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ORIGINAL RESEARCH

Variation in Hypertension Control by Race and Ethnicity, and Geography in US Veterans

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BACKGROUND: Hypertension control and related cardiovascular outcomes among Americans remain suboptimal, and differ by race, ethnicity, and geography. Healthcare access is one of multiple critical factors in hypertension control. Understanding the degree to which healthcare access, versus other factors, produce these outcomes can inform policies and interventions to improve cardiovascular outcomes and reduce disparities. Department of Veterans Affairs Healthcare System data provide a unique opportunity to understand residual racial and ethnic differences in hypertension control after accounting for healthcare access. Our objective was to describe pre-pandemic post-Affordable Care Act implementation hypertension control by geographic sector and race and ethnicity, and assess spatial clustering of hypertension control.

METHODS AND RESULTS: A secondary data analysis of hypertension control among US veterans (n=1 619 414) nationwide and in 4 US territories was conducted using electronic health record data. Age- and sex-adjusted regression models estimated overall and race- and ethnicity-specific rates by geographic sector. We created choropleth maps of hypertension control rates and assessed spatial autocorrelation. Hypertension control rates varied across sectors by race and ethnicity (range, 44.1%–97.5%); Black veterans, followed by American Indian or Alaska Native veterans, had the lowest mean control rates (72.5% and 75.4%, respectively). There was clustering of low hypertension control rates for Black veterans in the Pacific Northwest, Southwest, Missouri, Kansas, and Arkansas, and for American Indian or Alaska Native veterans in the West and Southwest.

CONCLUSIONS: Hypertension control rates varied geographically for veteran groups experiencing racial and ethnic disparities. Geographic areas with concentrations of low rates of hypertension control should be a focus for interventions to address racial and ethnic disparities.

Key Words: disparities ■ health equity ■ hypertension ■ secondary prevention

Recent research found that greater access to primary care and pharmacy benefits from Medicaid expansions improved hypertension control rates,[1,2] highlighting the importance of coverage and access to healthcare in managing chronic conditions and reducing disparities. Despite gains in healthcare coverage and access related to implementation of the Patient Protection and Affordable Care Act, hypertension control rates have decreased in the US general population over the past decade, dropping from 53.8% controlled in 2013 to 2014 to 43.7% controlled in 2017 to 2018, with stark racial and ethnic disparities in hypertension, lowest for Hispanic (36.8%), followed by non-Hispanic Black (38.5%) and non-Hispanic Asian (43.4%).[3]

Hypertension is an ideal model for examining the impact of healthcare access on chronic disease management because it is relatively common, and

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CLINICAL PERSPECTIVE

What Is New?

- This study is the first to examine geographic variation in hypertension control across the United States by race and ethnicity groupings that include Native Hawaiian and other Pacific Islander and American Indian and Alaska Native patient groups which are often omitted in other reports, and suggests that differences in healthcare access alone do not fully explain racial and ethnic disparities in hypertension control, because rates varied geographically for veteran groups experiencing racial and ethnic disparities.

What Are the Clinical Implications?

- To resolve disparities, factors besides access to care must be addressed, including variation in healthcare quality between and within geographic regions, which may be related to discrimination and social determinants of health.
- Some geographic areas achieved hypertension control >90%, highlighting that near perfect hypertension control is achievable, and offer potentially valuable case studies to replicate success.

Nonstandard Abbreviations and Acronyms

ADI	Area Deprivation Index
AIAN	American Indian or Alaska Native
NHOPI	Native Hawaiian or Other Pacific Islander
VA	Department of Veterans Affairs

has effective and affordable medications and lifestyle interventions available.[4–7] Conditions related to uncontrolled hypertension (eg, stroke and cardiovascular disease) have been found to have higher prevalence in some racial and ethnic minoritized populations, and have also been observed to have notable geographic patterns (ie, Southern United States stroke belt).[8,9] However, less is known about geographic variation in racial and ethnic disparities in uncontrolled hypertension, and how these disparities might persist after addressing healthcare access. Data from the Department of Veterans Affairs (VA) Healthcare System, the largest integrated healthcare delivery system in the country, provide a unique opportunity to examine this research gap and expand our understanding of the degree to which racial and ethnic differences and the variation by geography in hypertension control persist accounting for healthcare access (ie, theoretical access, similar to having health insurance).[10,11] The VA user population is also an excellent context in which to examine hypertension control, because this population has a notably high prevalence of hypertension (51% compared with 32% among the general US population[3,12]).

The aims of this research were to describe and map pre-COVID-19 pandemic post-Patient Protection and Affordable Care Act implementation era hypertension control of veterans by race and ethnicity including for American Indian or Alaska Native (AIAN) and Native Hawaiian or other Pacific Islander (NHOPI) adults (who have not been reported in national, population-based studies[3]), assess spatial clustering of hypertension control, and determine if geographic variation in hypertension control could be explained by differences in patient age and sex within a national racially and ethnically diverse cohort of patients with access to healthcare through the VA. These aims serve to further our understanding of the role of access to care in improving chronic disease management.

METHODS

Due to the risks of patient reidentification, the data sets used in this study are not publicly available, but requests to access redacted data sets from qualified researchers trained in human subject confidentiality protocols are available upon reasonable request from author Dr Donna Washington at donna.washington@va.gov.

Data and Sample

This retrospective cross-sectional analysis used electronic health record data from the VA Corporate Data Warehouse, which cover all VA ambulatory healthcare delivery sites (VA medical centers and community-based outpatient clinics) in all states nationwide and in Puerto Rico, American Samoa, Guam, the Northern Mariana Islands, and the Philippines. We included veterans with diagnosed hypertension from October 1, 2016 to September 30, 2017 (fiscal year 2017) who were 18 to 85 years of age on October 1, 2016. Fiscal year 2017 was of particular interest, because it allowed us to establish pre-pandemic rates that could be compared with the general US population,[3,13] while many of the components of the Patient Protection and Affordable Care Act had been implemented (likely impacting general US population trends coming from the National Health and Nutrition Examination Survey[3]), particularly those that decreased the uninsured rate for Americans and made preventive care available without copayments, and before the 2016 election, which set in motion events that ultimately led to the elimination of the federal tax penalty for not having health

insurance (originally included in the Patient Protection and Affordable Care Act), which has had implications for insurance and access to care for Americans.

We included patients who used care at sites that could be matched to a geographic sector, and included sectors with ≥30 total patients with hypertension, because this provided sufficient sample size for stable within-sector comparisons. We excluded patients with end-stage renal disease, recent history of kidney transplant, pregnancy during the study year, or a recent non-acute inpatient admission, because these groups are excluded from hypertension quality assessment reporting.[14] All codes used to define eligibility and outcomes are specified in Data S1. This study was approved by the VA Greater Los Angeles Healthcare System Institutional Review Board, and a waiver of informed consent was granted.

Measures

Outcome

The outcome of hypertension control was defined as blood pressure <140/90 mm Hg for all patients 18 to 59 years of age and patients 60 to 85 years of age with diabetes, and <150/90 mm Hg for patients 60 to 85 years of age without diabetes, which is consistent with the Healthcare Effectiveness Data and Information Set measure for hypertension control.[14] For patients with multiple blood pressure readings, we used the measurement from their most recent outpatient visit during the study period.

