Uptake and Equity in Influenza Vaccination Among Veterans with VA Coverage, Veterans Without VA Coverage, and Non-Veterans in the USA, 2019–2020

Adam Gaffney, MD, MPH[1,2], *David U. Himmelstein, MD*[1,2,3,4], *Samuel Dickman, MD*[5], *Danny McCormick, MD, MPH*[1,2], and *Stephanie Woolhandler, MD, MPH*[1,2,3,4]

[1]Department of Medicine, Cambridge Health Alliance, Cambridge, MA, USA; [2]Harvard Medical School, Boston, MA, USA; [3]Hunter College, City University of New York, New York, NY, USA; [4]Public Citizen Health Research Group, Washington, DC, USA; [5]Planned Parenthood South Texas, San Antonio, TX, USA.

BACKGROUND: Vaccination is a primary method of reducing the burden of influenza, yet uptake is neither optimal nor equitable. Single-tier, primary care-oriented health systems may have an advantage in the efficiency and equity of vaccination.

OBJECTIVE: To assess the association of Veterans' Health Administration (VA) coverage with influenza vaccine uptake and disparities.

DESIGN: Cross-sectional.

PARTICIPANTS: Adult respondents to the 2019–2020 National Health Interview Survey.

MAIN MEASURES: We examined influenza vaccination rates, and racial/ethnic and income-based vaccination disparities, among veterans with VA coverage, veterans without VA coverage, and adult non-veterans. We performed multivariable logistic regressions adjusted for demographics and self-reported health, with interaction terms to examine differential effects by race/ethnicity and income.

KEY RESULTS: Our sample included n=2,277 veterans with VA coverage, n=2,821 veterans without VA coverage, and n=46,456 non-veterans. Veterans were more often White and male; among veterans, those with VA coverage had worse health and lower incomes. Veterans with VA coverage had a higher unadjusted vaccination rate (63.0%) than veterans without VA coverage (59.1%) and non-veterans (46.5%) (p<0.05 for each comparison). In our adjusted model, non-veterans were 11.4 percentage points (95% CI −14.3, −8.5) less likely than veterans with VA coverage to be vaccinated, and veterans without VA coverage were 6.7 percentage points (95% CI −10.3, −3.0) less likely to be vaccinated than those with VA coverage. VA coverage, compared with non-veteran status, was also associated with reduced racial/ethnic and income disparities in vaccination.

CONCLUSIONS: VA coverage is associated with higher and more equitable influenza vaccination rates. A single-tier health system that emphasizes primary care may improve the uptake and equity of vaccination for influenza, and possibly other pathogens, like SARS-CoV2.

Received March 30, 2022
Accepted September 7, 2022

Published online: 26 September 2022

KEY WORDS: influenza; vaccination; Veterans Health; health care access.

J Gen Intern Med
DOI: 10.1007/s11606-022-07797-7

INTRODUCTION

SARS-CoV-2 is likely to continue circulating in the population, together with other common respiratory viruses such as influenza, respiratory syncytial virus, and the seasonal coronaviruses. Becoming "endemic" does not mean, however, that COVID-19's impact will be limited or mild. Endemic infectious diseases often impose serious, inequal burdens of morbidity and mortality on populations. However, an ongoing, robust medical response might reduce the loss of life from COVID-19, as it does from influenza. A key component of that response is vaccination, including primary series, "boosters," and possibly (as with influenza) annual revaccination.[1] Prior experiences with vaccination campaigns against pathogens like influenza could help inform such ongoing vaccination efforts.

Health care system factors may affect the efficiency and equity of vaccination efforts. During the COVID-19 pandemic, nations with similar levels of economic development but different health systems have achieved substantially different vaccination rates. However, international differences may reflect factors other than health care delivery, such as the politicization of COVID-19 vaccines in some countries. Hence, comparing vaccine uptake and equity among health systems within a nation may yield additional insights. For instance, early studies suggested that the Veterans Health Administration (VA) may have had an advantage over the civilian sector in the equity, and possibly speed, of COVID-19 vaccination in early 2021.[2,3] However, the extraordinary nature of the 2021 COVID-19 vaccination campaign may limit its relevance to the routine provision of preventive care during a future endemic phase — a phase that may more closely resemble the circumstances surrounding influenza prevention.

