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ORIGINAL PAPER

Prevalence and predictors of cancer screening among American Indian and Alaska native people: the EARTH study

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Abstract
Purpose The purpose of this study was to examine the prevalence rates for cervical, breast, and colorectal cancer screening among American Indian and Alaska Native people living in Alaska and in the Southwest US, and to investigate predictive factors associated with receiving each of the cancer screening tests.
Methods We used the Education and Research Towards Health (EARTH) Study to measure self-reported cancer screening prevalence rates among 11,358 study participants enrolled in 2004–2007. We used prevalence odds ratios to examine demographic, lifestyle and medical factors associated with receiving age- and sex-appropriate cancer screening tests.
Results The prevalence rates of all the screening tests were higher in Alaska than in the Southwest. Pap test in the past 3 years was reported by 75.1% of women in Alaska and 64.6% of women in the Southwest. Mammography in the past 2 years was reported by 64.6% of women aged 40 years and older in Alaska and 44.0% of those in the Southwest. Colonoscopy or sigmoidoscopy in the past 5 years was reported by 41.1% of study participants aged 50 years and older in Alaska and by 11.7% of those in the Southwest US. Multivariate analysis found that location (Alaska versus the Southwest), higher educational status, income and the presence of one or more chronic medical condition predicted each of the three screening tests. Additional predictors of Pap test were age (women aged 25–39 years more likely to be screened than older or younger women), marital status (ever married more likely to be screened), and language spoken at home (speakers of American Indian Alaska Native language only less likely to be screened). Additional predictors of mammography were age (women aged 50 years and older were more likely to be screened than those aged 40–49 years), positive family history of breast cancer, use of smokeless tobacco (never users more likely to be screened), and urban/rural residency (urban residents more likely to be screened). Additional predictors of colonoscopy/sigmoidoscopy were age (men and women aged 60 years and older slightly more likely to be screened than those aged 50–59 years), family history of any cancer, family history of colorectal cancer, former smoking, language spoken at home (speakers of American Indian Alaska Native language less likely to be screened), and urban/rural residence (urban residents more likely to be screened).
Conclusion Programs to improve screening among American Indian and Alaska Native people should include efforts to reach individuals of lower socioeconomic status and who do not have regular contact with the medical care system. Special attention should be made to identify and provide needed services to those who live in rural areas, and to those living in the Southwest US.

Keywords Papanicolaou test · Mammography · Colon cancer screening · American Indian · Alaska Native

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Introduction

Cancer is the leading cause of death among Alaska Native people and the second leading cause of death among American Indian people [1–3]. Trends in cancer incidence rates among American Indian and Alaska Native people have been stable or decreasing, whereas cancer mortality rates have increased, indicating the need for improved early detection and treatment [4]. Few studies have examined the factors that predict cancer screening in American Indian and Alaska Native populations [5–8].

The studies that have been done include analysis of the Behavioral Risk Factor Surveillance System [5], interviews conducted among specific groups of American Indian and Alaska Native People [6, 7], and analysis of the National Health Interview Survey [8]. Predictors of a Pap test have been found to be younger age, higher education, higher income, having seen a physician in the past year and current smoking [5]. Factors related to having a mammogram within the past 2 years include higher education, poorer general health status, having seen a physician in the past year, knowledge about when screening should occur, knowledge about the availability of no-cost mammography, knowledge about the procedure, and belief that the mammogram could detect cancer [5–7] Colorectal cancer screening has been found to be related to educational level [8].

The reported prevalence of Pap test in the past three years among American Indian and Alaska Native people ranges from 62.0 to 84.1%; reported mammography in the past two years ranges from 26.4 to 67.0%, and colorectal cancer screening ranges from 26.4 to 44.2% [5–16]. Screening rates vary widely by region of the country, and therefore, national aggregated rates of screening among American Indian and Alaska Native people can be misleading.

The Education and Research Towards Health (EARTH) Study has been collecting data related to risk factors for chronic diseases among American Indian and Alaska Native people since 2004. In addition to extensive information on behavior and lifestyle factors related to health, participants reported whether or not they had received age- and sex-appropriate cancer screening tests. In this analysis, we measured the prevalence rates of screening for cervical, breast, and colorectal cancer and then examined demographic, lifestyle and medical factors associated with receiving each of the screening tests.

Methods

Data collection

Detailed study methods have been described [17]. Participants in the study were recruited in several areas of Alaska and on the Navajo Nation in Arizona and New Mexico. Regional, local, and village tribal health boards and chapters within local health boards approved and supported the study. The study protocol was approved by the following institutional review boards: University of Utah; Navajo Nation; the Alaska Area, and National Indian Health Service.

Participants in Alaska were recruited from three distinct regions: Southcentral Alaska, an urban area (which contains Anchorage, a city of over 280,000 people); Southeast Alaska, an area of small towns and villages in a largely coastal setting; and Southwest Alaska, which includes over 50 small villages accessible only by air or river travel. A total of 26 villages and communities participated in Alaska. Alaska Native people do not live on reservations (with the exception of one small community not included in this study) and health care is administered through a network of tribally run hospitals and clinics under compact to the Indian Health Service.

