



Trends in cigarette smoking among American Indians and Alaska Natives in the USA: 1992–2015

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Received: 23 March 2019 / Accepted: 4 November 2019 / Published online: 16 November 2019
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Abstract

Purpose While smoking prevalence may be declining in the general population, health disparities in tobacco use remain a public health priority. This study examined national, sociodemographic, and geographic trends in American Indians and Alaska Natives (AIs/ANs) smoking prevalence from 1992/1993 to 2014/2015. Additionally, correlates of cigarette smoking were examined among this group.

Methods Data were drawn from the 1992–2015 Tobacco Use Supplement to the Current Population Survey. Cochran–Armitage tests were used to assess changes in the prevalence of smoking over time in the population, as well by sociodemographic characteristics. Multivariable logistic regression was conducted to examine the correlates of cigarette smoking for AIs/ANs in 2014/2015.

Results The trend analysis indicated that the prevalence of smoking, among AIs/ANs, decreased significantly from 39.1% in the 1992/1993 cycle to 20.9% in the 2014/2015. This decrease was seen in both males and females, with the prevalence of smoking decreasing from 43.6% and 35.4%, respectively, in 2006/2007 to 23.8% and 18.3% in 2014/2015. The decreasing trend was also found for all subgroups, except for the 55+ age group. Multivariable analysis showed higher odds of smoking among males, those with low income compared to those with median or higher income, and those living in non-metropolitan areas. Those aged 25–54 were more likely to be smokers compared with the 55+ age group.

Conclusions Results indicate a recent decrease in AIs/ANs smoking prevalence, although these populations still experience a high prevalence of smoking compared to the general population. Our findings highlight the need for a comprehensive tobacco control strategy that includes working with stakeholders within the AI/AN community.

Keywords Cigarette smoking · Commercial tobacco · Health disparities · Minority groups · American Indians/Alaska natives

Introduction

The adverse health effects of tobacco use have been well established. Smokers are more likely to suffer from heart disease, stroke, and lung cancer when compared to

non-smokers [1]. Although there has been considerable progress in reducing the prevalence of smoking over the past half-century, cigarette smoking remains the leading cause of preventable disease and death in the USA [2]. Smoking is the cause of 90% of all lung cancer-related deaths and 80% of all chronic obstructive pulmonary disease-related deaths [1]. In the USA alone, over 16 million people live with a disease caused by smoking, and more than 480,000 people die annually due to smoking [1]. Smoking rates remain high among certain subpopulations (i.e., sexual minorities, some racial and ethnic groups, those with a low socioeconomic background or mental health disorders) despite recent improvements in the general population.

American Indians and Alaska Natives (AIs/ANs) are an example of subpopulations that are uniquely burdened by tobacco use and its harmful health consequences. For

Electronic supplementary material The online version of this article (<https://doi.org/10.1007/s10552-019-01250-7>) contains supplementary material, which is available to authorized users.

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example, AIs/ANs have one of the highest prevalence of cigarette smoking when compared to all other racial/ethnic groups in the USA [3]. The adverse health outcomes of smoking among AIs/ANs are severe: cardiovascular disease is the leading cause of death, lung cancer is the leading cause of cancer deaths, and diabetes is the fourth leading cause of death [3]—all diseases strongly related to smoking [4]. It has been suggested that AI/AN populations have higher rates of smoking due in part to lower socioeconomic status, which has a strong association with tobacco use [5]. In addition, AI/AN populations face issues that prevent them from receiving quality medical care (e.g., geographic separation, cultural barriers, and low income [6]), which means they may have less medical support for quitting and less information about tobacco's adverse health effects. Another possible contributor to this population's high cigarette use is the tobacco industry's targeted marketing. The tobacco industry has historically promoted products featuring symbols, names, and images that would appeal to AIs/ANs [7]. Although the tobacco industry has been charged with exploring and misappropriating the traditional and cultural AI/AN uses of tobacco for profit [8], it is nonetheless valuable to note that some AI/AN tribes use tobacco for ceremonial, medicinal, and spiritual purposes [9]. Given that it may conflict with their beliefs on cultural and traditional use of tobacco, it remains unclear how public campaigns on the harmful effects of smoking have impacted smoking in AI/AN communities. Historically, less comprehensive tobacco control measures have been adopted in this community given its sovereignty [10].

Although it is commonly acknowledged that tobacco use is high among AIs/ANs, there is a dearth of research chronicling trends in AI/AN smoking prevalence, especially geographic and demographic trends. Identifying whether a subpopulation with a heightened risk of smoking has witnessed similar smoking prevalence reduction observed in the general population is important for prevention and cessation targeting. In the present study, we examined national, sociodemographic and geographic trends of AI/AN commercial cigarettes smoking prevalence from 1992/1993 to 2014/2015. Additionally, correlates of commercial cigarettes use are examined among this group.

