Rural and Urban American Indian and Alaska Native Veteran Health Disparities: a Population-Based Study

Carol E. Kaufman [1,2] · Nancy L. Asdigian [1] · Ursula Running Bear [1] · Janette Beals [1] · Spero M. Manson [1] · Nancy Dailey [2] · Byron Bair [2] · Jay H. Shore [1,2,3]

Abstract

The health service ecology varies considerably across urban-rural divides for American Indian and Alaska Native (AIAN) veterans, which may place rural AIAN veterans at high risk for poor health outcomes. Using the Behavioral Risk Factor Surveillance System 2011 and 2012 data for its detailed race information, we employed adjusted multinomial logistical regression analyses to estimate differences in health outcomes among rural AIAN veterans ($n = 1500$) and urban AIAN veterans ($n = 1567$). We used rural White ($n = 32,316$) and urban White ($n = 59,849$) veteran samples as comparators. No statistically significant differences between urban and rural AIAN veterans' health outcomes were found. Urban AIAN veterans were 72% more likely to report financial barriers to care compared with urban White veterans ($P = .002$); no other healthcare access differences were found. Compared with their White veteran counterparts, both urban and rural AIAN veterans were significantly more likely to report poorer physical and mental health across an array of outcomes. Overall, rural and urban AIAN veterans' health outcomes were similar, but both groups suffered compromised health compared with that of both rural and urban White veterans. The findings identified key areas for improving and innovating care for both rural and urban AIAN veterans.

Keywords American Indian and Alaska Native · Veterans · Rural health · Urban health · Health disparities

American Indian and Alaska Native (AIAN) veterans serve in the military at disproportionately high levels and often in the most dangerous positions [1–3]. The small body of research focused on this population has pointed towards poor health [3–7] and access challenges [8]. For US veterans generally, urban or rural residence makes a difference. Health-related quality of life measures consistently show urban veteran advantage [9, 10], including a higher probability of mental health treatment for urban veterans [11]. For AIAN veterans, rural-urban differences may be especially important. AIAN veterans are more rural than other veterans—48% compared

with 24% of veterans nationally [7]—which may magnify rural disadvantage for the AIAN veteran population. The service ecology for AIAN veterans across rural-urban divides may play a particularly critical role in available care and ultimately health outcomes. Many AIAN veterans have access to the Indian Health Service (IHS) which is centered on rural tribal areas. While consistently funded at levels lower than for federal prisoners [12], the IHS may offer the only local option for care. Urban-based AIAN veterans, in contrast, may have little access to IHS services. Urban Indian Health Programs, formerly a part of IHS, now operating independently since the early 2000s [13], number only 34 across 19 states; the extent of veteran utilization of these facilities is unknown. However, urban AIAN veterans are likely to have greater access to Veteran Health Administration (VHA) care compared with their rural counterparts. Kramer et al. showed that 46% of AIAN veterans used IHS as their sole source of care, 28% used VHA services only, and 25% used both IHS and VHA services; overall, 30%, 63%, and 38% of these user groups resided in metropolitan counties, respectively [14]. This striking utilization pattern may contribute substantially to dissimilar healthcare access and outcomes that would warrant distinct programmatic and policy intervention; to date,

✉ Carol E. Kaufman
  carol.kaufman@cuanschutz.edu

1 Centers for American Indian and Alaskan Native Health, Colorado School of Public Health, University of Colorado Anschutz Medical Campus, Aurora, CO, USA

2 U.S. Department of Veterans Affairs Office of Rural Health, Veterans Rural Health Resource Center in Salt Lake City, Salt Lake City, UT, USA

3 Department of Psychiatry, University of Colorado Anschutz Medical Campus, Aurora, CO, USA

however, we know little about urban-rural differences in AIAN veteran health.

The paucity of research on AIAN veteran health is due in part to their small numbers—less than 2% of the total veteran population. Since almost half do not access VHA care [7], VHA data exclude important segments of this population and provide limited insight to their health. National samples include veterans regardless of VHA access, but rarely with sufficient numbers of AIAN veterans for meaningful analyses. Moreover, national data sources do not always contain appropriately detailed race information, providing data on race only by single-race categories and a "multiple race" option. However, nationally, 53% of veterans endorsing AIAN as a race also indicated at least one other race compared with only 1% of White veterans [15]. In surveys with restricted race categories, about half of sampled AIANs are likely to be categorized as "mixed race" or misclassified in some other way; those who remain in the AIAN (sole race) category are likely to be unrepresentative of the overall AIAN population. Moreover, poor health outcomes have been associated with mixed race status [16, 17], and among AIANs in particular, those indicating multiple races report worse mental health outcomes compared with those indicating a single race [18]. Ignoring racial heterogeneity among AIAN veterans disadvantages those who may be in most need of healthcare resources.

