ORIGINAL RESEARCH

Insights Into Veterans' Motivations and Hesitancies for COVID-19 Vaccine Uptake: A Mixed-Methods Analysis

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Background: Despite the morbidity and mortality associated with COVID-19 infection, vaccine hesitancy remains a barrier to uptake. This article assessed whether unique clusters can be identified based on COVID-19–related thoughts and feelings and whether cluster membership is associated with COVID-19 vaccination. We also explored how individuals' thoughts, beliefs, and trust shape motivations and hesitancies for vaccine use.

Methods: This mixed-methods quality improvement project was conducted from July 2021 through May 2022 in Primary Care at the Veterans Affairs Pittsburgh Healthcare System. The primary outcome was self-reported COVID-19 vaccination. K-means analysis were used to identify clusters based on questionnaire responses, and multivariable logistic regression were used to assess the association between cluster membership and vaccination. We conducted qualitative interviews with patients in the 2 clusters with the lowest vaccination rates to explore vaccination motivations and hesitancies.

Results: Among 1208 respondents, 1034 (85.6%) were vaccinated. Four unique clusters were identified with vaccination rates of 29.9%, 93.3%, 93.5%, and 98.9%. Cluster membership was independently associated with vaccination, with adjusted odds ratios in the 3 most frequently vaccinated clusters of 12.1 (95% CI, 6.1-23.8), 13.0 (95% CI, 6.9-24.5), and 48.6 (95% CI, 15.5-152.0). Thematic analyses of 47 qualitative interviews found that protecting oneself and protecting others were the most common motivators for vaccination. The most common concerns were the rapid development of the vaccines and adverse effects, both more frequently endorsed in the cluster with the lowest vaccination rate.

Conclusions: Unique patient clusters based on infection- and vaccine-related thoughts and feelings are independently associated with COVID-19 vaccination. Identifiable themes regarding vaccine uptake and hesitancy vary among these clusters. These themes can be used to tailor strategies to diminish vaccine hesitancy and augment vaccination uptake among veterans.

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The SARS-CoV-2 virus has resulted in > 778 million reported COVID-19 cases and > 7 million deaths worldwide.[1] About 70% of the eligible US population has completed a primary COVID-19 vaccination series, yet only 17% have received an updated bivalent booster dose.[2] These immunization rates fall below the World Health Organization (WHO) target of 70%.[3]

Early in the pandemic, US Department of Veterans Affairs (VA) vaccination rates ranged from 46% to 71%.[4,5] Ensuring a high level of COVID-19 vaccination in the largest integrated US health care system aligns with the VA priority to provide high-quality, evidence-based care to a patient population that is older and has more comorbidities than the overall US population.[6-9]

Vaccine hesitancy, defined as a "delay in acceptance or refusal of vaccination despite availability of vaccination service," is a major contributor to suboptimal vaccination rates.[10-13] Previous studies used cluster analyses to identify the unique combinations of behavioral and social factors responsible for COVID-19 vaccine hesitancy.[10,11] Lack of perceived vaccine effectiveness and low perceived risk of the health consequences from COVID-19 infection were frequently identified in clusters where patients had the lowest intent for vaccination.[10,11] Similarly, low trust in health care practitioners (HCPs), government, and pharmaceutical companies diminished intent for vaccination in these clusters.[10] These quantitative studies were limited by their exclusive focus on unvaccinated individuals, reliance on self-reported intent, and lack of assessment of a health care system with a COVID-19 vaccine delivery program designed to overcome barriers to health care access, such as the VA.

Prior qualitative studies of vaccine uptake in distinct veteran subgroups (ie, unhoused and in VA facilities with low vaccination rates) demonstrated that overriding medical priorities among the unhoused and vaccine safety concerns were associated with decreased vaccine uptake, and positive perceptions of HCPs and the health care system

TABLE 1. Respondent Sociodemographic, Personal, and Clinical Characteristics by Cluster Membership[a,b]

Characteristics	Overall, No. (%)	Clusters				*P* value[c]
		Concerned believers, No. (%)	Unconcerned believers, No. (%)	Concerned ambivalents, No. (%)	Unconcerned disbelievers, No. (%)	
Sociodemographic characteristics						
Total	1208	375	336	298	174	
Age						< .001
< 50 y	274 (22.7)	59 (15.7)	81 (24.1)	57 (19.1)	73 (42.0)	
50-64 y	400 (33.1)	108 (28.8)	110 (32.7)	98 (32.9)	72 (41.4)	
65-84 y	382 (31.6)	154 (41.1)	95 (28.3)	105 (35.2)	23 (13.2)	
> 84 y	152 (12.6)	54 (14.4)	50 (14.9)	38 (12.8)	6 (3.5)	
Female sex	530 (43.9)	171 (45.6)	138 (41.1)	132 (44.3)	76 (43.7)	.67
Race and ethnicity						< .001
AI, AN, NH, or PI	16 (1.3)	5 (1.3)	2 (0.6)	1 (0.3)	6 (3.5)	
Asian	6 (0.5)	1 (0.3)	3 (0.9)	1 (0.3)	1 (0.6)	
Black	303 (25.1)	93 (24.9)	67 (19.9)	112 (37.7)	25 (14.5)	
Hispanic	47 (3.9)	15 (4.0)	15 (4.5)	11 (3.7)	6 (3.5)	
White	828 (68.5)	259 (69.3)	248 (73.8)	171 (57.6)	134 (77.9)	
Multiracial and/or multiethnic	3 (0.3)	1 (0.3)	1 (0.3)	1 (0.3)	0 (0)	
Urban location	914 (76.2)	296 (79.1)	255 (76.8)	229 (77.4)	118 (67.8)	.03
Highest educational level						.21
Not high school graduate	38 (3.2)	10 (2.7)	14 (4.2)	11 (3.8)	3 (1.7)	
High school graduate or equivalent	308 (25.7)	94 (25.2)	90 (26.8)	83 (28.3)	32 (18.6)	
Some college	496 (41.4)	144 (38.6)	136 (40.5)	122 (41.6)	85 (49.4)	
College graduate	208 (17.4)	67 (18.0)	57 (17.0)	44 (15.0)	37 (21.5)	
Graduate degree	142 (11.9)	56 (15.0)	37 (11.0)	32 (10.9)	14 (8.1)	
Prefer not to answer	6 (0.5)	2 (0.5)	2 (0.6)	1 (0.3)	1 (0.6)	
Personal and clinical characteristics						
Political views						< .001
Very conservative or conservative	286 (23.7)	64 (17.1)	90 (26.8)	61 (20.5)	66 (37.9)	
Moderate	324 (26.8)	111 (29.6)	87 (25.9)	83 (27.9)	37 (21.3)	
Very liberal or liberal	207 (17.2)	108 (28.8)	45 (13.4)	45 (15.1)	8 (4.6)	
Prefer not to answer	390 (32.3)	92 (24.5)	114 (33.9)	109 (36.6)	63 (36.2)	
Prior COVID-19 infection	130 (10.8)	22 (5.9)	37 (11.0)	35 (11.7)	36 (20.7)	< .001
Prior vaccination						
Influenza	1072 (88.8)	356 (94.9)	301 (89.6)	356 (94.9)	131 (75.7)	< .001
Any	1020 (84.5)	334 (89.1)	283 (84.2)	248 (83.2)	134 (77.5)	.007
Comorbidities that increase risk for severe COVID-19 illness						< .001
Yes	516 (42.8)	191 (51.1)	109 (32.5)	160 (53.7)	44 (25.3)	
No	567 (47.0)	149 (39.8)	195 (58.2)	105 (35.2)	109 (62.6)	
Unsure	123 (10.2)	34 (9.1)	31 (9.3)	33 (11.1)	21 (12.1)	

Abbreviations: AI, American Indian; AN, Alaskan Native; NH, Native Hawaiian; PI, Pacific Islander.

[a]Of 1208 total participants, 1183 had complete responses for 6 survey items related to COVID-19 infection and vaccines and were assigned to 4 clusters; data for sociodemographic, personal, and clinical characteristics were missing for < 1%.

[b]Percentages calculated after removing missing responses.