Prior to COVID-19, influenza was a major global cause of death from acute respiratory tract infection.[4] In the USA, 12,000 to 61,000 deaths annually were attributed to influenza in the decade prior to the emergence of COVID-19.[5] Like SARS-CoV-2, influenza imposes a disproportionate burden on disadvantaged groups. Relative to Whites, Black individuals have an 81% higher risk of hospitalization from influenza and a 15% higher risk of death,[6] and people residing in poor (vs. affluent) neighborhoods have 31% higher odds of influenza hospitalization.[7]

Vaccination is a principal tool for controlling influenza, yet vaccine uptake remains well below the *Healthy People 2030* goal of 70%,[8] and several studies have documented stark disparities in influenza vaccination rates[9–12] that persisted into the COVID-19 era.[10] Few recent studies, however, have examined the association of health system factors, including VA coverage, with influenza vaccine uptake or equity.

The VA is an integrated, publicly owned, and publicly financed health system that provides care for many but not all US veterans. All VA patients are encouraged (but not required) to see a primary care physician or mid-level practitioner. Older research found that VA enrollees had higher influenza vaccine uptake relative to those cared for elsewhere,[13,14] but that White VA enrollees had higher uptake than Black VA users[15] or both Black and Hispanic VA users.[16] Most recently, an analysis of 2010 data identified elevated rates of H1N1 and seasonal influenza vaccinations among veterans overall, but lacked data on VA coverage.[17]

We assessed contemporary influenza vaccine uptake and disparities among veterans with VA coverage, veterans without VA coverage, and adult non-veterans before and during the COVID-19 pandemic.

METHODS

Data

We analyzed the 2019–2020 National Health Interview Survey (NHIS), described elsewhere.[18] In brief, the NHIS is a household interview survey of the non-institutionalized US population conducted annually since 1957 by the Centers for Disease Control and Prevention (CDC). In 2019, the NHIS underwent a major redesign that precludes combined analysis with previous years' surveys. In 2020, the NHIS was mostly conducted by telephone due to the COVID-19 pandemic, and in the second half of the year, the survey underwent a change in sampling design, with follow-up interviews of 2019 NHIS respondents replacing roughly half the originally intended random annual adult sample.[18,19] Following NHIS instructions,[18] we excluded repeat respondents from our 2020 sample to permit analysis of combined 2019–2020 data, using NHIS' weights specially designed for this purpose.

Exposure

Our primary exposures were (a) veteran status and (b) VA coverage. We categorized veteran status based on the question: "Did you ever serve on active duty in the U.S. Armed Forces, military Reserves, or National Guard?" As recommended by the NHIS,[20] we considered an individual to have VA coverage if they (a) mentioned VA health care in the health insurance portion of the interview; (b) reported receiving "any care at a Veteran's Health Administration facility or receive any other health care paid for by the VA" in the past 12 months; or (c) stated they had "ever enrolled in or used VA health care."

Using these two variables we constructed a mutually exclusive three-category "veteran/VA indicator" variable: (a) veteran with VA coverage; (b) veteran without VA coverage; and (c) adult non-veteran. Of the total sample of *n*=53,150 adults, we excluded *n*=1436 with "refused," "not ascertained," or "don't know" responses to the veteran question and *n*=19 adults who reported having VA coverage despite not being a veteran.

We examined respondents' race/ethnicity reduced to four categories: Hispanic, Non-Hispanic White only, Non-Hispanic Black/African American only, and "other" (a heterogeneous group which includes Non-Hispanic Asian only, Non-Hispanic American Indian or Alaskan Native only, Non-Hispanic American Indian or Alaskan Native and any other group, and "other single and multiple races").

Finally, we examined respondents' family income using the categories reported in the NHIS, which we reduced to three categories: (1) "low income" (less than $50,000); (2) "middle income" ($50,000–$99,999); and (3) "high income" ($100,000 or greater). This variable included NHIS' single imputation for those with missing data.

Outcome

Our study outcome was receipt of an influenza vaccine in the past 12 months, based on the question: "There are two types of flu vaccinations. One is a shot and the other is a spray, mist, or drop in the nose. During the past 12 months, have you had a flu vaccination?" We excluded *n*=141 individuals with "refused," "not ascertained," or "don't know" responses to this question.

Analysis

We first examined the unadjusted proportion with an influenza vaccination in the past 12 months by veteran/VA coverage status. We then evaluated the association between influenza vaccination and veteran/VA coverage status using a multivariable logistic regression model controlling for age category (18–24, 25–34, 35–44, 45–54, 55–64, 65–74, 75+ years), sex (male, female), race/ethnicity (as defined above), self-reported health status (poor/fair vs. good or better), and family income (categories as defined above). Veterans with VA coverage were treated as the reference group. We excluded 0.3% observations (*n*=134 of 51,554) with missing data on one or more covariate from this analysis.