To address substantive gaps and methodological challenges, the current analyses used data from the 2011 and 2012 Behavioral Risk Factor Surveillance System (BRFSS), a large annual national study supported by the Centers for Disease Control and Prevention and carried out by states to assess health behaviors of their populations. Prior to 2013, BRFSS data provided detailed racial information, including all races endorsed by an individual. Using data from 2011 and 2012 allowed us to include respondents who self-identified as AIAN only or as AIAN in combination with one or more other race. We used these data to investigate disparities across rural and urban AIAN veteran populations in several domains of health outcomes. To assess how urban and rural AIAN veteran health fared relative to other veterans, we compared them with their respective White counterparts in urban and rural areas. We hypothesized that rural AIAN veterans would have significantly worse health outcomes compared with urban AIAN veterans. We also expected the health outcomes of both rural and urban AIAN health outcomes to be worse than those of rural and of urban White veterans, respectively.

Methods

Data

We pooled BRFSS data across the two most recent years with detailed race data (2011 and 2012). The complex sampling methodology of BRFSS is well documented elsewhere [19].

The BRFSS data used for analysis consisted of a core set of questions comprising the use of and barriers to health services, general health, health behaviors, and reported diagnosed health conditions. All data are self-reported. The overall response rates were 49.7% in 2011 and 45.2% in 2012 (response rates by race were not published).

Veteran, Race, and Urban-Rural Status Measures

We selected all who endorsed the following question: "Have you ever served on active duty in the United States Armed Forces, either in the regular military or in a National Guard or military reserve unit. Active duty does not include training for the Reserves or National Guard, but DOES include activation, for example, for the Persian Gulf War." We retained those who lived in the 50 states or District of Columbia and those who endorsed AIAN or White as their race. We coded all who endorsed AIAN, either alone or in combination with other races, as 1. To ensure discrete categories, all those who endorsed White as their only race were coded as 0.

We determined rural and urban residence for each race group based on the BRFSS variable indicating metropolitan statistical area (MSA) status, a variable populated on the basis of the landline sample. Respondents using cell phones could not be similarly populated and were coded as missing, representing about 23% of the sample. Participants were coded "1" if rural (not living in an MSA) or "0" if urban (including those living in the center city of an MSA, outside the center city of an MSA but inside the county containing the center city, inside a suburban county of the MSA, or in an MSA that has no center city). Based on the foregoing, we created a nominal variable indicating veteran race and residence: 1 = AIAN rural ($n = 1500$), 2 = AIAN urban ($n = 1567$), 3 = White rural ($n = 32,316$), and 4 = White urban ($n = 59,849$).

Outcome Measures

Following Hoerster et al. [20] and Lehavot et al. [21], we selected measures from the core set of questions to capture conditions related to veteran health. Variables were chosen in 4 categories: healthcare access, general health indicators, health risk behaviors, and physical/mental conditions. Variables were dichotomous (0/1), with 1 indicating endorsement.

Healthcare access variables included having health insurance, including IHS eligibility (for those under 65); having a regular or personal healthcare provider; not seeking care because of cost in past 12 months; and getting a check-up within the past 12 months.

General health indicators included endorsing fair or poor on a self-rated health scale, and indicating limitations because of physical, mental, or emotional problems. Another item asked number of days in the past 30 days a respondent experienced

poor physical health and a similar question about poor mental health. Based on prior research [22, 23], we converted these to two respective dichotomous variables, with those reporting 14+ days of poor health coded as 1, 0 otherwise.

Health risk behavior measures included tobacco use, alcohol use, and lack of exercise in the past 30 days. Tobacco use included reports of current smoking or smokeless tobacco use. We created a variable indicating heavy drinking based on reported number of drinks per day over the last 30 days. Using the National Institute of Alcohol Abuse and Alcoholism definition, heavy alcohol use was endorsed for men who reported drinking more than 2 drinks per day and for women who reported more than 1 drink per day.

Physical and mental health conditions were assessed by respondents' reports of ever been diagnosed with various conditions, or of specific physical characteristics. These included a calculated body mass index (BMI) considered obese ($\geq$ 30.0 kg/m^2); respondent reports of having a heart attack, angina, infarction, or a stroke (cardiovascular disease, CVD); and respondent reports of ever being told by a provider they had diabetes or a kidney disease, asthma or chronic obstructive pulmonary disease (COPD), skin cancer, any other cancer, arthritis, or depression.