Key Variables

Patients were assigned to a home ambulatory healthcare site, the primary location where they receive healthcare services, and the home site was then allocated to its geographic sector. We used sector as the primary geographic unit in this analysis. Sector was the geospatial unit of analysis, because it was the smallest area for which mapping shape files were available. Sectors represent clusters of adjacent counties within a VA submarket and are smaller than health system markets (similar to healthcare system catchment areas); we obtained sector identification from the Veteran Affairs Site Tracking database. We obtained age (on October 1, 2016), sex, and self-reported race and ethnicity from the Corporate Data Warehouse. During the year of the study, the VA electronic health record did not distinguish between biological sex and self-identified gender identity. Therefore, our measure of sex is a composite variable that primarily, but does not exclusively, represent biological sex. We included the following racial and ethnic groups in our analysis: AIAN, Asian, Black/African American (reported as Black hereafter), Hispanic, NHOPI, White, and unknown (unknown race is not reported separately, but these veterans were included in overall rate calculations). As measures of access to care (realized access,[15] specifically), we calculated the number of primary care visits each patient had during the year and the percentage of patients with hypertension who used the hypertension clinic (if there was one at the site), overall and by race and ethnicity. As a measure of socioeconomic status (SES), we merged on the Area Deprivation Index (ADI)[16] national ranking at the Census tract level of the patients' residence. For those missing ADI data due to missing address data or other reasons, we coded a missing level for ADI, and for those with complete ADI data, we ranked them by national quartile.

Statistical Analysis

Descriptive statistics were calculated for patient and sector characteristics. Unadjusted sector-level hypertension control rates were calculated overall and for each racial and ethnic group as the number of patients with hypertension control divided by the number of patients with hypertension in the sector from that group.

We applied the Institute of Medicine disparity definition to our analysis, that is, we define a disparity as the difference in outcomes between groups that are not attributable to differences in underlying healthcare needs and access.[17] Because the outcome measure already excludes those not eligible for hypertension quality measurement, thereby accounting for health status, and our patient population all has access to care, then in applying this disparity definition, we therefore adjusted only for age and sex in our primary analyses to examine disparities. We ran age- and sex-adjusted models for hypertension control for the sample overall, and for each racial and ethnic group included in our analyses. Age- and sex-adjusted sector-level hypertension control rates were estimated using a linear probability model.[18] For the model estimating adjusted overall hypertension control rates, we included indicator variables for age group (18–34, 35–49, 50–64, 65–74, and 75–85 years [reference group]) and sex (men were the reference group), and included fixed effects for sector. For adjusted race- and ethnicity-specific sector rates, we used a similar approach but fit separate models for each racial and ethnic group to allow age and sex effects to differ by race and ethnicity.

The goal of our main analysis, conducted within the Institute of Medicine disparities framework, was to estimate the extent of disparities by race and ethnicity. Having completed our main analysis and having found differences in hypertension control by race and ethnicity, we then conducted post hoc analyses with the intention to better understand the potential contribution of realized access and of SES to the variation in hypertension control by race and ethnicity from our main

analysis; we ran 2 additional sets of adjusted models. Our post hoc analyses added (1) access to care factors (number of primary care visits each patient had during the year and the percentage of patients with hypertension who used the hypertension clinic) and (2) SES (ADI) as covariates.

Choropleth maps of unadjusted sector-level hypertension control rates by race and ethnicity were created for states and territories using quintiles of the shared distribution of each racial and ethnic group's rates in ArcGIS 15.0. Global and local tests of spatial autocorrelation of unadjusted control rates were assessed using the Moran's I, which indicates the degree of similarity between neighboring values in sectors, weighted by an inverse Euclidian distance band allowing for non-adjacency between values and standardized by the variance.[19] In the global test of unadjusted rates, a positive Moran's I value approaching 1.0 indicates clustering of values across the entire data set. With the Anselin local Moran's I, we evaluated the degree of similarity between neighboring sectors on a local level, depicting clustering of low and high rates as well as outliers surrounded by concentrations of extreme rates in mapping illustrations. Statistical inference of both tests used a Monte Carlo simulation of the statistic across randomized permutations of the unadjusted rates in sectors.

Data management and analyses were conducted using SAS 9.4 and SAS EG 8.3. All statistical tests were 2-sided, and we used a type I error rate of 0.05.

RESULTS

A total of 1 619 414 veterans with hypertension from 519 sectors (1078 sites) were included in the analyses. Sample size and exclusions are presented in Figure S1. Our analysis included 4.71% women, 0.8% AIAN, 0.76% Asian, 20.33% Black, 0.7% NHOPI, 67.53% White, 5.53% Hispanic veterans with an overall mean±SD age of 65.6±10.6 years. Overall, among veterans with hypertension, 78% achieved hypertension control in fiscal year 2017. Compared with patients with uncontrolled hypertension, those with controlled hypertension had lower proportions of patients who were women, AIAN, Asian, Black, and NHOPI, and greater proportions of patients who were White, Hispanic, and ≥65 years of age (Table 1).

There was notable variation in hypertension control rates across sectors with a mean±SD of 78.3%±5.2% and range of 53.6% to 94.1% (unadjusted) (Table 2). Adjusting for age and sex produced similar estimates (<1 percentage point different than unadjusted rates) across all groups (Table 2). Mean sector-level hypertension control rates, unadjusted and age and sex adjusted, respectively, were lowest for Black veterans (72.5% and 72.5%, respectively), followed by AIAN veterans (75.4% and 75.4%, respectively), Hispanic veterans (76.8% and 77.2%, respectively), NHOPI veterans (78.0% and 77.9%, respectively), Asian veterans (78.4% and 78.9%, respectively), and highest for White veterans (79.6% and 79.6%, respectively). The widest range of rates were observed for Black veterans (unadjusted range, 44%–94%). In the post hoc analyses, adjusting for access to care and SES had minimal impacts on the estimates, with changes <0.5% increase or decrease from the age- and sex-adjusted mean rates (Table 2).

The descriptive choropleth maps in Figure S2 and Figures 1 through 3 illustrate hypertension control overall, and by race and ethnicity, respectively, across the United States and territories; the lightest color indicates the highest hypertension control, and the darker colors indicate worse hypertension control. In Figure 1A and 1B, hypertension control among White veterans showed wide variation in control levels, whereas Black veterans experienced predominantly lower levels of control, with a few exceptions mainly in the southern and eastern states. In Figure 2A and 2B, hypertension control among Hispanic veterans was exhibited in western and southern states, with a wide range of control rates in these states (range, 52.8%–97.5%), whereas AIAN veterans resided predominantly in western and northern states and most of Oklahoma, and exhibited a larger number of higher uncontrolled rates by geography than lower ones. Figure 3A and 3B show hypertension control among NHOPI and Asian veterans, both of which resided primarily in California, southern states, and US territories, and exhibited a mix of low and high rates.

The global test of spatial autocorrelation confirmed clustering in overall hypertension control rate with a Moran' index of 0.12 (P<0.001). The Anselin local Moran's I clustering and outlier analysis (Figure S3) identified outliers in the overall rate in the Pacific Northwest, the South and Southwest, and the North Atlantic, where low and high rates clustered together and were sometimes surrounded by contrasting outliers.

