Natives, United States, 1992–1999. *Public Health Rep*. 2004;119:443-451.
21. Stanford JL, Stephenson RA, Coyle LM, et al. Prostate cancer trends 1973–1995. NIH Pub. No. 99–4543. Bethesda, MD: Surveillance, Epidemiology, and End Results Program, National Cancer Institute; 1999.
22. Swan J, Edwards BK. Cancer rates among American Indians and Alaska Natives: is there a national perspective. *Cancer*. 2003;98:1262-1272.
23. Wiggins C, Espey D, Wingo PA, et al. Cancer among American Indians and Alaska Natives in the United States, 1999–2004. *Cancer*. 2008;113(5 suppl):1142-1152.
24. Hernandez J, Thompson IM. Prostate-specific antigen: a review of the validation of the most commonly used cancer biomarker. *Cancer*. 2004;101:894-904.
25. Steyerberg EW, Roobol MJ, Kattan MW, van der Kwast TH, de Koning HJ, Schroder FH. Prediction of indolent prostate cancer: validation and updating of a prognostic nomogram. *J Urol*. 2007;177:107-112; discussion 112.
26. Candas B, Cusan L, Gomez JL, et al. Evaluation of prostatic specific antigen and digital rectal examination as screening tests for prostate cancer. *Prostate*. 2000;45:19-35.
27. Gong Z, Neuhaus ML, Goodman PJ, et al. Obesity, diabetes, and risk of prostate cancer: results from the prostate cancer prevention trial. *Cancer Epidemiol Biomarkers Prev*. 2006;15:1977-1983.
28. Meyer P, Zuern C, Hermanns N, Haak T. The association between paternal prostate cancer and type 2 diabetes. *J Carcinog*. 2007;6:14.
29. Tavani A, Gallus S, Bertuzzi M, et al. Diabetes mellitus and the risk of prostate cancer in Italy. *Eur Urol*. 2005;47:313-317; discussion 317.
30. Gonzalez-Perez A, Garcia Rodriguez LA. Prostate cancer risk among men with diabetes mellitus (Spain). *Cancer Causes Control*. 2005;16:1055-1058.
31. Kasper JS, Giovannucci E. A meta-analysis of diabetes mellitus and the risk of prostate cancer. *Cancer Epidemiol Biomarkers Prev*. 2006;15:2056-2062.
32. Tande AJ, Platz EA, Folsom AR. The metabolic syndrome is associated with reduced risk of prostate cancer. *Am J Epidemiol*. 2006;164:1094-1102.
33. Werny DM, Saraiya M, Gregg EW. Prostate-specific antigen values in diabetic and nondiabetic US men, 2001–2002. *Am J Epidemiol*. 2006;164:978-983.
34. Lee ET, Howard BV, Savage PJ, et al. Diabetes mellitus and impaired glucose tolerance in three American Indian populations aged 45–74 years: the Strong Heart Study. *IHS Primary Care Provider*. 1995;20:97-109.
35. Lee ET, Howard BV, Go O, et al. Prevalence of undiagnosed diabetes in 3 American Indian populations. A comparison of the 1997 American Diabetes Association

- diagnostic criteria and the 1985 World Health Organization diagnostic criteria: the Strong Heart Study. *Diabetes Care*. 2000;23:181-186.
36. Gohdes D. Diabetes in North American Indians and Alaska Natives. In: National Diabetes Data Group, *Diabetes in America*. 2nd ed. NIH Pub. No. 95-1468, 683-701. Bethesda, MD: National Institute of Diabetes and Digestive and Kidney Diseases, National Institutes of Health; 1995.
  37. Lee ET, Welty TK, Cowan LD, et al. Incidence of diabetes in American Indians of 3 geographic areas: the Strong Heart Study. *Diabetes Care*. 2002;25:49-54.
  38. Mokdad AH, Bowman BA, Engelgau MM, Vinicor F. Diabetes trends among American Indians and Alaska Natives: 1990-1998. *Diabetes Care*. 2001;24:1508-1509.