Demographic Measures

To adjust estimates for demographic variability across the four main veteran groups, we included measures of sex, age, educational attainment, marital status, income, and geographic regions of the country, based on Census definitions [24].

All demographic and health and behavior measures had very little missing data (< 6%), with the exception of income (11%), for which we retained a "missing data" category in analyses.

Statistical Analysis

We used Stata v.14.1 [25] for analyses, adjusting descriptive and multivariate estimates for complex sampling (see BRFSS documentation for weight calculations [26]). We summarized and compared characteristics and health outcomes of AIAN rural and urban veterans and their White rural and urban veteran counterparts using design-based F tests to adjust for the sampling design. We used multinomial logistic regression (MNLR) methods, combined with Long and Freese's post-estimation procedures [27], to statistically evaluate pairwise differences between each race and residence group on all demographic characteristics and health measures. We adjusted for multiple comparisons using the Bonferroni correction. In the present analysis, MNLR fits a series of simultaneous binary logit models to evaluate the degree to which a predictor variable (e.g., diagnosis of arthritis) influences the odds of being in one veteran race-residence group vs. another group. To retain focus on AIAN veterans and their residence, we limit comparisons to rural

AIAN vs. urban AIAN, rural AIAN vs. rural White, and urban AIAN vs. urban White. Controlling for sociodemographic characteristics, the resulting adjusted odds ratios (AORs) reflect the change in odds of group membership associated with the presence of that covariate. Below, we describe prevalence levels for statistically significant outcomes, F test results, and Bonferroni-corrected P values; 95% confidence intervals and adjusted odds ratios can be found in the tables.

Results

In Table 1, weighted percentages of sample characteristics of each group are presented. In total, 48% of 3067 AIAN veterans were rural. All groups were predominantly male (> 92%), and no significant differences were detected by race across urban and rural settings. Rural and urban AIAN veterans were similar in age, marital status, and education, but rural AIAN veterans were statistically less likely to earn $50,000 or more (26.5% vs. 38.9%; $F[15, 94,282] = 41.48$, $P = .017$). AIAN veterans were significantly younger and were less likely to be married, be a college graduate, or earn $50,000 or more compared with White veterans regardless of residence. Consistent with their distribution in the population [28], rural and urban AIAN veterans had greater representation in the West compared with White veterans.

Table 2 displays the results of the adjusted multinomial logistic regression analysis. No significant differences were detected between rural and urban AIAN veterans. No significant differences between rural AIAN and rural White veterans were detected for any healthcare access measure. Urban AIAN veterans were significantly more likely to report financial barriers to care compared with urban White veterans (14.4% vs. 6.0%; $F[45, 93,339] = 47.70$, $P = .002$); no other indicators of healthcare access were significantly different. In general health, rural AIAN veterans compared with their rural White counterparts were significantly more likely to report fair or poor self-rated health (35.4% vs. 25.0%; $F[45, 93,143] = 47.39$, $P = .003$), limited activities (47.4% vs. 33.6%; $F[45, 90,228] = 45.10$, $P = .0005$), and 14+ days of poor physical (25.6% vs. 17.0%; $F[45, 91,315] = 47.24$, $P = .005$) and mental (17.5% vs. 9.5%; $F[45, 91,909] = 46.8$, $P = .025$) health in the past month. Similarly, urban AIAN veterans were significantly more likely than urban White veterans to report limited activities (38.8% vs. 30.6%; $F[45, 90,228] = 45.10$, $P = .009$) and poor physical health (25.0% vs. 14.6%; $F[45, 91,271] = 47.24$, $P < .0000$) and poor mental health (20.0% vs. 8.5%; $F[45, 91,953] = 46.8$, $P < .0000$). AIAN veterans reported significantly more tobacco use than White veterans in both rural (40.1% vs. 24.3%; $F[45, 93,029] = 48.44$, $P < .006$) and urban (29.0% vs. 17.8%; $F[45, 93,073] = 48.44$, $P = .034$) settings. No other significant differences were detected for health risk behaviors.

