ORIGINAL PAPER

COVID-19 Vaccination Attitudes and Intentions Among U.S. Soldiers: Results from the U.S. Army Behavioral Health Advisory Team (BHAT)

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Abstract
Introduction The objective of this study is to characterize the associations between demographic, attitudinal, and leadership factors with COVID-19 vaccination rates, vaccination intentions among those not vaccinated, and attitudes about vaccination safety, effectiveness, and importance.
Methods A serial cross-sectional anonymous online survey was administered to soldiers at two large U.S. Army Divisions located in the Southwestern region of the U.S. at two different time points (April-May 2021 [Time 1; T1] N = 24,629; July-August 2021 [Time 2; T2] N = 21,116). Binary logistic regressions were used to assess demographic and attitudinal predictors of vaccination receipt and vaccination intent. Multinomial logistic regressions were used to assess demographic and leadership predictors of endorsement of three vaccination attitudes concerning effectiveness, safety, and importance.
Results Approximately 43% of soldiers reported that they received a COVID-19 vaccine at T1, increasing to 67% at T2. Soldiers who agreed with three separate statements on vaccination effectiveness, safety, or importance were more likely to indicate that they intended to get the vaccination at both time points. Soldiers who reported that their immediate supervisor encouraged soldiers to get a COVID-19 vaccine were more likely to indicate that the vaccination was effective, safe, or important at both time points.
Discussion Negative attitudes about COVID-19 vaccines were prevalent and correlated with less intention to get a vaccination. However, prioritizing leadership engagement around the importance of vaccinations may be a simple but widely effective intervention point to increase future vaccine uptake following the development of novel vaccines to future COVID-19 variants.

Keywords Vaccination Attitudes · Vaccination Uptake · Vaccination Intentions · Leadership

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Introduction

The Coronavirus Disease 2019 (COVID-19) pandemic is a persistent and significant threat to U.S. military health and readiness [1–3]. While safe and effective COVID-19 vaccine options have been readily available since early 2021 [4, 5], voluntary COVID-19 vaccination rates were low enough that the U.S. Secretary of Defense mandated vaccination in August 2021 for all service members [6]. Despite the vaccination mandate, approximately 1.5% of the active duty military did not get vaccinated by the December 15,

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Table 1 Demographics, Vaccination Attitudes, and Vaccination Behaviors of Soldiers Responding to the Behavioral Health Assessment Tool (BHAT) COVID-19 Survey, Two U.S. Army Divisions, 2021 (n=45,745).*

	Time 1- April-May 2021 (n=24,629)		Time 2 - July-August 2021 (n=21,116)	
	n	%	n	%
Gender				
Male	17,894	85.0%	14,754	84.5%
Female	3,154	15.0%	2,712	15.5%
Race/Ethnicity				
White Only	9,294	45.7%	7,690	45.5%
Black or African-American Only	3,494	17.2%	2,850	16.9%
Hispanic or Latino Only	4,184	20.6%	3,525	20.9%
Other	3,353	16.5%	2,828	16.7%
Education				
High school diploma/GED	8,818	41.2%	7,120	39.8%
Some college	8,005	37.4%	6,624	37.0%
Bachelor's degree or higher	4,569	21.4%	4,160	23.2%
Rank				
Junior Enlisted (E1-E4)	11,476	54.3%	9,380	53.1%
Senior Enlisted (E5-E9)	6,606	31.2%	5,540	31.4%
Officer (W1-W5; O1-O4 and above)	3,058	14.5%	2,744	15.5%
Vaccination Attitudes				
Please rate the extent to which you agree or disagree with the following statements…				
Getting the vaccine will help decrease the spread of COVID-19 in my community.				
Strongly Disagree or Disagree	5,064	23.2%	5,115	27.8%
Neither Agree nor Disagree	8,414	38.6%	6,260	34.1%
Strongly Agree or Agree	8,344	38.2%	7,006	38.1%
The vaccine is safe.				
Strongly Disagree or Disagree	5,339	24.6%	4,617	25.1%
Neither Agree nor Disagree	10,146	46.7%	7,822	42.6%
Strongly Agree or Agree	6,249	28.8%	5,921	32.2%
Getting the vaccine is an important step in combating the pandemic.				
Strongly Disagree or Disagree	4,896	22.5%	4,675	25.5%
Neither Agree nor Disagree	8,438	38.7%	6,416	35.0%
Strongly Agree or Agree	8,463	38.8%	7,251	39.5%
Leadership Behaviors				
Please rate the extent to which you agree or disagree with the following statements about your immediate supervisor….is an effective leader.				
Strongly Disagree or Disagree	2,148	10.5%	2,021	11.4%
Neither Agree nor Disagree	4,566	22.2%	3,817	21.6%
Strongly Agree or Agree	13,830	67.3%	11,820	66.9%
For the following statements, please rate the extent to which you agree or disagree with the following statements about your immediate supervisor…				
Encourages Soldiers to get a COVID-19 vaccine.				
Strongly Disagree or Disagree	1,898	9.3%	1,893	10.3%
Neither Agree nor Disagree	8,903	43.6%	8,247	45.0%
Strongly Agree or Agree	9,624	47.1%	8,207	44.7%
Vaccination Actions/Intentions				
Since the beginning of the COVID-19 pandemic, have you received a COVID-19 vaccine?				
Yes	9,179	42.7%	12,288	67.3%
No	12,342	57.3%	5,973	32.7%
Do you intend to get the COVID-19 vaccine when it is available to you?				
Yes	2,905	23.9%	1,106	19.2%
No	9,256	76.1%	4,658	80.8%

*When examining the total responses, "Prefer not to Response" was an additional option for the Demographics question. The proportion of respondents who selected "Prefer not to respond" ranged from 4.2–8.4%. Missing or No Response ranged from 9–17.1% for each question analyzed.

