

HEALTH DISPARITIES: DIFFERENCES IN VETERAN AND NON-VETERAN POPULATIONS USING GENERATIVE AI

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ABSTRACT

Introduction: This study investigated self-reported health status, health screenings, vision problems, and vaccination rates among veteran and non-veteran groups to uncover health disparities that are critical for informed health system planning for veteran populations.

Methods: Using public-use data from the National Health Interview Survey (2015-2018), this study adopts an ecologic cross-sectional approach to conduct an in-depth analysis and visualization of the data assisted by Generative AI, specifically ChatGPT-4. This integration of advanced AI tools with traditional epidemiological principles enables systematic data management, analysis, and visualization, offering a nuanced understanding of health dynamics across demographic segments and highlighting disparities essential for veteran health system planning.

Findings: Disparities in self-reports of health outcomes, health screenings, vision problems, and vaccination rates were identified, emphasizing the need for targeted interventions and policy adjustments.

Conclusion: Insights from this study could inform health system planning, using epidemiological data assessment to suggest enhancements for veteran healthcare delivery. These findings highlight the value of integrating Generative AI with epidemiological analysis in shaping public health policy and health planning.

KEYWORDS

Descriptive Epidemiology, Ecologic Study, Generative AI, Health Disparities, Veteran and Non-veteran Populations, National Health Interview Survey, 2015-2018.

1. INTRODUCTION

Historical analysis [1] highlights the ongoing struggle between public health reformers and entrenched private interests within the American hospital system. Despite the Hill-Burton Act of 1946 vision for community-based healthcare, resistance from local entities and adherence to traditional acute-care models by the medical community have redirected health planning towards market-driven approaches instead of the envisioned community-centric health system.

This evolution necessitated a reevaluation of the impact of systems for public health and medical care on health outcomes, emphasizing the critical role of public health initiatives in enhancing disease prevention and healthcare delivery [2]. Although public health efforts and clinical preventive services have extended life and curtailed mortality, systemic impediments like inadequate healthcare coverage continue to perpetuate public health outcome inequities across populations.

The Healthy People initiative of the US Department of Health and Human Services [3] has as one of its 2030 goals [3] reducing health disparities with a focus on socioeconomic, racial, and disability factors. Additionally, healthcare executives, guided by the American College of Healthcare Executives' Code of Ethics [4], are urged to champion healthcare access for all. The presence of healthcare services within a region, while necessary, does not automatically equate to accessible care for all its inhabitants. Factors like minority status, socioeconomic conditions, educational attainment, rural settings, and cultural differences play significant roles in determining healthcare access. These factors are primarily responsible for the observed variations in health service utilization and outcomes[4].

This study explores a public-use dataset to examine further veteran and non-veteran populations on the topics of overall health status, health screenings, vision problems, and vaccination services. This exercise sought to identify if health disparities existed between and within the study groups. Then, we offer a reflection on the findings for health system planning efforts.

2. METHODS

Investigation Question

Are there differences in self-reported health status, health screenings, vision problems, and vaccination among veterans and non-veterans during the study period?

Study Design Overview

Our study adopts an ecologic cross-sectional approach [4-8] for a descriptive epidemiologic assessment of aggregate data from the 2015-2018 National Health Interview Survey (NHIS), facilitated by the National Center for Health Statistics (NCHS) at the US Centers for Disease Control and Prevention (CDC). This study design was selected because it was appropriate for the investigation question and the available dataset. Through a collaborative Interagency Agreement (IAA) between the US Department of Veterans Affairs (VHA) and the CDC/NCHS, these federal agencies, jointly, investigated health outcomes and behaviors among veterans. This effort has been pivotal in generating detailed data tables for comparing health outcomes between veterans and non-veterans, across epidemiologically relevant data fields [9,10].

Population

The target population for NHIS included the civilian noninstitutionalized population of the United States. Persons excluded were patients in long-term care institutions (e.g., nursing homes for the elderly, hospitals for the chronically ill or physically or intellectually disabled, and wards for abused or neglected children); inmates of correctional facilities (e.g., prisons or jails, juvenile detention centers, and halfway houses); active-duty Armed Forces personnel (although their civilian family members are included); homeless persons; and U.S. nationals living in foreign countries. Sampling and interviewing were continuous throughout each year. The sampling plan followed an area probability design to permit the representative sampling of households and noninstitutional group quarters (e.g., college dormitories). During the data collection period (2015-2018), the sample size for Veterans interviewed was 11,935 (population weight: 85,485; 9%) and the sample size for nonveterans interviewed was 104,298 (population weight: 864,631; 91%) [9]

Detailed Data Fields of Interest

This study centered on several key health outcome variables (including crude and age-adjusted percentages with 95% confidence intervals) as outlined by the NHIS [9]:

1. **Overall Health Status:** Based on survey responses to general health conditions, categorized as "Excellent," "Very Good," "Good," "Fair," and "Poor." For clarity, "Excellent" and "Very Good" are combined, as are "Fair" and "Poor."
2. **Health Screenings:** Addition of health screenings based on respondents' reports of having blood pressure, cholesterol, and blood glucose checks by healthcare professionals within the past 12 months, highlighting the importance of routine health checks in assessing veterans' health status compared to non-veterans.
3. **Vision Status:** Evaluated through survey questions about visual difficulties, even with corrective measures, and queries on blindness. To maintain comparability, respondents who are blind, a condition precluding military service eligibility, were excluded from the vision analysis.
4. **Receipt of Vaccinations:** Encompassing data on the receipt of influenza, pneumococcal, and shingles vaccines, based on specific survey questions regarding vaccination within the past 12 months or ever, respectively, with particular emphasis on age-specific vaccination recommendations (such as tetanus in the past decade).

Analytic Methods and Framework

Employing the sophisticated capabilities of Generative AI, specifically ChatGPT-4 (Data Analyst), the study analyzed and visualized self-reported health survey data from the NHIS dataset. This approach enabled an in-depth examination of health disparities between veterans and non-veterans, providing detailed insights into population health dynamics.