Table 1 Weighted demographic characteristics by veteran race and urban-rural status, 2011–2012 Behavioral Risk Factor Surveillance System Survey

Characteristic	Veteran race and urban-rural status								Odds ratio		
	AIAN[a]—rural[b] (n = 1500)		AIAN[a]—urban[c] (n = 1567)		White—rural[b] (n = 32,316)		White—urban[c] (n = 59,849)		AIAN[a]—rural[b] vs. AIAN[a]—urban[c]	AIAN[a]—rural[b] vs. White—rural[b]	AIAN[a]—urban[c] vs. White-urban[c]
	%	CI[d]	%	CI[d]	%	CI[d]	%	CI[d]			
Male	94.5	92.2–96.1	92.8	90.8–94.4	94.7	94.2–95.1	93.7	93.4–94.0	1.33	0.96	0.86
Age group											
18–24	1.0	0.40–2.22	1.1	0.61–2.13	0.64	0.41–1.01	1.0	0.79–1.25	0.65	1.80	1.70
25–44	18.0	11.4–27.3	19.2	15.1–24.2	11.3	10.4–12.2	12.7	12.1–13.3	0.76	1.95[e]	2.24[g]
45–64	38.0	32.4–44.1	44.8	40.0–49.7	35.6	34.6–36.7	34.9	34.2–35.6	0.69	1.30	1.90[g]
65+	43.0	36.6–49.7	34.9	30.7–39.3	52.5	51.4–53.6	51.5	50.7–52.2	1	1	1
Marital status											
Married/cohabiting	64.5	58.5–70.0	64.6	59.7–69.3	73.3	72.4–74.2	73.3	72.7–73.9	0.99	0.661[f]	0.67[g]
Unmarried	35.5	30.0–41.5	35.4	30.7–40.3	26.7	25.8–27.6	26.7	26.1–27.3	1	1	1
Education											
<High school	15.9	11.5–21.6	11.3	8.2–15.3	11.7	10.8–12.5	7.2	6.7–7.6	1	1	1
High school	27.9	22.9–33.6	28.2	24.1–32.7	36.7	35.7–37.8	28.9	28.2–29.6	0.70	0.56[e]	0.62
Some college	41.7	34.7–49.0	39.2	34.4–44.2	32.8	31.7–33.8	33.8	33.1–34.5	0.75	0.93	0.74
College graduate	14.5	11.6–18.0	21.3	18.0–25.1	18.8	18.2–19.5	30.2	29.6–30.7	0.48	0.56[e]	0.45[g]
Income											
Less than $15K	15.3	11.5–20.1	8.5	6.4–11.2	6.9	6.4–7.5	4.0	3.7–4.2	1	1	1
$15–$24.9K	19.4	15.6–23.8	15.9	12.7–19.7	17.8	17.1–18.8	11.9	11.4–12.3	0.68	0.049[f]	0.62
$25–$34.5K	13.7	10.0–18.5	11.9	9.2–15.3	13.8	13.1–14.5	10.8	10.3–11.2	0.64	0.45[f]	0.52[e]
$35–$49.9 K	14.2	11.0–18.1	13.0	10.3–16.4	17.6	16.8–18.5	15.4	14.9–15.9	0.61	0.37[g]	0.39[g]
$50 K+	26.5	19.5–34.9	38.9	34.0–43.9	33.5	32.4–34.5	47.2	46.5–47.9	0.38[e]	0.36[g]	0.38[e]
Missing	10.9	7.5–15.5	11.8	9.2–15.1	10.3	9.7–10.9	10.8	10.4–11.3	0.51	0.48[e]	0.50[e]
Geography											
Northeast	7.8	4.5–13.2	10.4	7.7–13.8	13.6	12.8–14.5	19.4	19.1–19.7	1	1	1
Midwest	25.0	18.1–33.4	17.6	14.1–21.7	31.1	30.2–31.9	19.9	19.5–20.3	1.88	1.41	1.65
South	39.0	33.0–45.2	34.0	29.6–38.7	40.6	39.8–41.5	37.5	37.0–38.0	1.52	1.68	1.70[e]
West	28.3	23.6–33.5	38.1	33.5–42.9	14.7	14.1–15.3	23.2	22.8–23.6	0.98	3.36[g]	3.08[g]

[a] American Indian Alaska Native

[b] *Rural* not in a metropolitan statistical area (MSA)

[c] *Urban* in an MSA or county of an MSA

[d] Confidence interval

[e] $P < .05$

[f] $P < .01$

[g] $P < .001$

Table 2 Health Outcomes by veteran race and urban-rural status, 2011–2012 Behavioral Risk Factor Surveillance System Survey