Participants in the Southwest were recruited on the Navajo reservation in two separate areas. In addition to the two clinic sites, a mobile van was used to increase access to the study.

An open recruitment method was used. Information about the project was disseminated in the communities through brochures and posters, presentations at formal and informal gatherings, advertisements in newspapers and announcements on local radio and television.

As the Tribal Advisory Board had requested that "American Indian or Alaska Native" be defined more rigorously than self-reported race, we required participants to be American Indian or Alaska Native eligible for Indian Health Services-funded health care. The most common standard applied for eligibility for health services from the Indian Health Services is that the individual be an enrolled member of a Federally recognized tribe, although other criteria are sometimes applied [18].

Additional EARTH Study eligibility criteria required participants to be at least 18 years of age, not pregnant, not actively undergoing cancer treatment, and physically and mentally able to read and understand the consent form and to complete survey instruments and medical tests.

The baseline study visit included a detailed Health, Lifestyle, and Physical Activity Questionnaire (HLPA) which asked about: physical activity; medical conditions; perceived health status; language use at home; family history of several conditions including cancer, heart disease, and diabetes; reproductive history for women; cancer screening practices; and use of tobacco and alcohol. The questionnaire was administered using audio computer-assisted self interview (ACASI) technology; participants completed the questionnaire using a touch-screen computer. Participants could choose to hear the questions read

in English, Yupik or Navajo. Participants also completed a diet history questionnaire (DHQ) using ACASI. Demographic data collected included level of education, age, sex, number of people living in the household, and marital status. Medical tests included sitting blood pressure, lipid panel, and fasting blood sugar. Height and weight, as well as waist and hip circumferences were measured. At the conclusion of the study visit, participants were provided feedback regarding the results of their medical tests and responses to questions about health risk behaviors. Quality control procedures assured that data were collected in a standardized way across study centers.

Screening outcomes

The cancer screening questions are shown in Table 1. Analysis of Pap test information was restricted to women aged 18 years and older who had not had a hysterectomy. Analyses examining predictors of screening classified women as having had a Pap test in past three years or not (Pap test longer than three years ago or never having had a Pap test). Those with unknown timing for the Pap test were excluded from the analyses.

Analysis of mammogram data was restricted to women aged 40 years and older. Analyses classified women as having had a mammogram in past two years or not, and women with unknown timing were excluded.

Colonoscopy/sigmoidoscopy analyses were restricted to men and women aged 50 years and older. Analyses classified individuals as having had a colonoscopy/sigmoidoscopy in the past five years, or not, and individuals with unknown duration were excluded.

Definitions of variables examined

For each of the screening tests, we examined the following variables as potential predictors: age; sex (for sigmoidoscopy/colonoscopy); location (Alaska versus Southwest); employment; marital status; educational level; family history of cancer; smoking status; use of snuff or chew, perceived general health; body mass index; language spoken at home; residence (urban versus rural), income, and factors potentially related to traditional lifestyle.

Age was defined as age at baseline study visit. Location was Alaska or Southwest United States. Employment status was dichotomized as currently employed (currently employed for wages, self-employed, out of work for less than one year, or between seasonal jobs) and not employed (out of work for more than one year, retired, a homemaker or a student). Marital status was defined as: married (married or living as married); separated, widowed or divorced; and never married. Educational status was grouped into four categories: less than high school; high school graduate or GED; vocational/technical school, associate's degree or some college; and college graduate or higher.

Family history of cancer was based on positive response to the query regarding family members (mother, father, brother, sister) with any cancer. For mammography screening we also examined family history of breast cancer, and for colonoscopy/sigmoidoscopy screening, family history of colorectal cancer.

The definition of smoking status included use of cigarettes in the past five years. Categories included: current smoker (at least one cigarette a day for three months or

Table 1 Cancer screening questions

Mammogram	Pap test	Colonoscopy
Did you ever have a mammogram? • Yes • No • Not sure	Did you ever have a Pap smear? • Yes • No	Did you ever have a colonoscopy or sigmoidoscopy? These are tests in which a tube is inserted in the rectum to view the bowel. • Yes • No • Not sure
How old were you when you had your last mammogram? • ____ Age • Not sure	How old were you when you had your last Pap smear? • ____ Age • Not sure	How old were you when you last had a colonoscopy or sigmoidoscopy? • ____ Age • Not sure
If not sure:	*If not sure:*	*If not sure:*
About how long has it been since you had your last mammogram? • Less than five years ago • 5 to 10 years ago • Over 10 years ago • Not sure	About how long has it been since you had your last PAP smear? • Less than five years ago • 5 to 10 years ago • Over 10 years ago • Not sure	About how long has it been since you had your last colonoscopy or sigmoidoscopy? • Less than five years ago • 5 to 10 years ago • Over 10 years ago • Not sure

longer within the past five years); former smoker (smoker who quit greater than five years prior to study visit); and never smoker (never smoked regularly). We also collected information on smokeless tobacco (snuff and chew), and participants were defined as current, former, or never users.