- **Data Comprehension and Management:** Initiating with a comprehensive review of the NHIS dataset, our analysis covered overall health status, vision status, vaccination receipt, and included health screenings. This ensured that our data management practices were in line with epidemiological standards for case definitions and consistency.
- **Data Analysis and Visualization:** By leveraging Generative AI, we developed descriptive visualizations, such as combined bar charts, to illustrate the distribution of health statuses and screening outcomes across different population segments. Age-adjusted comparisons are particularly vital for revealing epidemiological patterns and informing healthcare policy.
- **Integration of Descriptive Epidemiology Principles:** This methodology, rooted in descriptive epidemiology, allowed for identification and documentation of health conditions. Analyzing data with an emphasis on person and place characteristics for the data set, we highlighted demographic and geographical health disparities. The interactive and iterative nature of ChatGPT-4's analysis process underlines the significant potential of Generative AI to refine and enhance epidemiological research.
- **Collaborative Analytic Process:** The study demonstrated a successful blend of human expertise and AI innovation. This allowed for the customization of data visualizations to specific epidemiological inquiries, offering iterative enhancements based on expert review, which showcases the improved quality and efficiency achievable with AI-supported epidemiological investigations.

Integrating Generative AI with traditional epidemiological methods has provided a comprehensive exploration of health disparities between veterans and non-veterans. The insights

gained from this collaborative effort are set to influence health system planning substantially, using epidemiological data assessments to inform and enhance healthcare delivery for veterans.

3. FINDINGS

The National Health Interview Survey (NHIS) facilitated a comprehensive examination of health disparities between veterans and non-veterans, revealing critical insights across health status, screenings, vision issues, and vaccination rates. Non-veterans generally reported more favorable perceptions of their health (excellent/very good) compared to veterans, highlighting a discrepancy that was especially pronounced across race and ethnic groups as well as geographical regions. Conversely, veterans demonstrated a greater propensity for engaging in preventive health measures, as evidenced by higher self-reported rates of health screenings (blood pressure, cholesterol, and blood glucose checks), reflecting a proactive stance towards population health management within this cohort.

Notably, vision challenges were more prevalent among veterans, with disparities intensifying with age, indicating potential age-related complications that warrant targeted healthcare interventions. Furthermore, vaccination rates (influenza, pneumococcal, and shingles) were substantially higher among veterans, possibly indicative of more effective health service access or utilization strategies within veteran communities.

Table 1 (below) showed self-reports of health status. In this survey instrument for health self-report: excellent/very good, non-veterans rated themselves higher than veterans for all selected characteristics. For health self-report: good or fair, veterans rated themselves higher compared to non-veterans. Interestingly, this was especially evident in the race and Hispanic origin response characteristic and in residence and region characteristic between Veterans and non-veterans.