Because the overall rate was heavily influenced by control rates among White veterans, Figures 4 through 6 illustrate control rates by racial and ethnic group. Hypertension control for White veterans (Figure 4A) clustered in a comparable pattern to the overall rate, with clusters of low control (indicated by the pink color) mainly from Montana and Wyoming in the north to Washington and Oregon in the Pacific Northwest, Arizona in the Southwest, and Arkansas in the South. Outliers of high control in these (indicated by royal blue color) occurred in Portland, southern Oregon, Nevada, Salt Lake City, western New Mexico, northern Mississippi, and large portions of Nebraska and

Table 1. Sample Characteristics by Hypertension Control (n=1 619 414 People)

Variable	Hypertension not controlled (n=354 597)	Hypertension controlled (n=1 264 817)
Patient demographics		
Women	18 252 (5.15%)	57 981 (4.58%)
Men	336 345 (94.85%)	1 206 836 (95.42%)
Race and ethnicity		
American Indian/Alaska Native	3046 (0.86%)	9857 (0.78%)
Asian	2719 (0.77%)	9585 (0.76%)
Black	87 176 (24.58%)	242 110 (19.14%)
Hispanic	19 498 (5.50%)	70 072 (5.54%)
Native Hawaiian or Pacific Islander	2647 (0.75%)	8763 (0.69%)
Race and ethnicity unknown	5961 (1.68%)	15 764 (1.25%)
White	233 550 (65.86%)	908 666 (71.84%)
Age, y	63.87±11.34	66.1±10.28
Age group, y		
18–34	5897 (1.67%)	12 086 (0.95%)
35–49	35 862 (10.11%)	82 130 (6.49%)
50–64	114 758 (32.37%)	346 880 (27.43%)
65–74	142 679 (40.23%)	589 365 (46.60%)
75–85	55 401 (15.62%)	234 356 (18.52%)
Access to care		
Hypertension clinic at site of care, yes	249 462 (70.35%)	871 342 (68.89%)
Percentage of patients using hypertension clinic		
Overall	5.87±3.47	5.76±3.44
American Indian/Alaska Native	6.15±9.97	5.95±9.52
Asian	5.91±12.16	5.61±11.53
Black	7.6±5.61	7.55±5.80
Hispanic	5.91±7.07	5.78±7.23
Native Hawaiian or Pacific Islander	7.23±9.53	7.14±9.72
White	5.5±3.27	5.4±3.28
No. of primary care visits during the year	2.85±1.43	2.82±1.40
Socioeconomic status		
Area Deprivation Index	57.11±24.90	55.68±25.07
Sector location		
Census division		
East North Central	48 573 (13.70%)	177 970 (14.07%)
East South Central	32 058 (9.04%)	107 239 (8.48%)
Middle Atlantic	26 578 (7.50%)	116 033 (9.17%)
Mountain	27 220 (7.68%)	89 029 (7.04%)
New England	12 782 (3.60%)	43 431 (3.43%)
Pacific	34 287 (9.67%)	117 859 (9.32%)
South Atlantic	93 209 (26.29%)	319 056 (25.23%)
United States territories or another country (Philippines)	4909 (1.38%)	21 749 (1.72%)
West North Central	28 640 (8.08%)	99 854 (7.89%)
West South Central	46 341 (13.07%)	172 597 (13.65%)

Data are presented as n (percent) or mean±SD. Age was measured on October 1, 2016.

Kansas. Clusters of high control (indicated by sky blue color) emerged in the North Atlantic and Southern states of New York, Pennsylvania, New Jersey, Maryland, Virginia, West Virginia, and North Carolina, with outliers of low control occurring primarily in eastern Ohio, West Virginia, and upstate New York. Among

Table 2. Summary Statistics for Unadjusted and Adjusted Sector-Level Hypertension Control Rates

Group	No. of sectors	Mean±SD	Minimum	Maximum
Overall, unadjusted	519	78.33%±5.24%	53.55%	94.08%
Overall, age and sex adjusted	519	78.12%±5.13%	53.38%	93.59%
Overall, age, sex, and access adjusted	519	77.92%±5.15%	52.18%	92.41%
Overall, age, sex, access, and SES adjusted	519	77.89%±5.12%	52.94%	92.42%
AIAN, unadjusted	120	75.42%±5.94%	60.78%	90.32%
AIAN, age and sex adjusted	120	75.42%±6.07%	60.48%	89.93%
AIAN, age, sex, and access adjusted	120	75.38%±6.06%	60.88%	90.44%
AIAN, age, sex, access, and SES adjusted	120	75.38%±6.04%	60.95%	90.54%
Asian, unadjusted	50	78.36%±6.44%	65.00%	95.35%
Asian, age and sex adjusted	50	78.87%±6.61%	66.61%	97.08%
Asian, age, sex, and access adjusted	50	78.94%±6.62%	66.82%	96.29%
Asian, age, sex, access, and SES adjusted	50	79.20%±6.71%	67.59%	97.51%
Black, unadjusted	398	72.48%±6.66%	44.12%	94.00%
Black, age and sex adjusted	398	72.49%±6.57%	43.91%	93.90%
Black, age, sex, and access adjusted	398	72.40%±6.60%	43.08%	93.42%
Black, age, sex, access, and SES adjusted	398	72.38%±6.58%	43.61%	92.95%
Hispanic, unadjusted	279	76.84%±7.16%	52.78%	97.50%
Hispanic, age and sex adjusted	279	77.17%±7.21%	53.45%	98.23%
Hispanic, age, sex, and access adjusted	279	76.95%±7.23%	53.84%	96.90%
Hispanic, age, sex, access, and SES adjusted	279	76.80%±7.20%	53.46%	96.92%
NHOPI, unadjusted	80	78.00%±6.73%	60.53%	91.53%
NHOPI, age and sex adjusted	80	77.86%±6.63%	60.11%	92.41%
NHOPI, age, sex, and access adjusted	80	77.86%±6.62%	60.18%	92.36%
NHOPI, age, sex, access, and SES adjusted	80	78.22%±6.79%	60.99%	92.56%
White, unadjusted	519	79.64%±5.13%	60.55%	93.83%
White, age and sex adjusted	519	79.58%±5.06%	60.15%	93.68%
White, age, sex, and access adjusted	519	79.49%±5.08%	59.40%	92.93%
White, age, sex, access, and SES adjusted	519	79.47%±5.05%	59.83%	93.01%

Adjusted sector-level rates are model-based estimates from a linear probability model fit using patient-level data. Rates are reported only for sectors with at least 30 patients in a given group. AIAN indicates American Indian or Alaska Native; NHOPI, Native Hawaiian or other Pacific Islander; and SES, socioeconomic status.