We then examined racial/ethnic and income-related disparities in vaccine uptake with four logistic regressions. These models were designed to examine effect modification of race/ethnicity (or income) by veteran/VA status, with and without further adjustment for other covariates. Model 1 included only three predictors of vaccination rate: race/ethnicity, veteran/VA indicator, and an interaction term for veteran/VA indicator * race/ethnicity. Model 2 was additionally adjusted for age category, sex, and self-reported health status. Models 3 and 4 were identical to Models 1 and 2, except that family income was substituted for race. We refer to Models 1 and 3 as "unadjusted" and Models 2 and 4 as "adjusted." (We did not mutually-adjust for income and race/ethnicity in these analyses because we consider income to be a likely mediator between systemic racism and the outcome).[9]

We used Stata's *margins* commands to calculate predicted probabilities from each model (note that estimates of unadjusted probabilities using this approach are identical to simple cross-tabulations). We then calculated the marginal effect on influenza vaccination, within each of the three population categories, of each non-White racial/ethnic group relative to White non-Hispanic persons, and for each lower income group vs. the highest income category. Finally, using estimates from our adjusted effect modification models, we calculated the differential effect of each non-White racial/ethnic group vs. White race, or low and middle income vs. high income, among non-veterans (or among veterans without VA coverage) relative to that difference in veterans with VA coverage. (Although we show findings for our "other" category in the tables for completeness, we do not report them in the text due to the category's heterogeneity).

We used Stata/SE 16's *svy* commands that account for the complex sampling design, and NHIS-provided weights which permit national estimates. The authors' Institutional Review Boards do not consider analyses of de-identified, publicly available data human subject research.

RESULTS

Our primary study population included n=2277 veterans with VA coverage, n=2821 veterans without VA coverage, and n=46,456 non-veteran adults. Table 1 provides their characteristics. Veterans with and without VA coverage were older (mean 59.9 and 61.3 years, respectively) than non-veterans (46.7 years). Nearly 90% of veterans were male vs. 44.7% of non-veterans. A higher proportion of veterans than non-veterans were White; among veterans, those with VA coverage were more often Black or Hispanic (16.5% and 8.0%, respectively) than those without VA coverage (9.3% and 4.9%, respectively). Relative to non-veterans, veterans who did not use the VA had higher incomes, while those who used the VA had lower incomes and lower educational attainment. Finally, a higher proportion of veterans with VA coverage reported fair/poor health (25.7%) compared to veterans without VA coverage (14.4%) and non-veterans (13.8%).

Table 2 provides influenza vaccination rates, both unadjusted and adjusted for age, sex, race/ethnicity, family income, and self-reported health status. Veterans with VA coverage had higher unadjusted vaccination rates (63.0%) than veterans without VA coverage (59.1%) or non-veterans (46.5%). Adjusted findings were similar, showing lower vaccination rates for both non-veterans (−11.4 percentage points; 95% CI −14.3, −8.5; p<0.001) and veterans lacking VA coverage (−6.7 percentage points; 95% CI −10.3, −3.0; p<0.001) relative to those with VA coverage.

Table 3 provides unadjusted and adjusted rates of vaccination by race/ethnicity within each population group. Among non-veterans, the unadjusted influenza vaccination rate was higher among White individuals (49.9%) than among Hispanic (37.3%) and Black (38.3%) individuals (p<0.001 for each comparison); adjusted differences were similar (e.g., a −9.0 percentage point difference among Black vs. White individuals (95% CI −11.0, −7.1)). Among veterans without VA coverage, the unadjusted vaccination rate of White veterans (61.1%) was similar to that of Hispanic veterans (58.6%), but higher than that of Black (48.5%) veterans in unadjusted analyses (p=0.002); however, adjusted differences did not reach statistical significance.

Among veterans with VA coverage, differences between racial groups were small and non-significant in all analyses. There was some evidence for effect modification of VA coverage by race/ethnicity. Specifically, the difference in the adjusted probability of vaccination for Hispanic vs. White individuals among non-veterans was significantly greater than that difference among veterans with VA coverage (−18.4 percentage points; 95% CI −29.9, −7.0).

Table 4 provides unadjusted and adjusted vaccination rates by family income. Among non-veterans, poorer persons were less likely to report being vaccinated. For instance, those with low incomes had a 13.8 percentage point lower adjusted probability of vaccination (95% CI −15.2, −12.3) than those with high incomes. Among veterans lacking VA coverage, income differences appeared small and non-significant in unadjusted analyses. However, after adjustment, low- and middle-income veterans without VA coverage had significantly lower probabilities of vaccination relative to high-income veterans without VA coverage. Among veterans with VA coverage, there was no apparent income gradient in unadjusted analyses, but adjusted analyses showed a significant difference in the adjusted probability of vaccination (−7.1, 95% CI −13.3, −0.8) for low- vs. high-income veterans. Differences between middle- vs. high-income veterans were non-significant.