Table 1 : Age-adjusted percent distribution (with 95% confidence intervals) of respondent - assessed self-reported health among adults aged 20 and over, by Veteran and Non-veteran status with other selected characteristics : United States, 2015- 2018

Selected Characteristics	Veteran (age-adjusted %)			Nonveteran (age-adjusted %)		
	Excellent/Very Good	Good	Fair/Poor	Excellent/Very Good	Good	Fair/Poor
Sex						
Male	55.6 (53.7-57.5)	30.2 (28.4-32.1)	14.1 (13.1-15.3)	62.3 (61.7-63.0)	25.7 (25.2-26.3)	11.9 (11.5-12.4)
Female	52.4 (48.3-56.5)	33.0 (29.3-36.8)	14.6 (11.8-17.8)	60.4 (59.8-61.0)	26.9 (26.4-27.4)	12.7 (12.4-13.1)
Age (years)						
20-34	65.4 (61.0-69.7)	26.0 (22.0-30.3)	8.6 (6.4-11.1)	73.9 (73.1-74.7)	20.8 (20.1-21.6)	5.3 (4.9-5.6)
35-49	56.0 (52.8-59.1)	32.8 (29.8-35.8)	11.3 (9.4-13.4)	64.5 (63.7-65.3)	25.8 (25.1-26.5)	9.7 (9.2-10.2)
50-64	48.2 (45.6-50.7)	30.5 (28.3-32.7)	21.4 (19.4-23.4)	53.1 (52.3-53.9)	29.4 (28.6-30.1)	17.5 (16.9-18.1)
65-79	47.4 (45.5-49.3)	33.0 (31.3-34.8)	19.6 (18.1-21.1)	48.4 (47.5-49.3)	32.1 (31.2-32.9)	19.5 (18.8-20.3)
80 and over	47.4 (45.5-49.3)	33.0 (31.3-34.8)	19.6 (18.1-21.1)	48.4 (47.5-49.3)	32.1 (31.2-32.9)	19.5 (18.8-20.3)
Race and Hispanic origin						
Hispanic	48.3 (41.8-54.8)	37.6 (31.2-44.2)	14.2 (10.8-18.1)	53.0 (51.8-54.1)	30.1 (29.1-31.1)	16.9 (16.1-17.8)
Non-Hispanic white	58.7 (56.8-60.6)	27.7 (26.0-29.4)	13.6 (12.4-14.8)	65.0 (64.5-65.6)	24.4 (24.0-24.9)	10.5 (10.2-10.9)
Non-Hispanic black	44.8 (40.2-49.3)	36.5 (32.2-41.0)	18.7 (15.9-21.9)	51.8 (50.5-53.0)	30.1 (29.0-31.2)	18.1 (17.3-19.0)
Non-Hispanic Asian	55.2 (43.5-66.5)	31.4 (21.5-42.6)	13.4 (7.6-21.4)	64.7 (63.0-66.3)	25.4 (23.9-26.9)	9.9 (9.0-10.9)
Education						
High school diploma or GED4 or less	44.4 (40.8-48.0)	37.1 (33.7-40.7)	18.5 (16.2-21.0)	46.9 (46.1-47.7)	33.2 (32.5-33.8)	20.0 (19.4-20.5)
Some college	50.3 (47.9-52.8)	32.3 (30.0-34.6)	17.4 (15.8-19.1)	58.6 (57.8-59.4)	28.6 (27.9-29.3)	12.8 (12.3-13.4)
Bachelor's degree or higher	66.0 (63.2-68.7)	25.3 (22.8-27.8)	8.8 (7.5-10.2)	74.2 (73.6-74.8)	20.1 (19.5-20.7)	5.7 (5.4-6.1)
Current employment						
Employed	63.2 (61.1-65.2)	29.6 (27.6-31.6)	7.3 (6.3-8.4)	69.2 (68.5-69.8)	24.8 (24.2-25.3)	6.1 (5.7-6.4)
Not employed and looking for work	46.2 (38.1-54.4)	33.4 (26.6-40.8)	20.4 (14.0-28.3)	53.6 (51.0-56.2)	33.0 (30.5-35.6)	13.4 (11.7-15.2)
Not employed and not looking for work	36.6 (32.5-40.8)	31.7 (27.8-35.8)	31.7 (28.0-35.6)	47.0 (46.0-48.0)	28.1 (27.3-29.0)	24.9 (24.1-25.7)
Marital status						
Married/living with partner	57.2 (55.0-59.4)	30.2 (28.2-32.3)	12.6 (11.4-13.9)	64.5 (63.9-65.0)	25.3 (24.8-25.7)	10.2 (9.9-10.6)
Widowed, divorced, or separated	46.8 (42.7-50.9)	32.2 (28.3-36.2)	21.0 (18.1-24.3)	52.6 (51.3-53.8)	30.5 (29.3-31.6)	17.0 (16.2-17.8)
Never married	53.6 (49.7-57.6)	29.4 (26.0-33.1)	16.9 (14.0-20.2)	54.0 (53.0-55.1)	28.8 (27.8-29.7)	17.2 (16.4-18.1)
Residence						
Urban	55.9 (54.0-57.8)	30.3 (28.6-32.1)	13.8 (12.7-15.0)	62.4 (61.9-62.9)	25.9 (25.5-26.3)	11.7 (11.4-12.0)
Rural	51.2 (47.2-55.2)	31.8 (28.0-35.8)	17.0 (14.4-19.8)	54.6 (53.1-56.2)	29.6 (28.5-30.7)	15.8 (14.9-16.8)
Region						
Northeast	58.5 (53.8-63.1)	31.0 (26.5-35.8)	10.5 (8.1-13.3)	63.9 (62.8-64.9)	25.1 (24.2-26.0)	11.1 (10.4-11.7)
Midwest	54.0 (50.3-57.7)	30.9 (27.7-34.3)	15.1 (12.9-17.5)	61.4 (60.4-62.4)	27.4 (26.6-28.3)	11.1 (10.6-11.7)
South	54.5 (51.8-57.2)	30.4 (27.9-33.0)	15.1 (13.5-16.7)	59.8 (59.0-60.6)	26.2 (25.6-26.9)	14.0 (13.5-14.5)
West	55.9 (52.4-59.3)	29.7 (26.7-32.9)	14.4 (12.2-16.7)	62.0 (61.1-62.9)	26.4 (25.6-27.2)	11.6 (11.1-12.2)