Method

Data

The Tobacco Use Supplement to the Current Population Survey (TUS-CPS) is a large household survey among the civilian noninstitutionalized population 16 years of age and older in the USA and is administered by the Census Bureau and sponsored by the National Cancer Institute

(NCI). The CPS is a monthly labor force survey conducted in more than 50,000 interviewed households across the country. Since 1992, the TUS-CPS is conducted every 3 to 4 years as a supplement of CPS to assess many topics including smoking status, amount smoked, use of menthol cigarettes, smoking history, quit attempts and intention to quit, level of nicotine dependence, and other tobacco-related topics. In our study, we used TUS-CPS data from 1992 to 2015 from the NCI TUS Team. The pooled data only included respondents age 18 and older and questions used in two or more questionnaires [11].

Study cohorts

Questions about race have been available since the first TUS-CPS conducted in 1992/1993, but the available responses changed in 2003. Before the 2003 survey cycle, respondents could select only one of the following four responses: "White," "Black," "American Indian, Aleut, Eskimo," or "Asian or Pacific Islander" (in 1992/1993, respondents could also select "Other" as their response). As of the 2003 survey cycle, respondents can select one or more race as their response to the question. For this study, we defined AI/AN as those reporting race as "American Indian, Aleut, Eskimo." In order to assess the trend of smoking prevalence in AIs/ANs, we recoded the race response after the 2001/2002 survey cycle to make four consistent categories. We excluded respondents selecting three or more race categories. We assigned respondents selecting two races to the race category that had the smaller sample size (e.g., White American Indian subject was assigned to AI/AN). In the final analysis, we included 23,376 AIs/ANs who met the inclusion criteria since the 1992/1993 survey cycle.

Measures

Independent variables

We obtained age, sex, Hispanic origin, family income, education level, and metropolitan status from the harmonized data. We further categorized age as 18–24, 25–44, 45–64, and 65+; and education level as less than high school, high school or some college, and at least a bachelor's degree. In addition, we obtained data on the annual median household level from the US Census Bureau [12] and used the Pew Research Center's definition of middle class, which is income between 67 and 200% of the national median income [13]. We categorized the income into low income (lower than 67% median income), lower median income (between 67 and 100% of median income), median income or higher.

Outcome variables

Our main outcome of interest was smoking status. We defined a smoker as a respondent who identified smoking every day or some days at the time of the survey and who had smoked at least 100 cigarettes in their lifetime.

Statistical analysis

Weighted demographic characteristics were generated by smoking status (smoker vs. nonsmoker). Rao–Scott χ^2 tests were used to compare characteristics between two groups. We generated estimates of the prevalence of smoking for each year of survey data. Additionally, prevalence estimates were calculated for sociodemographic (sex, income and education levels, and age subgroups) and geographical (metropolitan vs. non-metropolitan and region of residence) variables. In the trend analyses, Cochran–Armitage tests were used to assess the statistical significance of changes in the prevalence of smoking over time. Additionally, we conducted Cochran–Armitage tests to examine the statistical significance of changing trends in subgroups, including sex, age, income and education levels. Multivariable logistic regression was performed to assess the correlates of cigarette smoking adjusting for age, sex, income, education, metropolitan status and region of residence using the 2014/2015 survey cycle. Sampling weights were included in all analyses to account for the complex survey design. In addition, we repeated the analyses for the general population to compare it with AI/AN subgroup. Since 19.4% of AI/ANs had Hispanic origin in this study, we have conducted sensitivity analysis to examine if Hispanic origin had an influence on the prevalence of smoking within the AI/ANs subpopulation. All tests were two-sided and a p value of <0.05 was considered significant. We performed all data analyses using SAS version 9.4 (SAS Institute, Inc., Cary, NC).

Results

The distribution of characteristics of all included AI/ANs according to their smoking status is listed in Table 1. Of the 23,267 AI/ANs included in the analysis, 39.7% were aged 45–54. The majority of participants in the full sample were non-Hispanic (80.6%). More than half of the AI/AN sample was female (53.2%), had a low household income (52.9%), and lived in a metropolitan area (69.5%). Nearly 40.5% of all included participants lived in the West, 32.9% lived in the South, 16.0% lived in the Midwest, and 7.8% lived in the Northeast.

Table 2 reports estimates of smoking prevalence in AI/ANs by age, income, and metropolitan status. Throughout the study period, males consistently had higher smoking

rates than females. Similarly, those with low income usually had the highest prevalence of smoking, except for the 1995/1996 cycle during which those with lower median income had the highest prevalence of smoking at 41.4%. Those living in non-metropolitan areas had a higher prevalence of smoking, apart from the 1992/1993 cycle when those living in metropolitan areas had a 0.03% higher prevalence of smoking than those living in non-metropolitan areas. AI/ANs living in the Midwestern region had the highest prevalence of smoking for all survey cycles, ranging from 53.1% prevalence in the 1992/1993 cycle to 27.6% in the 2014/2015 cycle. Among the AI/AN population, the prevalence of smoking decreased significantly from 39.1% in the 1992/1993 cycle to 20.9% in the 2014/2015 cycle ($p < 0.0001$). In both male and female AI/ANs, the prevalence of smoking decreased significantly from 43.6% and 35.4%, respectively, in 2006/2007 to 23.8% and 18.3% in 2014/2015 ($p < 0.0001$); the prevalence of smoking was significantly higher in males than females (Fig. 1). The difference in smoking prevalence between males and females decreased from 8.2% in the 1992/1993 survey to 5.5% in the 2014/2015 cycle.