There was evidence of effect modification of VA coverage by family income: income-related differences in the probability of vaccination among non-veterans, and among veterans without VA coverage, were larger than the differences among veterans with VA coverage. For example, the difference in the adjusted probability of vaccination in middle- vs. high-income individuals among non-veterans relative to that difference among veterans with VA coverage was −8.5 percentage points (95% CI −15.6, −1.4;

Table 1 Characteristics of Veterans with VA Coverage, Veterans Without VA Coverage, and Adult Non-Veterans (*n*=51,554)

	Non-Veterans (*n*=46,456)	Veterans without VA coverage (*n*=2821)	Veterans with VA coverage (*n*=2277)
Age (mean ± SE)	46.7 ± 0.15	61.3 ± 0.44	59.9 ± 0.60
Sex (%)			
Male (*n*=23,729)	44.7	89.7	88.6
Female (*n*=27,821)	55.3	10.3	11.4
Race/ethnicity (%)			
Hispanic (*n*=6567)	17.4	4.9	8.0
White (*n*=35,582)	62.3	81.5	70.6
Black (*n*=5430)	11.5	9.3	16.5
Other (*n*=3975)	8.8	4.3	4.9
Family income			
$0 to $49,999 (*n*=20,975)	37.1	27.5	41.3
$50,000 to $99,999 (*n*=15,922)	31.6	37.6	35.7
≥$100,000 (*n*=14,657)	31.2	35.0	23.0
Education			
<High school (*n*=4457)	12.6	4.2	5.8
High school/GED (*n*=12,886)	27.3	28.1	27.8
Some college (*n*=15,021)	30.2	37.7	43.1
Bachelors (*n*=11,551)	18.9	18.5	13.3
>Bachelor (*n*=7392)	11.0	11.5	9.9
Health status			
Good/excellent health (*n*=43,745)	86.2	85.6	74.3
Fair/poor health (*n*=7,784)	13.8	14.4	25.7

Number with missing: age (n=107); sex (n=4); education (n=247); health status (n=25)
GED General Educational Development degree

p=0.020). The corresponding difference in the adjusted probability of vaccination between middle- vs. high-income veterans without VA coverage relative to that difference among veterans with VA coverage was numerically similar but not statistically significance (−8.0 percentage points; 95% CI −16.7, 0.9; *p*=0.08).

DISCUSSION

Veterans with VA coverage, despite their relatively lower socio-economic status, are more likely to be vaccinated against influenza compared to both non-veterans and veterans without VA coverage. Moreover, income and racial/ethnic disparities in influenza vaccination are narrower among individuals enrolled in VA care than in other adults. These findings suggest that VA health care may have an advantage in the equitable provision of vaccination.

Our findings are consistent with previous, albeit dated studies of veterans over 65. Two decades ago, elderly VA enrollees had higher rates of influenza vaccination than the general elderly population[16] or veterans reliant on Medicare Health Maintenance Organization (HMO) coverage.[14] Another study identified a rise in the influenza vaccination rate in the VA population between 1997 and 2003, when it exceeded the rate in the general population, although the datasets used to compare the two populations were not directly comparable.[13] The most recent study of this issue[17] lacked data on VA enrollment and used 2010 data, a period prior to the implementation of the Affordable Care Act, which expanded Medicaid (especially to lower income men) and required that insurers cover preventive services such as influenza vaccination without cost-sharing. Nevertheless, our analysis suggests that the VA has retained an advantage in influenza vaccination.

We also found some evidence for better income and racial equity of vaccine uptake among persons with VA coverage. In particular, VA coverage was associated with differentially higher vaccination rates among Hispanic and lower income individuals. This comports with evidence of greater equity in

Table 2 Influenza Vaccination Rates Among Veterans with VA Coverage, Veterans Without VA Coverage, and Adult Non-Veterans, Unadjusted and Adjusted for Differences in Age, Sex, Race/Ethnicity, Income, and Health Status

	Unadjusted (*n*=51,554)			Adjusted (*n*= 51,420)*		
	% Vaccinated	Pct. point difference (95% CI)	*p*-value	% Vaccinated	Pct. point difference (95% CI)	*p*-value
Non-Veterans	46.5	−16.5 (−19.1, −13.8)	<0.001	47.0	−11.4 (−14.3, −8.5)	<0.001
Veterans without VA coverage	59.1	−3.9 (−7.2, −0.5)	0.02	51.8	−6.7 (−10.3, −3.0)	<0.001
Veterans with VA coverage	63.0	Reference		58.4	Reference	