Perceived general health status was based the question "In general, would you say that your health is excellent, very good, good, fair or poor?" We grouped the answers into three categories: excellent/very good, good, and fair/poor.

History of chronic medical conditions was ascertained through asking "Did a doctor or other health care provider ever tell you that you had (insert medical condition)?" Medical conditions included were hypertension, heart disease, elevated cholesterol, stroke, gallbladder disease, kidney failure, liver disease, thyroid disease, asthma, arthritis, chronic lung disease, glaucoma, cataracts, depression, diabetes and cancer. The number of positive answers were summed, and categorized into: none, one, and two or more medical conditions.

Body mass index was calculated from measured height and weight according to the standard formula [wt (kg)/ht (m) ^{2}] and categorized as normal weight (<25), overweight (≥25 to <30), obese (≥30 to <35), and very obese (≥35). Language usually spoken at home was categorized as: American Indian/Alaska Native language; English; or both. Residence was defined as urban or rural based on the 2000 U.S. Census definition of urbanized area. Communities with a population of 50,000 people or more were considered urban, and those with less than 50,000 were classified as rural [19]. Income, defined as household income, was categorized as ≤$15,000 per year, >$15,000–$35,000 per year, and >$35,000 per year.

Factors potentially related to traditional lifestyle were taking traditional medicine in the past year (yes or no); consulting a traditional healer in the past year (yes or no); participating in traditional events in the past year (yes or no); identity with tribal tradition (a lot, some, a little, and not at all), and identity with non-Native culture (a lot, some, a little, and not at all).

Data analysis

Data were analyzed using SAS statistical package (version 9, Cary, NC). In order to investigate factors related to screening and to control for potential confounders, prevalence odds ratios and their 95% confidence intervals were calculated using unconditional logistic regression models. Although prevalence odds ratios for outcomes with high prevalence will be farther from the null than prevalence risk ratios, we used odds ratios as a primary analysis measures in order to control for confounders. Prevalence odds ratios are considered a valid way to present prevalence data, although the prevalence odds ratio can be difficult to interpret [20–22]. Linear tests for trend were done by including the categorical variable as a continuous variable in the logistic regression analysis.

For each of the potential predictors described, we calculated odds ratios and 95% confidence limits controlling for age and location because age and location most often confounded the relationship between the predictor and the screening test. Multivariate logistic regression was then done including all variables that were statistically significantly related to the screening test (95% confidence limits exclude 1.0) in the analysis controlling for age and location. The final logistic models presented in the article included only those variables that were found to be statistically significant in the multivariate analysis, with the exception that sex was included in the final model for colon cancer screening despite lack of statistical significance. The multivariate models excluded participants who were missing any of the data points included in the model.

Data presented are from participants enrolled from 1 March 2004 through 30 July 2007) and include a total of 11,358 participants (3,832 from Alaska and 7,536 from the Southwest).

Results

Study population

Demographic descriptions of the Alaska and Southwest populations are shown in Table 2. The two populations showed similar distributions for age and sex. Overall the study population was predominately young (almost 50% less than 40 years of age) and included more women than men (62% versus 38%). Over 40% had at least some college or technical training beyond high school. Less than half were currently married. Although the sample was one of convenience and women were overrepresented, the distribution of the two populations closely resembled the distributions of age, employment and marital status reported by the 2000 US census for American Indian and Alaska Native people in the respective regions (data not shown) [17, 23].

Approximately 45% of study participants reported that they either did not know their family history or preferred not to answer questions regarding family history. For all other variables, missing values were relatively rare. Of those who reported family history, a positive history was more common among Alaska residents.

Tobacco use was much more prevalent in Alaska than in the Southwest. In Alaska 33.1% of participants spoke their Native language at home, either alone or in combination with English; while in the Southwest, 70.8% spoke their

Table 2 Description of Alaska Native and SW American Indian population: variables included in multivariate analyses for one or more screening tests