A significant decreasing trend was found in all age groups, income, and metropolitan subgroups except in the 55+ age group (Fig. 2). Over the study period, the prevalence of smoking was lowest in the 55+ age group; however, the prevalence difference has narrowed between age groups. Among those 18–24 years old, smoking prevalence declined from 37.0% to 19.0% in the 2014/2015 cycle, which was 18.0% absolute decline and 48.7% relative decline. For adults aged 25–34 and 35–54 years, smoking prevalence relatively declined to 23.5% (from 44.6 to 23.5%) and 22.4% (from 41.9 to 22.4%). In the income subgroups, the prevalence difference between low income and median income or higher remained around 12% for both the 2014/2015 survey cycle and the 1992/1993 cycle (Fig. 3). The prevalence of smoking in those living in metropolitan and non-metropolitan areas was about the same in the 1992/1993 survey cycle; however, as smoking prevalence declined faster for AI/ANs living in metropolitan areas, the prevalence became 9.7% lower than that of those living in non-metropolitan areas.

Figure 3 also presents trends of smoking prevalence in AI/ANs by education level. A significant decline in the prevalence of smoking was found in all education level subgroups ($p < 0.01$). The prevalence of smoking was lowest in AI/ANs with at least a bachelor's degree. Smoking prevalence differed between all education levels. The smoking prevalence difference between at least a bachelor's degree and high school diploma or some college decreased from 14.4% in the 1992/1993 cycle to 13.9% in the 2014/2015 cycle. The difference between those with at least a bachelor's

Table 1 Sample characteristics of AIs/ANs in combined dataset (TUS-CPS 1992/1993–2014/2015)

	AI/ANs			<i>p</i> value	General population			<i>p</i> value
	Full sample (<i>n</i> = 23,267)	Smoker (<i>n</i> = 7,556)	Non-smoker (<i>n</i> = 15,711)		Full sample (<i>n</i> = 1,593,413)	Smoker (<i>n</i> = 319,309)	Non-smoker (<i>n</i> = 1,268,059)	
Age				< 0.0001				< 0.0001
18–24	14.84	15.1	14.74		12.78	14.37	12.42	
25–44	21.57	24.13	20.6		19.07	21.81	18.41	
45–54	39.66	43.72	37.98		38.29	43.92	36.92	
55 +	23.94	17.05	26.68		29.86	19.90	32.25	
Sex				< 0.0001				< 0.0001
Male	46.84	51.22	45.07		47.99	53.31	46.67	
Female	53.16	48.78	54.93		52.01	46.69	53.33	
Hispanic origin				< 0.0001				< 0.0001
Hispanic	19.44	12.39	22.25		11.89	8.31	12.77	
Non-Hispanic	80.56	87.61	77.75		88.11	91.69	87.23	
Income*				< 0.0001				< 0.0001
Low	52.92	61.55	49.36		38.18	48.32	35.58	
Lower median	14.64	14.42	14.76		14.46	15.57	14.18	
Median or higher	32.43	24.03	35.88		47.36	36.11	50.23	
Education				< 0.0001				< 0.0001
Less than high school	22.19	25.86	20.69		15.39	20.04	14.23	
High school or some college	64.14	67.59	62.75		58.45	67.95	56.12	
At least a bachelor's degree	13.67	6.54	16.56		26.16	12.02	29.65	
Metropolitan status				< 0.0001				< 0.0001
Metropolitan	69.53	64.02	71.68		82.28	83.16	78.62	
Non-metropolitan	30.47	35.98	28.32		17.72	16.84	21.38	
Region				< 0.0001				< 0.0001
Northeast	7.75	8.31	8.24		19.15	18.10	19.39	
Midwest	16.02	23.13	14.06		22.55	25.48	21.84	
South	32.93	34.33	33.53		35.81	37.76	35.34	
West	40.49	34.24	44.17		22.50	18.66	23.43	

*All variables were presented in weighted column percentage and $p < 0.05$ is considered significant and presented in bold. Income was categorized into low income (lower than 67% median income), lower median income (between 67 and 100% of median income), and median income or higher

degree and less than high school decreased from 20.2% in 1992/1993 to 17.7% in 2014/2015.

Results from multivariable regressions examining correlates of AI/AN smoking are reported in Table 3. Among AIs/ANs from 2014/2015 survey circle, significant higher odds of cigarette smoking were found for males (OR 1.35; 95% CI 1.05–1.77); those aged 25–44 (OR 1.57; 95% CI 1.09–2.26); and also those in the 45–54 age group (OR 1.53; 95% CI 1.12–2.08). Similarly, those with low income (OR 1.82; 95% CI 1.27–2.61), less than a high school education (OR 2.44; 95% CI 1.40–4.25), and high school or some college (OR 2.36; 95% CI 1.47–3.81) were more likely to be cigarette smokers. Results also showed that region of residence (Midwest, OR 1.87; 95% CI 1.33–2.64; South, OR 1.43; 95% CI 1.05–1.96) and living in metropolitan areas (OR 1.70; 95% CI 1.31–2.22) were associated with cigarette smoking.