Black veterans (Figure 4B), clustering of hypertension control mimicked some patterns among White veterans, with clusters of high control and adjacent outliers of low control in North Atlantic states. Clustering of low control among Black veterans (Figure 4B) was found mainly in parts of Washington, Oregon, Idaho, Arizona, New Mexico, Wyoming, Iowa, Missouri, and Arkansas, with outliers of high control in Eugene, Oregon, eastern Arizona, western New Mexico, as well as central Missouri and southern Arkansas. Among Hispanic veterans (Figure 5A), clustering of low control occurred primarily in Washington, Oregon, Idaho, Arizona, and Nebraska, with a large high control outlier area in eastern Wyoming into Nebraska, whereas high control clusters among Hispanic veterans emerged mainly in southern states, with low control outliers in Raleigh, North Carolina, Columbia, South Carolina, central Georgia, and a swath of eastern Texas. Among AIAN veterans (Figure 5B), there was clustering of low control in western states, with outliers of high control in southern Oregon and eastern Washington. Among NHOPI veterans (Figure 6A), there were clusters of low control in southwestern states and the California coast, with outliers of high control in central California and western Nevada; there were clusters of high control mainly in Florida, with sporadic low control outliers in southern states. Concentrations of high control among Asian veterans (Figure 6B) were identified only in Texas.

DISCUSSION

Among veterans with hypertension who used the VA for healthcare in 2017, a majority male population, we found that hypertension control varied by race and ethnicity, and geography. The differences in mean hypertension control rates between racial and ethnic groups was however notably smaller than the ranges

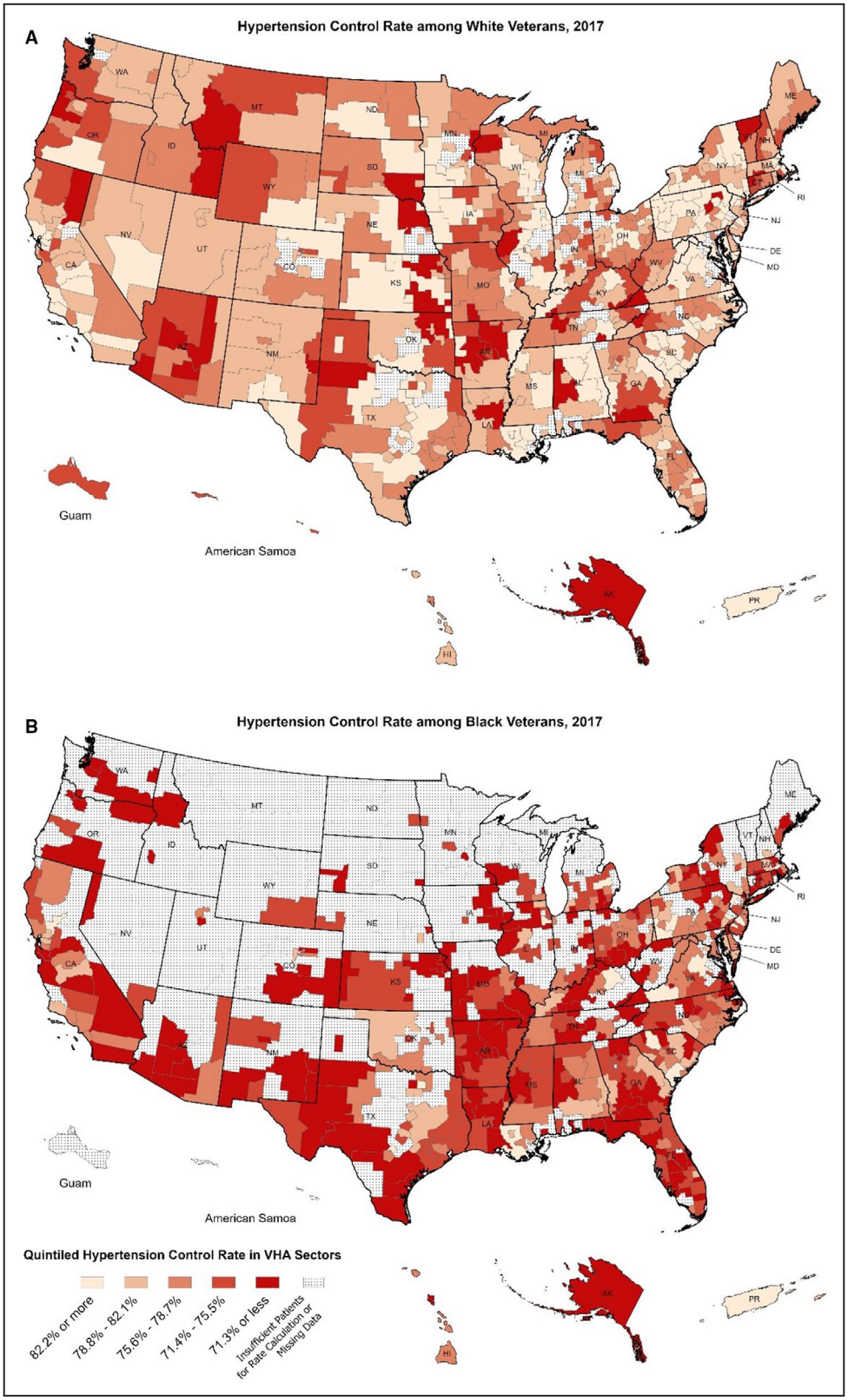

Figure 1. Hypertension control rate (unadjusted) by sector among White and Black veterans. Hypertension control rates ranged from 60.6% to 93.8% among White veterans (**A**) and 44.1% to 94.0% among Black veterans (**B**). Rates are reported only for sectors with at least 30 patients in a given group; the Northern Mariana Islands are not included in these maps due to insufficient sample. VHA indicates Veterans Health Affairs.