Adapted from: NCHS, National Health Interview Survey, 2015-2018, Table 1a.

Table 2: Crude and age-adjusted percentages (with 95% confidence intervals) of selected health screenings among adults aged 20 and over, by veteran and Non-veteran status with other selected characteristics : United States, 2015 -2018

Selected Characteristic	Veteran (crude)			Veteran (age-adjusted)			Nonveteran (age-adjusted)		
	Blood pressure check	Cholesterol check	Blood glucose check	Blood pressure check	Cholesterol check	Blood glucose check	Blood pressure check	Cholesterol check	Blood glucose check
Overall	91.1 (90.3-91.8)	81.8 (80.8-82.7)	63.8 (62.6-65.0)	86.9 (85.4-88.4)	71.3 (69.7-72.9)	54.3 (52.6-56.0)	83.5 (83.1-83.9)	65.8 (65.3-66.2)	48.1 (47.6-48.6)
Sex									
Male	91.1 (90.2-91.8)	82.4 (81.3-83.4)	64.4 (63.1-65.6)	86.0 (84.2-87.6)	70.7 (68.9-72.5)	53.7 (51.9-55.6)	78.1 (77.5-78.7)	61.9 (61.3-62.5)	44.9 (44.2-45.5)
Female	91.2 (88.5-93.5)	75.3 (71.6-78.8)	57.6 (53.5-61.6)	91.2 (88.4-93.6)	73.4 (69.5-77.1)	56.2 (52.0-60.4)	88.3 (87.9-88.8)	69.4 (68.8-69.9)	51.2 (50.6-51.8)
Age (years)									
20-34	79.9 (75.3-84.1)	52.0 (47.4-56.5)	35.0 (30.8-39.4)	79.9 (75.3-84.1)	52.0 (47.4-56.5)	35.0 (30.8-39.4)	74.7 (73.9-75.6)	44.8 (43.9-45.7)	29.6 (28.7-30.4)
35-49	86.8 (84.5-88.9)	71.1 (68.3-73.9)	54.7 (51.5-57.9)	86.8 (84.5-88.9)	71.1 (68.3-73.9)	54.7 (51.5-57.9)	81.4 (80.7-82.0)	63.4 (62.6-64.2)	45.7 (44.8-46.6)
50-64	89.6 (88.0-91.0)	81.1 (79.1-83.0)	65.3 (62.9-67.7)	89.6 (88.0-91.0)	81.1 (79.1-83.0)	65.3 (62.9-67.7)	89.0 (88.5-89.5)	78.6 (77.9-79.2)	60.5 (59.6-61.3)
65-79	95.0 (94.1-95.7)	90.9 (89.8-92.0)	72.9 (71.2-74.6)	95.0 (94.1-95.7)	90.9 (89.8-92.0)	72.9 (71.2-74.6)	94.7 (94.3-95.1)	88.6 (88.0-89.2)	69.1 (68.1-70.0)
80 and over	96.2 (95.0-97.1)	91.8 (90.3-93.1)	67.7 (65.0-70.4)	96.2 (95.0-97.1)	91.8 (90.3-93.1)	67.7 (65.0-70.4)	95.8 (95.1-96.4)	88.6 (87.5-89.6)	63.2 (61.5-64.9)
Race and Hispanic origin									
Hispanic	86.0 (81.7-89.7)	78.1 (73.2-82.6)	64.0 (58.5-69.2)	83.4 (77.9-88.0)	74.1 (68.3-79.4)	59.1 (53.0-65.0)	75.0 (74.0-75.9)	62.9 (61.9-63.9)	49.3 (48.2-50.3)
Non-Hispanic white	91.3 (90.5-92.1)	81.8 (80.7-82.9)	64.2 (62.8-65.5)	86.4 (84.6-88.2)	68.8 (66.8-70.7)	53.3 (51.3-55.2)	86.2 (85.8-86.6)	65.6 (65.0-66.1)	47.3 (46.7-47.9)
Non-Hispanic black	92.7 (90.4-94.6)	85.3 (82.5-87.8)	62.7 (58.9-66.4)	90.7 (86.8-93.8)	80.9 (76.7-84.6)	56.8 (52.3-61.3)	85.4 (84.5-86.3)	69.9 (68.7-71.0)	48.7 (47.4-49.9)
Non-Hispanic Asian	88.1 (80.7-93.4)	81.9 (73.5-88.5)	66.1 (56.6-74.7)	86.6 (77.6-92.9)	75.3 (63.7-84.7)	58.4 (46.9-69.4)	80.7 (79.3-82.0)	69.0 (67.4-70.6)	53.5 (51.8-55.3)
Education									
High School diploma or GED or less	89.8 (88.3-91.2)	82.0 (80.2-83.7)	62.0 (59.7-64.3)	82.8 (79.5-85.8)	70.4 (67.0-73.7)	51.2 (47.7-54.8)	78.6 (77.9-79.2)	63.3 (62.6-64.0)	46.6 (45.8-47.4)
Some college	90.6 (89.3-91.8)	80.3 (78.7-81.9)	63.4 (61.6-65.2)	87.9 (86.0-89.6)	73.2 (70.9-75.4)	56.4 (54.1-58.7)	86.4 (85.9-87.0)	69.4 (68.7-70.2)	51.8 (51.0-52.7)
Bachelor's degree or higher	93.3 (92.2-94.4)	85.1 (83.5-86.6)	67.7 (65.6-69.7)	90.7 (88.6-92.6)	77.1 (74.4-79.6)	61.4 (58.4-64.2)	88.9 (88.5-89.4)	73.1 (72.5-73.7)	54.1 (53.3-54.8)
Current employment									
Employed	87.3 (85.9-88.6)	73.6 (71.9-75.3)	57.3 (55.5-59.2)	85.9 (84.2-87.6)	69.4 (67.4-71.3)	52.1 (50.1-54.1)	82.9 (82.5-83.4)	65.0 (64.4-65.6)	47.2 (46.5-47.9)
Not employed and looking for work	79.7 (70.8-86.9)	62.5 (54.6-69.9)	42.3 (34.4-50.5)	81.6 (73.4-88.2)	64.6 (57.1-71.6)	44.7 (36.8-52.9)	76.7 (74.7-78.7)	55.9 (53.0-58.8)	39.1 (36.1-42.2)
Not employed and not looking for work	94.9 (94.1-95.5)	89.8 (88.8-90.7)	70.5 (68.9-72.0)	91.4 (88.2-93.9)	77.7 (73.8-81.4)	61.4 (57.2-65.6)	85.8 (84.9-86.6)	68.3 (67.3-69.2)	51.6 (50.6-52.5)
Residence									
Urban	91.2 (90.3-92.0)	82.0 (80.9-83.0)	64.3 (62.9-65.6)	87.2 (85.5-88.8)	71.9 (70.1-73.6)	54.7 (52.9-56.6)	83.6 (83.2-83.9)	66.6 (66.2-67.1)	48.7 (48.2-49.2)
Rural	90.4 (88.7-91.9)	80.7 (78.5-82.8)	61.4 (58.6-64.2)	85.3 (81.5-88.5)	68.1 (64.2-71.9)	52.3 (48.0-56.5)	83.2 (81.8-84.5)	59.6 (58.1-61.0)	44.1 (42.5-45.6)
Region									
Northeast	92.0 (89.6-94.0)	84.2 (81.4-86.6)	65.7 (61.9-69.4)	87.2 (82.0-91.3)	70.5 (65.1-75.6)	51.8 (46.7-56.9)	86.8 (85.9-87.6)	70.8 (69.7-71.8)	49.1 (47.8-50.4)
Midwest	92.1 (90.7-93.4)	81.2 (79.3-82.9)	63.1 (60.7-65.3)	88.2 (85.3-90.7)	69.1 (65.6-72.4)	52.6 (49.2-56.1)	85.0 (84.3-85.7)	63.1 (62.0-64.1)	47.6 (46.4-48.7)
South	91.2 (89.8-92.4)	82.2 (80.6-83.8)	63.3 (61.2-65.3)	87.4 (85.0-89.6)	73.2 (70.8-75.5)	54.6 (52.0-57.2)	83.1 (82.4-83.8)	67.1 (66.4-67.8)	48.1 (47.3-48.9)
West	89.2 (87.5-90.8)	80.0 (77.8-82.1)	64.3 (62.0-66.6)	84.9 (81.4-87.9)	70.3 (66.7-73.8)	56.7 (53.1-60.1)	80.4 (79.7-81.1)	62.6 (61.7-63.4)	47.8 (46.8-48.8)

Adapted from: NCHS, National Health Interview Survey, 2015-2018, Table 12a

Table 2, above, considers selected health screening checks. Comparing veterans with non-veterans during the data collection period, the former group self-reported a higher positive percentage compared to non-veterans for blood pressure check, cholesterol check, and blood glucose check. The remaining characteristics were about the same for veterans and non-veterans.