Health outcomes	Veteran race and rural-urban status								Odd ratios Adjusted for sociodemographics		
	AIAN[a]—rural[b]		AIAN[a]—urban[c]		White—rural[b]		White—urban[c]		AIAN[a]—rural[b] vs. AIAN—urban[c]	AIAN[a]—rural[b] vs. White—rural[b]	AIAN[a]—urban[c] vs. White—urban[c]
	%	CI[d]	%	CI[d]	%	CI[d]	%	CI[d]			
Healthcare access											
Has health insurance (<65) (n = 36,409 under 65)	85.9	80.6–89.9	89.0	85.0–92.1	85.8	84.3–87.2	91.0	90.3–91.7	0.92	1.38	1.18
Has a regular provider	83.9	80.2–87.0	86.2	82.1–89.5	87.1	86.3–87.9	89.8	89.3–90.3	0.80	1.11	1.12[f]
Financial barrier to care	13.6	10.4–17.7	14.4	11.3–18.1	7.8	7.1–8.5	6.0	5.6–6.4	0.77	1.28	1.72[f]
Check-up, prior 12 months	78.8	74.6–82.6	72.2	67.2–76.8	78.3	77.4–79.2	80.6	79.9–81.1	1.43	1.32	0.82
General health											
Fair/poor self-rated health	35.4	29.7–41.4	26.0	22.1–30.3	25.0	24.1–26.0	20.6	20.0–21.2	1.25	1.59[f]	1.31
Limited activities	47.4	40.5–54.3	38.8	34.2–43.7	33.6	32.6–34.6	30.6	29.9–31.3	1.23	1.63[g]	1.37[f]
14+ days in past month:											
Poor physical health	25.6	21.0–30.8	25.0	21.0–29.5	17.0	16.1–17.8	14.6	14.1–15.1	0.84	1.52[f]	1.80[g]
Poor mental health	17.5	13.5–22.3	20.0	16.0–24.7	9.5	8.9–10.2	8.5	8.1–9.0	0.72	1.52[e]	2.04[g]
Health risk behaviors											
Any tobacco use	40.1	33.1–47.6	29.0	24.6–33.7	24.3	23.4–25.3	17.8	17.2–18.4	1.60	1.66[f]	1.35[e]
Heavy drinker	4.6	3.2–6.7	6.8	4.8–9.5	6.0	5.5–6.5	5.9	5.5–6.3	0.67	0.65	1.01
No exercise, past 30 days	32.5	26.8–38.8	25.5	21.3–30.2	29.6	28.6–30.6	24.3	23.7–25.0	1.18	1.15	1.06
Physical/mental conditions											
Obese	33.7	28.2–39.7	36.2	31.5–41.2	30.0	29.0–31.0	28.9	28.3–29.6	0.86	1.16	1.34[e]
Cardiovascular disease	24.5	20.0–29.8	20.9	17.7–24.6	23.5	22.6–24.4	21.4	20.9–22.0	1.00	1.22	1.19
Diabetes/kidney disease	30.2	24.4–36.7	23.2	19.3–27.7	20.4	19.6–21.2	20.0	19.4–20.5	1.26	1.94[g]	1.45[e]
Asthma/COPD	24.4	20.0–29.5	21.2	17.9–25.0	16.7	16.0–17.5	15.4	14.9–16.0	1.07	1.52[f]	1.41[f]
Skin cancer	11.2	8.1–15.4	10.1	7.9–12.9	17.5	16.7–18.3	17.0	16.5–17.5	1.06	0.70	0.70[e]
Other cancers	14.2	9.9–19.8	9.1	7.0–11.8	13.1	12.4–13.7	13.5	13.1–14.0	1.57	1.36	0.82
Arthritis	49.8	43.0–56.6	47.4	42.6–52.3	41.9	40.8–42.9	38.8	38.1–39.5	0.95	1.53[f]	1.69[g]
Depression	25.3	20.5–30.7	19.9	16.3–24.1	15.5	14.7–16.3	13.2	12.7–13.7	1.25	1.51[e]	1.34

Note: Adjusted models control for age, sex, marital status, education, income, and region

[a] American Indian Alaska Native

[b] *Rural* not in a metropolitan statistical area (MSA)