Table 2 Logistic Regression of Demographics on Receiving the COVID-19 Vaccine for Soldiers Responding to the Behavioral Health Assessment Tool (BHAT) COVID-19 Survey by Time Period, Two U.S. Army Installations, 2021

	Time 1 - April-May 2021 (n = 18,936)				Time 2 - July-August 2021 (n = 15,919)			
	Est	SE	p-value	OR (95% CI)	Est	SE	p-value	OR (95% CI)
Gender (REF = Female)	0.19	0.04	< 0.0001	1.21 (1.11–1.32)	0.23	0.05	< 0.0001	1.26 (1.14–1.38)
Rank (REF = Junior Enlisted (E1-E4))	$p < 0.0001$				$p < 0.0001$			
Senior Enlisted (E5-E9)	0.42	0.04	< 0.0001	1.52 (1.42–1.63)	0.24	0.04	< 0.0001	1.28 (1.18–1.38)
Officer (W1-W5; O1-O4 and above)	0.91	0.07	< 0.0001	2.48 (2.18–2.81)	0.75	0.09	< 0.0001	2.12 (1.79–2.51)
Race/Ethnicity (REF = White)	$p < 0.0001$				$p < 0.0001$			
Black or African-American Only	-0.34	0.05	< 0.0001	0.71 (0.65–0.78)	-0.35	0.05	< 0.0001	0.70 (0.64–0.77)
Hispanic or Latino Only	0.07	0.04	0.1042	1.07 (0.99–1.16)	0.11	0.05	0.0152	1.12 (1.02–1.23)
Other	-0.04	0.04	0.4006	0.96 (0.88–1.05)	0.17	0.05	0.0015	1.18 (1.07–1.31)
Education (REF = High school diploma/GED)	$p < 0.0001$				$p < 0.0001$			
Some college	0.28	0.04	< 0.0001	1.32 (1.23–1.42)	0.26	0.04	< 0.0001	1.30 (1.20–1.41)
Bachelor's degree or higher	0.92	0.06	< 0.0001	2.52 (2.26–2.82)	0.89	0.07	< 0.0001	2.43 (2.12–2.79)

2021 deadline [7]. For the U.S. Army, 98% of the active duty component had received at least one dose of a COVID-19 vaccine before the deadline, but approximately 3,800 refused the vaccination [8]. It is essential to understand the demographics and rationale of service members who refuse to vaccinate to inform future vaccination campaigns for COVID-19 variants.

Vaccination hesitancy, or a lack of an intention to get a vaccination, may be driven by a multitude of factors. A published review of influenza vaccination prior to the COVID-19 pandemic demonstrated that influenza vaccination hesitancy is a combination of psychological barriers (e.g., perceived risk, social benefit, and subject norms), physical barriers (e.g., pre-existing medical conditions), and contextual barriers (e.g., access, interaction with the healthcare system) [9]. During the COVID-19 pandemic, studies in the U.S. have demonstrated that vaccination hesitancy is significantly associated with identification as African-American or Hispanic [10–12], lower income/educational attainment [10, 11, 13], having school-aged children at home [13], conservative political affiliation [10, 12, 13], and not having received the influenza vaccine in the past year [11]. Furthermore, vaccination hesitancy has also been associated with lower perceived threat/susceptibility of getting infected with COVID-19 [12, 13]. Despite the growing literature on vaccination hesitancy during the COVID-19 pandemic, there is a paucity of knowledge concerning attitude-based predictors of vaccination uptake and intentions in the military.

Only two studies to date have analyzed COVID-19 vaccination acceptance or hesitancy in the U.S. military. In a study of deployed soldiers (n = 1,809), vaccination acceptance rates were lowest among African-American soldiers and those in the National Guard/Reserve [14]. A second study of service members at one installation (n = 816) reported that vaccination hesitant soldiers were more likely to be concerned about short-term side effects, long-term

side effects, vaccination effectiveness, being infected with COVID-19 from the vaccine, and worry about misinformation/political agenda [15]. However, no studies in the military have assessed personnel across multiple installations. Moreover, no studies have examined variability in vaccination hesitancy over time.

Finally, Social Learning Theory posits that people learn by observing others' actions and the associated benefits of those actions. In a military setting, leadership behaviors specific to health-related outcomes (e.g., sleep leadership) [16], above and beyond general leadership qualities, appear to be a robust mechanism for positive health behavior engagement [17, 18]. We examined whether leadership encouragement of vaccinations, above and beyond general leadership, was related to vaccination attitudes and behaviors.

The objective of this manuscript is to characterize the associations between demographic, attitudinal, and leadership factors with vaccination uptake, intention to get a vaccination among those who are unvaccinated, and soldiers' vaccination attitudes. The manuscript summarizes findings from a serial cross-sectional survey (Time 1 [T1] in April-May 2021; Time 2 [T2] in July-August 2021) conducted at two large U.S. Army Divisions located in the Southwestern United States.

Methods

The Walter Reed Army Institute of Research (WRAIR) and U.S. Army Public Health Center (APHC) developed the Behavioral Health Advisory Team (BHAT) COVID-19 Survey to comprehensively assess the behavioral and public health impact of the COVID-19 pandemic on Soldiers and their families. The WRAIR and APHC administered the BHAT COVID-19 Survey electronically to all active duty soldiers at two large U.S. Army Divisions located in the

Table 3 Logistic Regression of Demographics and Vaccination Attitudes on Intending to Receive the COVID-19 Vaccine for Soldiers Responding to the Behavioral Health Assessment Tool (BHAT) COVID-19 Survey, Two U.S. Army Divisions, 2021