**Adjusted for age category (18–24, 25–34, 35–44, 45–54, 55–64, 65–74, 75+ years), sex (male, female), race/ethnicity (Hispanic, Non-Hispanic White, Non-Hispanic Black, Other), self-reported health status (poor/fair vs. good or better), and family income (less than $50,000, $50,000 - $99,999, or $100,000 or greater)*

Table 3 Racial/Ethnic Differences in the Probability of Influenza Vaccination Among Veterans with VA Coverage, Veterans without VA Coverage, and Adult Non-Veterans

Veteran/VA Status	Race/ ethnicity	Unadjusted* (n= 51,554)		Adjusted** (n= 51,420)								
		Probability (%)	p-value	Probability (%)	Effect of Race by veteran/VA status (pp)	95% confidence interval		p-value	Effect of race among non-veterans (or among veterans without VA) vs. effect of race among those with VA coverage (pp)	95% confidence interval		p-value
Non-Veterans	Hispanic	37.3	<0.001	41.2	−7.8	−9.7	−5.9	<0.001	−18.4	−29.9	−7.0	0.002
	White	49.9	Reference	49.0	Reference				Reference			
	Black	38.3	<0.001	40.0	−9.0	−11.0	−7.1	<0.001	−6.9	−15.2	1.4	0.10
	Other	51.0	0.33	53.3	4.3	2.0	6.6	<0.001	5.4	−7.6	18.3	0.42
Veterans without VA	Hispanic	58.6	0.66	59.0	5.0	−6.3	16.4	0.38	−5.6	−22.1	10.9	0.50
	White	61.1	Reference	53.9	Reference				Reference			
	Black	48.5	0.002	48.1	−5.8	−13.7	2.1	0.15	−3.7	−14.9	7.6	0.52
	Other	43.9	0.007	44.3	−9.6	−20.6	1.5	0.09	−8.5	−26.2	9.2	0.35
Veterans with VA	Hispanic	66.1	0.78	68.2	10.7	−0.7	22.0	0.07	Reference			
	White	64.5	Reference	57.6	Reference				Reference			
	Black	56.4	0.052	55.4	−2.1	−10.4	6.1	0.61	Reference			
	Other	58.2	0.35	56.5	−1.1	−14.0	11.8	0.87	Reference			

*Probabilities are from a logistic regression model adjusted for race/ethnicity * veteran/VA indicator interaction term and main effects; these estimates are identical to frequencies obtained from simple cross-tabulations. The p-value represents the significance of the marginal effect of each race/ethnicity group (versus White race) within each population group on the probability of vaccination. Probabilities are multiplied by 100 to produce percentage point estimates*

***All estimates are from a multivariable logistic regression model adjusted for age category (18–24, 25–34, 35–44, 45–54, 55–64, 65–74, 75+ years), sex (male, female), self-reported health (poor/fair vs. good or better), race/ethnicity, veteran/VA indicator, and a race/ethnicity * veteran/VA indicator interaction term. Effect of race by veteran/VA status represents difference in probability in vaccination by race within each population group. For instance, among non-veterans, the adjusted probability of vaccination among Hispanics is 41.2% and among Whites is 49.0%; the effect of Hispanic ethnicity among non-veterans = 41.2% – 49.0% = −7.8 pp, as shown. The effect of race among non-veterans (or among veterans without VA) vs. the effect of race among veterans with VA coverage is the difference in difference in adjusted probabilities by race/ethnicity and veteran/VA status. For instance, while the difference in vaccination among Hispanics relative to Whites = −7.8pp among non-veterans, it is 10.7pp among veterans with VA; the difference between these differences is −7.8 − 10.7 = −18.4 (slight discrepancy due to rounding)*

Table 4 Income-Based Differences in the Probability of Influenza Vaccination Among Veterans with VA Coverage, Veterans without VA Coverage, and Adult Non-Veterans