[c]Generated using χ^2 or Fisher exact test.

were associated with increased vaccine uptake.[11,12] However, these studies were conducted during periods of greater COVID-19 vaccine availability and acceptance, and prior to booster recommendations.[4,12,13]

This mixed-methods quality improvement (QI) project assessed the barriers and facilitators of COVID-19 vaccination among veterans receiving primary care at a single VA health care facility. We assessed whether unique patient clusters could be identified based on COVID-19–related and vaccine-related thoughts and feelings and whether cluster membership was associated with COVID-19 vaccination. This analysis also explored how individuals' beliefs and

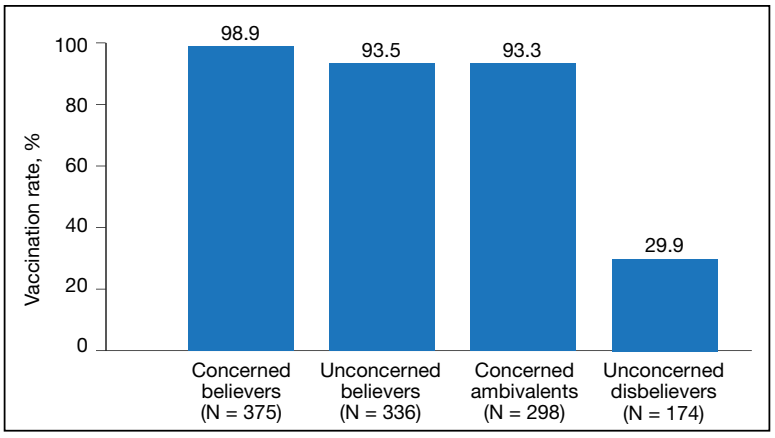

FIGURE. COVID-19 vaccination status by cluster membership. The frequency of COVID-19 vaccination varied more than 3-fold, from 29.9% among Unconcerned Disbelievers to 98.9% among Concerned Believers ($P < .001$).

trust shaped motivations and hesitancies for vaccine uptake in quantitatively derived clusters with varying vaccination rates.

METHODS

This QI project was conducted at the VA Pittsburgh Healthcare System (VAPHS), a tertiary care facility serving > 75,000 veterans in Pennsylvania, West Virginia, and Ohio. The VAPHS Institutional Review Board determined this QI study was exempt from review.[14-17] Participation was voluntary and had no bearing on VA health care or benefits. Financial support for the project, including key personnel and participant compensation, was provided by VAPHS. We followed the STROBE reporting guideline for cross-sectional studies and the COREQ checklist for qualitative research.[18,19]

Quantitative Survey

The 32,271 veterans assigned to a VAPHS primary care HCP, effective April 1, 2020, were eligible. To ensure representation of subgroups underrecognized in research and/or QI projects, the sample included all 1980 female patients at VAPHS and a random sample of 500 White and 500 Hispanic and/or non-White men within 4 age categories (< 50, 50-64, 65-84, and > 84 years). For the < 50 years or > 84 years categories, all Hispanic and/or non-White men were included due to small sample sizes.[20-22] The nonrandom sampling frame comprised 1708 Hispanic and/or non-White men and 2000 White men. After assigning the 5688 potentially eligible individuals a unique identifier, 31 opted out, resulting in a final sample of 5657 individuals.

The 5657 individuals received a letter requesting their completion of a future questionnaire about COVID-19 infection and vaccines. An electronic Qualtrics questionnaire link was emailed to 3221 individuals; nonresponders received 2 follow-up email reminders. For the 2436 veterans without an email address on file, trained interviewers conducted phone surveys and entered responses. Those patients who completed the questionnaire could enter a drawing to win 1 of 100 cash prizes valued at $100. We collected questionnaire data from July to September 2021.

Questionnaire Items

We constructed a 60-item questionnaire based on prior research on COVID-19 vaccine hesitancy and the WHO Guidebook for Immunization Programs and Implementing Partners.[4,23-25] The WHO Guidebook comprises survey items organized within 4 domains reflecting the behavioral and social determinants of vaccination: thoughts and feelings; social processes; motivation and hesitancy; and practical factors.[23]

Sociodemographic, clinical, and personal characteristics. The survey assessed respondent ethnicity and race and used these data to create a composite race and ethnicity variable. Highest educational level was also attained using 8 response options. The survey also assessed prior COVID-19 infection; prior receipt of vaccines for influenza, pneumonia, tetanus, or shingles; and presence of comorbidities that increase the risk of severe COVID-19 infection. We used administrative data from the VA Corporate Data Warehouse to determine respondent age, sex, geographic residence (urban, rural), and to fill in missing self-reported data on sex (n = 4) and ethnicity and race (n = 12). The survey assessed political views using a 5-point Likert scale (1, very liberal; 5, very conservative) and was collapsed into 3 categories (ie, very conservative or conservative, moderate, very liberal or liberal), with prefer not to answer reported separately.

COVID-19 infection and vaccine. We asked veterans if they had ever been infected with COVID-19, whether they had been offered and/or received a COVID-19 vaccine, and

type (Pfizer, Moderna, or Johnson & Johnson), and number of doses received. Positive vaccination status was defined as the receipt of ≥ 1 dose of a COVID-19 vaccine approved by the US Food and Drug Administration.

COVID-19 opinions. Respondents were asked about perceived risk of COVID-19 infection and related health outcomes, as well as beliefs about COVID-19 vaccines, using a 4-point Likert scale for all items: (1, not at all concerned; 4, very concerned). Respondents were asked about concerns related to COVID-19 infection and severe illness. They also were asked about vaccine-related short-term adverse effects (AEs) and long-term complications. Respondents were asked how effective they believed COVID-19 vaccines were at preventing infection, serious illness, or death. Unvaccinated and vaccinated veterans were asked similar items, with a qualifier of "before getting vaccinated…" for those who were vaccinated.

Social processes. Respondents were asked to rate their level of trust in various sources of COVID-19 vaccine information using a 4-point Likert scale (1, trust not at all; 4, trust very much). Respondents were asked whether community or religious leaders or close family or friends wanted them to get vaccinated (yes, no, or unsure).

Practical factors. Respondents were asked to rate the logistical difficulty of getting vaccinated or trying to get vaccinated using a 4-point Likert scale (1, not at all; 4, extremely).

Participants

Respondents were asked to participate in a follow-up qualitative interview. Among 293 participants who agreed, we sampled all 86 unvaccinated individuals regardless of cluster assignment, a random sample of 88 individuals in the cluster with the lowest vaccination rate, and all 33 vaccinated individuals in the cluster with the second-lowest vaccination rate. Forty-nine veterans completed qualitative interviews.

Two research staff trained in qualitative research completed telephone interviews, averaging 16.5 minutes (March to May 2022), using semistructured scripts to elicit vaccine-related motivations, hesitancies, or concerns. Interviews were recorded, transcribed, and deidentified. Participants provided written consent for recording and received $50 cash-equivalent compensation for interview completion.

Qualitative Interview Script

The interview script consisted of open-ended questions related to vaccine uptake across WHO domains.[23] Both unvaccinated and vaccinated respondents were asked similar questions and customized questions about boosters for the vaccinated subgroup. To assess motivations and hesitancies, respondents were asked how they made their decisions about vaccination and what they considered when deciding. Vaccinated participants were asked about motivations and overcoming concerns. Unvaccinated respondents were asked about reasons for concern. To assess social processes, the interviewers asked participants whose opinion or counsel they trusted when deciding whether to get vaccinated. Questions also focused on positive experiences and vaccination barriers. Vaccinated participants were asked what could have improved their vaccination experiences. Finally, the interviewers asked participants who received a complete primary vaccine series about their motivations and plans related to booster vaccines, and whether information about emerging COVID-19 variants influenced their decisions.

Data Analyses

This analysis used χ^2 and Fisher exact tests to assess the associations among respondent characteristics, questionnaire responses, vaccination status, and cluster membership. Items phrased similarly were handled in a similar fashion for vaccinated and unvaccinated respondents.