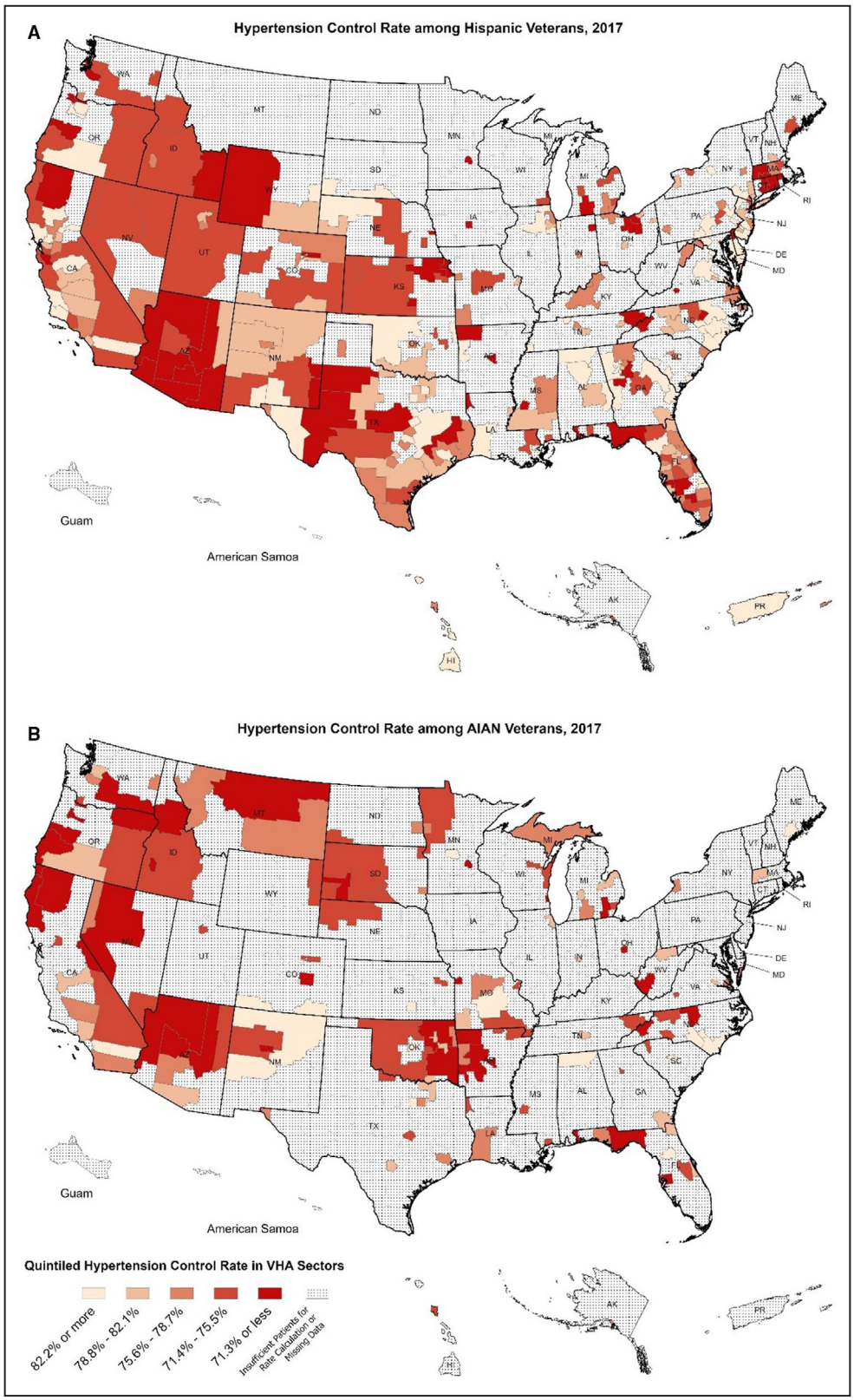

Figure 2. Hypertension control rate (unadjusted) by sector among Hispanic and AIAN veterans.
Hypertension control rates ranged from 52.8% to 97.5% among Hispanic veterans (**A**) and 60.8% to 90.3% among AIAN veterans (**B**). Rates are reported only for sectors with at least 30 patients in a given group; the Northern Mariana Islands are not included in these maps due to insufficient sample. AIAN indicates American Indian or Alaska Native; and VHA indicates Veterans Health Affairs.

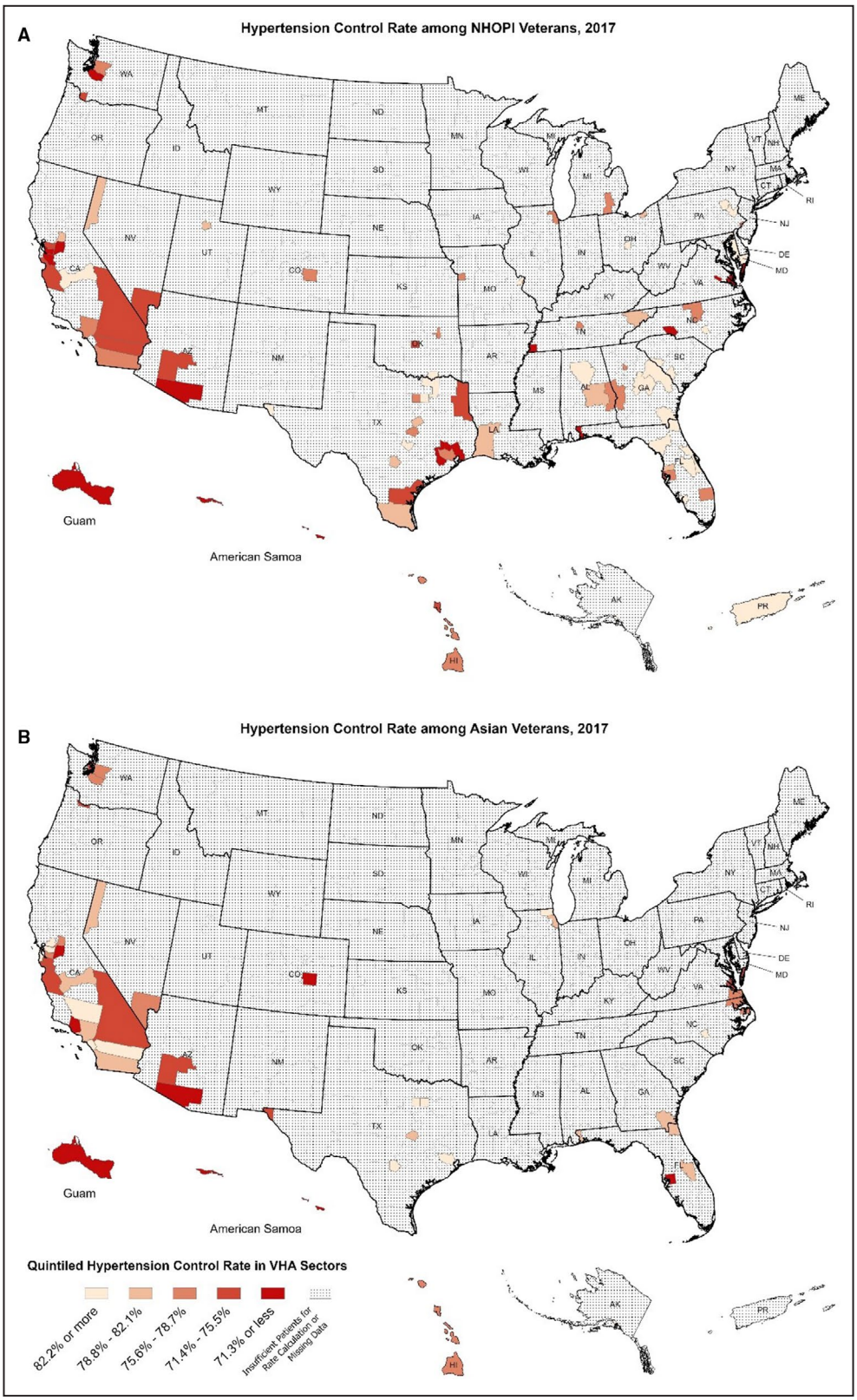

Figure 3. Hypertension control rate (unadjusted) by sector among NHOPI and Asian veterans. Hypertension control rates ranged from 60.5% to 91.5% among NHOPI veterans (**A**) and 65.0% to 95.4% among Asian veterans (**B**). Rates are reported only for sectors with at least 30 patients in a given group; the Northern Mariana Islands are not included in these maps due to insufficient sample. NHOPI indicates Native Hawaiian or other Pacific Islander; and VHA, Veterans Health Affairs.