Veteran/ VA Status	Family income	Unadjusted* (*n*= 51,554) %	Unadjusted* *p*-value	Adjusted** (*n*=51,420) %	Effect of income by veteran/VA status (pp)	95 confidence interval		*p*-value	Effect of income in general population (or among veterans without VA) vs. effect of income among those with VA coverage (pp)	95 confidence interval		*p*-value
Non-Veterans	Low income	43.3	<0.001	41.1	−13.8	−15.2	−12.3	<0.001	−6.7	−13.2	−0.1	0.046
	Middle income	45.0	<0.001	46.1	−8.7	−10.2	−7.2	<0.001	−8.5	−15.6	−1.4	0.020
	High income	51.8	Reference	54.8	Reference				Reference			
Veterans w/o VA	Low income	58.1	0.36	47.3	−11.5	−17.3	−5.7	<0.001	−4.4	−12.9	4.0	0.30
	Middle income	58.3	0.39	50.8	−8.1	−13.5	−2.7	0.003	−8.0	−16.7	0.9	0.08
	High income	60.8	Reference	58.9	Reference				Reference			
Veterans w/ VA	Low income	63.6	0.34	53.2	−7.1	−13.3	−0.8	0.026	Reference			
	Middle income	63.9	0.33	60.1	−0.2	−7.1	6.7	0.95	Reference			
	High income	60.3	Reference	60.3	Reference				Reference			

pp percentage point

**Probabilities are obtained from a logistic regression model adjusted for income * veteran/VA indicator interaction term (and main effects); these estimates are identical to frequencies obtained from simple cross-tabulations. The p-value represents the significance of the marginal effect of low (or middle) income versus high income within each population group on the probability of influenza vaccination. Probabilities are multiplied by 100 to produce percentage point estimates*

***All adjusted estimates are derived from a multivariable logistic regression model adjusted for age category (18–24, 25–34, 35–44, 45–54, 55–64, 65–74, 75+ years), sex (male, female), self-reported health status (poor/fair vs. good or better), income, three-category veteran/VA indicator, and an income * veteran/VA indicator interaction term. Effect of income by veteran/VA status represents income effects within each population group. For instance, among non-Veterans, the adjusted probability of vaccination among low-income individuals is 41.1% and among high-income individuals is 54.8%; the effect of low income versus high income for this group =41.1% − 54.8% = −13.8 pp, as shown. The effect of income among non-veterans (or among veterans without VA) vs. the effect of income among those with VA coverage represents the difference in difference in probabilities by income and veteran/VA status. For instance, the difference in vaccine probability between low-income and high-income individuals is −13.8 among non-veterans and −7.1 among veterans with VA coverage. Hence, the difference between these differences = (−13.8%) − (−7.1%) = −6.7pp, as shown*

VA care in other domains, e.g., cost-related medication non-adherence[21] and COVID-19 vaccination.[3,22] Additionally, the Black-White disparities in all-cause mortality observed in the general population are not apparent among VA enrollees.[23] While disparities in some disease outcomes have been described among VA users,[24] most studies suggest that the integrated, single-tier, low-cost access provided by the VA has improved equity.

The reasons for the apparent VA advantage in influenza vaccination are uncertain. Veterans, regardless of VA coverage status, had higher rates of influenza vaccine uptake relative to non-veterans, suggesting that non-health system factors such as more frequent visits due to greater health needs are at work. The experience of military service, where vaccination is an expected and indeed mandatory requirement of duty, could also be a factor. However, the higher rate of vaccination among veterans with VA coverage relative to veterans without VA coverage — even with adjustment for demographic factors, socio-economic status, and health status — suggests that features of the VA health care delivery system are advantageous.

In the mid-1990s, the VA underwent a major reorganization[25] including a major expansion of primary care enrollment, staffing, and resources.[26] Increasing influenza vaccination uptake was one of many new quality goals, and efforts to achieve it involved increased nursing staff support and clinical reminders for providers.[13] These factors, zero or low cost-sharing for visits, and perhaps other delivery factors may facilitate the use of preventive care inclusive of vaccination and help explain our results.

Transnational comparisons could yield additional insights on the impact of integrated universal systems on vaccine uptake. However, relatively few nations have publicly owned and operated national health systems akin to the VA, and cross-national differences in influenza vaccination recommendations, and other non-health system factors, hamper comparisons. Still, one nation with a national health service (NHS), the UK, achieved higher influenza vaccination relative to the USA among those 65 and older (the population targeted for influenza vaccination in the UK) every year from 2000 to 2019, although differences were modest in some years.[27]

Our study has limitations. First, we do not know where influenza vaccination was administered — i.e. at a VA facility or elsewhere. VA coverage status and receipt of an influenza vaccination are self-reported, although the use of health surveys to assess coverage and vaccination rates is standard, and our survey estimate of the number of VA covered individuals (8.5 million) aligns with administrative data from the VA (~9 million). Finally, as with any observational study, causality cannot be established. For instance, although we controlled for multiple sociodemographic factors, greater health care contact due to greater medical needs among VA covered individuals could have contributed to our findings of higher vaccination rates in this group. On the other hand, more health care use could stem from better health care access and could be one mechanism by which VA coverage leads to better vaccination, i.e., it may lie on the causal pathway between our exposure and outcome.