Cluster analysis assessed the possible groupings in responses to the quantitative questionnaire items focused on thoughts and feelings about COVID-19 infection risk and severity, vaccine effectiveness, and vaccine safety. This analysis treated the items' ordinal response categories as continuous. We performed factor analysis using principal component analysis to explore dimension reduction and account for covariance between items. Two principal components were calculated and applied k-means clustering, determining the number of clusters through agreement from the elbow, gap statistic, and silhouette

TABLE 2. Survey Responses for COVID-19 Infection- and Vaccine-Related Thoughts and Feelings, Social

Responses	Overall (N = 1208), No. (%)	Clusters				*P* value[c]
		Concerned believers (n = 375), No. (%)	Unconcerned believers (n = 336), No. (%)	Concerned ambivalents (n = 298), No. (%)	Unconcerned disbelievers (n = 174), No. (%)	
COVID-19 infection and vaccine-related thoughts and feelings						
Risk of COVID-19 infection						< .001
Not at all concerned	216 (18.3)	2 (0.5)	106 (31.6)	3 (1.0)	106 (60.9)	
Slightly concerned	230 (19.5)	13 (3.5)	151 (44.9)	14 (4.7)	52 (29.9)	
Moderately concerned	276 (23.4)	103 (27.5)	67 (19.9)	92 (30.9)	14 (8.1)	
Very concerned	460 (38.9)	257 (68.5)	12 (3.6)	189 (63.4)	2 (1.2)	
Severe COVID-19 illness risk						< .001
Not at all concerned	237 (20.1)	2 (0.5)	131 (39.0)	4 (1.3)	101 (58.1)	
Slightly concerned	221 (18.7)	18 (4.8)	135 (40.2)	15 (5.0)	53 (30.5)	
Moderately concerned	260 (22.0)	98 (26.1)	61 (18.2)	84 (28.2)	17 (9.8)	
Very concerned	464 (39.3)	257 (68.5)	9 (2.7)	195 (65.4)	3 (1.7)	
COVID-19 vaccine AE concerns						
Short-term						< .001
Not at all concerned	467 (39.5)	208 (55.5)	196 (58.3)	10 (3.4)	53 (30.5)	
Slightly concerned	332 (28.1)	139 (37.1)	120 (35.7)	44 (14.8)	29 (16.7)	
Moderately concerned	182 (15.4)	19 (5.1)	18 (5.4)	111 (37.3)	34 (19.5)	
Very concerned	201 (17.0)	9 (2.4)	2 (0.6)	133 (44.6)	58 (33.3)	
Long-term						< .001
Not at all concerned	429 (36.3)	220 (58.7)	176 (52.4)	5 (1.7)	28 (16.1)	
Slightly concerned	283 (23.9)	125 (33.3)	117 (34.8)	27 (9.1)	14 (8.1)	
Moderately concerned	177 (15.0)	20 (5.3)	37 (11.0)	95 (31.9)	25 (14.4)	
Very concerned	293 (24.8)	10 (2.7)	6 (1.8)	171 (57.4)	107 (61.5)	
COVID-19 vaccine effectiveness						
Infection						< .001
Not at all effective	108 (9.1)	0 (0)	8 (2.4)	5 (1.7)	96 (55.2)	
Slightly effective	147 (12.4)	0 (0)	51 (15.2)	35 (11.7)	61 (35.1)	
Moderately effective	379 (32.1)	80 (21.3)	154 (45.8)	131 (44.0)	14 (8.1)	
Very effective	548 (46.4)	295 (78.7)	123 (36.6)	127 (42.6)	3 (1.7)	
Severe illness and death						< .001
Not at all effective	105 (8.9)	0 (0)	13 (3.9)	4 (1.3)	89 (51.2)	
Slightly effective	145 (12.3)	5 (1.3)	42 (12.5)	35 (11.7)	63 (36.2)	
Moderately effective	371 (31.4)	76 (20.3)	153 (45.5)	121 (40.6)	21 (12.1)	
Very effective	561 (47.5)	294 (78.4)	128 (38.1)	138 (46.3)	1 (0.6)	
Sources of trust and advice						
VA health care practitioner						< .001
Trust not at all	80 (6.7)	6 (1.6)	12 (3.6)	17 (5.7)	43 (25.0)	
Trust a little	99 (8.3)	9 (2.4)	20 (6.0)	23 (7.7)	43 (25.0)	
Trust moderately	279 (23.3)	56 (15.1)	91 (27.3)	76 (25.6)	49 (28.5)	
Trust very much	739 (61.7)	299 (80.8)	211 (63.2)	181 (60.9)	37 (21.5)	

methods.[26] Each cluster was named based on its unique pattern of responses to the items used to define them (eAppendix 1; available at doi:10.12788/fp.0602).

Multivariable logistic regression analyses assessed the independent association between cluster membership as the independent measure and vaccination status as the dependent measure, adjusting for respondent sociodemographic and personal characteristics and 2 measures of trust (ie, local VA HCP and the CDC). We selected these trust measures because they represent objective sources of medical information and were independently associated with COVID-19 vaccination status in a logistic regression model comprising all 6 trust items assessed.

This study defined statistical significance as a 2-tailed *P* value < .05. SAS 9.4 was used for all statistical analyses and Python 3.7.4 and the Scikit-learn package for cluster analyses.[27] For qualitative analyses, this study used an inductive thematic approach guided by conventional qualitative content

Processes, and Practical Factors by Cluster Membership[a,b]

Responses	Overall (N = 1208), No. (%)	Clusters				*P* value[c]
		Concerned believers (n = 375), No. (%)	Unconcerned believers (n = 336), No. (%)	Concerned ambivalents (n = 298), No. (%)	Unconcerned disbelievers (n = 174), No. (%)	
Sources of trust and advice						
VA health care						< .001
Trust not at all	71 (6.0)	5 (1.4)	13 (4.0)	11 (3.8)	40 (23.4)	
Trust a little	95 (8.0)	7 (1.9)	14 (4.3)	23 (7.9)	46 (26.9)	
Trust moderately	317 (26.8)	61 (16.7)	108 (32.9)	90 (30.7)	48 (28.1)	
Trust very much	698 (59.1)	292 (80)	193 (58.8)	169 (57.7)	37 (21.6)	
State/local government leaders						< .001
Trust not at all	292 (24.9)	38 (10.4)	78 (24.2)	49 (16.8)	118 (69.0)	
Trust a little	306 (26.1)	71 (19.4)	106 (32.8)	82 (28.2)	41 (24.0)	
Trust moderately	359 (30.6)	150 (41.0)	96 (29.7)	102 (35.1)	7 (4.1)	
Trust very much	217 (18.5)	107 (29.2)	43 (13.3)	58 (19.9)	5 (2.9)	
CDC						< .001
Trust not at all	178 (15.1)	13 (3.5)	37 (11.4)	25 (8.6)	99 (57.9)	
Trust a little	174 (14.8)	24 (6.5)	52 (16.1)	52 (17.9)	41 (24.0)	
Trust moderately	339 (28.8)	97 (26.4)	125 (38.6)	92 (31.6)	20 (11.7)	
Trust very much	486 (41.3)	234 (63.6)	110 (34.0)	122 (41.9)	11 (6.4)	
Federal government leaders						< .001
Trust not at all	317 (27.0)	39 (10.6)	91 (28.1)	53 (18.2)	124 (72.5)	
Trust a little	277 (23.6)	61 (16.6)	92 (28.4)	84 (28.9)	35 (20.5)	
Trust moderately	356 (30.3)	153 (41.7)	97 (29.9)	93 (32.0)	7 (4.1)	
Trust very much	226 (19.2)	114 (31.1)	44 (13.6)	61 (21.0)	5 (2.9)	
Want you to get COVID-19 vaccine						
Community or religious leaders						< .001
Yes	549 (52.5)	196 (58.3)	138 (47.9)	151 (57.0)	59 (42.1)	
No	95 (9.1)	25 (7.4)	25 (8.7)	13 (4.9)	30 (21.4)	
Unsure	402 (38.4)	115 (34.2)	125 (43.4)	101 (38.1)	51 (36.4)	
Family or friends						< .001
Yes	748 (65.4)	286 (80.8)	201 (62.8)	207 (71.6)	41 (25.8)	
No	178 (15.6)	25 (7.1)	38 (11.9)	29 (10.0)	80 (50.3)	
Unsure	217 (19.0)	43 (12.2)	81 (25.3)	53 (18.3)	38 (23.9)	
Practical factors						
Difficulty accessing vaccine						.27
Not at all	1030 (85.5)	316 (84.3)	289 (86.0)	245 (82.5)	161 (92.5)	
Slightly	87 (7.2)	29 (7.7)	26 (7.7)	25 (8.4)	6 (3.5)	
Moderately	59 (4.9)	20 (5.3)	16 (4.8)	18 (6.1)	4 (2.3)	
Extremely	29 (2.4)	10 (2.7)	5 (1.5)	9 (3.0)	3 (1.7)	

Abbreviations: AE, adverse effect; CDC, Centers for Disease Control and Prevention; VA, US Department of Veterans Affairs.
[a]Missing responses: practical factors (< 1%), social processes (< 5%), community or religious leaders would want vaccination (13%).
[b]Percentages calculated after removing missing responses.
[c]Generated using χ^2 or Fisher exact test.

analysis, NVivo 12 Plus for Windows to code and analyze interview transcripts.[28,29] We created an initial codebook based on 10 transcripts that were selected for high complexity and represented cluster membership and vaccination status.[30,31] After 2 qualitative staff developed the initial codebook, 11 of 49 (22%) transcripts were independently coded by a primary and secondary coder to ensure consistent code application. Both coders reviewed the cocoded transcripts and resolved all discrepancies through negotiated consensus.[32] After the cocoding process was complete, the primary coder coded the remaining transcripts. The primary and secondary coder met as needed to review and discuss any questions that arose during the primary coder's work.