Table 3: Crude and age-adjusted percentages (with 95% confidence intervals) of vision trouble among adults aged 20 and over, by Veteran and Non-Veteran status with other selected characteristics : United States, 2015- 201

Selected Characteristic	Veterans (crude)	Veteran (age-adjusted)	Nonveterans (age-adjusted)
	Vision Trouble	Vision Trouble	Vision Trouble
Overall	12.3 (11.5-13.1)	10.0 (9.1-11.1)	10.4 (10.1-10.6)
Sex			
Male	12.1 (11.3-12.9)	9.3 (8.3-10.4)	8.6 (8.3-9.0)
Female	14.7 (12.1-17.7)	14.4 (11.6-17.5)	11.8 (11.5-12.2)
Age (years)			
20-34	6.1 (3.9-9.0)	6.1 (3.9-9.0)	6.6 (6.2-7.0)
35-49	9.2 (7.5-11.1)	9.2 (7.5-11.1)	8.7 (8.3-9.2)
50-64	13.6 (12.0-15.4)	13.6 (12.0-15.4)	13.2 (12.7-13.8)
65-79	12.1 (11.0-13.3)	12.1 (11.0-13.3)	14.4 (13.7-15.0)
80 and over	18.1 (16.0-20.3)	18.1 (16.0-20.3)	20.5 (19.2-21.9)
Race and Hispanic origin			
Hispanic	13.0 (9.9-16.8)	11.4 (8.4-15.1)	10.9 (10.2-11.6)
Non-Hispanic white	11.9 (11.1-12.8)	9.7 (8.5-11.0)	10.2 (9.9-10.6)
Non-Hispanic black	14.4 (12.0-17.0)	11.2 (8.9-13.9)	12.3 (11.5-13.1)
Non-Hispanic Asian	9.3 (5.5-14.7)	8.6 (4.5-14.4)	7.2 (6.3-8.1)
Education			
High school diploma or GED or less	14.7 (13.3-16.2)	11.3 (9.5-13.2)	12.4 (12.0-12.9)
Some college	12.8 (11.5-14.2)	11.9 (10.4-13.5)	11.9 (11.4-12.4)
Bachelor's degree or higher	9.5 (8.4-10.8)	7.3 (6.2-8.5)	8.0 (7.6-8.4)
Current employment			
Employed	8.3 (7.3-9.4)	7.6 (6.5-8.7)	8.2 (7.8-8.5)
Not employed and looking for work	13.9 (8.6-20.9)	14.4 (9.0-21.5)	13.5 (11.7-15.5)
Not employed and not looking for work	15.7 (14.6-16.9)	14.5 (12.0-17.3)	14.4 (13.7-15.0)
Residence			
Urban	11.9 (11.1-12.8)	9.8 (8.8-11.0)	10.0 (9.8-10.3)
Rural	14.4 (12.5-16.4)	10.9 (8.8-13.3)	12.5 (11.7-13.4)
Region			
Northeast	10.8 (8.9-12.8)	8.5 (6.5-10.9)	8.9 (8.3-9.4)
Midwest	11.8 (10.4-13.3)	9.1 (7.4-11.0)	10.3 (9.8-10.9)
South	12.2 (10.9-13.5)	10.2 (8.6-12.0)	11.0 (10.6-11.5)
West	14.0 (12.4-15.7)	11.4 (9.4-13.5)	10.6 (10.0-11.1)

Adapted from: NCHS, National Health Interview Survey, 2015-2018, Table 16a.

In terms of self-reported vision problems Table 3, indicates that male and female veterans were more likely to indicate that they had vision problems compared to non-veterans. This was also found to be the situation among veterans in the older age groups compared to non-veterans. The remaining characteristics were about the same for veterans and non-veterans.

Table 4: Crude and age-adjusted percentages (with 95% confidence intervals) of receipt of selected vaccination among adults aged 20 and over, by Veteran status and other selected characteristics: United States, 2015- 2018