	Time 1 - April-May 2021 (n=9,874)				Time 2 - July-August 2021 (n=4,672)			
	Est	SE	p-value	OR (95% CI)	Est	SE	p-value	OR (95% CI)
Gender (REF=Female)	0.11	0.08	0.1831	1.11 (0.95–1.30)	-0.22	0.11	0.0452	0.80 (0.64-1.00)
Rank (REF=Junior Enlisted (E1-E4))	$p=0.42$				$p=0.85$			
Senior Enlisted (E5-E9)	0.07	0.07	0.2681	1.08 (0.94–1.23)	-0.01	0.10	0.9111	0.99 (0.81–1.21)
Officer (W1-W5; O1-O4 and above)	-0.06	0.14	0.6905	0.95 (0.72–1.24)	0.11	0.22	0.604	1.12 (0.73–1.73)
Race/Ethnicity (REF=White)	$p=0.03$				$p=0.57$			
Black or African-American Only	-0.16	0.08	0.0479	0.85 (0.73-1.00)	0.15	0.11	0.1892	1.16 (0.93–1.45)
Hispanic or Latino Only	-0.01	0.08	0.8942	0.99 (0.85–1.15)	0.06	0.11	0.6074	1.06 (0.85–1.33)
Other	0.12	0.08	0.1419	1.13 (0.96–1.33)	0.12	0.13	0.3468	1.13 (0.88–1.46)
Education (REF=High school diploma/GED)	$p=0.05$				$p=0.09$			
Some college	0.10	0.07	0.1319	1.10 (0.97–1.25)	0.02	0.10	0.8406	1.02 (0.85–1.23)
Bachelor's degree or higher	0.27	0.11	0.0182	1.31 (1.05–1.63)	-0.35	0.18	0.0472	0.70 (0.50-1.00)
Getting the vaccine will help decrease the spread of COVID-19 in my community. (REF=Strongly Diagree or Disagree)	$p<0.0001$				$p<0.0001$			
Neither Agree nor Disagree	0.09	0.10	0.3845	1.10 (0.89–1.34)	0.58	0.13	<0.0001	1.79 (1.38–2.33)
Strongly Agree or Agree	0.72	0.12	<0.0001	2.06 (1.63–2.59)	1.12	0.17	<0.0001	3.06 (2.20–4.25)
The vaccine is safe. (REF=Strongly Disagree or Disagree)	$p<0.0001$				$p<0.0001$			
Neither Agree nor Disagree	1.23	0.10	<0.0001	3.41 (2.81–4.13)	0.75	0.12	<0.0001	2.13 (1.68–2.69)
Strongly Agree or Agree	2.09	0.12	<0.0001	8.08 (6.34–10.29)	1.54	0.19	<0.0001	4.67 (3.24–6.75)
Getting the vaccine is an important step in combating the pandemic. (REF=Strongly Disagree or Disagree)	$p<0.0001$				$p<0.0001$			
Neither Agree nor Disagree	0.46	0.12	<0.0001	1.58 (1.25–1.99)	0.85	0.15	<0.0001	2.34 (1.75–3.13)
Strongly Agree or Agree	1.83	0.13	<0.0001	6.22 (4.84–7.98)	1.84	0.18	<0.0001	6.28 (4.43–8.91)
Please rate the extent to which you agree or disagree with the following statements about your immediate supervisor….is an effective leader.	$p=0.58$				$p=0.07$			
Neither Agree nor Disagree	-0.03	0.12	0.7861	0.97 (0.77–1.23)	0.30	0.17	0.0747	1.36 (0.97–1.90)
Strongly Agree or Agree	-0.09	0.11	0.4026	0.91 (0.74–1.13)	0.36	0.16	0.0207	1.44 (1.06–1.95)
[Immediate Supervisor] Encourages Soldiers to get a COVID-19 vaccine. (REF=Strongly Disagree or Disagree)	$p<0.0001$				$p=0.0002$			
Neither Agree nor Disagree	0.20	0.12	0.1133	1.22 (0.95–1.55)	0.03	0.16	0.8712	1.03 (0.75–1.41)
Strongly Agree or Agree	0.67	0.13	<0.0001	1.96 (1.53–2.51)	0.40	0.17	0.017	1.49 (1.07–2.08)

Southwestern United States. Soldiers completed the survey from 1 April through 17 May 2021 for the first time point (T1) (response rate=41%). Soldiers completed the survey for the second time point (T2) between 6 July and 13 August 2021 (response rate=35%).

Table 4 Multinomial Logistic Regression of Demographics on COVID-19 Vaccination Attitude Outcomes* for Soldiers Responding to the Behavioral Health Assessment Tool (BHAT) COVID-19 Survey, Two U.S. Army Divisions, 2021, Time 1 - April-May 2021