[c] *Urban* in an MSA or county of an MSA

[d] Confidence interval

[e] $P < .05$

[f] $P < .01$

[g] $P < .001$

Among physical conditions, AIAN veterans in both rural and urban settings were significantly more likely to report having been diagnosed with diabetes or kidney disease, asthma or COPD, and arthritis compared with their respective White veteran counterparts. Reported conditions with the widest prevalence gaps included diabetes and kidney disease in rural areas (AIAN 30.2% vs. 20.4% for Whites; $F[45, 93,551] = 47.99$, $P = .011$), rural depression (25.3% vs. 15.5%; $F[45,93,160] = 47.90$, $P = .020$), and arthritis in urban areas (47.4% vs. 38.8%, $F[45, 93,006] = 47.52$, $P < .0000$). Also, compared with urban White veterans, urban AIAN veterans were significantly more likely to be obese (36.2% vs. 28.9%; $F[45, 92,401] = 46.49$, $P = .023$), but less likely to have been diagnosed with skin cancer (10.1% vs. 17.0%; $F[45. 93,187] = 46.81$, $P = .037$). No differences were found among the groups in CVD or other cancers.

Discussion

Rural and urban AIAN veterans face considerable barriers to appropriate care, but assessing their health has been especially difficult. Health-service-based data (VHA or IHS) capture only a small part of the population, and most national population data provide inadequate sample sizes with narrowly defined race data. The BRFSS 2011–2012 data offer a valuable exception, allowing robust comparisons among veteran populations. Furthermore, these data are population-based and not restricted to patients receiving care in particular settings. Our results are the first to examine the health of rural and urban AIAN veterans relative to each other and their rural and urban White counterparts at a population level.

Contrary to our hypothesis, few differences between rural and urban AIAN veterans were detected in spite of the very different healthcare delivery environments. Since urban populations tend to be healthier than rural counterparts [29], these results underscore the uniqueness of the AIAN veteran population and the importance of addressing their health needs, regardless of residence.

While rural and urban AIAN veteran health outcomes were similar, the pattern of results suggests overall worse health conditions of both groups compared with their rural and urban White veteran counterparts. With few exceptions, rural and urban AIAN veteran health disadvantages were observed across an array of health outcomes. These differences between AIAN and White veterans may be explained in part by the overall poorer health and well-being of AIAN veterans [7], or serving disproportionately in dangerous military positions [3]. Disparities across these veteran racial groups may also reflect overall social and economic disparities seen in the civilian population [30], likely pinioned by historical and contemporary trauma [36]. Taken together, these results present strong evidence for strengthening healthcare for rural and urban AIAN veterans.

Our findings supported the hypothesis that rural and urban AIAN veterans fare worse than White veterans living in similar settings with regard to health indicators (general health and conditions), but not for healthcare access or health behavior, except for tobacco use. Only one healthcare access measure was significant: urban AIAN veterans were 72% more likely to report a financial barrier to care compared with urban White veterans, even after controlling for income. In contrast to prior research [8], we found no differences in reports of insurance coverage. The inconsistency may be due to BRFSS wording which included IHS explicitly in the insurance coverage question. This may have given rise to the equivalent (and high) levels of insurance coverage reported in Table 2. However, IHS is not a type of insurance. It is a congressional appropriation to support healthcare. A facility is allotted a certain amount regardless of care required; if money is spent before the next allocation, patients go without care. AIAN veterans are not likely to enjoy the same level of actual insurance coverage as their White counterparts, which may explain the higher financial barriers for AIAN veterans.

A few specific points of programmatic address are suggested by our results: Reports of tobacco use was the single behavioral indicator showing statistically significant racial differences by urban and rural divides, consistent with racial disparities of tobacco use for the general population [31]. Given the sacred nature of tobacco in many AIAN cultures, this finding supports targeted and culturally appropriate work with AIAN veterans in smoking cessation. Conversely, our findings indicate that drinking and exercise patterns did not systematically differ across the veteran groups. However, given established veteran level of problem alcohol use [32], and concerning obesity levels generally, all groups will benefit from additional substance use treatment, healthy living, and exercise opportunities. Finally, while our findings suggest a number of specific prevention, screening, and treatment initiatives to address physical and mental health disparities, the disproportionate burden of ill-health among AIAN veterans in both settings suggests that social determinants of health may play a significant role in health. Assessing system-level supports or barriers to health for AIAN veterans may provide important advances in health equity gains.