RESULTS

Of 5657 eligible participants, 1208 (21.4%) completed a questionnaire. Overall,

TABLE 3. Adjusted Independent Association Between Cluster Membership and COVID-19 Vaccination[a]

Variables	AOR (95% CI)	*P* value
Cluster membership		< .001
Unconcerned disbelievers	REF	
Concerned ambivalents	12.0 (6.1-23.8)	
Unconcerned believers	13.0 (6.91-24.5)	
Concerned believers	48.6 (15.5-152.1)	
Age		.10
< 50 y	REF	
50-64 y	1.0 (0.6-1.9)	
65-84 y	1.8 (0.9-3.7)	
≥ 85 y	3.8 (1.1-13.6)	
Sex		.70
Female	REF	
Male	1.1 (0.6-1.8)	
Race and ethnicity		.15
White	REF	
AI, AN, NH, or PI	0.4 (0.1-2.6)	
Asian[b]	NA	
Black	2.4 (1.2-4.7)	
Hispanic	2.4 (0.6-9.5)	
Multiracial and/or multiethnic[b]	Not applicable	
Location of residence		.62
Rural	REF	
Urban	0.9 (0.5-1.6)	
Highest educational level		.91
Less than high school	REF	
High school graduate or equivalent	1.8 (0.4-8.6)	
Some college, associate degree, or vocational school	1.5 (0.3-7.2)	
College graduate	2.0 (0.4-10.3)	
Graduate degree	1.3 (0.2-7.1)	
Political views		.15
Moderate	REF	
Very conservative or conservative	1.7 (0.9-3.4)	
Very liberal or liberal	1.5 (0.6-3.9)	
Prefer not to answer	2.2 (1.1-4.2)	
Trust in COVID-19 vaccine information provided by[c]:		
Local VA health care practitioner	2.1 (1.6-2.8)	< .001
Centers for Disease Control and Prevention	1.6 (1.2-2.1)	.002

Abbreviations: AI, American Indian; AN, Alaskan Native; AOR, adjusted odds ratio; NH, Native Hawaiian; PI, Pacific Islander; REF, reference value; VA, US Department of Veterans Affairs.
[a]Positive vaccination status was defined as the self-reported receipt of ≥ 1 doses of a US Food and Drug Administration-approved COVID-19 vaccine.
[b]Participants were not included in modeling due to small sample sizes and an absence of variation in vaccination status.
[c]Used a 4-point Likert scale.

674 (55.8%) were aged < 65 years, 530 (43.9%) were women, 828 (68.5%) were non-Hispanic White, 303 (25.1%) were Black, and 47 (3.9%) were Hispanic, and 1034 (85.6%) were vaccinated (Table 1). Compared to the total sampled population, respondents were more often older, female, and White (eAppendix 2; available at doi:10.12788/fp.0602).

Cluster Membership

Four clusters were identified from 1183 (97.9%) participants who provided complete responses to 6 items assessing thoughts and feelings about COVID-19 infection and vaccines (Table 2). Of the 1183 respondents, 375 (31.7%) were Concerned Believers (cluster 1), 336 (28.4%) were Unconcerned Believers (cluster 2), 298 (25.2%) were Concerned Ambivalents (cluster 3), and 174 (14.7%) were Unconcerned Disbelievers (cluster 4). The Concerned Believers were moderately/very concerned about COVID-19 infection (96.0%) and becoming very ill from infection (94.6%), believed the vaccine was moderately/very effective in preventing COVID-19 infection (100%) and severe illness or death from infection (98.7%), and had slight concern about short-term AEs (92.6%) or long-term complications (92.0%) from the vaccine. The Unconcerned Believers had no/slight concern about COVID-19 infection (76.5%) or becoming very ill (79.2%), believed the vaccine was effective in preventing infection (82.4%) and severe illness and death (83.6%), and had no/slight concern about short-term AEs (94.0%) or long-term complications (87.2%) from the vaccine. The Concerned Ambivalents were moderately/very concerned about COVID-19 infection (94.3%) and becoming very ill (93.6%), believed the vaccine was moderately/very effective in preventing infection (86.6%) and severe illness or death (86.9%), and were moderately/very concerned about short-term AEs (81.9%) or long-term complications (89.3%) from the vaccine. The Unconcerned Disbelievers had no/slight concern about COVID-19 infection (90.8%) and becoming very ill (88.6%), believed the vaccine was not at all/slightly effective in preventing infection (90.3%) and severe illness or death (87.4%), and were moderately/very concerned about short-term AEs (52.8%) or long-term complications (75.9%) from the vaccine.

Cluster Membership

Respondent age, race and ethnicity, and political viewpoints differed significantly by cluster ($P < .001$). Compared with the other clusters, the Concerned Believer cluster was older (55.5% age ≥ 65 years vs 16.7%-48.0%)

and more frequently reported liberal political views (28.8% vs 4.6%-15.1%). In contrast, the Unconcerned Disbeliever cluster was younger (83.4% age ≤ 64 vs 44.5%-56.8%) and more frequently reported conservative political views (37.9% vs 17.1%-26.8%) than the other clusters. Whereas the Concerned Ambivalent cluster had the highest proportion of Black (37.7%) and the lowest proportion of White respondents (57.6%), the Unconcerned Disbelievers cluster had the lowest proportion of Black respondents (14.5%) and the highest proportion of White respondents (77.9%). The Unconcerned Disbelievers cluster were significantly less likely to trust COVID-19 vaccine information from any source and to believe those close to them wanted them to get vaccinated.

Association of Cluster Membership and COVID-19 Vaccination

COVID-19 vaccination rates varied more than 3-fold ($P < .001$) by cluster, with 29.9% of Unconcerned Disbelievers, 93.3% of Concerned Ambivalents, 93.5% of Unconcerned Believers, and 98.9% of Concerned Believers reporting being vaccinated. (Figure). Cluster membership was independently associated with vaccination, with adjusted odds ratios (AORs) of 12.0 (95% CI, 6.1-23.8) for the Concerned Ambivalent, 13.0 (95% CI, 6.9-24.5) for Unconcerned Believer, and 48.6 (95% CI, 15.5-152.1) for Concerned Believer clusters (Table 3). Respondent trust in COVID-19 vaccine information from their VA HCP (AOR 2.1; 95% CI, 1.6-2.8) and the CDC (AOR 1.6; 95% CI, 1.2-2.1) were independently associated with vaccination status, while the remaining respondent sociodemographic or personal characteristics were not.

Qualitative Interview Participants

A 49-participant convenience sample completed interviews, including 30 Concerned Ambivalent, 17 Unconcerned Disbeliever, and 2 Unconcerned Believer respondents cluster. The data were not calculated for Unconcerned Believers due to the small sample size. Interview participants were more likely to be younger, female, non-Hispanic, White, less educated, and more politically conservative than the questionnaire respondents as a whole (Appendix). The vaccination rate for the interview participants was 73.5%, ranging from 29.9% in the Unconcerned Disbeliever to 93.3% in the Concerned Ambivalent cluster. Qualitative themes and participant quotes for Concerned Ambivalent and Unconcerned Disbeliever respondents are in eAppendix 3; available at doi:10.12788/fp.0602.

Motivations. Wanting personal protection from becoming infected or severely ill from COVID-19 (63.8%), caregiver wanting to protect others (17.0%), and employment vaccine requirements (14.9%) were frequent motivations for vaccination. Whereas personal protection (90.0%) and protection of others (23.3%) were identified more frequently in the Concerned Ambivalents cluster, employment vaccine requirements (35.3%) were more frequently identified in the Unconcerned Disbelievers cluster.

Hesitancies or concerns. Lack of sufficient information related to rapid vaccine development (55.3%), vaccine AEs (38.3%), and low confidence in vaccine efficacy (23.4%) were frequent concerns or hesitancies about vaccination. Unconcerned Disbelievers expressed higher levels of concern about the vaccine's rapid development (82.4%), low perceived vaccine efficacy (47.1%), and a lack of trust in governmental vaccine promotion (23.5%) than did the Concerned Ambivalents.

Overcoming concerns. Not wanting to get sick or die from infection coupled with an understanding that vaccine benefits exceed risks (23.4%) and receiving information from a trusted source (10.6%) were common ways of overcoming concerns for vaccination. Although the Unconcerned Disbelievers infrequently identified reasons for overcoming concerns, they identified employment requirements (17.6%) as a reason for vaccination despite concerns. They also identified seeing others with positive vaccine experiences and pressure from family or friends as ways of overcoming concerns (11.8% each).