	Getting the vaccine will help decrease the spread of COVID-19 in my community. (n=17,905)				The vaccine is safe. (n=17,842)				Getting the vaccine is an important step in combating the pandemic. (n=17,889)			
	Est	SE	p-value	OR (95% CI)	Est	SE	p-value	OR (95% CI)	Est	SE	p-value	OR (95% CI)
Agree vs. Disagree												
Gender (REF=Female)	0.01	0.06	0.8625	1.01 (0.90–1.14)	0.18	0.06	0.0053	1.20 (1.06–1.36)	-0.02	0.06	0.6959	0.98 (0.86–1.10)
Rank (REF=Junior Enlisted (E1-E4))												
Senior Enlisted (E5-E9)	0.05	0.05	0.3018	1.05 (0.96–1.16)	0.25	0.05	<0.0001	1.28 (1.15–1.42)	0.15	0.05	0.0031	1.16 (1.05–1.28)
Officer (W1-W5; O1-O4 and above)	0.54	0.09	<0.0001	1.72 (1.44–2.06)	0.80	0.10	<0.0001	2.23 (1.85–2.69)	0.57	0.09	<0.0001	1.76 (1.47–2.12)
Race/Ethnicity (REF=White)												
Black or African-American Only	0.22	0.06	0.0004	1.25 (1.10–1.42)	0.05	0.07	0.4513	1.05 (0.92–1.20)	0.36	0.06	<0.0001	1.43 (1.27–1.62)
Hispanic or Latino Only	0.46	0.06	<0.0001	1.58 (1.41–1.76)	0.48	0.06	<0.0001	1.61 (1.43–1.82)	0.76	0.06	<0.0001	2.13 (1.90–2.39)
Other	0.28	0.06	<0.0001	1.32 (1.17–1.48)	0.29	0.06	<0.0001	1.34 (1.18–1.52)	0.45	0.06	<0.0001	1.57 (1.39–1.77)
Education (REF=High school diploma/GED)												
Some college	0.33	0.05	<0.0001	1.39 (1.26–1.53)	0.36	0.05	<0.0001	1.44 (1.30–1.59)	0.29	0.05	<0.0001	1.33 (1.21–1.47)
Bachelor's degree or higher	0.97	0.08	<0.0001	2.63 (2.24–3.08)	1.18	0.08	<0.0001	3.24 (2.75–3.83)	0.93	0.08	<0.0001	2.54 (2.16–2.99)
Please rate the extent to which you agree or disagree with the following statements about your immediate supervisor….is an effective leader.												
Neither Agree nor Disagree	0.24	0.08	0.0032	1.28 (1.08–1.50)	0.18	0.09	0.0444	1.20 (1.01–1.43)	0.35	0.08	<0.0001	1.42 (1.20–1.67)
Strongly Agree or Agree	0.35	0.07	<0.0001	1.42 (1.23–1.63)	0.33	0.08	<0.0001	1.40 (1.20–1.62)	0.40	0.07	<0.0001	1.49 (1.29–1.71)
[Immediate Supervisor] Encourages Soldiers to get a COVID-19 vaccine. (REF=Strongly Disagree or Disagree)												
Neither Agree nor Disagree	0.35	0.07	<0.0001	1.41 (1.22–1.63)	0.14	0.08	0.0693	1.16 (0.99–1.35)	0.32	0.07	<0.0001	1.37 (1.19–1.58)
Strongly Agree or Agree	1.25	0.07	<0.0001	3.48 (3.01–4.02)	1.25	0.08	<0.0001	3.48 (2.98–4.07)	1.33	0.07	<0.0001	3.79 (3.28–4.38)
Neutral vs. Disagree												
Gender (REF=Female)	-0.18	0.06	0.002	0.83 (0.74–0.94)	-0.07	0.06	0.1859	0.93 (0.83–1.04)	-0.22	0.06	0.0003	0.80 (0.71–0.90)
Rank (REF=Junior Enlisted (E1-E4))												
Senior Enlisted (E5-E9)	0.01	0.05	0.8045	1.01 (0.92–1.11)	0.14	0.05	0.0019	1.15 (1.05–1.26)	0.10	0.05	0.0324	1.11 (1.01–1.22)
Officer (W1-W5; O1-O4 and above)	-0.37	0.10	0.0004	0.69 (0.57–0.85)	0.04	0.10	0.6866	1.04 (0.86–1.26)	-0.22	0.10	0.0319	0.80 (0.65–0.98)
Race/Ethnicity (REF=White)												
Black or African-American Only	0.52	0.06	<0.0001	1.69 (1.50–1.90)	0.41	0.06	<0.0001	1.51 (1.36–1.69)	0.53	0.06	<0.0001	1.69 (1.50–1.90)
Hispanic or Latino Only	0.34	0.06	<0.0001	1.41 (1.27–1.57)	0.49	0.05	<0.0001	1.63 (1.47–1.81)	0.52	0.06	<0.0001	1.68 (1.50–1.88)
Other	0.18	0.06	0.0032	1.19 (1.06–1.34)	0.34	0.06	<0.0001	1.40 (1.25–1.57)	0.32	0.06	<0.0001	1.38 (1.22–1.55)
Education (REF=High school diploma/GED)												
Some college	-0.07	0.05	0.1488	0.94 (0.85–1.02)	-0.01	0.04	0.9017	1.00 (0.91–1.08)	-0.16	0.05	0.0005	0.85 (0.78–0.93)
Bachelor's degree or higher	-0.02	0.09	0.8484	0.98 (0.83–1.16)	0.17	0.08	0.0338	1.19 (1.01–1.39)	-0.10	0.09	0.2485	0.90 (0.76–1.07)
Please rate the extent to which you agree or disagree with the following statements about your immediate supervisor….is an effective leader.												
Neither Agree nor Disagree	0.56	0.08	<0.0001	1.76 (1.51–2.04)	0.62	0.07	<0.0001	1.86 (1.61–2.15)	0.68	0.08	<0.0001	1.97 (1.70–2.30)

Table 4 (continued)

	Getting the vaccine will help decrease the spread of COVID-19 in my community. (n=17,905)				The vaccine is safe. (n=17,842)				Getting the vaccine is an important step in combating the pandemic. (n=17,889)			
Strongly Agree or Agree	0.18	0.07	0.007	1.20 (1.05–1.38)	0.25	0.07	0.0001	1.28 (1.13–1.46)	0.19	0.07	0.007	1.20 (1.05–1.38)
[Immediate Supervisor] Encourages Soldiers to get a COVID-19 vaccine. (REF=Strongly Disagree or Disagree)												
Neither Agree nor Disagree	0.92	0.07	<0.0001	2.51 (2.19–2.88)	0.83	0.07	<0.0001	2.30 (2.01–2.62)	0.98	0.07	<0.0001	2.67 (2.33–3.08)
Strongly Agree or Agree	0.97	0.07	<0.0001	2.64 (2.29–3.06)	1.08	0.07	<0.0001	2.94 (2.56–3.37)	1.11	0.08	<0.0001	3.04 (2.62–3.52)

*All Type 3 Analysis of Effects p-values are less than 0.0001 except for Gender in the first model which is p=0.0002

The BHAT COVID-19 Survey included two screener questions to determine eligibility for participation. The first question asked potential participants about their military affiliation. If they self-identified as an Army soldier (Active Duty, Activated Reservist), they were eligible to proceed with participation. The second question asked potential participants about whether they agreed to participate. If they agreed, they proceeded with participation. The survey was voluntary, so soldiers did not have to complete any portion of the survey that they chose not to complete. All survey items were either optional or had a "Prefer not to respond" option to provide participants the opportunity to opt out of answering questions they elected not to answer. No personal identifying information was collected. No incentive was provided for completing the survey. The protocol was reviewed and approved by the Office of Human Protections at the APHC and the Institutional Review Board at the WRAIR.