Similar results were found using data from the 1992/1993 survey circle (Table 3). In addition, AIs/ANs in the 18–24 age group (OR 1.76; 95% CI 1.69–1.84) and living in Northeast region (OR 1.18; 95% CI 1.14–1.23) had higher odds of cigarette smoking compared to the reference categories.

Sensitivity analysis

The prevalence of smoking did not differ significantly between AIs/ANs with non-Hispanic origin and AIs/ANs in general. In particular, in 2014/2015, the prevalence of smoking was found to be 20.9% (95% CI 19.0–22.8) among AIs/ANs in general and 23.5% (95% CI 21.3–25.7) among non-Hispanic AIs/ANs. However, we observed that the relative change in the prevalence of smoking from 1992/1993 to 2014/2015 was higher among AIs/ANs in

Table 2 National estimates of smoking prevalence (with 95% confidence intervals) in AIs/ANs since 1992

	1992–1993	1995–1996	2000	2006–2007	2010–2011	2014–2015	Relative % ^b	<i>p</i> value ^a
Full sample	39.13 (36.44, 41.82)	36.10 (33.40, 38.79)	30.50 (27.57, 33.43)	28.21 (26.23, 30.18)	25.24 (23.28, 27.21)	20.89 (19.00, 22.77)	–46.6	<0.0001
Age								
18–24	36.99 (30.48, 43.50)	39.08 (31.92, 46.23)	33.88 (25.65, 42.12)	29.71 (23.38, 36.04)	23.83 (17.83, 29.83)	18.97 (13.00, 24.94)	–48.7	<0.0001
25–34	44.56 (39.26, 49.85)	37.20 (31.62, 42.77)	30.50 (24.58, 36.43)	33.54 (28.57, 38.51)	29.13 (24.49, 33.77)	23.47 (19.08, 27.86)	–47.3	<0.01
35–54	41.86 (37.45, 46.27)	40.16 (35.99, 44.33)	34.91 (30.26, 39.56)	30.45 (27.39, 33.52)	27.67 (24.49, 30.86)	22.41 (19.35, 25.46)	–46.5	<0.0001
55+	28.08 (22.33, 33.83)	20.89 (15.54, 26.24)	19.72 (14.04, 25.40)	20.30 (17.27, 23.32)	19.93 (16.79, 23.08)	17.98 (15.01, 20.94)	–36.0	0.12
Sex								
Male	43.58 (39.36, 47.80)	39.24 (34.92, 43.56)	31.88 (27.39, 36.38)	32.09 (28.94, 35.24)	27.38 (24.35, 30.42)	23.79 (20.72, 26.86)	–45.4	<0.0001
Female	35.43 (31.99, 38.86)	33.64 (30.23, 37.05)	29.41 (25.56, 33.25)	24.53 (22.12, 26.94)	23.30 (20.76, 25.85)	18.33 (16.05, 20.61)	–48.3	<0.0001
Income								
Low income	43.60 (40.12, 47.09)	38.46 (34.86, 42.06)	36.04 (31.66, 40.42)	31.80 (28.95, 34.66)	33.21 (30.09, 36.32)	24.82 (22.03, 27.61)	–43.1	<0.0001
Lower median income	33.90 (27.19, 40.61)	41.35 (33.64, 49.05)	28.89 (20.86, 36.92)	30.46 (24.47, 36.44)	20.92 (16.05, 25.78)	21.28 (15.80, 26.76)	–37.2	<0.01
Median income or higher	31.23 (25.78, 36.68)	29.54 (24.37, 34.71)	23.90 (18.98, 28.82)	23.52 (20.05, 26.99)	15.22 (12.26, 18.18)	13.31 (10.17, 16.45)	–57.4	<0.0001
Education								
Less than high school	44.55 (39.24, 49.86)	40.33 (35.15, 45.52)	33.42 (27.21, 39.64)	31.15 (26.71, 35.59)	26.19 (21.53, 30.84)	26.33 (21.49, 31.17)	–40.9	<0.0001
High school or some college	38.71 (35.41, 42.01)	37.89 (34.40, 41.38)	31.73 (28.03, 35.43)	29.59 (27.10, 32.08)	28.75 (26.19, 31.30)	22.52 (20.11, 24.93)	–41.8	<0.0001
At least a bachelor's degree	24.36 (15.85, 32.87)	15.13 (9.31, 20.95)	18.92 (11.94, 25.90)	16.14 (12.09, 20.18)	10.31 (7.13, 13.49)	8.65 (5.27, 12.03)	–64.5	<0.01
Metropolitan status								
Metropolitan	39.24 (35.30, 43.19)	34.09 (30.55, 37.63)	27.73 (23.83, 31.64)	26.26 (23.84, 28.68)	23.91 (21.55, 26.27)	18.66 (16.41, 20.91)	–52.4	<0.0001
Non-metropolitan	39.21 (35.65, 42.77)	39.70 (35.70, 43.70)	35.07 (30.83, 39.31)	33.15 (29.73, 36.58)	28.79 (25.20, 32.37)	28.33 (24.54, 32.12)	–27.7	<0.0001
Region								
Northeast	42.30 (32.03, 52.58)	31.82 (22.58, 41.06)	26.88 (16.78, 36.97)	27.90 (20.80, 34.99)	30.28 (22.67, 37.89)	20.61 (13.87, 27.34)	–51.3	<0.0001
Midwest	53.06 (47.46, 58.66)	51.62 (45.25, 57.99)	43.33 (35.64, 51.01)	41.22 (36.14, 46.31)	33.38 (28.54, 38.21)	27.63 (22.70, 32.57)	–47.9	<0.0001
South	39.02 (34.17, 43.88)	36.10 (31.15, 41.05)	29.49 (24.08, 34.90)	27.54 (24.36, 30.71)	25.63 (22.25, 29.01)	22.44 (19.06, 25.82)	–42.5	<0.0001
West	32.06 (27.95, 36.17)	30.79 (26.81, 34.76)	27.29 (23.08, 31.50)	23.31 (20.25, 26.37)	20.57 (17.66, 23.49)	17.19 (14.53, 19.86)	–46.4	<0.0001