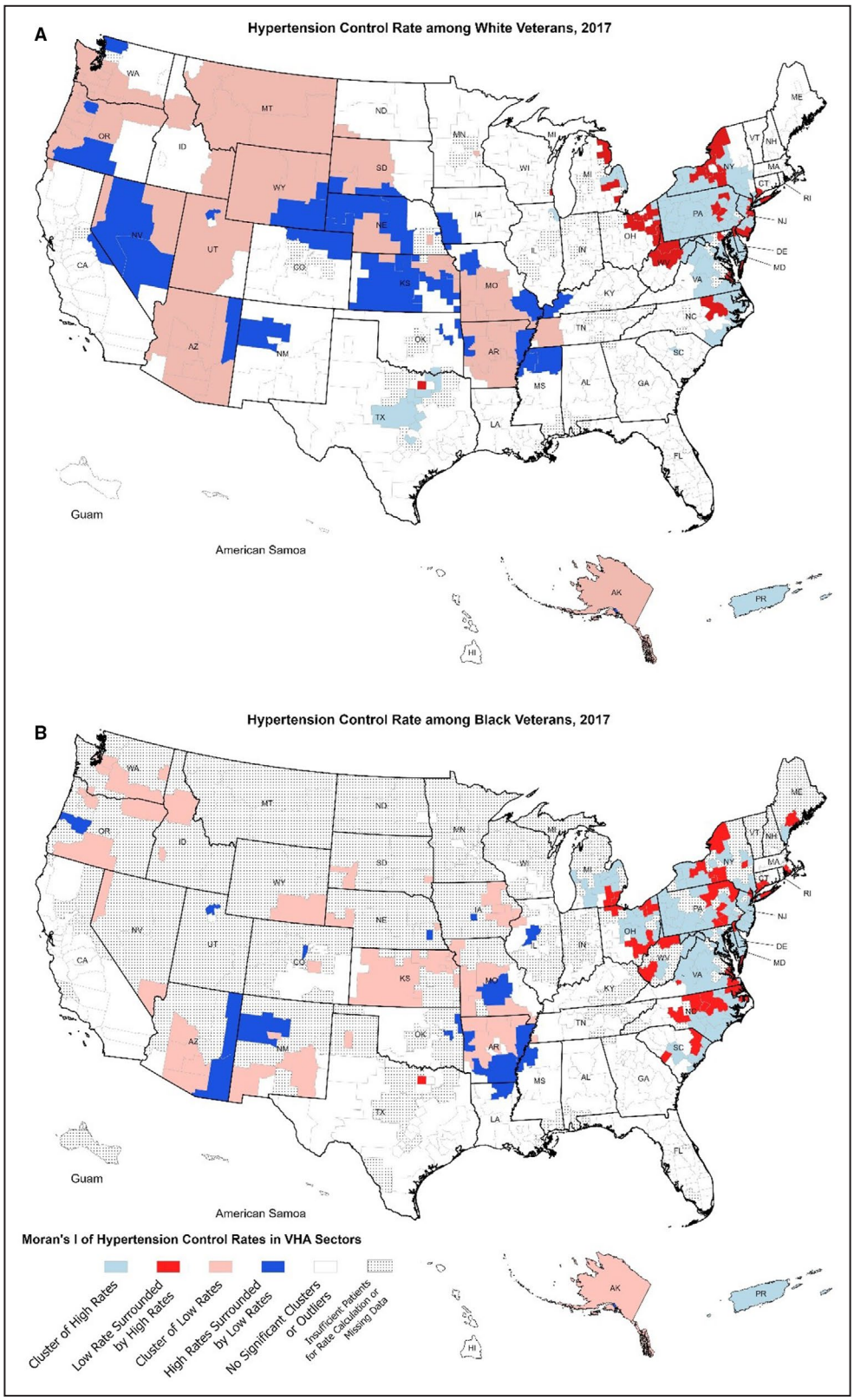

Figure 4. Moran's I map of hypertension control by sector among White and Black veterans. Hypertension control rates ranged from 60.6% to 93.8% among White veterans (**A**) and 44.1% to 94.0% among Black veterans (**B**). Rates are reported only for sectors with at least 30 patients in a given group; the Northern Mariana Islands are not included in these maps due to insufficient sample. VHA indicates Veterans Health Affairs.