	Alaska Native		SW American Indian	
	N	%	*N*	%
Totals[a]	3,832	100.0	7,526	100.0
Age (years)				
18–29	1087	28.4	2,187	29.1
30–39	794	20.7	1,556	20.7
40–49	950	24.8	1,808	24.0
50–59	569	14.9	1,246	16.6
60+	431	11.3	728	9.7
Total	3,831		7,525	
Sex				
Male	1,507	39.3	2,762	36.7
Female	2,325	60.7	4,764	63.3
Total	3,832		7,526	
Marital status				
Married/living as married	1,633	42.8	3,298	43.9
Separated/divorced/ widowed	786	20.6	1,500	20.0
Never married	1,397	36.6	2,719	36.2
Total	3,816		7,517	
Education level				
<High school	855	22.5	1,981	26.5
High school or GED	1,410	37.2	2,370	31.8
Voc/Tech/Assoc/some college	1,316	34.7	2,748	36.8
College degree or higher	212	5.6	364	4.9
Total	3,793		7,463	
Family history of any cancer				
Yes	884	48.1	865	25.9
No	952	51.9	2,473	74.1
Total	1,836		3,338	
Family history of breast cancer				
Yes	243	10.7	231	6.0
No	2,032	89.3	3,645	94.0
Total	2,275		3,876	
Family history of colorectal cancer				
Yes	239	12.7	180	5.2
No	1,644	87.3	3,305	94.8
Total	1,883		3,485	
Smoke cigarettes in past 5 years				
Current	1,722	45.0	1,091	14.8
Former	421	11.0	246	3.3
Never	1,683	44.0	6,028	81.8
Total	3,826		7,365	
Currently use chew or snuff				
Current	684	17.9	605	8.2
Former	677	17.7	1,184	16.1
Never	2,465	64.4	5,571	75.7
Total	3,826		7,460	
Chronic medical conditions[b]				
No disease	1,518	39.7	3,517	47.6
1 disease	1,054	27.5	1,847	25.0
2+ diseases	1,256	32.8	2,020	27.4
Total	3,828		7,384	
Language at home				
American Indian/ Alaska Native language	303	7.9	861	11.7
English	2,548	66.8	2,138	29.2
Both	962	25.2	4,330	59.1
Total	3,813		7,329	
Residency				
Urban	1,398	36.5	355	5.0
Rural	2,434	63.5	6,805	95.0
Total	3,832		7,160	
Income				
≤$15,000	1,344	41.1	3,379	53.6
$15,001–$35,000	976	29.8	1,806	28.7
≥$35,001	950	29.1	1,117	17.7
Total	3,270		6,302	

[a] Totals are not identical for each variable because of missing values; percentages may not total to 100% because of rounding

[b] Conditions include: hypertension, heart disease, elevated cholesterol, stroke, gall bladder disease, kidney failure, liver disease, thyroid disease, asthma, arthritis, chronic lung disease, glaucoma, cataracts, depression, diabetes, and cancer

Native language at home. In Alaska, 36.5% of the participants lived in an urban area (population ≥50,000); in the Southwest only 5.0% lived in an urban area.

As employment, perceived general health, body mass index, and factors potentially related to traditional lifestyle were not associated with any of the screening tests in the multivariate models, data on the distribution of these characteristics in the study population are not presented in Table 2.

Screening test prevalence

Table 3 presents the prevalence of the three screening tests. For Pap test, there were 6,435 women with available Pap test information who had not had a hysterectomy. Of these, 75.1% of women living in Alaska, and 64.6% of women living in the Southwest reported a Pap test in the past 3 years (Table 3). Fewer women in Alaska than in the Southwest reported never having had a Pap test (5.4% in Alaska and 13.4% in the Southwest).

Table 3 Prevalence of cancer screening tests among Alaska Native and Southwest American Indian populations

	Alaska Native		SW American Indian	
Pap test[a]	*N*	%	*N*	%
Yes, within past 3 years	1,565	75.1	2,811	64.6
Yes, greater than 3 years ago	188	9.0	594	13.6
Yes, unknown time	217	10.4	365	8.4
Never	113	5.4	582	13.4
Total	2,083		4,352	
Mammogram[b]				
Yes, within past 2 years	755	64.6	1,050	44.0
Yes, greater than 2 years ago	174	14.9	456	19.1
Yes, unknown time	102	8.7	163	6.8
Never	138	11.8	720	30.1
Total	1,169		2,389	
Colonscopy/sigmoidoscopy[c]				
Yes, within past 5 years	390	41.1	214	11.7
Yes, greater than 5 years ago	79	8.3	74	4.0
Yes, unknown time	18	1.9	16	0.9
Never	462	48.7	1,526	83.4
Total	949		1,830	

[a] Pap test restricted to women 18 years and older who have not had a hysterectomy

[b] Mammogram screening restricted to women 40 years and older

[c] Colonoscopy/sigmoidoscopy screening restricted to participants 50 years or older

Mammography data were available on 3,558 women aged 40 years and older. Of these, 64.6% in Alaska and 44.0% in the Southwest reported having had a mammogram in the past two years. In Alaska, 11.8% had never had a mammogram, and in the Southwest 30.1% had never had a mammogram.

Among participants 50 years and older, data on colonoscopy/sigmoidoscopy were available for 2,779 people. Of these, 41.1% in Alaska and 11.7% in the Southwest reported having had a colonoscopy or sigmoidoscopy in the past five years. Less than half of participants in Alaska had never had a colonoscopy or sigmoidoscopy, whereas 83.4% of those in the Southwest reported never having had a colonoscopy or sigmoidoscopy.

Predictors of Pap test

Table 4 presents predictors for Pap test among the 5,853 women for whom the timing of the last test was known. The youngest and the oldest participants were least likely to have had a Pap test in the past three years. The age groups most likely to have had a Pap test in the past three years were those aged 25–29 and 30–39. Alaska residents were more likely to have had a Pap test than were residents of the Southwest American. Women who had never been married were least likely to have had a Pap test. There was an increasing trend in screening with increasing level of education (test for trend $P < 0.01$). Individuals with one or chronic medical conditions were more likely to be screened. Women who spoke only their American Indian Alaska Native language at home were less likely to have been screened than were women who spoke only English at home. Income was also positively related to screening, although not as strongly as educational status. Variables found *not* to be significant in the final multivariate analyses were: employment, family history of cancer, tobacco use, perceived general health, body mass index, urban/rural residence, use of traditional medicines, advice from traditional healer, identity with tribal tradition, identity with non-Native culture, and participation in traditional events.