Social influences. Family members or partners (38.3%), personal opinions (38.3%), and HCPs (23.4%) were frequent social influences for vaccination. Concerned Ambivalents mentioned family members and partners (46.7%), HCPs (26.7%), and friends (20.0%) as common influences, while Unconcerned Disbelievers more frequently relied on their opinion (41.2%) and quoted

specific scientifically reputable data sources (17.6%) to guide vaccine decision-making, although it is unclear whether these sources were accessed directly or if this information was obtained indirectly through scientifically unvetted data platforms.

Practical factors. Most participants had positive vaccination experiences (68.1%), determined mainly by the Concerned Ambivalents (90.0%), who were more highly vaccinated. Barriers to vaccination were reported by 9 (19.1%) participants, driven by those in the Concerned Ambivalent cluster (26.7%). Eight (17.0%) participants suggested improvements for vaccination processes, with similar overall reporting frequencies across clusters.

COVID-19 boosters and variants. Wanting continued protection from COVID-19 (36.2%), recommendations from a doctor or trusted source (17.0%), and news about emerging variants (10.6%) were frequent motivations for receiving a vaccine booster (eAppendix 4; available at doi:10.12788/fp.0602). These motivations were largely driven by the Concerned Ambivalents, of whom 25 of 30 were booster eligible and 24 received a booster dose. Belief that boosters were unnecessary (8.5%), concerns about efficacy (6.4%), and concerns about AEs (6.4%) were frequently identified hesitancies. These concerns were expressed largely by the Unconcerned Disbelievers, of whom 7 of 17 were booster dose eligible, but only 1 received a dose.

Evolving knowledge about variants was not a major concern overall and did not change existing opinions about the vaccine (36.2%). Concerned Ambivalents believed vaccination provided extra protection against variants (36.7%) and the emergence of variants served as a reminder of the ongoing pandemic (30.0%). In contrast, Unconcerned Disbelievers believed that the threat of variants was overblown (35.3%) and mutations are to be expected (17.6%).

DISCUSSION

This study used a complementary mixed-methods approach to understand the motivations, hesitancies, and social and practical drivers of COVID-19 vaccine uptake among VA beneficiaries. Our quantitative analyses identified 4 distinct clusters based on respondents' opinions on COVID-19 infection severity and vaccine effectiveness and safety. Veterans in 3 clusters were 12 to 49 times more likely to be vaccinated than those in the remaining cluster, even when controlling for baseline respondent characteristics and level of trust in credible sources of COVID-19 information. The observed vaccination rate of nearly 86% was higher than the contemporaneous national average of 62% for vaccine-eligible individuals, likely reflecting the comprehensive VA vaccine promotion strategies tailored to a patient demographic with a high COVID-19 risk profile.[2,10]

This cluster analyses demonstrated the importance of thoughts and feelings about COVID-19 infection and vaccination as influential social and behavioral drivers of vaccine uptake. These opinions help explain the strong association between cluster membership and vaccination status in this multivariable modeling. The cluster composition was consistent with findings from studies of nonveteran populations that identified perceived vulnerability to COVID-19 infection, beliefs in vaccine effectiveness, and adherence with protective behaviors during the pandemic as contributors to vaccine uptake.[13,33] Qualitative themes showed that personal protection, protecting others, and vaccine mandates were frequent motivators for vaccination. Whereas protection of self and others from COVID-19 infection were more often expressed by the highly vaccinated Concerned Ambivalents, employment and travel vaccine mandates were more often identified by Unconcerned Disbelievers, who had a lower vaccination rate. Among Unconcerned Disbelievers, an employer vaccine requirement was the most frequent qualitative theme for overcoming vaccination concerns.

In addition to cluster membership, our modeling showed that trust in local VA HCPs and the CDC were independently associated with COVID-19 vaccination, which has been found in prior research.[20] This qualitative analyses regarding vaccine hesitancy identified trust-related concerns that were more frequently expressed by Unconcerned Disbelievers than Concerned Ambivalents. Concerns included the rapid development of the vaccines potentially limiting the generation of scientifically sound effectiveness and

safety data, and potential biases involving the entities promoting vaccine uptake.

Whereas the Concerned Believers, Unconcerned Believers, and Concerned Ambivalents all had high COVID-19 vaccination rates (≥ 93%), the decision-making pathways to vaccine uptake likely differ by their concerns about COVID-19 infection and perceptions of vaccine safety and effectiveness. For example, this mixed-methods analysis consistently showed that people in the Concerned Ambivalent cluster were positively motivated by concerns about COVID-19 infection and severity and beliefs about vaccine effectiveness that were tempered by concerns about vaccine AEs. For this cluster, their frequent thematic expression that the benefits of the vaccine exceed the risks, and the positive social influences of family, friends, and HCPs may explain their high vaccination rate.

Such insights into how the patterns of COVID-19–related thoughts and feelings vary across clusters can be used to design interventions to encourage initial and booster doses of COVID-19 vaccines. For example, messaging that highlights the infectivity and severity of COVID-19 and the potential for persistent negative health outcomes associated with long COVID could reinforce the beliefs of Concerned Believers and Concerned Ambivalents, and such messaging could also be used as a targeted intervention for Unconcerned Believers who expressed fewer concerns about the health consequences of COVID-19.[23] Likewise, messaging about the safety profile of COVID-19 vaccines may reduce vaccine hesitancy for Concerned Ambivalents. Importantly, purposeful attention to health equity, community engagement, and involvement of racially diverse HCPs in patient discussions represent successful strategies to increase COVID-19 vaccine uptake among Black individuals, who were disproportionately represented in the Concerned Ambivalent cluster and may possess higher levels of mistrust due to racism experienced within the health care system.[24]

Our findings suggest that the greatest challenge for overcoming vaccine hesitancy is for individuals in the suboptimally vaccinated (30%) Unconcerned Disbeliever cluster. These individuals had low levels of concern about COVID-19 infection and severity, high levels of concern about vaccine safety, low perceived vaccine effectiveness, and low levels of trust in all information sources about COVID-19. While the Unconcerned Disbelievers cited scientifically reputable data sources, we were unable to verify whether participants accessed these reputable sources of information directly or obtained such information indirectly through potentially biased online sources. Nearly half of this cluster trusted their VA HCP and believed their community or religious leaders would want them to get vaccinated. This qualitative analyses found that Unconcerned Disbelievers relied on personal beliefs for vaccine decision-making more than Concerned Ambivalents. While Unconcerned Disbelievers were less likely to be socially influenced by family, friends, or religious leaders, they still acknowledged some impact from these sources. These findings suggest that addressing vaccine hesitancy among Unconcerned Disbelievers may require a multifaceted approach that respects their reliance on personal research while also leveraging the potential social influences. This approach supports the promising, previously reported practices of harnessing the social influences of HCPs and other community and religious leaders to promote vaccine uptake among Unconcerned Disbelievers.[34,35] One evidence-based approach to effectively change patient health care behaviors is through motivational interviewing strategies that use open-ended questions, nonjudgmental interactions, and collaborative decision-making when discussing the risks and benefits of vaccination.[21,22]

Limitations

This study was conducted at a single VA health care facility and our sampling technique was nonrandom, suggesting that these results may not be generalizable to all veterans or non-VA patient populations. The 21% questionnaire response rate could have introduced selection bias into the respondent sample. All questionnaire data were self-reported, including vaccination status. Finally, the qualitative interviews consisted of a small number of unvaccinated individuals in 2 clusters (ie, Concerned Ambivalents and Unconcerned Disbelievers) and may not have reached thematic saturation in these subgroups.

CONCLUSIONS

Quantitative analyses identified 4 clusters based on individual thoughts and feelings about COVID-19 infection and vaccines. Cluster membership and levels of trust in COVID-19 information sources were independently associated with vaccination. Understanding the quantitative patterns of thoughts and beliefs across clusters, enriched by common qualitative themes for vaccine hesitancy, help inform tailored interventions to augment COVID-19 vaccine uptake and highlight the importance of targeted, trust-based communication and culturally sensitive interventions to enhance vaccine uptake across diverse populations.

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Ethics and consent

The Veterans Affairs Pittsburgh Healthcare System Institutional Review Board determined that this study was exempt from review. Participation was voluntary and had no bearing on VA health care or benefit.