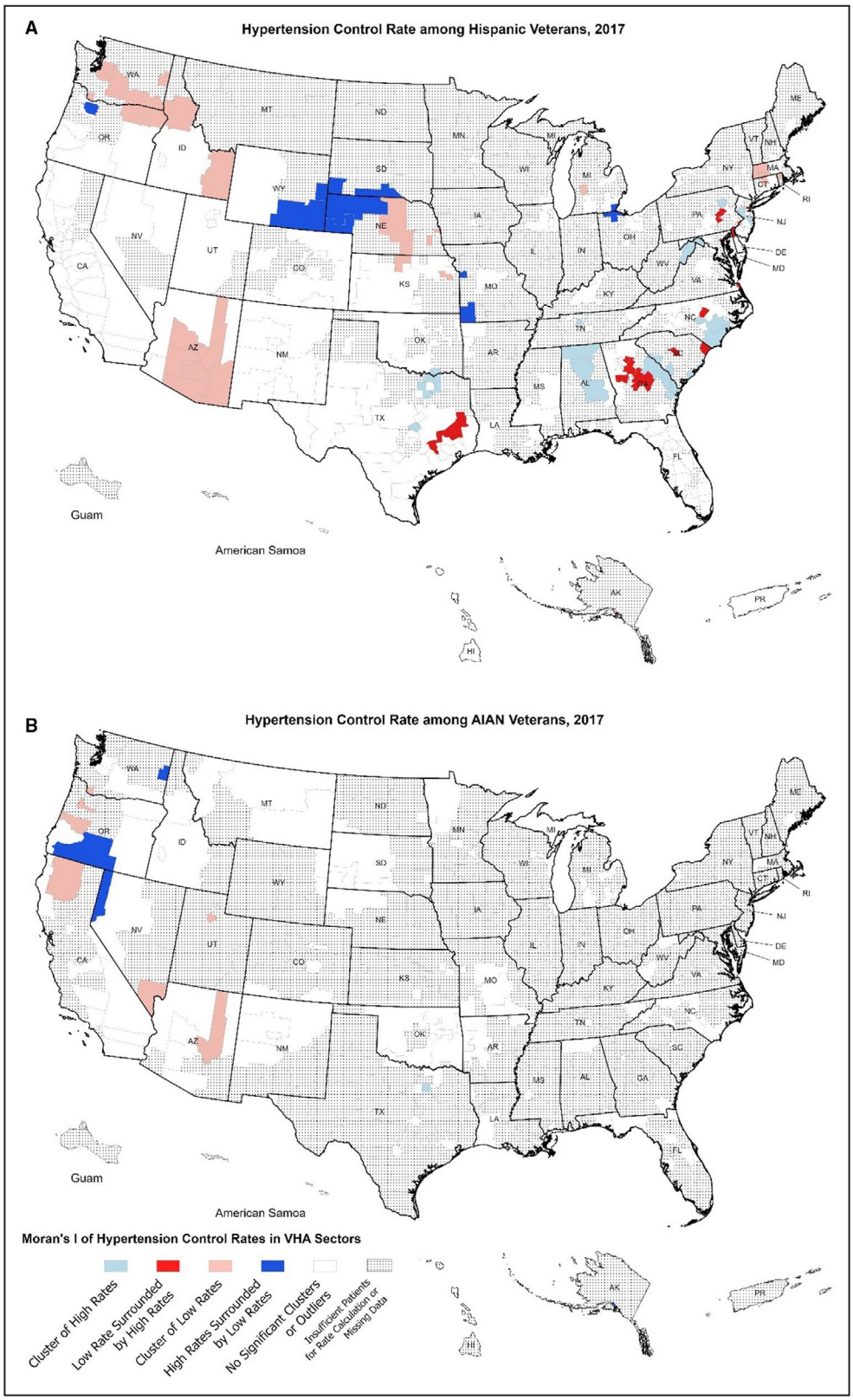

Figure 5. Moran's I map of hypertension control by sector among Hispanic and AIAN veterans. Hypertension control rates ranged from 52.8% to 97.5% among Hispanic veterans (**A**) and 60.8% to 90.3% among AIAN veterans (**B**). Rates are reported only for sectors with at least 30 patients in a given group; the Northern Mariana Islands are not included in these maps due to insufficient sample. AIAN indicates American Indian or Alaska Nativ; and VHA, Veterans Health Affairs.

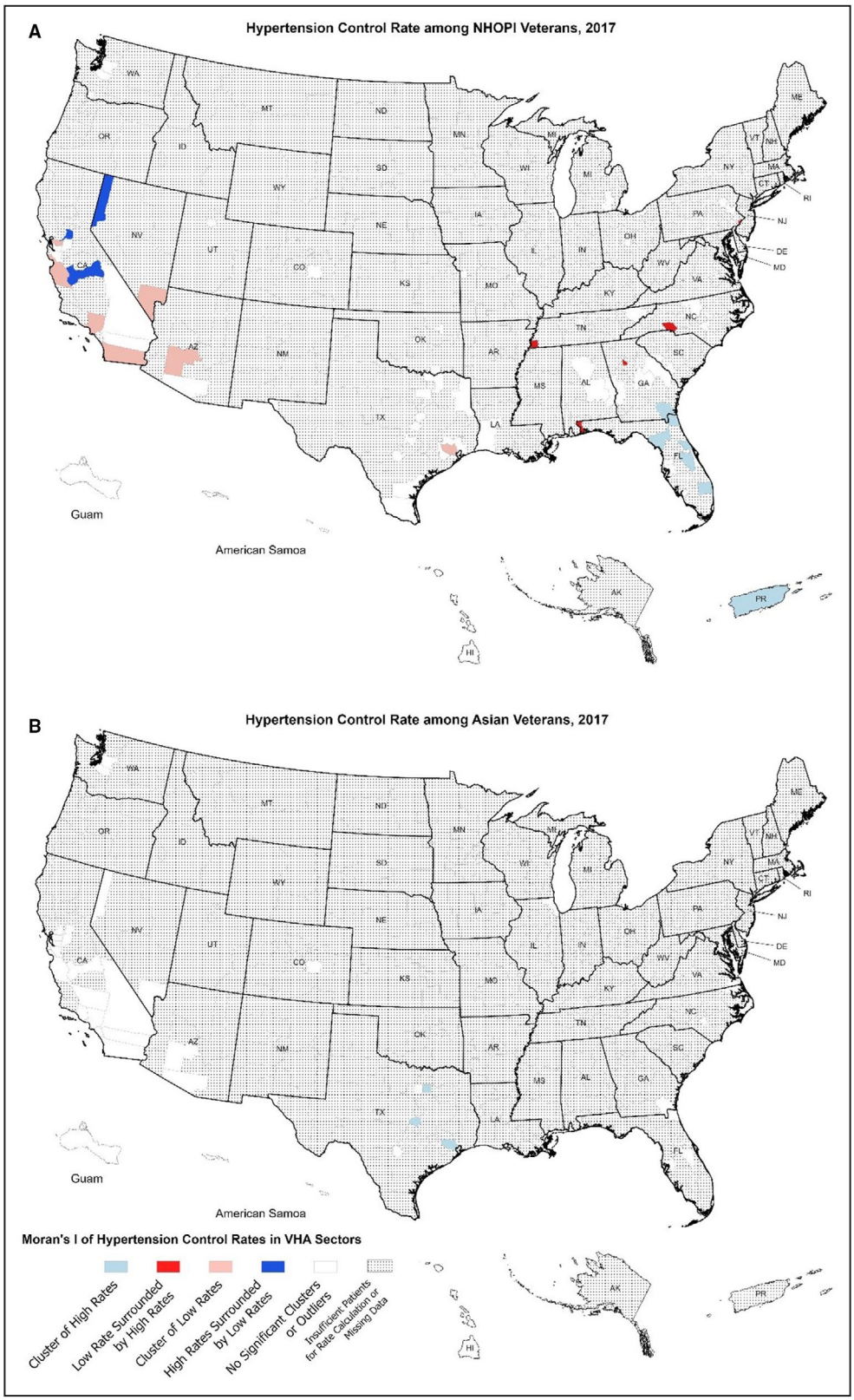

Figure 6. Moran's I map of hypertension control by sector among NHOPI and Asian veterans. Hypertension control rates ranged from 60.5% to 91.5% among NHOPI veterans (**A**) and 65.0% to 95.4% among Asian veterans (**B**). Rates are reported only for sectors with at least 30 patients in a given group; the Northern Mariana Islands are not included in these maps due to insufficient sample. NHOPI indicates Native Hawaiian or other Pacific Islander; VHA indicates Veterans Health Affairs.

in rates observed within groups. Hypertension control was lowest among Black veterans and highest among White veterans. There was geographic variation in hypertension control by race and ethnicity; for example we observed high control for White veterans but low control for Black veterans in the Portland area and in most of the southern United States.

Although racial and ethnic disparities persisted in hypertension control, the VA's overall hypertension control rates outperformed national averages for the overall US general population,[3] as well as for Americans with insurance (Medicare, Medicaid, or commercial insurance) in 2017.[14] Racial and ethnic disparities are generally smaller in the VA compared with the US general population,[20,21] which may in part be attributable to transformation of VA healthcare starting in 1995, which emphasized healthcare quality management and primary care access,[22] and plausibly contributed to hypertension control rates among VA users increasing from 45.7% in 2000 to 76.3% in 2010.[23] However, improvements in hypertension control previously observed during 2000 to 2010 have largely plateaued, because we observed only a 2% higher overall control rate compared with historical 2010 rates.[23] These findings suggest that having access to healthcare likely leads to greater hypertension control; however, healthcare access is necessary, though not sufficient, to close gaps in racial and ethnic disparities in hypertension control. Closing gaps in disparities may require healthcare systems to examine racial and ethnic inequities in healthcare quality both within and between facilities. Healthcare systems and providers can also consider ways to address patients' social needs, such as assessing social needs (eg, VA Assessing Circumstances and Offering Resources for Needs [ACORN] screener[24]) and partnerships with community resources to address patients' social needs.