Predictors of mammography

Table 5 presents the predictors for mammography among the 3,293 women for whom the timing of the last mammogram was known. Women in the age groups 50–59 and 60+ were more likely to have had a recent mammogram than those aged 40–49 years. Residents of Alaska were more likely to be screened than those living in the Southwest (70.8% versus 47.2%). As with Pap test screening, a statistically significant trend for increasing mammogram screening with increasing education was found (test for trend $P < 0.01$). Women with a positive family history of breast cancer were more likely to report mammography. Current users of snuff or chew tobacco were less likely to be screened than former or never users. Women with other medical conditions were more likely to be screened. Urban residents were more likely to be screened than those living in rural areas. In addition, mammography screening increased with increasing income. Those who had had other screening tests (Pap and colonoscopy/sigmoidoscopy) were much more likely to have received mammography in the past two years. Variables found *not* to be significant in the final analyses were: employment, family history of any cancer, cigarette use, perceived general health, body mass index, language at home, use of traditional medicines, advice from traditional healer, identity with Tribal tradition, identity with non-Native culture, and participation in traditional events.

Predictors of colonoscopy/sigmoidoscopy

Table 6 presents the predictors of colonoscopy/sigmoidoscopy among the 2,745 men and women for whom timing since the last procedure was known. Individuals in the age group 60+ were somewhat more likely to have received colonoscopy or sigmoidoscopy in the past five years than

Table 4 Predictors of Pap test in past three years among Alaska Native and SW American Indian women: $N = 5,853$

Pap test in past 2 years[a]	Yes	% Yes	No[b]	% No	Odds ratio[c]	95% CL	
						Lower	Upper
Total	4,376	74.8	1,477	25.2			
Age							
30–39	1,105	82.5	235	17.5	1.00		
<20	187	46.2	218	53.8	0.33	0.24	0.46
21–24	511	73.3	186	26.7	0.91	0.69	1.18
25–29	538	83.0	110	17.0	1.12	0.85	1.47
40–49	1,108	77.3	326	22.7	0.67	0.54	0.82
50–59	653	74.2	227	25.8	0.55	0.43	0.70
60+	274	61.0	175	39.0	0.35	0.25	0.47
Location							
SW American Indian	2,811	70.5	1,176	29.5	1.00		
Alaska Native	1,565	83.9	301	16.1	1.84	1.54	2.20
Marital status							
Never married	1,288	66.7	643	33.3	1.00		
Separated/divorced/widowed	883	73.1	325	26.9	1.46	1.18	1.81
Married	2,194	81.2	508	18.8	1.76	1.48	2.10
Education level							
<High school	789	60.0	525	40.0	1.00		
High school or GED	1,336	74.3	462	25.7	1.62	1.34	1.95
Voc/Tech/Assoc/Col	1,903	81.9	420	18.1	2.01	1.67	2.43
Bach/Master/PhD	319	86.0	52	14.0	2.40	1.68	3.44
History of chronic medical condition[d]							
No disease	1,680	69.2	749	30.8	1.00		
1 disease	1,299	78.0	367	22.0	1.38	1.16	1.64
2 + diseases	1,397	79.5	361	20.5	1.61	1.34	1.93
Language at home							
English	2,068	79.4	537	20.6	1.00		
American Indian/Alaska Native language	304	65.0	164	35.0	0.75	0.57	0.97
Both	1,990	72.5	755	27.5	0.93	0.79	1.09
Income							
≤$15,000	1,676	70.8	692	29.2	1.00		
$15,001–$35,000	1,254	82.2	271	17.8	1.43	1.20	1.69
≥$35,001	990	83.3	199	16.7	1.23	1.00	1.51

Variables examined and found not to be significant in the final analyses were: employment, family history of cancer, tobacco use, perceived general health, body mass index, urban/rural residence, use of traditional medicines, advice from traditional healer, identity with Tribal tradition, identity with non-Native culture, participation in traditional events

[a] Restricted to women 18 years and older who have not had a hysterectomy. Anyone with unknown time was excluded in this analysis

[b] Includes women who never had a Pap test and those whose most recent Pap test was >3 years

[c] Logistic models adjusting simultaneously for age, location, marital status, education, medical conditions, AIAN language, income

[d] Conditions include: hypertension, heart disease, elevated cholesterol, stroke, gall bladder disease, kidney failure, liver disease, thyroid disease, asthma, arthritis, chronic lung disease, glaucoma, cataracts, depression, diabetes, and cancer

those aged 50–59 years. Women were slightly more likely than men to be screened. There was a significant difference in the prevalence of screening by location (Alaska 41.9% versus Southwest 11.8%). There was an increasing trend in screening with increasing level of education (linear test for trend $P < 0.01$). Individuals with a family history of any cancer were more likely to be screened, as were those with a family history of colorectal cancer. Former smokers were more likely to be screened than current or never smokers; those with other medical conditions were more likely to be