The prevalence for all survey years are presented in Supplementary File

^aCochran–Armitage tests to examine the statistical significance of changing trends in full sample and subgroups stratified by sex, age, income, education levels, metropolitan status, and region. *p* < 0.05 is considered significant

^bRelative change% is calculated by (smoking prevalence in 2014/2015 – smoking prevalence in 1992/1993)/smoking prevalence in 1992/1993

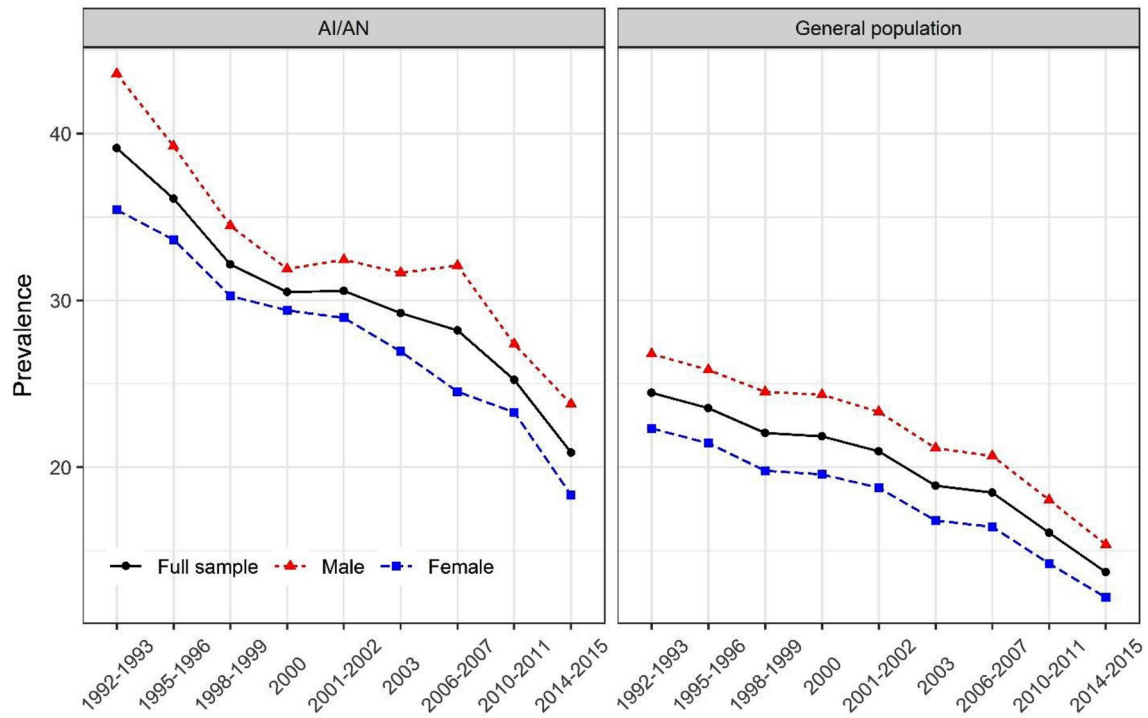


Fig. 1 Trend of the prevalence (with 95% confidence intervals) of smoking in AIs/ANs and general population by sex, since 1992