Selected Characteristic	Veteran (crude)			Veteran (age-adjusted)			Nonveteran (age-adjusted)		
	Influenza in past 12 months	Pneumococcal (65 >= years)	Shingles (50 >= years)	Influenza in past 12 months	Pneumococcal (65 >= years)	Shingles (50 >= years)	Influenza in past 12 months	Pneumococcal (65 >= years)	Shingles (50 >= years)
Overall	59.1 (57.9-60.2)	73.4 (71.9-74.8)	30.9 (29.7-32.1)	50.2 (48.5-52.0)	73.2 (71.8-74.7)	24.8 (23.7-25.8)	41.7 (41.2-42.1)	65.8 (65.0-66.7)	22.9 (22.4-23.4)
Sex									
Male	59.2 (57.9-60.4)	73.3 (71.8-74.7)	31.2 (30.0-32.5)	49.1 (47.1-51.0)	73.1 (71.6-74.6)	24.4 (23.3-25.5)	37.5 (36.9-38.1)	60.2 (58.6-61.9)	20.0 (19.2-20.7)
Female	57.8 (53.9-61.7)	77.3 (70.2-83.4)	25.4 (21.0-30.3)	57.3 (53.1-61.4)	77.5 (70.6-83.5)	28.5 (23.8-33.5)	45.3 (44.7-45.9)	68.2 (67.3-69.1)	24.5 (23.9-25.1)
Age (years)									
20-34	47.4 (42.9-52.0)	*..	*..	47.4 (42.9-52.0)	*..	*..	29.6 (28.9-30.4)	*..	*..
35-49	41.9 (38.6-45.1)	*..	*..	41.9 (38.6-45.1)	*..	*..	35.3 (34.5-36.1)	*..	*..
50-64	49.0 (46.6-51.4)	*..	11.1 (9.7-12.6)	49.0 (46.6-51.4)	*..	11.1 (9.7-12.6)	46.1 (45.3-46.9)	*..	11.2 (10.7-11.7)
65-79	68.8 (67.0-70.5)	70.9 (69.1-72.6)	41.3 (39.5-43.2)	68.8 (67.0-70.5)	70.9 (69.1-72.6)	41.3 (39.5-43.2)	65.9 (65.0-66.7)	64.1 (63.1-65.0)	38.1 (37.2-39.0)
80 and over	79.7 (77.3-81.9)	79.8 (77.4-82.0)	40.0 (37.2-42.9)	79.7 (77.3-81.9)	79.8 (77.4-82.0)	40.0 (37.2-42.9)	72.3 (70.8-73.8)	70.8 (69.3-72.3)	33.2 (31.7-34.8)
Race and Hispanic origin									
Hispanic	54.5 (48.7-60.3)	65.1 (56.7-72.9)	24.1 (18.9-29.9)	51.4 (44.8-58.1)	66.5 (58.5-73.8)	21.2 (16.7-26.4)	35.6 (34.7-36.6)	47.5 (44.5-50.5)	12.6 (11.3-14.0)
Non-Hispanic white	60.8 (59.5-62.0)	74.9 (73.3-76.4)	33.4 (32.1-34.8)	49.9 (47.9-52.0)	74.6 (73.0-76.2)	25.9 (24.7-27.1)	43.6 (43.1-44.2)	70.4 (69.6-71.3)	26.2 (25.6-26.8)
Non-Hispanic black	51.0 (47.4-54.6)	61.6 (55.9-67.0)	15.2 (12.6-18.1)	49.2 (44.7-53.6)	61.5 (55.7-67.0)	15.5 (13.0-18.4)	35.3 (34.1-36.6)	55.4 (52.9-57.9)	11.3 (10.3-12.4)
Non-Hispanic Asian	62.1 (52.6-71.0)	61.7 (46.7-75.2)	34.4 (24.1-45.8)	55.8 (43.5-67.6)	61.9 (47.1-75.2)	30.0 (19.7-41.9)	48.4 (46.6-50.1)	52.6 (48.7-56.4)	18.7 (16.6-21.0)
Education									
High School diploma or GED or less	56.9 (54.8-58.9)	72.1 (69.6-74.5)	25.3 (23.5-27.2)	42.7 (39.3-46.2)	71.6 (69.1-74.0)	19.1 (17.6-20.7)	35.9 (35.2-36.5)	61.7 (60.4-63.0)	17.5 (16.8-18.1)
Some college	55.1 (53.1-57.1)	73.3 (70.7-75.7)	29.5 (27.5-31.5)	47.7 (45.3-50.2)	73.7 (71.3-76.1)	24.4 (22.8-26.1)	41.2 (40.5-42.0)	68.9 (67.4-70.3)	24.6 (23.7-25.5)
Bachelor's degree or higher	65.7 (63.6-67.7)	74.8 (72.3-77.2)	38.6 (36.3-40.9)	58.2 (55.2-61.1)	74.5 (72.0-77.0)	31.4 (29.2-33.6)	51.8 (51.1-52.5)	70.5 (69.0-71.9)	29.3 (28.4-30.2)
Current employment									
Employed	50.1 (48.3-52.0)	64.3 (60.5-68.0)	20.4 (18.6-22.3)	49.9 (47.8-52.0)	67.1 (62.6-71.3)	23.6 (21.5-25.8)	40.6 (40.0-41.3)	59.5 (57.0-62.1)	22.4 (21.2-23.6)
Not employed and looking for work	39.9 (32.7-47.5)	*	14.7 (8.2-23.5)	39.0 (32.0-46.2)	*	20.5 (11.3-32.7)	30.6 (27.9-33.3)	58.4 (44.6-71.2)	18.8 (13.2-25.6)
Not employed and not looking for work	67.7 (66.2-69.1)	75.4 (73.8-76.9)	36.6 (35.1-38.2)	49.7 (45.5-53.9)	75.0 (73.4-76.6)	26.7 (25.1-28.4)	42.9 (42.0-43.8)	67.4 (66.5-68.3)	24.9 (24.2-25.7)
Residence									
Urban	59.4 (58.0-60.7)	73.4 (71.8-75.0)	31.1 (29.7-32.5)	51.1 (49.3-53.0)	73.3 (71.7-74.8)	25.0 (23.8-26.2)	42.2 (41.7-42.7)	65.9 (65.1-66.8)	23.3 (22.8-23.9)
Rural	57.5 (55.1-59.8)	73.1 (69.3-76.6)	30.0 (27.4-32.6)	44.4 (40.4-48.4)	73.1 (69.4-76.5)	23.6 (21.4-25.9)	38.0 (36.7-39.3)	65.3 (62.9-67.6)	20.7 (19.5-21.9)
Region									
Northeast	61.5 (58.5-64.4)	73.2 (69.4-76.7)	29.7 (26.8-32.7)	50.5 (45.0-55.9)	72.6 (68.7-76.2)	22.4 (20.1-24.9)	45.4 (44.4-46.5)	64.4 (62.4-66.3)	22.5 (21.4-23.6)
Midwest	60.8 (58.4-63.2)	76.2 (73.3-79.0)	32.5 (30.1-35.1)	49.1 (45.4-52.9)	75.9 (72.9-78.7)	25.3 (23.3-27.3)	42.4 (41.5-43.3)	71.2 (69.7-72.7)	25.2 (24.2-26.1)
South	56.8 (54.9-58.7)	71.9 (69.3-74.5)	28.5 (26.6-30.5)	48.9 (46.4-51.5)	72.0 (69.4-74.5)	23.7 (22.0-25.6)	39.7 (38.9-40.4)	63.9 (62.4-65.4)	20.3 (19.5-21.2)
West	59.7 (57.2-62.2)	72.9 (69.9-75.7)	34.1 (31.4-36.8)	53.7 (50.0-57.5)	72.8 (69.9-75.6)	27.3 (25.0-29.6)	41.2 (40.3-42.1)	65.0 (63.3-66.6)	25.4 (24.3-26.5)

Adapted from: NCHS, National Health Interview Survey, 2015-2018, Table 11a

Table 4, above, considers receipt of common vaccinations for adults--influenza, pneumococcal, and shingles. In nearly all response categories, veterans had higher self-reports of vaccination during the prior 12-month period compared to non-veterans.

Using descriptive epidemiological techniques and interpreting NHIS data (time; data collection period: 2015-2018), health disparities between veteran and non-veteran populations. Just as health data visualization pioneers John Snow and Florence Nightingale[11], this study uses modern data visualization techniques to highlight some important health disparities in greater detail. The NHIS data fields were categorized by person and place characteristics:

Person

- Race

Place

- County of Residence/Residence
- Region

This categorization facilitated a descriptive analysis that spotlighted disparities in self-reports of health status and vaccinations, providing an important epidemiological perspective for health planning.