Table 5 Predictors of mammogram in past two years among Alaska Native and SW American Indian women: $N = 3,293$

Mammogram in past 2 years[a]	Yes	% Yes	No[b]	% no	Odds ratio[c]	95% CL	
						Lower	Upper
Total	1,805	54.8	1,488	45.2			
Age							
40–49	730	45.4	878	54.6	1.00		
50–59	686	64.8	373	35.2	2.27	1.88	2.74
60+	389	62.1	237	37.9	2.32	1.80	2.98
Location							
SW American Indian	1,050	47.2	1,176	52.8	1.00		
Alaska Native	755	70.8	312	29.2	2.63	2.14	3.24
Education level							
<High school	383	45.5	458	54.5	1.00		
High school or GED	489	53.8	420	46.2	1.53	1.21	1.93
Voc/Tech/Assoc/Col	734	58.7	517	41.3	1.55	1.24	1.95
Bach/Master/PhD	181	69.1	81	30.9	2.00	1.38	2.91
Family history of breast cancer[d]							
No	1,080	58.3	774	41.7	1.00		
Yes	141	71.2	57	28.8	1.65	1.14	2.38
Use snuff or chew							
Current	143	47.0	161	53.0	1.00		
Former	163	52.1	150	47.9	1.38	0.94	2.01
Never	1,496	56.0	1,175	44.0	1.44	1.07	1.94
History of chronic medical condition[e]							
No disease	354	40.5	520	59.5	1.00		
1 disease	468	52.9	417	47.1	1.41	1.13	1.76
2 + diseases	983	64.1	551	35.9	1.94	1.59	2.37
Residency							
Rural	1,369	51.7	1,280	48.3	1.00		
Urban	391	71.4	157	28.6	1.29	1.00	1.67
Income							
≤$15,000	582	46.2	679	53.8	1.00		
$15,001–$35,000	532	61.5	333	38.5	1.74	1.43	2.12
≥$35,001	476	65.3	253	34.7	1.68	1.33	2.11
Other screening tests[f]							
No Pap in past 3 years	108	15.7	580	84.3	1.00		
Pap in past 3 years	1,318	67.1	647	32.9	15.8	12.15	20.50
No colonoscopy past 5 years[g]	691	56.9	524	43.1	1.00		
Colonoscopy past 5 years	328	84.8	59	15.2	3.31	2.41	4.54

Variables examined and found not to be significant in the final analyses were: employment, family history of any cancer, cigarette use, perceived general health, body mass index, AIAN language, use of traditional medicines, advice from traditional healer, identity with Tribal tradition, identity with non-Native culture, participation in traditional events

[a] Restricted to women 40 years and older. Anyone with unknown time was excluded in this analysis

[b] Includes women who never had a mammogram and those whose most recent mammogram was >2 years ago

[c] Logistic models adjusting simultaneously for age, location, education, snuff/chew, medical conditions, residency, income

[d] Family history odds ratio adjusted for age, location, education snuff/chew, medical conditions, residency, income; not included in models for other variables because of missing values

[e] Conditions include: hypertension, heart disease, elevated cholesterol, stroke, gall bladder disease, kidney failure, liver disease, thyroid disease, asthma, arthritis, chronic lung disease, glaucoma, cataracts, depression, diabetes, and cancer

[f] Logistic models adjusting for age and location

[g] Restricted to women aged 50 years and older

Table 6 Predictors of colonoscopy or sigmoidoscopy in past five years among Alaska Native and SW American Indian men and women: $N = 2,745$

Colonoscopy/sigmoidoscopy in past 5 years[a]	Yes	% Yes	No[b]	% No	Odds ratio[c]	95% CL	
						Lower	Upper
	604	22.0	2,141	78.0			
Age							
50–59	361	21.1	1,349	78.9	1.00		
60+	243	23.5	792	76.5	1.34	1.04	1.71
Location							
SW American Indian	214	11.8	1,600	88.2	1.00		
Alaska Native	390	41.9	541	58.1	3.86	2.92	5.10
Sex							
Male	189	19.9	761	80.1	1.00		
Female	415	23.1	1,380	76.9	1.23	0.96	1.57
Education level							
<High school	121	14.2	734	85.8	1.00		
High school or GED	141	19.9	569	80.1	1.37	0.97	1.93
Voc/Tech/Assoc/Col	250	27.2	668	72.8	1.65	1.19	2.29
Bach/Master/PhD	82	36.3	144	63.7	2.01	1.27	3.19
Family history of any cancer[d]							
No	216	23.0	722	77.0	1.00		
Yes	210	35.4	383	64.6	1.34	1.02	1.77
Family history of colorectal cancer[d]							
No	303	26.2	853	73.8	1.00		
Yes	75	44.1	95	55.9	1.94	1.30	2.89
Smoke cigarettes in past 5 years							
Current	112	29.6	267	70.4	1.00		
Former	136	51.3	129	48.7	1.78	1.20	2.63
Never	356	17.0	1,738	83.0	1.24	0.88	1.73
History of chronic medical condition[e]							
No Disease	70	10.6	588	89.4	1.00		
1 Disease	130	19.5	535	80.5	1.71	1.17	2.50
2+ Diseases	404	28.4	1,018	71.6	2.99	2.14	4.18
Language at home							
English	318	40.2	474	59.8	1.00		
American Indian/Alaska Native language	50	12.0	368	88.0	0.50	0.33	0.76
Both	234	15.5	1,278	84.5	0.65	0.50	0.85
Residency							
Rural	410	17.9	1,878	82.1	1.00		
Urban	180	50.4	177	49.6	1.82	1.34	2.47
Income							
≤$15,000	183	16.0	964	84.0	1.00		
$15,001–$35,000	180	27.9	466	72.1	1.53	1.16	2.02
≥$35,001	177	35.0	329	65.0	1.73	1.27	2.36
Other screening tests[f]							
No Pap in past 3 years	24	6.3	357	93.7	1.00		
Pap in past 3 years	255	28.8	629	71.2	5.63	3.51	9.04