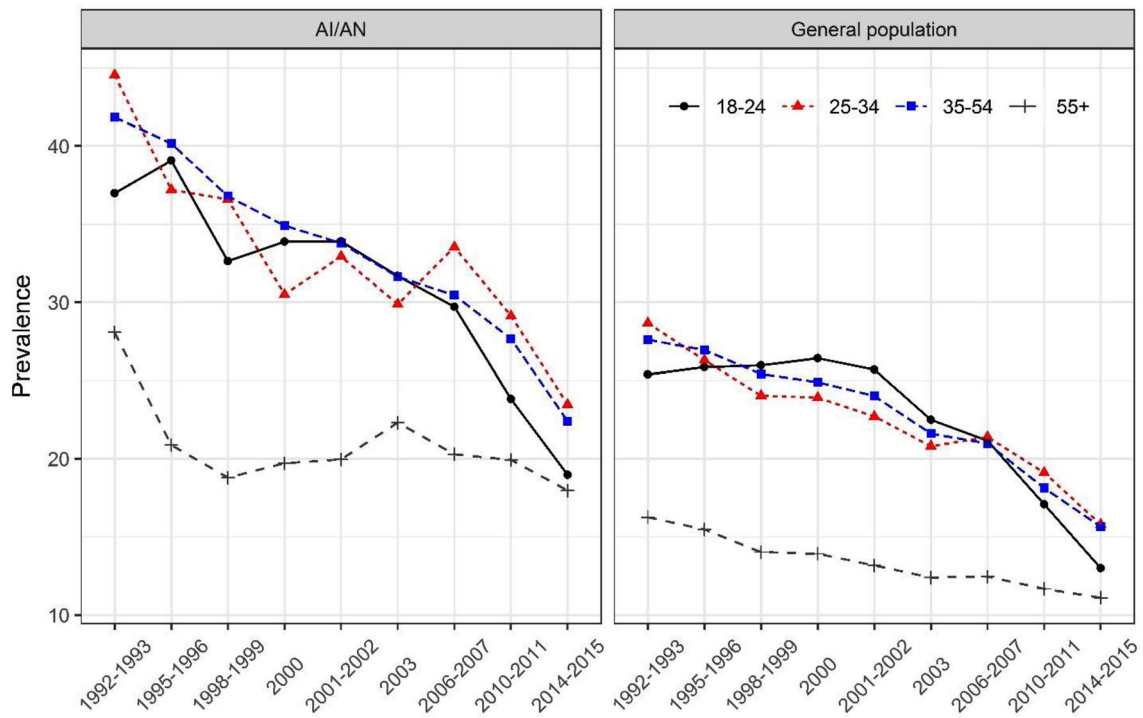


Fig. 2 Trend of the prevalence (with 95% confidence intervals) of smoking in AIs/ANs and general population by age, since 1992