The BHAT assessed a number of content areas, including demographics; information needs related to COVID-19; COVID-19 attitudes and preventive behavior engagement; COVID-19 vaccination beliefs, intentions, and uptake; COVID-19 stressors; leadership responses to the COVID-19 pandemic, and the impact of COVID-19 on soldiers' families.

The focus of this analysis is on the COVID-19 vaccination perceptions, intentions, and uptake content area. This content area included: (1) self-reported COVID-19 vaccination status; (2) intention to be vaccinated (if not yet vaccinated); (3) attitudes about vaccination effectiveness (*Getting the vaccine will help decrease the spread of COVID-19 in my community*), safety (*The vaccine is safe*), and importance (*Getting the vaccine is an important step in combating the pandemic*; (4) general leadership effectiveness (*My immediate supervisor is an effective leader*); and (5) vaccination-specific leadership behavior (*My immediate supervisor encourages Soldiers to get a COVID-19 vaccine*). Participants rated their attitudes about vaccination effectiveness, vaccination safety, vaccination importance, general leadership attitudes, and vaccination-specific leadership attitudes on a 5-point scale (1=Strongly Disagree to 5=Strongly Agree).

Data Analysis

Frequency distributions were computed for demographic and COVID-19 vaccination variables (i.e., vaccination status and intentions, attitudes, information needs, and leadership factors) for each time point. A binary logistic regression was used to determine the association between demographics and vaccination receipt for each time point. For soldiers who reported that they did not yet receive a

Table 5 Multinomial Logistic Regression of Demographics on COVID-19 Vaccination Attitude Outcomes* for Soldiers Responding to the Behavioral Health Assessment Tool (BHAT) COVID-19 Survey, Two U.S. Army Divisions, 2021, Time 2 - July-August 2021

	Getting the vaccine will help decrease the spread of COVID-19 in my community. (n=15,306)				The vaccine is safe. (n=15,285)				Getting the vaccine is an important step in combating the pandemic. (n=15,270)			
	Est	SE	p-value	OR (95% CI)	Est	SE	p-value	OR (95% CI)	Est	SE	p-value	OR (95% CI)
Agree vs. Disagree												
Gender (REF=Female)	-0.11	0.06	0.0983	0.90 (0.79-1.02)	0.07	0.07	0.2961	1.07 (0.94-1.22)	-0.27	0.07	<0.0001	0.76 (0.67-0.87)
Rank (REF=Junior Enlisted (E1-E4))												
Senior Enlisted (E5-E9)	0.02	0.05	0.7564	1.02 (0.92-1.13)	0.19	0.06	0.0008	1.21 (1.08-1.35)	0.12	0.05	0.0313	1.12 (1.01-1.25)
Officer (W1-W5; O1-O4 and above)	0.42	0.10	<0.0001	1.53 (1.27-1.84)	0.67	0.11	<0.0001	1.95 (1.59-2.39)	0.41	0.10	<0.0001	1.51 (1.24-1.83)
Race/Ethnicity (REF=White)												
Black or African-American Only	0.25	0.06	<0.0001	1.29 (1.13-1.46)	0.20	0.07	0.005	1.22 (1.06-1.40)	0.54	0.07	<0.0001	1.71 (1.50-1.96)
Hispanic or Latino Only	0.57	0.06	<0.0001	1.77 (1.58-1.99)	0.50	0.06	<0.0001	1.64 (1.45-1.86)	0.75	0.06	<0.0001	2.12 (1.88-2.39)
Other	0.50	0.06	<0.0001	1.66 (1.46-1.88)	0.42	0.07	<0.0001	1.53 (1.34-1.74)	0.59	0.07	<0.0001	1.80 (1.58-2.05)
Education (REF=High school diploma/GED)												
Some college	0.40	0.05	<0.0001	1.49 (1.35-1.65)	0.43	0.06	<0.0001	1.54 (1.38-1.72)	0.37	0.05	<0.0001	1.45 (1.31-1.61)
Bachelor's degree or higher	1.20	0.08	<0.0001	3.34 (2.83-3.93)	1.26	0.09	<0.0001	3.51 (2.94-4.19)	1.13	0.09	<0.0001	3.11 (2.62-3.68)
Please rate the extent to which you agree or disagree with the following statements about your immediate supervisor....is an effective leader.												
Neither Agree nor Disagree	0.15	0.08	0.0733	1.16 (0.99-1.37)	0.19	0.09	0.0333	1.21 (1.02-1.44)	0.18	0.09	0.0373	1.19 (1.01-1.41)
Strongly Agree or Agree	0.33	0.07	<0.0001	1.39 (1.21-1.60)	0.36	0.08	<0.0001	1.44 (1.24-1.67)	0.34	0.07	<0.0001	1.40 (1.22-1.62)
[Immediate Supervisor] Encourages Soldiers to get a COVID-19 vaccine. (REF=Strongly Disagree or Disagree)												
Neither Agree nor Disagree	0.75	0.08	<0.0001	2.11 (1.82-2.45)	0.77	0.08	<0.0001	2.16 (1.84-2.53)	0.76	0.08	<0.0001	2.14 (1.84-2.48)
Strongly Agree or Agree	1.77	0.08	<0.0001	5.89 (5.08-6.83)	1.90	0.08	<0.0001	6.69 (5.71-7.85)	1.89	0.08	<0.0001	6.62 (5.70-7.68)
Neutral vs. Disagree												
Gender (REF=Female)	-0.26	0.06	<0.0001	0.77 (0.68-0.87)	-0.05	0.06	0.4443	0.95 (0.85-1.08)	-0.38	0.07	<0.0001	0.69 (0.60-0.78)
Rank (REF=Junior Enlisted (E1-E4))												
Senior Enlisted (E5-E9)	0.00	0.05	0.952	1.00 (0.91-1.11)	0.14	0.05	0.005	1.15 (1.04-1.28)	0.13	0.05	0.0109	1.14 (1.03-1.27)
Officer (W1-W5; O1-O4 and above)	-0.21	0.11	0.057	0.81 (0.66-1.01)	0.15	0.11	0.1541	1.17 (0.94-1.44)	-0.05	0.11	0.6235	0.95 (0.76-1.18)
Race/Ethnicity (REF=White)												
Black or African-American Only	0.36	0.06	<0.0001	1.44 (1.27-1.62)	0.41	0.06	<0.0001	1.51 (1.34-1.71)	0.59	0.07	<0.0001	1.80 (1.58-2.04)
Hispanic or Latino Only	0.37	0.06	<0.0001	1.45 (1.29-1.62)	0.37	0.06	<0.0001	1.45 (1.30-1.62)	0.46	0.06	<0.0001	1.59 (1.41-1.79)
Other	0.32	0.06	<0.0001	1.38 (1.22-1.57)	0.31	0.06	<0.0001	1.37 (1.21-1.55)	0.40	0.07	<0.0001	1.49 (1.31-1.70)
Education (REF=High school diploma/GED)												
Some college	0.00	0.05	0.9864	1.00 (0.91-1.10)	0.02	0.05	0.6194	1.03 (0.93-1.13)	-0.05	0.05	0.3227	0.95 (0.86-1.05)
Bachelor's degree or higher	0.10	0.09	0.2434	1.11 (0.93-1.32)	0.33	0.09	0.0002	1.39 (1.17-1.65)	0.01	0.09	0.9445	1.01 (0.84-1.21)
Please rate the extent to which you agree or disagree with the following statements about your immediate supervisor....is an effective leader.												