Our findings have implications for the administration of other vaccines in the future, including (as seems likely) for periodic COVID-19 revaccinations.[1] The USA has lagged many peer nations in both primary COVID-19 vaccination rates and, to a greater extent, booster administration.[28] As of mid-February, despite the ongoing devastation of the Omicron wave, only half of eligible individuals had received a booster,[29] and disparities in uptake were stark.[30] Efforts to minimize health system barriers to care, as the VA has made, could prove critical to controlling both COVID-19 and future endemic and pandemic disease threats.

With declining use of non-pharmaceutical interventions for COVID-19, two developments seem likely in coming months and years. Influenza will experience a resurgence after two years of relative dormancy, and COVID-19 will transition to an endemic respiratory pathogen. Each development could worsen population health and health disparities, yet each can also be ameliorated by equitable, widespread vaccination. Integrated, universal health systems that hold an advantage in the delivery of this bedrock preventive care should be considered potential health care reform models in dealing with the health risks imposed by such pathogens.

Corresponding Author: *Adam Gaffney, MD, MPH; Harvard Medical School, Boston, MA, USA (e-mail: agaffney@cha.harvard.edu).*

Declarations:

Conflict of Interest: *Adam Gaffney, David Himmelstein, Steffie Woolhandler, and Danny McCormick are, or have served as, leaders of Physicians for a National Health Program (PNHP), a non-profit organization that favors coverage expansion through a single payer program; however, none of them receives any compensation from that group, although some of Dr. Gaffney's travel on behalf of the organization was previously reimbursed by it. The spouse of Adam Gaffney is an employee of Treatment Action Group (TAG), a non-profit research and policy think tank focused on HIV, TB, and Hepatitis C treatment.*