Table 6 continued

Colonoscopy/sigmoidoscopy in past 5 years[a]	Yes	% Yes	No[b]	% No	Odds ratio[c]	95% CL	
						Lower	Upper
No mammogram in past 2 years	61	10.4	526	89.6	1.00		
Mammogram in past 2 years	328	32.2	691	67.8	3.24	2.37	4.44

Variables examined and found not to be significant in the final analyses were: employment, marital status, chew/snuff use, perceived general health, body mass index, use of traditional medicines, advice from traditional healer, identity with Tribal tradition, identity with non-Native culture, participation in traditional events

[a] Restricted to 50 years and older. Anyone with unknown time was excluded in this analysis

[b] Includes those who never had a colonoscopy/sigmoidoscopy and those whose most recent one was >5 years ago

[c] Logistic models adjusting simultaneously for age, sex, location, education, smoking, medical conditions, AIAN language, residency, income

[d] Family history odds ratio adjusted for age, sex, location, education, smoking, medical conditions, AIAN language, residency, income; not included in models for other variables because of missing values

[e] Conditions include: hypertension, heart disease, elevated cholesterol, stroke, gall bladder disease, kidney failure, liver disease, thyroid disease, asthma, arthritis, chronic lung disease, glaucoma, cataracts, depression, diabetes, and cancer

[f] Logistic models adjusted for age, and location; restricted to women

screened. Individuals who spoke only English at home versus those who spoke a Native language (either alone or with English) were also more likely to be screened, as were those residing in an urban area, and those with higher incomes. Women who had received other screening tests (Pap test or mammogram) were also more likely to have received a colonoscopy or sigmoidoscopy. Variables found *not* to be significant in the final analyses were: employment, marital status, chew/snuff use, perceived general health, body mass index, use of traditional medicines, advice from traditional healer, identity with Tribal tradition, identity with non-Native culture, and participation in traditional events.

Discussion

This study describes current screening rates and associated factors for a large number of American Indian and Alaska Native people surveyed in two regions of the US. Location (Alaska versus Southwestern US), educational status, income, and having one or more chronic medical conditions were consistently predictive of all three screening tests.

The overall prevalence of Pap test and mammography screening reported in the EARTH Study data were only slightly higher compared to rates reported by the Indian Health Services Government Performance Results Act (GPRA) Clinical Reporting System of medical encounter data collected from 1 July 2004 to 30 June 2005 for the Alaska and Southwest areas, and rates for colorectal cancer screening were similar [24]. The differences in the screening prevalences between Alaska and the Southwest as measured by the IHS data were similar to those found in the EARTH Study.

The prevalence rates of cancer screening found in this study are lower than those reported by Coughlin using the 1992–1997 Behavioral Risk Factor Surveillance System (BRFSS) data [5]. In addition, the EARTH Study findings for Alaska are lower than those reported by the Alaska BRFSS for 2002–2003 [25]. The EARTH data are much closer to the IHS GPRA data than to the BRFSS data. Reasons for the discrepancies between EARTH and the BRFSS include: differences between statewide and regional data; differences in selection of study participants (the BRFSS only included people with telephones); and differences in how the questions were asked. The EARTH Study asked individuals how old they were at their last screening test (Table 1); the BRFSS asked survey respondents "how long has it been since you had your last test?" It has been suggested that there is a common tendency to underestimate the amount of time that has elapsed since a clinic visit [14]. Therefore, asking how many years it has been since the last test may yield different results than asking how old one was at the last test.

Another difference between the EARTH Study and the BRFSS (and other studies of American Indian and Alaska Native populations) is that we did not use self-reported race, but required participants to state that they were eligible for Indian Health Services (IHS)-funded health care. Medical record review for Alaska EARTH Study participants found that it was a rare occurrence to find a participant who did not have a medical record in the IHS-funded tribally run system. However, we did not require participants to present documentation of their eligibility and it is possible that, given the areas in which we recruited participants, our definition may not represent a significant difference from self-reported race.