Table 5 (continued)

	Getting the vaccine will help decrease the spread of COVID-19 in my community. (n=15,306)				The vaccine is safe. (n=15,285)				Getting the vaccine is an important step in combating the pandemic. (n=15,270)			
Neither Agree nor Disagree	0.50	0.08	<0.0001	1.64 (1.41–1.91)	0.55	0.08	<0.0001	1.74 (1.50–2.02)	0.61	0.08	<0.0001	1.84 (1.57–2.15)
Strongly Agree or Agree	0.09	0.07	0.1909	1.10 (0.96–1.26)	0.21	0.07	0.0015	1.24 (1.09–1.41)	0.13	0.07	0.0631	1.14 (0.99–1.31)
[Immediate Supervisor] Encourages Soldiers to get a COVID-19 vaccine. (REF = Strongly Disagree or Disagree)												
Neither Agree nor Disagree	1.56	0.07	<0.0001	4.76 (4.11–5.51)	1.48	0.07	<0.0001	4.40 (3.84–5.04)	1.51	0.07	<0.0001	4.54 (3.93–5.25)
Strongly Agree or Agree	1.33	0.08	<0.0001	3.77 (3.23–4.39)	1.42	0.07	<0.0001	4.14 (3.58–4.78)	1.33	0.08	<0.0001	3.80 (3.25–4.43)

*All Type 3 Analysis of Effects p-values are less than 0.0001 except for Gender in the first model (p = 0.0001) and second model (p = 0.11).

COVID-19 vaccination, a second binary logistic regression determined the association between vaccination intention and demographics, vaccination attitudes, and leadership behaviors for each time point. Lastly, a multinomial logistic regression determined the association between demographics and leadership factors with each of the three vaccination perceptions for each time point. Data were analyzed using SAS (version 9.4) (Cary, NC).

Results

Descriptive Statistics

The plurality of soldiers who participated were male (85%), non-Hispanic White (46%), and junior enlisted (54%) (Table 1). Three-quarters of soldiers reported a high school diploma/GED or some college as their highest level of educational attainment. The demographic profile did not differ significantly between T1 and T2.

Approximately 43% of soldiers reported that they received a COVID-19 vaccine at T1, and this percentage increased to 67% at T2. Among soldiers who reported that they had not received the vaccination at each time point, three of four reported that they did not intend to receive a vaccination at T1 (76%) and T2 (81%). Approximately one in three soldiers agreed or strongly agreed that the vaccination would help decrease the spread of COVID-19 (effectiveness), or that getting the vaccination is an important step in combating the pandemic (importance). These proportions were relatively consistent between time points. One in four soldiers agreed or strongly agreed that the vaccination is safe (safety) at both time points.

In the models that analyzed previous receipt of COVID-19 vaccination, male soldiers, senior enlisted personnel and officers/warrant officers, as well as soldiers with higher educational attainment were more likely than their respective counterparts to report to report that they had received the COVID-19 vaccine at both time points. Non-Hispanic Whites were more likely than non-Hispanic Blacks to report receiving the vaccination (Table 2).

In the models that analyzed intent to receive a COVID-19 vaccine, soldiers who agreed or strongly agreed with the statements "Getting the vaccine will help decrease the spread of COVID-19 in my community," "The vaccine is safe," or "Getting the vaccine is an important step in combating the pandemic" were more likely to indicate that they intended to get the vaccination at both time points when compared to soldiers who disagreed or strongly disagreed with the statements on vaccination effectiveness, safety, or importance (Table 3). Similarly, soldiers who agreed or strongly agreed that their immediate supervisor encourages

soldiers to get a COVID-19 vaccine, relative to those who disagreed or strongly disagreed, were more likely to report intent to receive the COVID-19 vaccine at both time points.