  39. Calton BA, Chang SC, Wright ME, et al. History of diabetes mellitus and subsequent prostate cancer risk in the NIH-AARP Diet and Health Study. *Cancer Causes Control*. 2007;18:493-503.
  40. Barrett-Connor E, Khaw KT, Yen SS. Endogenous sex hormone levels in older adult men with diabetes mellitus. *Am J Epidemiol*. 1990;132:895-901.
  41. Tenover JS. Effects of testosterone supplementation in the aging male. *J Clin Endocrinol Metab*. 1992;75:1092-1098.
  42. Shegem NS, Alsheek Nasir AM, Batiha AM, El-Shanti H, Ajlouni KM. Effects of short term metformin administration on androgens in diabetic men. *Saudi Med J*. 2004;25: 75-78.
  43. Shegem NS, Nasir AM, Jbour AK, Batiha AM, El-Khateeb MS, Ajlouni KM. Effects of short term metformin administration on androgens in normal men. *Saudi Med J*. 2002; 23:934-937.
  44. Bruun L, Ekberg H, Bjork T, Lilja H, Hoglund P, Christenson A. Rapid elimination by glomerular filtration of free prostate specific antigen and human kallikrein 2 after renal transplantation. *J Urol*. 2004;171:1432-1435.
  45. Espey D, Paisano R, Cobb N. Regional patterns and trends in cancer mortality among American Indians and Alaska Natives, 1990-2001. *Cancer*. 2005;103:1045-1053.
  46. Espey DK, Paisano RE, Cobb N. Cancer mortality among American Indians and Alaska Natives: regional differences, 1994-1998. *Indian Health Service*; 2003.
  47. Young TK. Review of research on aboriginal populations in Canada: relevance to their health needs. *BMJ*. 2003;327: 419-422.
  48. Wingo PA, King J, Swan J, et al. Breast cancer incidence among American Indian and Alaska Native Women: US, 1999-2004. *Cancer*. 2008;113(5 suppl):1191-1202.
  49. Perdue D, Perkins C, Jackson-Thompson J, et al. Regional differences in colorectal cancer incidence, stage, and subsite among American Indians and Alaska Natives, 1999-2004. *Cancer*. 2008;113(5 suppl):1179-1190.
  50. Canales MK. Connecting to nativeness: the influence of women's American Indian identity on their health-care decisions. *Can J Nurs Res*. 2004;36:18-44.
  51. Canales MK, Rakowski W, Howard A. Traditionality and cancer screening practices among American Indian women in Vermont. *Health Care Women Int*. 2007;28:155-181.
  52. Coe K, Attakai A, Papenfuss M, Giuliano A, Martin L, Nuvayestewa L. Traditionalism and its relationship to disease risk and protective behaviors of women living on the Hopi reservation. *Health Care Women Int*. 2004;25:391-410.
  53. Risendal B, DeZapien J, Fowler B, Papenfuss M, Giuliano A. Pap smear screening among urban Southwestern American Indian women. *Prev Med*. 1999;29(6 pt 1):510-518.
  54. Solomon TG, Gottlieb NH. Measures of American Indian traditionality and its relationship to cervical cancer screening. *Health Care Women Int*. 1999;20:493-504.
  55. Giuliano A, Papenfuss M, de Guernsey de Zapien J, Tilousi S, Nuvayestewa L. Breast cancer screening among southwest American Indian women living on-reservation. *Prev Med*. 1998;27:135-143.
  56. Pearson D, Cheadle A, Wagner E, Tonsberg R, Psaty BM. Differences in sociodemographic, health status, and lifestyle characteristics among American Indians by telephone coverage. *Prev Med*. 1994;23:461-464.
  57. Haverkamp D, Espey DK, Paisano RE, Cobb N. Cancer mortality among American Indians and Alaska Natives: regional differences, 1999-2003. *Indian Health Service*; 2008.