The findings of this study should be considered in light of their limitations. BRFSS is self-reported data and limited in description of veteran experience such as data on service-connected disability, enrollment in, or eligibility for, VHA or IHS care, or specific utilization of either healthcare entity. As such, no conclusions can be made with respect to VHA or IHS care provision. Further, BRFSS classification of IHS enrollment as insurance precluded conclusion about insurance coverage differences. Causality cannot be determined from these cross-sectional data. We also know little about the extent to which veterans travel between rural and urban areas to receive care. While anecdotally, such mobility is common, especially

for AIANs, for a variety of reasons, little research has investigated these patterns [33]. Finally, we were not able to include the cell phone sample since no geographic attribution was possible. This exclusion likely biased the sample in conservative ways since those with cell phones were likely to be younger, have higher incomes, and have more access to health resources. In spite of these limitations, these data provide advances in determining healthcare access and conditions for rural and urban AIAN veterans across the nation.

Conclusions

These analyses examined the potential health disparities of rural and urban AIAN veterans compared with rural and urban White veterans. With renewed efforts between the VHA and IHS to provide care coordination for tribal veterans, and VHA outreach in partnership to rural communities, the results of this study may inform a new framework for improving and innovating care for AIAN veterans. A major finding of this study underscores the similarly poor health of rural and urban AIAN veterans. Since AIAN veterans may also circulate between urban and rural settings, these findings urge (1) an improved understanding of the nature and extent of urban-rural migration and (2) the development of outreach, intervention, and care coordination that views urban and rural as connected, not as discrete, locales. Such interventions may include, for example, expanding area coverage for veteran patient navigators or tribal veteran representatives [34], perhaps assisted by telehealth care [35], to assure AIAN veterans are connected with appropriate care in any setting. In short, while these analyses underscored health disadvantages experienced by both rural and urban AIAN veterans, they also provide a blueprint for creative approaches and partnerships to mitigate these disparities.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Human Subjects This study was determined to be a non-human subjects research by the Colorado Multiple Institutional Review Board (#14-0892).

Disclaimer The views expressed in this article are those of the authors and do not necessarily reflect the position or policy of the U.S. Department of Veterans Affairs.

References

1. Department of Defense. 2013: Demographics: profile of the military community, Office of the Deputy Assistant Secretary of Defense 2013. http://download.militaryonesource.mil/12038/MOS/Reports/2013-Demographics-Report.pdf. Accessed 4 June 2019.

2. US Census Bureau American Community Survey 3-Year Estimates, 2011-2013. https://factfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t. Accessed 4 June 2019.

3. Beals J, Manson SM, Shore JH, Friedman M, Ashcraft M, Fairbank JA, et al. The prevalence of posttraumatic stress disorder among American Indian Vietnam veterans: disparities and context. J Trauma Stress. 2002;15(2):89–97.

4. Westermeyer J, et al. Perceived barriers to VA mental health care among upper Midwest American Indian veterans: description and associations. Med Care. 2002;40(Suppl 1):62–70.

5. Dickerson DL, O'Malley SS, Canive J, Thuras P, Westermeyer J. Nicotine dependence and psychiatric and substance use comorbidities in a sample of American Indian male veterans. Drug Alcohol Depend. 2009;99(1–3):169–75.

6. Kasprow WJ, Rosenheck R. Substance use and psychiatric problems of homeless Native American veterans. Psychiatr Serv. 1998;49(3):345–50.

7. Kaufman CE, Brooks E, Kaufmann LJ, Noe T, Nagamoto HT, Dailey N, et al. Rural native veterans in the veterans health administration: characteristics and service utilization patterns. J Rural Health. 2013;29:304–10.

8. Johnson PJ, Carlson KF, Hearst MO. Healthcare disparities for American Indian veterans in the United States: a population-based study. Med Care. 2010;48(6):563–9.

9. Weeks WB, Kazis LE, Shen Y, Cong Z, Ren XS, Miller D, et al. Differences in health-related quality of life in rural and urban veterans. Am J Public Health. 2004;94(10):1762–7.

10. Wallace AE, et al. A longitudinal analysis of rural and urban veterans' health-related quality of life. J Rural Health. 2010;26(2):156–63.

11. Teich J, Ali MM, Lynch S, Mutter R. Utilization of mental health services by veterans living in rural areas. J Rural Health. 2017;33(3):297–304.

12. Warne D, Frizzell LB. American Indian health policy: historical trends and contemporary issues. Am J Public Health. 2014;104(S3):S263–7.

13. Urban Indian Health Commission. Invisible tribes: urban Indians and their health in a changing world. A Report Issued by the Urban Indian Health Commission with Support from the Robert Wood Johnson Foundation 2015 https://www2.census.gov/cac/nac/meetings/2015-10-13/invisible-tribes.pdf. Access 18 January 2019.