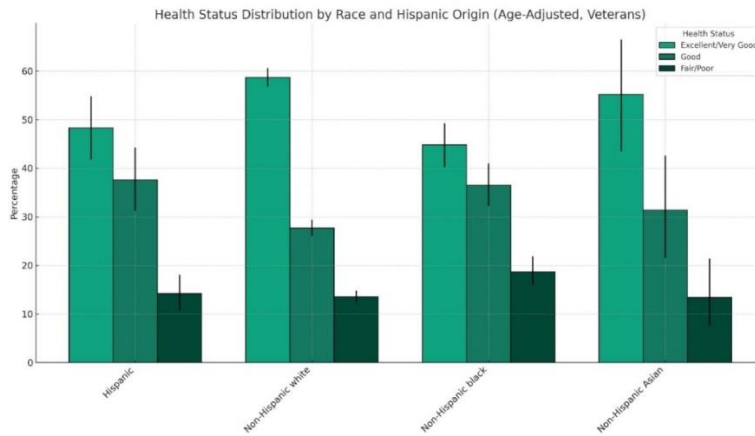


Chart 1: Examining Health Status by veteran race and ethnic origin, 2015-2018
Adapted: Table 1; NCHS National Health Interview Survey, 2015-2018, Table 1a

Chart 1 reveals marked disparities in self-reported health status, with non-Hispanic White and Asian veterans generally reporting better health (excellent/very Good) compared to their Hispanic and non-Hispanic Black counterparts. These findings suggest the presence of significant health inequities, potentially influenced by factors such as access to healthcare, socioeconomic status, and the burden of chronic diseases, which vary across racial and ethnic groups.

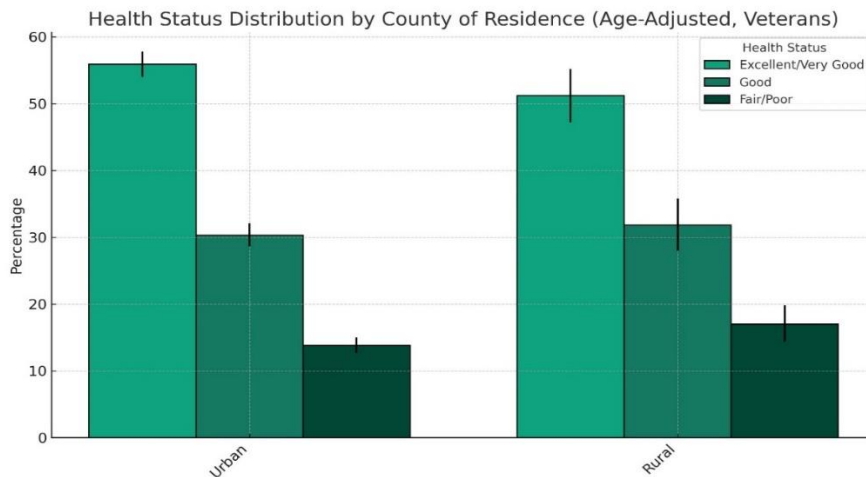


Chart 2: Examining Health Status by veteran county of residence, 2015-2018
Source: Table 1; NCHS National Health Interview Survey, 2015-2018, Table 1a

Chart 2 extends the analysis and underscores geographical disparities in health perceptions. Specifically, veterans residing in rural areas report worse health outcomes (higher fair/poor ratings) compared to their urban counterparts, highlighting a crucial area for targeted health system planning. The findings advocate for the development of tailored interventions and resource allocations to address the unique challenges faced by rural veteran populations.

In Chart 3 the visualization of health status distribution by region among veterans showed nuanced regional disparities in self-reported health outcomes. The combined bar chart indicates that veterans in the South report a slightly higher incidence of fair/poor health status compared to other regions, highlighting regional variations in health determinants such as access to healthcare, lifestyle factors, and the prevalence of chronic conditions. These regional differences in health perceptions among veterans may suggest the need for region-specific public health strategies to address health disparities.

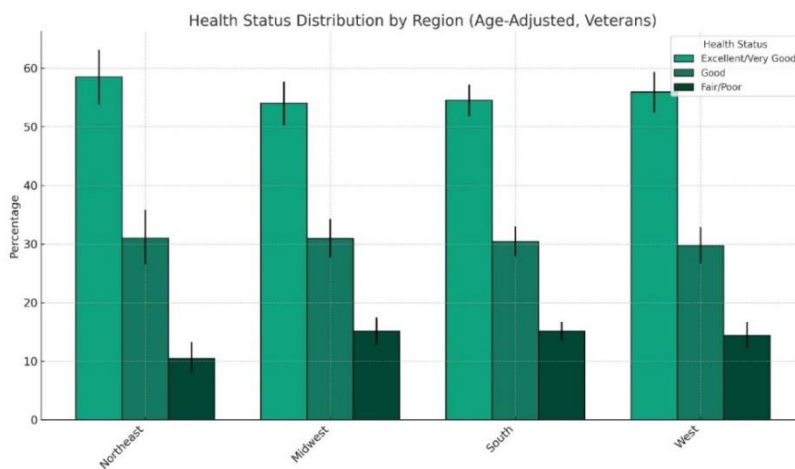


Chart 3: Examining Health Status by veteran region, 2015-2018
 Source: Table 1; ; NCHS National Health Interview Survey, 2015-2018, Table 1a

Vaccinations within a population are typically associated with public health strategies, and a closer examination of self-reported receipt of vaccinations revealed additional epidemiologic insights for public health action. Chart 4 reveals insightful disparities in vaccination receipt among different racial and ethnic groups.

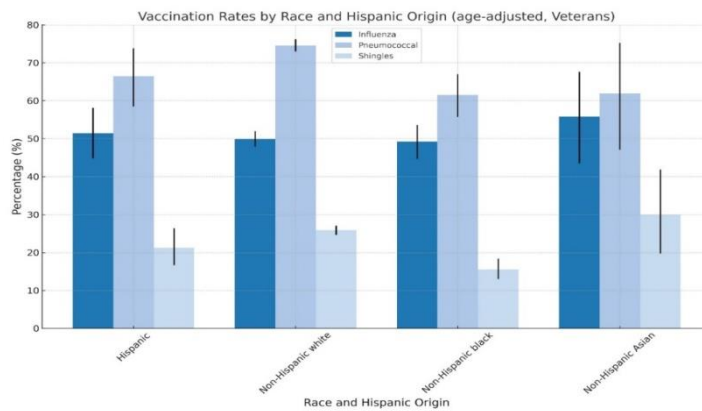


Chart 4: Examining Vaccination Rates by veteran race and ethnic origin, 2015-2018
 Source: Table 4; NCHS National Health Interview Survey, 2015-2018, Table 11a

Influenza Vaccination Rates: The influenza vaccination rates show variability across racial and ethnic groups, with the non-Hispanic asian, veteran population showing a slightly higher vaccination rate compared to the other groups. This suggests a differential uptake of influenza vaccinations, which may be influenced by various factors including access to healthcare services, public health outreach, and cultural attitudes towards vaccination.