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APPENDIX. Qualitative Interview Participant Sociodemographic and Personal Characteristics by Cluster Membership

Characteristics	Overall (n = 49), No. %	Unconcerned believers (n = 2), No. %	Concerned ambivalents (n = 30), No. %	Unconcerned disbelievers (n = 17), No. %
Vaccination status				
Unvaccinated	13 (27)	1 (50)	2 (7)	10 (59)
Vaccinated	36 (74)	1 (50)	28 (93)	7 (41)
Booster	25 (51)	0 (0)	24 (80)	1 (6)
Age				
< 50 y	15 (31)	1 (50)	10 (33)	4 (24)
50-64 y	23 (47)	1 (50)	9 (30)	13 (77)
65-84 y	10 (20)	0 (0)	10 (33)	0 (0)
≥ 85 y	1 (2)	0 (0)	1 (3)	0 (0)
Sex				
Female	30 (61)	2 (100)	20 (67)	8 (47)
Male	19 (39)	0 (0)	10 (33)	9 (53)
Race and ethnicity				
AI, AN, NH, or PI	1 (2)	0 (0)	0 (0)	1 (6)
Black	9 (18)	1 (50)	6 (20)	2 (12)
Hispanic	1 (2)	0 (0)	1 (3)	0 (0)
White	38 (78)	1 (50)	23 (77)	14 (82)
Location of residence				
Rural	14 (29)	1 (50)	7 (23)	6 (35)
Urban	35 (71)	1 (50)	23 (77)	11 (65)
Highest education level				
High school graduate	9 (18)	0 (0)	7 (23)	2 (12)
Some college, associate degree, or Vocational school	16 (33)	1 (50)	10 (33)	5 (29)
College graduate	14 (29)	1 (50)	7 (23)	6 (35)
Graduate degree	10 (20)	0 (0)	6 (20)	4 (24)
Personal characteristics				
Political views				
Moderate	12 (25)	0 (0)	10 (33)	2 (12)
Very conservative or conservative	17 (35)	1 (50)	7 (23)	9 (53)
Liberal or very liberal	6 (12)	1 (50)	5 (17)	0 (0)
Prefer not to answer	14 (29)	0 (0)	8 (27)	6 (35)

Abbreviations: AI, American Indian; AN, Alaskan Native; NH, Native Hawaiian; PI, Pacific Islander;

eAPPENDIX 1. Patterns of Respondent COVID-19 Infection and Vaccine Thoughts and Feelings Underlying Naming of Clusters

Related questionnaire Items:	Concerned believers	Unconcerned believers	Concerned ambivalents	Unconcerned disbelievers
Concerns about COVID-19 illness risk and severity	↑[a]	↓[b]	↑	↓
Concerns about short and long-term vaccine safety	↓	↓	↑	↑
Beliefs about vaccine effectiveness in preventing illness and severe disease	↑	↑	↑	↓

Key: [a]↑ > 75% of cluster members have moderate to high concerns or beliefs for ≥ 1 of the relevant questionnaire items. [b]↓ > 75% of cluster members have little to no concern or beliefs for ≥ 1 of the relevant questionnaire items.

eAPPENDIX 2. Characteristics of the Sampling Frame and Questionnaire Respondents[a]

Characteristics	Sampling frame, No. (%)	Respondents No. (%
Total	5657	1208
Age		
< 50 y	1699 (30.0)	274 (22.7)
50-64 y	1785 (31.6)	400 (33.1)
65-84 y	1413 (25.0)	382 (31.6)
≥ 85 y	760 (13.4)	152 (12.6)
Female sex	1965 (34.7)	530 (43.8)
Race and ethnicity		
White	2197 (38.8)	828 (68.8)
Non-White	3449 (61.0)	375 (31.0)
Missing	11 (0.2)	5 (0.4)

[a]All characteristics were significantly different ($P < .05$) between individuals in the sampling frame and questionnaire respondents.

eAPPENDIX 3. Concerned Ambivalent and Unconcerned Disbeliever Clusters Common Qualitative Themes and Illustrative Quotes

Themes by category	Overall (N = 47)	Concerned ambivalents (n = 30)		Unconcerned disbelievers (n = 17)	
	No. (%)	No. (%)	Illustrative quotes	No. (%)	Illustrative quotes
Motivations for vaccination					
Wanting protection from becoming infected with or severely ill from COVID-19	30 (63.8)	27 (90.0)	VAX: I had COVID over Christmas of 2020. And so that was the worst experience I've ever had in my life and whatever I could do to prevent it was, that's the way I was going. UNVAX: Not dying. [Laughs]… I mean, I really don't wanna get so sick.	3 (17.6)	VAX: But as things got worse with COVID, I figured well, you know, I know that it's not gonna keep me from getting COVID, but it would probably help me from getting it as bad as I would had I not had the vaccine. So that was pretty much my deciding factor. UNVAX: Because I have children, it is the only thing that I have considered saying, 'Well, maybe I should,' 'cause I need to be here for them.
Employment vaccine requirements	7 (14.9)	1 (3.3)	VAX: Well, I'm a nurse, and I was thinking that I would, I don't wanna give it to other people if I get it. UNVAX: No relevant quotation	6 (35.3)	VAX: And then working for the government itself. They made it mandatory for us to get it, so that was another reason why I had to get it. UNVAX: The one motivating factor that I would consider getting vaccinated, probably would be the next person in line, would be if my employer required it.
Caregiver wanting to protect others	8 (17.0)	7 (23.3)	VAX: I'm a caregiver for my father. He's 94. So I made sure that he had his, that we were both then practically safe as far as you can be safe from a virus. UNVAX: No relevant quotation	1 (5.9)	VAX: No relevant quotation UNVAX: And because I have small children, because I have children, it is the only thing that I have considered saying, 'Well, maybe I should,' 'cause I need to be here for them.
Travel requirements	5 (10.6)	2 (6.7)	VAX: I was traveling at the time, too, so just going to different places and that, so I thought I should be on the safe side. UNVAX: No relevant quotation	3 (17.6)	VAX: I thought the government was gonna put restrictions on travel, more so airline travel. That was my biggest motivator was that I would not be able to travel freely about the country unless I was vaccinated. UNVAX: No relevant quotation
Information or recommendation from health care practitioner	4 (8.5)	3 (10.0)	VAX: I try to follow what the doctors say, and they all were saying to take the vaccine, so that's what I did. UNVAX: No relevant quotation	1 (5.9)	VAX: And I actually spoke with 3 different immunologists as customers about it, and at that point they were pretty upbeat and positive. One of the immunologists actually worked at a major children's hospital, and he said that he was involved with some clinical trials they were doing. And he kind of encouraged me and described the biological mechanism of how this thing was supposed to work, the mRNA, so. UNVAX: No relevant quotation
Hesitancies or concerns about vaccination					
Not enough information or time; vaccine developed too quickly	26 (55.3)	12 (40.0)	VAX: I was just nervous because it was a brand new vaccine for like a brand new disease, and that made me nervous. UNVAX: No relevant quotation	14 (82.4)	VAX: Only 'cause it was so fresh and early and the side effects. You know, it hasn't been a long enough time to actually see authentic or potential side effects from it, so that was one of my reservations, especially at the time. UNVAX: It seemed awful strange they could develop a vaccine that quickly but can't develop things for people with diabetes that quickly, or cancer. But they can develop a vaccine that was supposedly unknown and all of a sudden, they've got a vaccine right away. It took them years to develop a vaccine for mumps and measles and stuff like that, so I mean how can they develop a vaccine that quick without study.
Concerns about adverse effects	18 (38.3)	12 (40.0)	VAX: But that was my only hesitation would be the quickness of how they came out with them and the side effects, the side effects of what they could be down the road. UNVAX: No relevant quotation	6 (35.3)	VAX: You know the Johnson & Johnson. They had problems with that. You know, I mean, and you just don't know when a vaccine or medicine, any type of pharmaceutical, is so new you just don't know what the what the side effects might be and things of that nature. UNVAX: I just think that the vaccine was rushed and that they really didn't, they don't know all the side effects that could happen to the vaccine. And I just didn't feel comfortable getting it. There's been a lot of side effects that have come afterward and you know, it makes me feel even better knowing that I didn't get it.