REFERENCES

1. **Monto AS.** The future of SARS-CoV-2 vaccination — lessons from influenza. N Engl J Med. 2021;385(20):1825–7.
2. **Haderlein TP, Wong MS, Jones KT, Moy EM, Yuan AH, Washington DL.** Racial/ethnic variation in veterans health administration COVID-19 vaccine uptake. Am J Prev Med. 2022;62(4):596–601.
3. **Gaffney AW, Woolhandler S, Himmelstein DU.** Association of uninsurance and VA coverage with the uptake and equity of COVID-19 Vaccination: January–March 2021. J Gen Intern Med [Internet]. 2022 Jan 11 [cited 2022 Jan 11]; Available from: https://doi.org/10.1007/s11606-021-07332-0
4. Estimates of the global, regional, and national morbidity, mortality, and aetiologies of lower respiratory infections in 195 countries, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016. Lancet Infect Dis. 2018;18(11):1191–210.
5. Centers for Disease Control and Prevention. Past Seasons Estimated Influenza Disease Burden. 2020 [cited 2022 Jan 27]. Available from: https://www.cdc.gov/flu/about/burden/past-seasons.html
6. **O'Halloran AC, Holstein R, Cummings C, Daily Kirley P, Alden NB, Yousey-Hindes K, et al.** Rates of influenza-associated hospitalization, intensive care unit admission, and in-hospital death by race and ethnicity in the United States from 2009 to 2019. JAMA Netw Open. 2021;4(8):e2121880.
7. **Chandrasekhar R, Sloan C, Mitchel E, Ndi D, Alden N, Thomas A, et al.** Social determinants of influenza hospitalization in the United States. Influenza Other Respir Viruses. 2017;11(6):479–88.
8. U.S. Department of Health and Human Services. Healthy People 2030. Increase the proportion of people who get the flu vaccine every year — IID-09 [Internet]. [cited 2022 Jan 28]. Available from: https://health.gov/healthypeople/objectives-and-data/browse-objectives/vaccination/increase-proportion-people-who-get-flu-vaccine-every-year-iid-09
9. **Sundaram ME, Pamplin JR.** Racial disparities in influenza vaccination. Lancet Healthy Longevity. 2021;2(3):e115–6.
10. Centers for Disease Control and Prevention. Flu Vaccination Coverage, United States, 2020–21 Influenza Season. 2021 [cited 2022 Jan 27]. Available from: https://www.cdc.gov/flu/fluvaxview/coverage-2021estimates.htm
11. **Link MW, Ahluwalia IB, Euler GL, Bridges CB, Chu SY, Wortley PM.** Racial and ethnic disparities in influenza vaccination coverage among adults during the 2004-2005 season. Am J Epidemiol. 2006;163(6):571–8.
12. **Mahmud SM, Xu L, Hall LL, Puckrein G, Thommes E, Loiacono MM, et al.** Effect of race and ethnicity on influenza vaccine uptake among older US Medicare beneficiaries: a record-linkage cohort study. Lancet Healthy Longevity. 2021;2(3):e143–53.
13. **Jha AK, Wright SM, Perlin JB.** Performance measures, vaccinations, and pneumonia rates among high-risk patients in Veterans Administration health care. Am J Public Health. 2007;97(12):2167–72.
14. **Keyhani S, Ross JS, Hebert P, Dellenbaugh C, Penrod JD, Siu AL.** Use of preventive care by elderly male veterans receiving care through the veterans health administration, medicare fee-for-service, and medicare HMO plans. Am J Public Health. 2007;97(12):2179–85.
15. **Straits-Tröster KA, Kahwati LC, Kinsinger LS, Orelien J, Burdick MB, Yevich SJ.** Racial/ethnic differences in influenza vaccination in the veterans affairs healthcare system. Am J Prev Med. 2006;31(5):375–82.
16. **Chi RC, Reiber GE, Neuzil KM.** Influenza and pneumococcal vaccination in older veterans: results from the behavioral risk factor surveillance system. J Am Geriatr Soc. 2006;54(2):217–23.
17. **Der-Martirosian C, Heslin KC, Mitchell MN, Chu K, Tran K, Dobalian A.** Comparison of the use of H1N1 and seasonal influenza vaccinations between veterans and non-veterans in the United States, 2010. BMC Public Health. 2013;13:1082.
18. Centers for Disease Control and Prevention. Survey Description, National Health Interview Survey, 2020. Available from: https://ftp.cdc.gov/pub/Health_Statistics/NCHS/Dataset_Documentation/NHIS/2020/srvydesc-508.pdf
19. **Blumberg SJ, Parker JD, Moyer BC.** National health interview survey, COVID-19, and online data collection platforms: adaptations, tradeoffs, and new directions. Am J Public Health. 2021;111(12):2167–75.
20. Centers for Disease Control. 2020 National Health Interview Survey (NHS) Codebook for Sample Adult File [Internet]. Available from: https://ftp.cdc.gov/pub/Health_Statistics/NCHS/Dataset_Documentation/NHIS/2020/adult-codebook.pdf
21. **Gaffney A, Bor DH, Himmelstein DU, Woolhandler S, McCormick D.** The effect of veterans health administration coverage on cost-related medication nonadherence. Health Affairs. 2020;39(1):33–40.
22. **Haderlein TP, Wong MS, Jones KT, Moy EM, Yuan AH, Washington DL.** Racial/ethnic variation in veterans health administration COVID-19 vaccine uptake. Am J Prev Med. 2021;S0749379721005158 62(4):596-601.
23. **Kovesdy CP, Norris KC, Boulware LE, Lu JL, Ma JZ, Streja E, et al.** Association of race with mortality and cardiovascular events in a large cohort of US veterans. Circulation. 2015;132(16):1538–48.
24. **Peterson K, Anderson J, Boundy E, Ferguson L, McCleery E, Waldrip K.** Mortality disparities in racial/ethnic minority groups in the veterans

health administration: an evidence review and map. Am J Public Health. 2018;108(3):e1–11.

25. **Kizer KW, Dudley RA.** Extreme makeover: transformation of the veterans health care system. Annu Rev Public Health. 2009;30(1):313–39.
26. **Yano EM, Simon BF, Lanto AB, Rubenstein LV.** The evolution of changes in primary care delivery underlying the veterans health administration's quality transformation. Am J Public Health. 2007;97(12):2151–9.
27. Organisation for Economic Co-Operation and Development. OECD.Stat. [cited 2022 Jul 4]. Available from: https://stats.oecd.org/index.aspx?DataSetCode=HEALTH_STAT#
28. **Mueller B, Lutz E.** U.S. Has Far Higher Covid Death Rate Than Other Wealthy Countries. The New York Times [Internet]. 2022 Feb 1 [cited 2022 Feb 26]; Available from: https://www.nytimes.com/interactive/2022/02/01/science/covid-deaths-united-states.html
29. Centers for Disease Control and Prevention. COVID Data Tracker [Internet]. 2020 [cited 2022 Feb 18]. Available from: https://covid.cdc.gov/covid-data-tracker
30. **Gaffney A, Himmelstein DU, McCormick D, Woolhandler S.** Disparities in COVID-19 vaccine booster uptake in the USA: December 2021–February 2022. J Gen Inter Med. 2022;37(11):2918–2921.

Publisher's Note: *Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.*