Pneumococcal Vaccination Rates: Pneumococcal vaccination rates exhibit a notable disparity, with Non-Hispanic white veterans receiving this vaccine at a higher rate than other population groups. Given the importance of pneumococcal vaccination for preventing serious infections in older adults, this disparity underscores the need for targeted interventions to increase vaccination coverage among the other population groups.

Shingles Vaccination Rates: Shingles vaccination rates are lowest among the non-Hispanic black veteran population compared to other groups. Considering the significant morbidity associated with shingles, especially in older adults, the lower vaccination rates among all groups compared with the other vaccination categories might highlight a critical area for public health intervention and education.

Harnessing the power of health data visualizations, coupled with a descriptive epidemiologic perspective, the findings offer a useful view of veteran health disparities that could help drive health system planning.

4. DISCUSSION

In this section, the findings from the prior section are summarized. We offer a reflection on the implications of these findings for other, related analyses. The implications of these findings for public health practice are described. Finally, the study limitations are identified.

Highlights of findings

The National Health Interview Survey (NHIS) yielded epidemiological insights into the health disparities between veteran and non-veteran populations, covering aspects such as health status, preventive screenings, vision issues, and vaccination uptake. This survey illuminated a complex health landscape, where non-veterans perceive their health more favorably, contrasted against veterans' higher engagement in preventive health practices.

From an epidemiological standpoint, the data (2015-2018) underscores health inequities, particularly across racial, ethnic, and geographical divides. The disparities in health status, evident through self-reported measures, reveal a significant public health concern. Non-Hispanic white and asian veterans reporting superior health outcomes compared to Hispanic and non-Hispanic black counterparts is noteworthy. Similarly, the geographical analysis highlights the health access challenges faced by veterans in rural settings, who report inferior health outcomes compared to urban counterparts, pointing toward a pressing need for targeted healthcare interventions and policy adjustments to bridge these disparities. The higher vaccination rates observed among veterans suggest potentially more effective health service utilization.

Four applications for health system planning

The findings underscore critical areas for health system planning. Health system planning has the potential to shape the delivery of health care and public health [1]. The disparities in self-reported

health status may underscore the need for a focused approach within a health system to bridge these gaps in the veteran health landscape [12]. The proactive engagement of veterans in health screenings signifies an existing infrastructure for preventive health measures [13] that could be further optimized. The epidemiologic analysis presented here highlights these disparities and may lay the groundwork for public health strategies tailored to the unique needs of the veteran population.

Application #1, Integration of Epidemiologic Methods: Leveraging big data and advanced data science techniques is essential for deepening our understanding of health disparities and enhancing public health planning. By integrating vast datasets from healthcare records, surveys, and social determinants of health with AI and machine learning, we can derive precise epidemiologic insights. This approach enables predictive modeling and targeted intervention planning, identifying risk factors and health outcome disparities with greater accuracy. Collaboration across epidemiology, data science, and public health policy is crucial, optimizing health interventions and advancing towards the goals of Healthy People 2030.

Application #2, Urban/Rural Health Strategies: Analytic modeling and targeted intervention health planning capabilities of big data and advanced data science to address the unique challenges faced by veterans in rural and urban areas. Insights from epidemiologic methods guide the development of strategies that are responsive to the specific health determinants and barriers present in different geographic settings.

Application #3, Regional Health Initiatives: Tailored public health strategies should be informed by the nuanced understanding of regional disparities provided by big data analytics. Allocating resources to areas with lower vaccination rates and health outcomes requires a data-informed approach to engage local communities in health promotion efforts.

Application #4, Policy and Strategic Planning: Inform health policy formulation and strategic planning with insights from the comprehensive analysis facilitated by the integration of epidemiologic methods and the incorporation of Healthy People 2030's Overall Well-being Measure. Interdisciplinary workgroups could help prioritize the elimination of health disparities and advance health equity objectives to underscore the importance of a data-driven approach to health policymaking and strategic planning.

Implications for public health practice

Public health practice, defined as the strategic, organized, and interdisciplinary application of knowledge, skills, and competencies essential for performing public health services, is integral to improving the health of populations [6]. Public healthcare systems that integrate medical and public health services have an important role in monitoring and enhancing veteran population health. Utilizing data from Electronic Health Records (EHRs) and big data analytics, these systems can effectively monitor health trends and undertake comprehensive health promotion activities, including those related to public health prevention activities. The integration of public health informatics [14] and descriptive epidemiology, especially using Generative AI, optimize population health analytics [15] and health data visualization [11] to support an approach for examining health data and the utilization of health services [6,16] to foster improved health status within populations.

Study Limitations: The use of the ecological study design has inherent limitations for person-level application. Generative AI, as a new technology solution, has limitations, as well. The

employment of Generative AI for data management, analysis, and visualization necessitates the expertise of epidemiologists adept at utilizing these emerging technology solutions and critically examine data findings for relevance and accuracy.

5. CONCLUSION

The descriptive epidemiologic assessment undertaken in this study shows the disparities in personal health perceptions, health screening, vision problems, and vaccination rates between veterans and non-veterans. By integrating Generative AI with traditional epidemiological methods, this research provides essential insights into the health dynamics affecting these populations, pinpointing where health system planning might contribute to improvements in health status of the veteran population.

Our findings reveal significant disparities in health outcomes, with veterans experiencing worse health perceptions yet demonstrating higher engagement in preventive health practices (e.g., vaccination) compared to non-veterans. This paradox underscores the complex relationship between perceived health status and actual health behaviors, signaling a need to tailor its health promotion and disease prevention strategies.

This descriptive epidemiologic study highlights health disparities between veterans and non-veterans, offering a solid basis for health system planning. By leveraging epidemiologic methods with Generative AI, we can enhance our understanding of these health disparities and develop targeted interventions to improve health outcomes for veterans. As we move forward, interdisciplinary collaboration with refinements in analytic methods that are focused on the health needs of veterans will likely improve the health status of this population.

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