In the multinomial logistic regression models that assessed demographics and leadership behaviors on vaccination attitudes, Officers/warrant officers, non-White soldiers, and soldiers with higher educational attainment, relative to their respective counterparts, were more likely to agree with each of the vaccination attitudes assessed (vaccination was effective, safe, and important) for both T1 and T2 (Table 4). Additionally, soldiers who agreed or strongly agreed that their immediate supervisor was an effective leader or that their immediate supervisor encouraged soldiers to get a COVID-19 vaccine, relative to those who disagreed or strongly disagreed, were more likely to indicate that the vaccination was effective, safe, or important at both time points. These findings were consistent at T2 for each variable except perceptions of effective leadership (Table 5).

Discussion

In a survey with more than 45,000 responses collected in the late spring and summer of 2021, 43% reported that they received a COVID-19 vaccine at T1 and 67% at T2. Among soldiers who had not been vaccinated, 76% at T1 and 81% at T2 reported that they did not intend to receive the vaccine when it was available to them. Soldiers who agreed or strongly agreed with statements on vaccination effectiveness, safety, or importance were more likely to report that they intended to receive a COVID-19 vaccine when compared to soldiers who disagreed or strongly disagreed with the statements on vaccination effectiveness, safety, or importance.

These results demonstrate that public health messaging for future COVID-19 variants, and future pandemics, should target vaccination effectiveness, safety, and importance. A study conducted in the U.S. found that all four COIVD-19 vaccination video messages (treatment), compared to a placebo video, increased intentions to get vaccinated [19]. A second study in the U.S. reported that numerous types of public health messages increased COVID-19 vaccination intentions, but messages emphasizing personal health benefits were most efficacious [20]. Lastly, a study conducted in Latin American in January 2021 found that providing basic vaccination information persuaded about 8% of vaccination hesitant individuals to become willing to vaccinate [21]. Therefore, findings from this study on messaging match research in civilian samples both domestically and internationally.

Among soldiers who had not received a vaccination, an immediate supervisor encouraging COVID-19 vaccination was associated with higher intent to receive the vaccination at both time points, even after adjusting for perceptions on leader effectiveness as well as vaccination attitudes on effectiveness, safety, and importance. This finding suggests that leaders may be a particularly valuable resource for supporting public health messaging. This result is consistent with other studies of behavioral health leadership [17, 18] and represents a cost-effective method for increasing vaccination uptake among active-duty soldiers.

This analysis is subject to numerous limitations. First, the cross-sectional nature of the data precludes the ability to determine directional effects. Second, vaccination status was self-reported, although rates obtained in the survey were generally consistent with rates reported by the Department of Defense during the time of data collection [22]. Third, vaccination intention was assessed with a single binary question. Future studies assessing vaccination intention in the military should use Likert-type questions to more granularly measure hesitancy. Fourth, the Department of Defense required vaccination two weeks after the survey was closed [6]. Although the context is different, it is still valuable to understand drivers of vaccination hesitancy both for facilitating positive attitudes and for anticipating responses to future COVID-19 variants.

The data reported in this manuscript are critical to understand vaccination hesitancy among active duty soldiers in the U.S. Army. Targeting attitudes towards vaccination, coupled with encouraging military front-line leaders to encourage vaccination, may be effective strategies to address vaccination hesitancy. Public health campaigns and greater leadership encouragement appear to be critical to mitigate the threat of COVID-19 and maintain soldiers' health and readiness.

Declarations

Conflicts of interest/Competing Interests (include appropriate disclosures): The authors have no conflicts or competing interests to declare.

Ethics Approval (include appropriate approvals or waivers): The U.S. Army Public Health Center Public Health Review Board (#20–831 BHAT) and Walter Reed Army Institute of Research Institutional Review Board (#2766) determined this activity to be public health practice.

Consent to Participate (include appropriate consent statements): The following statement was included before the survey was started, "Your participation in this survey is voluntary, anonymous, and you can stop at any time. As part of collecting data to support this evaluation, you will be asked if your data can be used for possible future research purposes. Providing your consent for future use of your data is voluntary. It is up to you whether you choose to allow your data to be used for any potential future research. There are no penalties and you will not lose anything if you decide that you do not want your data to be used for research." Prospective participants were then asked "Do you agree to participate in this survey?" prior to being given the survey. Those who answered "Yes" were allowed to proceed with the survey, those who answered "No" were directed to a page with resources.

Consent for Publication (consent statement regarding publishing an individual's data or image): Not applicable.

References

1. Kasper, M. R., Geibe, J. R., Sears, C. L., Riegodedios, A. J., Luse, T., Von Thun, A. M., et al. (2020). An Outbreak of Covid-19 on an Aircraft Carrier. *New England Journal Of Medicine*, *383*(25), 2417–2426. doi: https://doi.org/10.1056/NEJMoa2019375

2. Letizia, A. G., Ramos, I., Obla, A., Goforth, C., Weir, D. L., Ge, Y., et al. (2020). SARS-CoV-2 Transmission among Marine Recruits during Quarantine. *New England Journal Of Medicine*, *383*(25), 2407–2416. doi: https://doi.org/10.1056/NEJMoa2029717

3. Letizia, A. G., Ge, Y., Goforth, C. W., Weir, D. L., Lizewski, R., Lizewski, S., et al. (2021). SARS-CoV-2 Seropositivity among US Marine Recruits Attending Basic Training, United States, Spring-Fall 2020. *Emerging Infectious Diseases*, *27*(4), 1188–1192. doi: https://doi.org/10.3201/eid2704.204732

4. Polack, F. P., Thomas, S. J., Kitchin, N., Absalon, J., Gurtman, A., Lockhart, S., et al. (2020). Safety and Efficacy of the BNT162b2 mRNA Covid-19 Vaccine. *New England Journal Of Medicine*, *383*(27), 2603–2615. doi: https://doi.org/10.1056/NEJMoa2034577