Concerns about vaccine efficacy	11 (23.4)	3 (10.0)	VAX: Because I've been hearing about how many people were still getting COVID even though they were vaccinated. UNVAX: No relevant quotation	8 (47.1)	VAX: My main concern was whether or not this was something worth doing because it was developed pretty quick, and obviously what I know now has influenced why I haven't received a booster as well. But at the time, my main concern was, how long is this thing gonna be in my body? And what's the effectiveness of it? UNVAX: President Biden came out and said very clearly, 'Get the vaccine. You won't get sick, you won't die.' President Biden said if you get the vaccine it guarantees that you won't do this, and the fact of the matter is, is that the vaccine does not prevent you from getting sick. It does not prevent you from spreading the virus. It does not prevent you from contracting it, so, and it's not going to stop you from dying because vaccinated people were still dying and dying in large numbers.
Concerns about pregnancy, infertility, or birth control	5 (10.6)	3 (10.0)	VAX: My only concern was I guess like the findings on the different types of vaccines. I knew for women under 40 I believe there were some studies that were published on the Johnson and Johnson & possibly maybe the Moderna. I am under 40, and I have small children, and one of my child[ren] is still breastfeeding, so that was my main concern. UNVAX: No relevant quotation	2 (11.8)	VAX: And again, it all kind of just goes back to conceiving for me. I just don't know how that would affect pregnancy, and I think it's pretty bold of somebody to tell somebody who's pregnant or trying to get pregnant that they have to do that, but it might influence how they are able to conceive. UNVAX: I was pregnant and it wasn't studied during pregnancy towards the second half of the whole thing when it became required, so I was able to be, like, exempt from it. And I have not, for the simple fact of there's no evidence that it does actually work.
Vaccine is politicized; do not trust government	5 (10.6)	1 (3.3)	VAX: If it wasn't made political, I think a lot more people would have just been appreciated that they had a vaccine and took it. I think that the politics is what caused the big fuss about, 'Oh, don't take the vaccine.' UNVAX: No relevant quotation	4 (23.5)	VAX: At that point we didn't know very much I guess about what the efficacy of the vaccine was. It was being sold as a super high effective deal, and I mean, I felt that politically it was being used as a tool to control things. UNVAX: But when you have government officials doing stupid things with it, like trying to get political points or something, I don't know, but then that tells me right there. It's not about the shot or the COVID it's about maintaining a power, maintaining something. They didn't care about the people, they were more concerned about their political viewpoints.
Overcoming concerns for vaccination[a,b]					
Not wanting to get sick or die; benefits outweigh risks	11 (23.4)	10 (33.3)	VAX: I thought the worst was I could die if I didn't get it, so I better get it no matter what. No sense taking a chance. UNVAX: NA	1 (5.9)	VAX: So I figured if I'm gonna get it, I'm gonna get it. But better that I come out on the better end of it than the worse end of it. 'Cause I kind of do want to be around to see grandchildren someday. UNVAX: NA
Receiving more information from a trusted source	5 (10.6)	4 (13.3)	VAX: But just from with health care and all the scientists on it and everything, I just really didn't think that they would put out a vaccine that was going to harm people. I mean, I really think that, although it was fast tracked and all that, I just felt comfortable that it was thoroughly tested. UNVAX: NA	1 (5.9)	VAX: At that point, I think it was the immunologist that basically said that the synthetic part of the vaccine, the mRNA would be expelled from my body and that there would be no residual problems that would occur with the way the vaccine was being administered. UNVAX: NA
Seeing or hearing others' experience with the vaccine	4 (8.5)	2 (6.7)	VAX: But the other thing was, I seen people who had already got it and they had no problem, so that helped, too. UNVAX: NA	2 (11.8)	VAX: Really once I seen that people, you know just ordinary, regular, everyday people were getting it and were being OK with it, I was like you know what the heck, I might as well get it, too. UNVAX: NA
Family or friend pressure	4 (8.5)	2 (6.7)	VAX: I guess a lot of it was just my friends, saying, 'You need to do this now.' You need to do this now because, you know, I just kept trying to put it off. UNVAX: NA	2 (11.8)	VAX: I don't want to say it was an obligation, but this is what the majority of my family is doing. UNVAX: NA

Employment requirements	3 (6.4)	0 (0)	VAX: No relevant quotation UNVAX: NA	3 (17.6)	VAX: But the main thing was, I guess I believe was my job, my job security, 'cause once the government stated that federal employees had to have it, it was like either that or lose your job, so I was like I got in close to retirement time. I'm not gonna lose my job over a shot. UNVAX: NA
Social influences of others					
Family or partner	18 (38.3)	14 (46.7)	VAX: Yes, I talked to my children. My son and my daughter, and they agreed. You know because, like I said, I have underlying conditions. So they feel that it was best, too. And they both got the shots, too, so. UNVAX: No relevant quotation	4 (23.5)	VAX: I don't want to say it was an obligation, but this is what the majority of my family is doing. UNVAX: Yeah, I mean, I talked to my husband, and I talked to my sister-in-law. And you know, we talked about it, and she didn't get it, either. Neither did he. And we, none of us had any intention of getting it. We just all feel the same way, that it was too rushed, too. Quick. And now they're up to a 4th booster they're considering. I mean, that's 4 shots of stuff that's being put in your body that you don't even really know what it's gonna do.
My own opinion	18 (38.3)	11 (36.7)	VAX: My intuition. Just me. UNVAX: My own [opinion].	7 (41.2)	VAX: It was my own gathering, my own reading, my intellect. At the time I didn't know who to believe, there was so much differing and conflicting information out there, so. I can't remember any publications, but it was made with my own intellect, with me reading publications and I don't recall specifically. UNVAX: It was my own decision.
Primary care or other health care provider	11 (23.4)	8 (26.7)	VAX: Yes. I talked to my oncologist and my nephrologist, and they both thought that that would be a good idea to be vaccinated. UNVAX: No relevant quotation	3 (17.6)	VAX: I actually talked to my PCP at work. And she was pretty thorough or you know, giving me the information of the COVID – well, not the side effects, but the information on the shot itself, and you know the recommendation of it was good to have. So, I like to credit that to my PCP. UNVAX: My [non-VA] primary care physician.
Friends	6 (12.8)	6 (20.0)	VAX: Ah, I would say my primary care physician. And also family and friends who I saw get the COVID, get the virus, and how it debilitated them quite a bit. UNVAX: No relevant quotation	0 (0)	No relevant quotations for VAX or UNVAX
Media	5 (10.6)	3 (10.0)	VAX: No basically just the NBC, the reporting that they had on there from the CDC…, you know that was recommending everybody get vaccinated, and trying to prevent it. That was the train I wanted to be on. UNVAX: No relevant quotation	2 (11.8)	VAX: No relevant quotation UNVAX: Oh, I just watched a little bit of TV, and people who got vaccinated are still getting [COVID]. So why get it
Specific data sources[c]	4 (8.5)	1 (3.3)	VAX: No relevant quotation UNVAX: Several sources. Doctor, the news, Dr. Fauci, the CDC. I go online and do a lot of research, like with WebMD and Mayo Clinic and other reliable websites.	3 (17.6)	VAX: A friend of mine works in the pharmaceutical industry, and his particular corporation had a hand in developing the vaccine. So I went to a source versus something that could, an actual personal experience with it, dealing with it, versus something that was in the media. Or an open source in the media. Or doctor, CDC, anything like that. UNVAX: I looked at the CDC data, the FDA data, Johns Hopkins, University of Pittsburgh Medical Center, the UPMC data. And then that was domestically, and then I started looking at a number of universities worldwide that specialized in research and reading what the actual reports were.... I looked at renowned experts across the globe, virologists, and read what they had published.... And tried to stay out of the fray of all the hyperbole of media blitz and yeah, the narrative. I tried to stay away from the narrative as much as I could and look at the real hard science and research."
Religious influences	4 (8.5)	3 (10.0)	VAX: I said, OK, well, I'll sit here and pray about it then. And so I did, and I got a good feeling from God. So I went to go get my second shot. UNVAX: No relevant quotation	1 (5.9)	VAX: No relevant quotation UNVAX: Something deep inside of me, saying do not do it, do not do it. Then I was watching my minister on YouTube, and he said the same thing. He said, 'Anybody out there getting the feeling, do not do this?' And I said, yeah. Yeah, so he didn't do it either.

Practical factors[b]					
Positive vaccination experiences	32 (68.1)	27 (90.0)	VAX: I thought everything went well. I mean, I didn't have any problems or anything. I had talked to a couple of friends the first day, and they had, it was organized chaos, but that was to be expected the first day. And after that I went couple days later, and I didn't have any problems. I thought it was organized well, and everything went well. UNVAX: NA	5 (29.4)	VAX: It was all very convenient at the VA clinic that I go to, you know, it's very organized down there. UNVAX: NA
Barriers to vaccination[d]	9 (19.1)	8 (26.7)	VAX: I called the CBOC to make an appointment, and they just said, 'Here's the date you gotta wait until.' Ah, I can't remember it may have been like 6 weeks or whatever. Some of my veteran friends got it faster, but they went to other CBOCs. UNVAX: NA	1 (5.9)	VAX: What did not go so well at the infancy, at the beginning, it was very difficult to make an appointment. There were long phone calls you have to make and stay on hold and if you, that's even if you got through. UNVAX: NA
Suggested improvements for vaccination[e]	8 (17.0)	5 (16.7)	VAX: I think it should have been made available to anybody that wanted it. UNVAX: NA	3 (17.6)	VAX: Yeah, just if it would have been a more... a better system to sign up. And if more vaccines were available. UNVAX: NA

Abbreviations: CBOC, community-based outpatient clinic; CDC, Centers for Disease Control and Prevention; FDA, US Food and Drug Administration; PCP, primary care practitioner; UNVAX, unvaccinated for COVID-19; UPMC, University of Pittsburgh Medical Center; VAX, vaccination for COVID-19.