Our finding of lower hypertension control rates among Black individuals compared with White individuals is consistent with previous studies in both the VA and the US general population.[25,26] However, we also found that Black veterans had the largest variation in hypertension control rates, including areas achieving hypertension control among nearly all Black veterans (94%), comparable to the overall maximum control rate observed. This indicates that some areas have achieved excellent control rates. It will be important to understand contributors, both related and external to the VA, to these positive outliers. Within the VA, this may include site-specific quality improvement or equity initiatives, fully staffed patient-centered medical home teams, or other healthcare innovations that are contributing to their success.[27] Outside of the VA, social determinants of health, including social context and connectedness, socioeconomic factors such as income, and built environment factors such as access to healthy foods, have been found to be associated with hypertension control.[28–30] We found that within this patient population with access to care, adjusting for age, sex, access factors, and SES had little impact on our estimates of hypertension control rates.

Importantly, although few national studies in the US general population have characterized hypertension control for smaller-sized racial and ethnic groups, we found that AIAN and NHOPI veterans had the second and fourth lowest mean hypertension control rates. Our study is among the first national studies of hypertension control among AIAN individuals who have not had their data reported in the large nationally representative reports on hypertension control that have used National Health and Nutrition Examination Survey data.[3,13] The few existing studies have focused on specific tribes and members residing on or near reservations and may not represent AIAN people residing in urban areas (which comprise approximately half of the AIAN veteran population[12]) or other people from the many tribes in the United States. Data for AIAN people are sparse, and hypertension prevalence and control rates have been found to vary by tribe, with some being notably high, for example Northern Arapaho and Eastern Shoshone on the Wind River Indian Reservation in Wyoming (hypertension prevalence 75%),[31] compared with 2 tribes in Oklahoma (prevalence 48%).[32] In our national sample of AIAN veterans, which includes a heterogeneous mix of tribal affiliation and geographic residence, we found that AIAN veterans may have worse hypertension control compared with other racial and ethnic groups, and they had the lowest maximum rate observed of any group. However, there were areas where AIAN veterans had higher control than White and Hispanic veterans in southern Arizona and northern New Mexico, which include reservations. Prior VA research on mortality found that for AIAN veterans, residential factors (eg, AIAN segregation), and geography (eg, residing on or near AIAN reservations) mediated AIAN–White mortality disparities.[20] It is possible that in our study, AIAN veterans living in these areas may benefit from living near reservations that could provide health benefits, including supporting hypertension control. More research is needed to understand where the greatest needs lie for improving AIAN hypertension control both for the veteran and civilian segments of the AIAN population.

Our study adds to the limited research on hypertension control among the NHOPI population. Studies that do include NHOPI individuals often combine NHOPI and Asian populations.[33] Combining these groups may mask disparities experienced by the NHOPI population. Limited studies that have disaggregated NHOPI from Asian individuals suggest worse hypertension control and cardiometabolic outcomes among NHOPI people.[33,34] Our sample of veterans also reflects this difference between NHOPI and Asian veterans.

Hispanic veterans had mean hypertension control rates slightly lower than the overall rates, but interestingly they had the highest maximum rate (97.5% unadjusted) observed for any group in a sector in northern New Jersey. Our geographic analysis identified areas with high control among Hispanic veterans, including New Jersey and Florida, where Hispanic (and White) veterans had high control, but Black veterans had worse hypertension control rates. Such sites may offer useful case studies in improving hypertension control and understanding why, within the same geographic sector, some racial and ethnic minoritized groups experience disparities whereas others do not. Our findings of similar or better hypertension control among Hispanic veterans compared with the overall rates contrast with disparities observed among Hispanic people in the US general population. We attribute these differing trends to better access to care for Hispanic veterans than Hispanic individuals in the general US population, and possibly the healthy soldier effect.[35]

Asian veterans had mean sector rates similar to the overall and White veteran rates, but notably, their minimum hypertension control rate was the highest of all groups (65% unadjusted). Asian veterans were the least geographically dispersed racial and ethnic group we reported on, with only 50 (of 519) sectors having at least 30 Asian patients with hypertension.

We did not see a strong pattern of low control rates in the stroke belt. We hypothesize that the absence of a stroke-belt pattern may be evidence of the impact of access to care in controlling hypertension (and thereby reducing stroke risk). We did not observe a clear pattern of control in states where Medicaid has and has not been expanded as other studies have, of which non-expansion states are heavily concentrated in the South.[1,2] But once again, although insurance status is an important factor in hypertension control,[25] veterans have access to care that the general US population may not have.

Geographic findings may have implications for closing the gap in racial and ethnic disparities; some facilities in some regions may be underperforming for all patients, whereas others have disparities. Our geographic analysis allowed us to further characterize racial and ethnic disparities, including identifying outlier sectors, such as regions with high quality for all racial and ethnic groups, and areas with disparities for some but not all groups, and identifying areas that may have factors external to the VA that influence hypertension control (eg, regional social policies or social determinants of health). Although we did not formally test racial and ethnic differences by sector for minoritized versus White veteran groups, the maps qualitatively suggest that spatial patterning differs by race and ethnicity. Future research could measure the extent of racial and ethnic disparities in these areas and characterize the drivers behind these differences beyond age, sex, access to care, and area-level SES. Geographic analyses also inform where and for whom interventions should be focused.

Strengths of our study include use of a large, national, racially and ethnically diverse sample that included most veteran VA healthcare users with diagnosed hypertension. This allowed us to examine racial groups that are often excluded in other national studies due to small sample size, including AIAN and NHOPI populations (although there may be limited generalizability between the AIAN and NHOPI individuals in the veteran population with the US general population). Given the importance of healthcare access to hypertension control, another strength is that our study allowed us to examine disparities beyond the differential effects of access, because the VA user population has access to healthcare. Also, our data provide a pre-pandemic benchmark that will be useful for later research examining impacts of the COVID-19 pandemic on chronic disease management. Study limitations include limited generalizability to the general US population, where healthcare access is subject to greater geographic variation from Medicaid expansion and other state policies, and where demographic composition differs, especially for sex and gender. The VA generally tends to have higher quality of care relative to other US providers,[36] and this study represents a population that has access to healthcare. Another limitation is that we did not examine maintenance of hypertension control over repeat visits, and some patients would have had their blood pressure measured less often than others who had more visits, nor did we control for more detailed information about the use of hypertension medications or of VA specialty clinics or services (eg, VA hypertension clinics, weight management programs). Additionally, we included ADI as a community-level SES measure, but acknowledge that individual-level SES also affects hypertension control. ADI may also be susceptible to ecological fallacy. Because the study population was predominantly male, we were unable to examine sex differences in hypertension across race and ethnicity and geography. Finally, we did not assess hypertension control rates for AIAN, Asian, or Hispanic subgroups; there is likely heterogeneity within these groups.

PERSPECTIVES

Although US veterans had higher hypertension control compared with the general US population in 2017 overall, racial and ethnic disparities persisted, particularly for Black veterans. These findings indicate that even in a nationally integrated learning health system with minimized access barriers, more work is needed

to reduce disparities in hypertension control. Improving hypertension control and reducing disparities in hypertension control could ultimately reduce racial and ethnic disparities in stroke and cardiovascular disease outcomes. Geographic variation in hypertension control identified clusters of geographic areas with low hypertension control rates in which to implement equity-focused quality improvement activities.

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Disclosures

None.

Supplemental Material

Data S1
Figures S1–S3

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