Residents of Alaska were more likely to receive age and sex-appropriate screening for cervical cancer, breast cancer

and colorectal cancer than residents of the Southwest. Other studies have found similar discrepancies [5, 9]. The American Indian and Alaska Native mortality rates for cancer are higher in Alaska than in the Southwest. For all cancers, the 1996–2001 age-adjusted (to US 2000 population) mortality rate in Alaska was 253.7/100,000, and for the Southwest the rate was 131.6/100,000 [3]. Because of the higher rates of death in Alaska from cancer, more concerted efforts are underway to get people screened; in time, it is hoped that these mortality rates will decrease. It is also possible that people value the importance of cancer screening differently in areas where cancer is seen as more of a threat to health.

All three screening practices were increased among those who had one or more chronic medical conditions. Other studies have found that a recent visit to a primary care provider or having had a recent routine check-up is a predictor of screening [5, 6, 29, 31]. Although the EARTH Study did not directly collect information on most recent visit or contact with the medical system, the relationship of screening to having a chronic medical condition provides indirect evidence that more frequent contact with the medical system leads to better screening outcomes.

The EARTH Study did not collect information on private or public health benefits other than Indian Health Service eligibility. A study among urban American Indian women found that those with private health insurance were more likely to report breast cancer screening, but a similar study conducted on a reservation did not find a relationship. [6, 7] We did ask participants where they usually went for medical care. Of 11,358 participants, only 4.1% were missing information on usual source of care. Of the remaining 10,891, the vast majority (99.6%) included at least one IHS or tribally run health facility as usual sources of health care.

For mammography and colorectal cancer screening, the prevalence of screening was higher among urban residents. Our finding that urban residents have higher rates of screening differs from some other studies of American Indian and Alaska Native populations which show that urban Indians who do not live near IHS facilities have difficulty gaining access to health care [6]. When we analyzed the EARTH Study data by location, we found that the relationship between screening and urban/rural residence was most apparent for Alaska. In the Southwest, recruitment took place on the reservation, and few urban residents were enrolled. In Alaska, IHS-funded tribally run facilities are available to most beneficiaries. For residents of the remote rural villages of Alaska, PAP test screening is usually locally available, however, obtaining colonoscopy or mammography screening may involve one or more airplane rides for several hours to another area of the state, at considerable cost in terms of both time and money. In the Southwestern US, obtaining screening services can also be costly in terms of time and money, involving driving long distances.

In this study we found that individuals who spoke only English at home, compared to those who spoke their Native language, were more likely to have gotten a Pap test in the past three years, and also more likely to have received a colonoscopy/sigmoidoscopy. The relationship was not seen for mammography. Studies in other populations have found that those who speak a language different than English at home tend to have lower breast and cervical cancer screening prevalences, although similar findings have not been reported for American Indian and Alaska Native populations [7, 26, 27]. Examining predictive factors specific to Alaska and to the Southwest revealed that the finding was most apparent in Alaska. It could be that language itself is not the risk factor, but rather a marker for access to services, despite efforts to control for other factors in the analyses. On the other hand, the finding could indicate that more culturally appropriate outreach efforts are needed to reach those less able to understand English. Factors potentially related to traditional lifestyle, including taking traditional medicine, consulting a traditional healer, participating in traditional events, identity with tribal tradition, and identity with non-Native culture were not related to screening prevalences. Other studies among American Indian and Alaska Native populations have also found these types of indicators not to be related to cancer screening. [7, 28]

Despite the fact that all study participants were eligible for IHS-funded health care, markers for socioeconomic status (education and income) predicted improved screening rates. Studies in many other populations have found educational status and/or income to be predictive of cancer screening [5, 8, 29–34]. The finding has important implications for reaching American Indian and Alaska Native people to improve cancer screening. It may be that current outreach efforts are more successful among people of higher socioeconomic status, and that different efforts need to be developed for people of a lower socioeconomic status.

Marital status was related to Pap test, with those who were never married less likely to have received a Pap test in the past 3 years. Other studies have found that marital status is related to cancer screening [31].

Having a family history of cancer may improve awareness of the disease, and increase both patient and provider efforts to obtain screening tests. We found that women with a family history of breast cancer were more likely to have received mammography, and that individuals with a family history of colorectal cancer were more likely to have had colonoscopy/sigmoidoscopy.

Former smokers were more likely to have had colonoscopy or sigmoidoscopy than current smokers or never

smokers. It may be that individuals who can make the effort to stop using tobacco are more likely to make the effort to obtain a fairly difficult screening test. Current users of smokeless tobacco (snuff or chew) were less likely to receive mammography than former or never users. The relationships with tobacco use were most apparent in Alaska where tobacco use was much higher than in the Southwest.

In summary, this study investigated predictors of cancer screening in American Indian and Alaska Native people living in Alaska and in the Southwest United States. The screening prevalences varied between Alaska and the Southwest. Higher educational status, higher income and the presence of one or more chronic medical condition predicted each of the screening tests. Rural residents were less likely to have received age and sex appropriate cancer screening tests. Programs to improve screening among American Indian and Alaska Native people should include efforts designed to be sure to reach individuals of lower socioeconomic status, and who do not have regular contact with the medical care system. Special attention should be made to improve services to those who live in rural areas, and to those living in the Southwest US.

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