[a]In some instances, participants mentioned that they did not fully overcome their concerns or were required to get vaccinated or felt pressured into getting vaccinated despite their concerns.

[b]NA (not applicable) indicates that questions related to a given category of themes were not relevant to the unvaccinated subgroup, as they specifically pertained to experiences or factors associated with receiving the vaccine. These sections focused on how vaccinated individuals overcame concerns and practical aspects of their vaccination experience.

[c]"Specific data sources" was coded any time an individual named a specific source that they consulted (as opposed to the broad category of "the media"). When participants cited specific scientifically reputable data sources, we cannot confirm whether they accessed these sources directly and utilized all the recommendations created by these entities, or if they relied on interpretations of these data from other, potentially less reputable platforms.

[d]Barriers to vaccination consisted of physical distance of VA facility (n = 2), confusion about vaccine priority group (n = 2), long wait times at community-based outpatient clinics (n = 1), getting family members at non-VA facilities (n = 1), using VA insurance at non-VA pharmacies (n = 1), delays in vaccine due to intervening illness (n = 1), travel difficulties (n = 1), being too busy (n = 1), and difficulty making appointments by phone (n = 1). All barriers except difficulty making appointments were observed in the Concerned-Ambivalent cluster.

[e]Suggested improvements for vaccination consisted of social distancing in vaccination clinics (n = 3), vaccine availability for all (n = 2), better patient outreach (n = 2), greater appointment availability (n = 1), improved scheduling processes (n = 1), distribution of COVID-19 literature (n = 1), and decreasing vaccination wait times (n = 1). Improvements related to patient outreach and reducing wait times were reported by the Concerned-Ambivalent cluster; suggestions for increasing appointment availability, improving scheduling processes, and distributing educational literature were reported by the Unconcerned-Disbeliever cluster.

eAPPENDIX 4. Concerned-Ambivalent and Unconcerned-Disbeliever Clusters Decision-Making for COVID-19 Boosters

Themes by category	Overall (N = 47)	Concerned Ambivalents (n = 30)		Unconcerned Disbelievers (n = 17)	
	No. (%)	No. (%)	Illustrative quote	No. (%)	Illustrative quote
Decision-making for COVID-19 boosters[a]					
Wanting continued protection from COVID	17 (36.2)	17 (56.7)	VAX: Anything that I could do to prevent it, I was willing to do, and I wanted to do just so that I didn't get – you know, I wanted to get as much protection as I could, put it that way. UNVAX: NA	0 (0)	VAX: No relevant quotation UNVAX: NA
Doctor or trusted source recommended it	8 (17.0)	7 (23.3)	VAX: My primary care provider said since I have ulcerative colitis that she recommends me to get one. So, I kind of didn't ask no questions because it was under her recommendation, so I just went ahead and got it. UNVAX: NA	1 (5.9)	VAX: And our physicians at the VA themselves were recommending it, so it was like I said, I'm just a patient and a worker so I'm gonna take the advice of my physician. So, if she recommends it or he recommends it, you know, and they already said they received it themselves as physicians, who am I not to say you know, not to get it because they went to school, they know about it. UNVAX: NA
News about emerging variants	5 (10.6)	5 (16.7)	VAX: And at the time, that's when we had like the Delta, and the Omicron was starting, and I felt like, you know, if I was eligible then I should do it. UNVAX: NA	0 (0)	VAX: No relevant quotation UNVAX: NA
Doesn't feel booster is necessary	4 (8.5)	0 (0)	VAX: No relevant quotation UNVAX: NA	4 (23.5)	VAX: Because it seems like we may be getting on the other side of this, where these vaccines, unless you have something, you're an older person with some immunocompromised area or something – those people might need it – but the rest of the population might not. UNVAX: NA
Concerns about booster vaccine efficacy; more information needed	3 (6.4)	1 (3.3)	VAX: I think if you get the booster shots then they're gonna want you to get another shot, then it's gonna be something else, another shot. I just think they're doing it too fast to really know what they're doing, and I'm not gonna take the shots for the rest of my life because they think it might be good. But they're not even sure, so why put something into my body that they're not really sure about. UNVAX: NA	2 (11.8)	VAX: So it's not something – unless I'm required to again, I'm not interested in getting a booster. And again, until it gets more regulated, and there's been still more time.... I'll just feel more comfortable once there's a lot of science put behind it. UNVAX: NA
Concerns about vaccine or booster side effects	3 (6.4)	0 (0)	VAX: No relevant quotation UNVAX: NA	3 (17.6)	VAX: So I from what I understand, the boosters – my friends and family got sick or had like 2 to 3 days of just not feeling well. So, at that point, I was like you know, I'm just not gonna get the booster because I don't wanna be down and out for 2 to 3 days if I don't have to be. UNVAX: NA
Thoughts about COVID-19 variants					
No concerns; has not changed my opinion	17 (36.2)	7 (23.3)	VAX: It hasn't changed my opinion. The strains made me more concerned on just taking precautions, but not against the vaccine. UNVAX: Still not. I'm still not interested.	10 (58.8)	VAX: It hasn't. UNVAX: I wouldn't say it really influenced them because I know viruses usually have strains –viruses mutate. I expected it in the beginning, so I wasn't really surprised. The different strains had no effect on my decision to get vaccinated or not. It was kind of like, not a moot point, but it wasn't something that affected my decision.

Vaccine is extra protection against variants; not concerned because I'm vaccinated	11 (23.4)	11 (36.7)	VAX: I wouldn't say that they have really changed any of my thinking on the vaccination. Like, being a fully vaccinated individual, I feel like I have a better, like I guess I have a safety net, sort of speak. UNVAX: No relevant quotation	0 (0)	No relevant quotations for VAX or UNVAX
Concerns about COVID not ending; still concerned about COVID	10 (21.3)	9 (30.0)	VAX: But is this going to turn into something that's going to be an ongoing requirement? You know, I mean, is this life as we know it now? UNVAX: No relevant quotation	1 (5.9)	VAX: Yeah, if anything, the variations, the only thing I'm thankful for is – and I quizzed doctors on this one, too – you know, there's the general concept that as viruses mutate they get weaker. And I did learn that that's not always the case, and I think with the Delta variant that we saw that, but with Omicron obviously we went right back to, 'Alright, this thing is going kind of the normal direction at this point.' UNVAX: No relevant quotation
Variants are blown out of proportion	6 (12.8)	0 (0)	NA	6 (35.3)	VAX: At this point, I believe that it's more hyped up. I don't believe the information that is being put out there, that they're much more contagious. UNVAX: Sometimes I think that they went overboard regarding it. Because when the flu came out and there was different variants of flu, there wasn't all this media, OK? And there wasn't – how would you keep track of how many people died? There wasn't all that back then. So I think the media hyped up everything with how many people were dying and how many people had gotten vaccinated.
Mutations are to be expected	6 (12.8)	3 (10.0)	VAX: Well, it is a living virus, so it will mutate. It will change itself. I mean, they get immune to one substance and then they just go on to another variant. I mean, I think that we will probably be getting like an annual COVID vaccine, like we get the annual flu. UNVAX: No relevant quotation	3 (17.6)	VAX: The variations, the only thing I'm thankful for is – and I quizzed doctors on this one, too – you know, there's the general concept that as viruses mutate they get weaker. UNVAX: I wouldn't say it really influenced them because I know viruses usually have strains –viruses mutate. I expected it in the beginning, so I wasn't really surprised.

Abbreviations: VAX, vaccination for COVID-19; UNVAX, unvaccinated for COVID-19.

[a]NA (not applicable) indicates that questions related to a given category of themes were not relevant to the unvaccinated subgroup, as they specifically pertained to experiences or factors associated with receiving the vaccine. The section addressed booster shot motivations, plans, and opinions among those who received the primary vaccination series, assessing willingness for additional vaccines beyond the initial series.