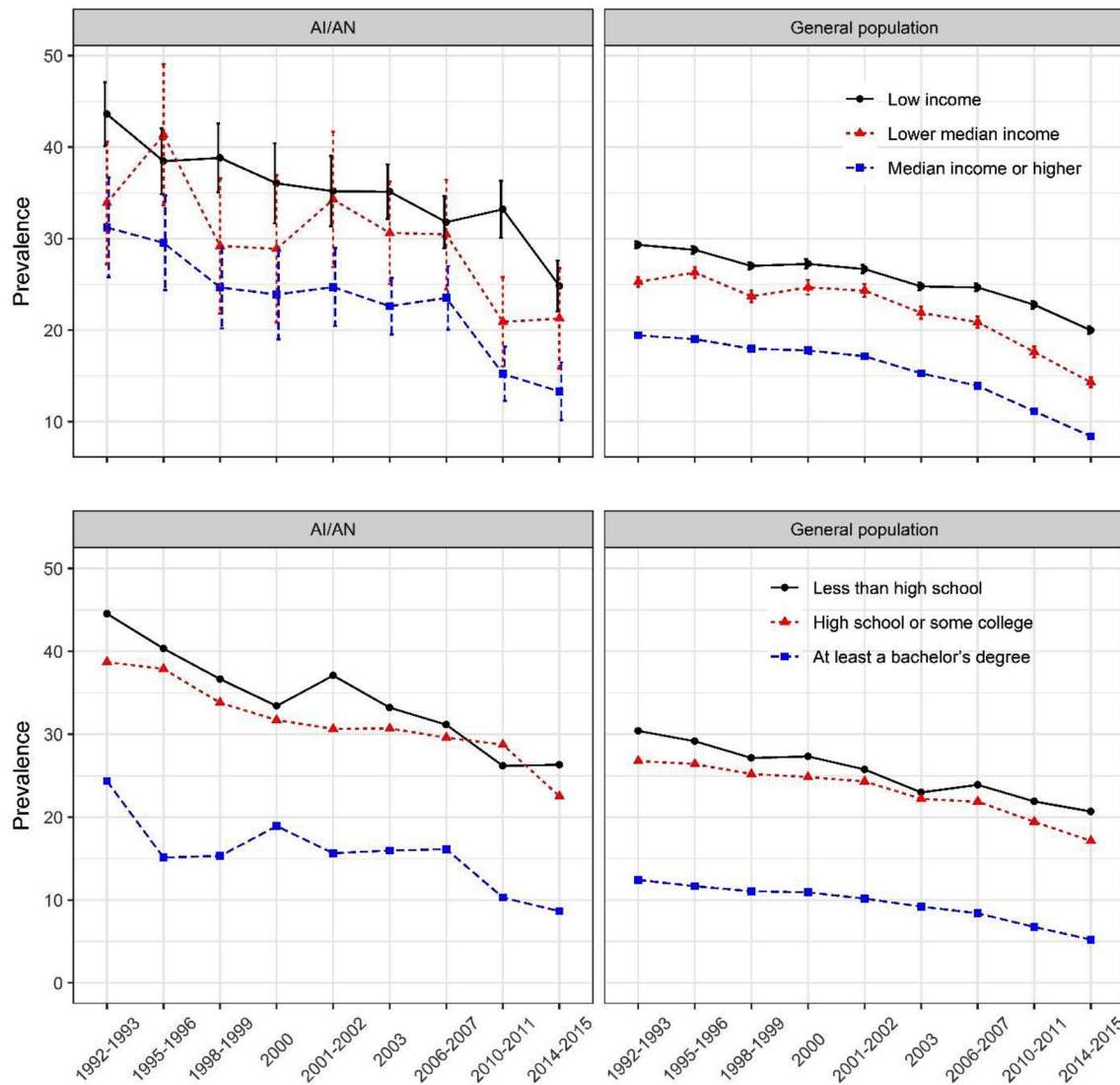


Fig. 3 Trend of the prevalence (with 95% confidence intervals) of smoking in AIs/ANs and general population by SES level (income and education), since 1992

general (−46.6%) than non-Hispanic AIs/ANs (−42.2%). It’s worth noting that the later relative change was very comparable to that in the general population (−43.9%). More details about the results from the sensitivity analysis results are presented in the Supplementary File.

Comparison with the general population

In 2014/2015, the general population had significantly lower prevalence of smoking than AIs/ANs; 13.7% (13.5–13.9) versus 20.9% (19.0–22.8). This variation was observed over time as shown in Figs. 1, 2, and 3 when

looking at the overall prevalence of smoking and when stratifying the prevalence by gender, age, income, and education.

Discussion

AIs/ANs have the highest prevalence of cigarette smoking when compared to all other racial/ethnic groups in the USA [3]; however, they are historically understudied. The present study augments the existing literature on smoking behaviors in AIs/ANs by examining national,

Table 3 Multivariable regression of correlates of cigarette smoking among AIs/ANs in 1992/1993 and 2014/2015

Covariates	1992/1993	2014/2015
	Adjusted odds ratio	Adjusted odds ratio
Age		
18–24	1.76 (1.69, 1.84)	0.95 (0.58, 1.55)
25–44	2.55 (2.46, 2.64)	1.57 (1.09, 2.26)
45–54	2.62 (2.54, 2.71)	1.53 (1.12, 2.08)
55+	Ref	Ref
Sex		
Male	1.35 (1.32, 1.38)	1.35 (1.05, 1.75)
Female	Ref	Ref
Income		
Low	1.61 (1.56, 1.66)	1.82 (1.27, 2.61)
Lower median	1.28 (1.24, 1.33)	1.58 (1.00, 2.50)
Median or higher	Ref	Ref
Education		
Less than high school	3.23 (3.09, 3.39)	2.44 (1.40, 4.25)
High school or some college	2.53 (2.44, 2.63)	2.36 (1.47, 3.81)
At least a bachelor's degree	Ref	Ref
Metropolitan status		
Metropolitan	Ref	Ref
Non-metropolitan	1.04 (1.01, 1.07)	1.70 (1.31, 2.22)
Region		
Northeast	1.18 (1.14, 1.23)	1.36 (0.83, 2.25)
Midwest	1.30 (1.26, 1.35)	1.87 (1.33, 2.64)
South	1.24 (1.19, 1.28)	1.43 (1.05, 1.96)
West	Ref	Ref

The odds ratio adjusted for age, sex, income, education level, metropolitan status, and region. The significant odds ratios are presented in bold

AI/AN American Indian/Alaska Natives, *Ref* reference category

sociodemographic, and geographic trends in smoking prevalence from 1992/1993 to 2014/2015.

As is consistent with overall national trends [1], the prevalence of smoking decreased significantly from the 1992/1993 cycle to the 2014/2015 cycle; however, smoking prevalence remains higher among this subpopulation than the national average [3]. In sex subgroups, the prevalence of smoking was significantly higher in males than females, which mirrors what is observed in the general population [14, 15]. In both male and female AIs/ANs, the prevalence of smoking decreased significantly from 2006/2007 to 2014/2015. The prevalence difference between males and females decreased from 8.2% in the 1992/1993 survey cycle to 5.5% in the 2014/2015 cycle, which is consistent with the finding that difference between smoking prevalence in men and women has decreased over time [16]. In the general population, the risk of death from

smoking-related causes has risen sharply among females and women who smoke are as likely as male smokers to suffer from smoking-related diseases and early death [17]. AI/AN women suffer disproportionately, with previous estimates placing smoking prevalence at 24% for AIs/ANs and the next closest prevalence a full 8% lower for non-Hispanic White women [18].