14. Kramer BJ, Wang M, Jouldjian S, Lee ML, Finke B, Saliba D. Veterans Health Administration and Indian Health Service: healthcare utilization by Indian Health Service enrollees. Med Care. 2009;47(6):670–6.

15. US Census Bureau American Community Survey 5-Year Estimates, 2006-2010. https://factfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t. Accessed 4 June 2019.

16. Wu L-T, Swartz MS, Burchett B, NIDA AAPI Workgroup, Blazer DG. Tobacco use among Asian Americans, Native Hawaiians/Pacific Islanders, and mixed-race individuals: 2002–2010. Drug Alcohol Depend. 2013;132(1–2):87–94.

17. Akinbami, L., et al., Trends in asthma prevalence, health care use, and mortality in the United States, 2001–2010, in NCHS data brief, no. 94 (May). 2012, National Center for Health Statistics: Hyattsville, MD: National Center for Health Statistics.

18. Asdigian NL, Running Bear U, Beals J, Manson SM, Kaufman CE. Mental health burden in a national sample of American Indian and Alaska Native adults: differences between multiple-race and single-race subgroups. Soc Psychiatry Psychiatr Epidemiol. 2018;53:521–30.

19. Centers for Disease Control and Prevention. Behavioral Risk Factor Surveillance System. no date. http://www.cdc.gov/brfss/. Accessed 5 February 2019.

20. Hoerster KD, et al. Health and health behavior differences: U.S. military, veteran, and civilian men. Am J Prev Med. 2012;43(5):483–9.

21. Lehavot K, Hoerster KD, Nelson KM, Jakupcak M, Simpson TL. Health indicators for military, veteran, and civilian women. Am J Prev Med. 2012;42(5):473–80.

22. Strine TW, Chapman DP, Kobau R, Balluz L, Mokdad AH. Depression, anxiety, and physical impairments and quality of life in the U.S. noninstitutionalized population. Psychiatr Serv. 2004;55(12):1408–13.

23. Li C, et al. Clustering of multiple healthy lifestyle habits and health-related quality of life among U.S. adults with diabetes. Diabetes Care. 2007;30(7):1770–6.

24. US Census Bureau. Census regions and divisions of the United States. no date. cited http://www2.census.gov/geo/pdfs/maps-data/maps/reference/us_regdiv.pdf. Accessed 9 February 2019.

25. StataCorp, Stata Statistical Software: Release 14.1. 2015, Stata Corporation: College Station, TX.

26. Centers for Disease Control and Prevention. BRFSS: weighting the data (2011 Weighting Formula). no date. http://www.cdc.gov/brfss/annual_data/2011/2011_weighting.htm. Accessed 10 January 2019.

27. Long JS, Freese J. Regression models for categorical dependent variables using Stata. 3rd ed. College Park: Stata Press; 2014.

28. Humes, K.R., N.A. Jones, and R.R. Ramirez. Overview of race and hispanic origin: 2010. 2010. Census Briefs 2011 http://www.census.gov/prod/cen2010/briefs/c2010br-02.pdf. Accessed 3 March 2019.

29. Singh GK, Siahpush M. Widening rural–urban disparities in life expectancy, U.S., 1969–2009. Am J Prev Med. 2014;46(2):e19–29.

30. Cobb N, Espey D, King J. Health behaviors and risk factors among American Indians and Alaska Natives, 2000–2010. Am J Public Health. 2014;104(S3):S481–9.

31. Mowery PD, et al. Disparities in smoking-related mortality among American Indians/Alaska Natives. Am J Prev Med. 2015;49(5):738–44.

32. Fuehrlein BS, Mota N, Arias AJ, Trevisan LA, Kachadourian LK, Krystal JH, et al. The burden of alcohol use disorders in US military veterans: results from the National Health and Resilience in Veterans Study. Addiction. 2016;111(10):1786–94.

33. Yuan NP, Bartgis J, Demers D. Promoting ethical research with American Indian and Alaska Native people living in urban areas. Am J Public Health. 2014;104(11):2085–91.

34. Kaufmann LJ, et al. Tribal Veterans Representative (TVR) training program: the effect of community outreach workers on American Indian and Alaska Native Veterans' access to and utilization of the Veterans Health Administration. J Community Health. 2014;39(5):990–6.

35. Shore JH, et al. Review of American Indian veteran telemental health. Telemed E Health. 2012;18(2):87–94.

36. Jones DS. The persistence of American Indian health disparities. Am J Public Health. 2006;96(12):2122–34.