5. Baden, L. R., Sahly, E., Essink, H. M., Kotloff, B., Frey, K., Novak, S., R., et al. (2021). Efficacy and Safety of the mRNA-1273 SARS-CoV-2 Vaccine. *New England Journal Of Medicine*, *384*(5), 403–416. doi: https://doi.org/10.1056/NEJMoa2035389

6. Secretary of Defense (2021). Mandatory Coronavirus Disease 2019 Vaccination of Department of Defense Service Members. Retrieved 3/28/2022, from https://media.defense.gov/2021/Aug/25/2002838826/-1/-1/0/Memorandum-for-mandatory-coronavirus-disease-2019-vaccination-of-department-of-defense-service-members.pdf

7. CBS News (2021). Military begins discharging troops who refuse COVID-19 vaccine. Retrieved 3/28/2022, from https://www.cbsnews.com/news/covid-vaccine-military-troops-discharged/

8. Army.mil (2021). Active Army achieves 98% vaccination rate with less than 1% refusal rate. Retrieved 3/28/2022, from https://www.army.mil/article/252821/active_army_achieves_98_percent_vaccination_rate_with_less_than_one_percent_refusal_rate

9. Schmid, P., Rauber, D., Betsch, C., Lidolt, G., & Denker, M. L. (2017). Barriers of Influenza Vaccination Intention and Behavior - A Systematic Review of Influenza Vaccine Hesitancy, 2005–2016. *Plos One*, *12*(1), e0170550. doi: https://doi.org/10.1371/journal.pone.0170550

10. Tram, K. H., Saeed, S., Bradley, C., Fox, B., Eshun-Wilson, I., Mody, A., & Geng, E. (2021). Deliberation, Dissent, and Distrust: Understanding distinct drivers of COVID-19 vaccine hesitancy in the United States. *Clinical Infectious Diseases*. doi: https://doi.org/10.1093/cid/ciab633

11. Fisher, K. A., Bloomstone, S. J., Walder, J., Crawford, S., Fouayzi, H., & Mazor, K. M. (2020). Attitudes Toward a Potential SARS-CoV-2 Vaccine: A Survey of U.S. Adults. *Annals Of Internal Medicine*, *173*(12), 964–973. doi: https://doi.org/10.7326/M20-3569

12. Gerretsen, P., Kim, J., Caravaggio, F., Quilty, L., Sanches, M., Wells, S., et al. (2021). Individual determinants of COVID-19 vaccine hesitancy. *Plos One*, *16*(11), e0258462. doi: https://doi.org/10.1371/journal.pone.0258462

13. Khubchandani, J., Sharma, S., Price, J. H., Wiblishauser, M. J., Sharma, M., & Webb, F. J. (2021). COVID-19 Vaccination Hesitancy in the United States: A Rapid National Assessment. *Journal Of Community Health*, *46*(2), 270–277. doi: https://doi.org/10.1007/s10900-020-00958-x

14. Higginson, J. D., Tumin, D., Kuehhas, T. C., DeLozier-Hooks, S. E., Powell, C. A., Ramirez, D. D., et al. (2021). COVID-19 Vaccine Hesitancy Among Deployed Personnel in a Joint Environment. *Military Medicine*. doi: https://doi.org/10.1093/milmed/usab518

15. Theis, S. R., Li, P. C., Kelly, D., Ocampo, T., Berglund, A., Morgan, D., et al. (2021). Perceptions and Concerns Regarding COVID-19 Vaccination in a Military Base Population. *Military Medicine*. doi: https://doi.org/10.1093/milmed/usab230

16. Adler, A. B., Bliese, P. D., LoPresti, M. L., McDonald, J. L., & Merrill, J. C. (2021). Sleep leadership in the army: A group randomized trial. *Sleep Health*, *7*(1), 24–30. doi: https://doi.org/10.1016/j.sleh.2020.06.001

17. Adler, A. B., Saboe, K. N., Anderson, J., Sipos, M. L., & Thomas, J. L. (2014). Behavioral health leadership: new directions in occupational mental health. *Curr Psychiatry Rep*, *16*(10), 484. doi: https://doi.org/10.1007/s11920-014-0484-6

18. Booth, L. C., Schwalb, M. E., Kim, P. Y., & Adler, A. B. (2021). Health-Promoting Leadership During an Infectious Disease Outbreak: A Cross-Sectional Study of US Soldiers Deployed to Liberia. *The Journal Of Nervous And Mental Disease*, *209*(5), 362–369. doi: https://doi.org/10.1097/NMD.0000000000001305

19. Jensen, U. T., Ayers, S., & Koskan, A. M. (2022). Video-based messages to reduce COVID-19 vaccine hesitancy and nudge vaccination intentions. *Plos One*, *17*(4), e0265736. doi: https://doi.org/10.1371/journal.pone.0265736

20. Ashworth, M., Thunstrom, L., Cherry, T. L., Newbold, S. C., & Finnoff, D. C. (2021). Emphasize personal health benefits to boost COVID-19 vaccination rates. *Proc Natl Acad Sci U S A*, *118*(32), doi: https://doi.org/10.1073/pnas.2108225118

21. Argote Tironi, P., Barham, E., Zuckerman Daly, S., Gerez, J. E., Marshall, J., & Pocasangre, O. (2021). Messages that increase COVID-19 vaccine acceptance: Evidence from online experiments in six Latin American countries. *Plos One*, *16*(10), e0259059. doi: https://doi.org/10.1371/journal.pone.0259059

22. Greve, J. E. (2021). 'We need a healthy and ready force': Pentagon to mandate Covid vaccine for US military. Retrieved 4/25/2022, from https://www.theguardian.com/us-news/2021/aug/09/us-military-covid-vaccine-mandate-military