A significant decreasing trend was found in all age subgroups except in the 55+ age group. Over the study period, the prevalence of smoking was lowest in the 55+ age group; however, the prevalence difference between 55+ and other age groups decreased from the 1992/1993 survey cycle to the 2014/2015 cycle. This suggests that the 55+ age group has not seen the same improvement in smoking rates as other age groups. Previous results have shown that 45–64-year-old adults have the highest prevalence of smoking in 2016 [19], which partly coincides with our findings that the 35–54-age group accounted for 43.7% of all smokers in our study. Additionally, this age group displayed some of the highest rates throughout the study period.

A significant decreasing trend was found in all income subgroups. The median income or higher group had the lowest prevalence of smoking throughout the study period. The highest prevalence was found among the low-income group for nearly all survey cycles, in keeping with prior research that has found a link between poverty status and higher prevalence of cigarette smoking [20]. Estimation based on American Community Survey found that in 2017 the US AI/AN population experienced high levels of poverty with more than 20% of AIs/ANs living in poverty, a prevalence more than doubles that of non-Hispanic Whites and the difference in median household income was greater than \$20,000 compared to non-Hispanic Whites [21].

A decline in the prevalence of smoking occurred in all education level subgroups across the study period. Those with at least a bachelor's degree consistently had the lowest prevalence of smoking. Previous estimates have found that approximately 11% of AIs/ANs held a bachelor's degree [22], while our sample had a higher prevalence of 13.7%. In AI/AN populations, 77% of individuals have a high school diploma, lower than the national prevalence of 86% [23]. Education is strongly related to smoking status. In 2016 the Jamal et al. from CDC found that current smoking prevalence were around 4.5% in graduate degree holders, 7.7% in those with an undergraduate degree, 16.8% in those with an associate's degree, 19.7% in high school graduates, and usually higher prevalence in those with less than a high school education [24].

Correlates of cigarette smoking were examined in the study population for the last survey cycle, 2014/2015. Certain age groups had elevated odds of smoking, including the 25–44 age range and the 45–54 age range, compared to adults aged 55 years or older. These align with national data,

which indicates that current cigarette smoking prevalence is highest among those aged 25–64 [25]. Males also displayed higher risk for smoking compared to females, which is a common finding among smokers in the general population [25]. Our results agree with the findings of the general population indicating higher smoking prevalence among those with less than a bachelor's degree and low income [25]. Current tobacco use among the general population is highest among those living in the US Southern and Midwestern regions [26], which is in line with our results that AI/ANs living in those regions have an increased risk of smoking. Those living in metropolitan areas had decreased odds of smoking compared to those living in non-metropolitan areas, consistent with national trends of a high prevalence of smoking in rural locations [27, 28].

There are many possible explanations for the high prevalence of smoking among the US AI/AN population apart from the socioeconomic status and educational barriers discussed above. The tobacco industry has been shown to target its products toward this population through the use of specific symbols, names, and images [7]. For example, the release of American Spirit cigarettes promoted the use of natural tobacco leaves as the “American Indian custom,” and used an image of an American Indian smoking a pipe on the package [7]. Another possible contributor to the steep prevalence of smoking is the cultural influences of tobacco use among AI/AN communities. Although certain groups have historically used tobacco for ceremonial, medicinal, and spiritual purposes, evidence suggests that commercial tobacco products (including cigarettes) are increasingly being used as a substitute [29, 30]. There is overwhelming evidence that higher taxes/price is one of the most effective tobacco use prevention measures [31]. However, AI/AN tribes operate as sovereign nations and are thus exempt from state excise taxes and can regulate their tobacco sales [10] and do not have to implement smoke-free workplace policies [32].

This study has some limitations, including the self-report nature of the survey, which introduces the possibility of inaccurate recall of events. As this was a trend study, we were unable to establish the causal relationships between socioeconomic characteristics and the significant changes in trends. Another possible limitation is the potential for misclassification of ethnicity. Due to lack of data, we did not study the prevalence of other tobacco product use. This study also had several strengths; we were able to investigate a significant public health issue among a large sample of AI/ANs, a population that is understudied. The large sample size enabled us to examine smoking differences by important sociodemographic characteristics among a subpopulation that is vulnerable to tobacco use.

Conclusion

Health disparities in tobacco use remain a public health priority. Specific subpopulations, including AI/ANs suffer disproportionately from cigarette smoking. This study examined general smoking trends in a population of AI/ANs, as well as trends by sex, age, income and education levels. The prevalence of smoking decreased significantly across the study period. Similar decreasing trends were found in males, females, most age subgroups, all income subgroups, and all education level subgroups. Overall, our results indicate a recent significant decrease in AI/AN smoking prevalence, although AI/AN populations still experience a high prevalence of smoking compared to the general population. Our findings highlight the need for a comprehensive tobacco control strategy that includes working with stakeholders within the AI/AN community.

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