Loneliness in U.S. military veterans during the COVID-19 pandemic: A nationally representative, prospective cohort study

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ABSTRACT

Loneliness was deemed a behavioral epidemic even prior to the COVID-19 pandemic. The COVID-19 pandemic and the subsequent social distancing policy measures have raised concerns about increased social isolation and loneliness, especially in vulnerable populations such as military veterans. However, little is known about the impact of the pandemic on longitudinal changes in loneliness in veterans, and potential protective psychosocial factors that may mitigate loneliness in this population. We analyzed data from the 2019–2020 National Health and Resilience in Veterans Study, which surveyed a nationally representative, prospective cohort of 3,078 US veterans before and 1-year into the pandemic. Prevalence, and risk and protective factors associated with changes in loneliness were examined. Results revealed that the prevalence of loneliness decreased over the study period—17.3% pre-pandemic to 15.9% peri-pandemic (p = 0.032). A total of 5.4% (n = 164) of veterans reported increased loneliness, 6.4% (n = 196) decreased loneliness, and 10.6% (n = 325) persistent loneliness during the pandemic. Multivariable logistic regression models indicated that not being married/partnered, and scoring lower on pre-pandemic measures of purpose in life and cognitive functioning were most strongly associated with increased loneliness. Pre-pandemic psychiatric disorder, unpartnered marital status, and pandemic-related social restriction and financial stressors were most strongly associated with persistent loneliness. Collectively, these results suggest that, contrary to concerns, the prevalence of loneliness subtly decreased one year into the pandemic. Veterans who are not partnered, have pre-existing psychiatric conditions, and endorse more COVID-related stressors may be at higher risk for experiencing loneliness during the pandemic. Interventions that promote social connectedness, as well as that target the aforementioned risk and protective factors, may help mitigate loneliness in veterans.

1. Introduction

Loneliness is defined as the subjective distress stemming from the discrepancy between one's desired and actual social network (Hawley and Cacioppo, 2010; Russell et al., 1980). Loneliness has been deemed an emerging public health concern (Anderson and Thayer, 2018; Straus et al., 2021). Two national surveys on adults 45 or older conducted by the American Association of Retired Persons (AARP) in 2010 and 2018 demonstrated a stable, but substantially high prevalence of loneliness, with approximately 35% respondents being categorized as lonely at both time points (Anderson and Thayer, 2018; Wilson and Moulton, 2010).

Previous meta-analyses have found that loneliness is linked to a 50% greater risk of developing dementia (Kuiper et al., 2015), 30% greater risk of cardiovascular diseases such as stroke or coronary artery disease (Donovan and Blazer, 2020; Valtorta et al., 2016), and 26% increased risk of premature mortality, even after adjusting for other health factors such as depression and health-related behaviors (Donovan and Blazer, 2020; Holt-Lunstad et al., 2015). Loneliness is also associated with worse mental health outcomes, such as higher prevalence of depression, anxiety, and suicidal behavior (Anderson and Thayer, 2018; CDC Alzheimer's Disease and Healthy Aging, 2020).

Recently, the COVID-19 pandemic has adversely impacted populations across the globe, with increased social isolation, mental

distress, and excessive mortality (Czeisler et al., 2020; Faust et al., 2020). Social distancing has been encouraged to mitigate the spread of the virus and stay-at-home orders were put in place during the pandemic in many parts of the US (Luchetti et al., 2020). Consequently, there have been concerns regarding increased social isolation and loneliness, and its negative impact on both mental and physical health (Kilgore et al., 2020). A preliminary report has confirmed these concerns by showing high prevalence of loneliness during the acute early stages of the pandemic when stay at home orders were in place (Kilgore et al., 2020). Further, this study has shown that loneliness was strongly associated with greater depression and suicidal ideation.

Military veterans represent a segment of the population that may be uniquely vulnerable to adverse mental health effects of the pandemic such as increased loneliness due to their older age (i.e., median age of veterans is 65; Vespa, 2020; Wiechers et al., 2015), and higher pre-pandemic prevalence of physical disabilities, as well as psychiatric conditions (e.g., posttraumatic stress disorder [PTSD], substance use disorder, suicidal behavior) relative to the general population (Dohrenwend et al., 2006; Pietrzak et al., 2014; Villa et al., 2003; Wiechers et al., 2015; Williamson et al., 2018). In a nationally representative sample of 4,069 US military veterans surveyed prior to the pandemic in 2019, cross-sectional results revealed high prevalence of loneliness in US veterans; 56.9% of veterans endorsed experiencing loneliness *at least sometimes* (Straus et al., 2021), with 19.7% reporting feeling lonely often and 37.2% sometimes. These groups were 12- and 3-times more likely to endorse suicidal ideation, respectively, compared with those who reported hardly ever feeling lonely. Nevertheless, in addition to risk factors, veterans may also possess protective factors such as camaraderie with other veterans, which may help protect against adverse mental health outcomes such as loneliness (McCormick et al., 2019).

To date, few studies have examined longitudinal changes in loneliness during the COVID-19 pandemic. One study that analyzed data from 1,545 U.S. adults in late January/early February 2020 (immediately prior to the outbreak in the US) and followed-up in late March and April 2020 (immediately after the outbreak in the US) reported that the mean level of loneliness was stable during the study period, with a mild increase in older adults during the acute phase of the pandemic ($d = 0.14$, $p < 0.05$) (Luchetti et al., 2020). Another study of 1,679 Dutch community-dwelling older adults (age 65 to 102) surveyed in October/November 2019 and May 2020 (two months after implementation of physical distancing policy measures) revealed a substantial increase in loneliness ($d = 0.49$, $p < 0.001$). While physical distancing measures did not lead to social isolation in this cohort, personal losses and worries about the pandemic were linked to increased emotional loneliness, as well as mental health problems (van Tilburg et al., 2020).

Extant research on loneliness during the COVID-19 pandemic is limited in four ways. First, the majority of published studies have used cross-sectional or retrospective surveys conducted after the outbreak. Consequently, few studies have examined how pre-pandemic factors may relate to loneliness during the pandemic, as well as the longitudinal impact of the COVID-19 pandemic on loneliness. Second, existing longitudinal studies have focused on the general population, and less is known about the longitudinal impact of the pandemic on loneliness in a higher-risk population such as US veterans. To date, no study has examined a comprehensive range of pre- and peri-pandemic risk and protective factors for loneliness in U.S. veterans. Third, studies have mostly focused on risk factors of loneliness such as depression, anxiety, and physical conditions, and less attention has been paid to protective psychosocial factors that may mitigate loneliness during the pandemic. Fourth, it remains unknown whether COVID-related stressors may influence loneliness in U.S. veterans. Identifying pre- and peri-pandemic risk and protective factors for loneliness in U.S. veterans is important, as it may help inform targeted policy and clinical intervention strategies to help mitigate the adverse effects of loneliness in this population.

To address these gaps and extend results of our cross-sectional, pre-pandemic study of loneliness (Straus et al., 2021), we analyzed data from the National Health and Resilience in Veterans Study (NHRVS), which surveyed a prospective, nationally representative sample of U.S. veterans (Hill et al., in press). We had two aims: 1) to examine longitudinal changes in loneliness from pre-to 1 year into the pandemic; and 2) to identify pre- and peri-pandemic risk and protective factors associated with courses of loneliness during the pandemic. Potential risk and protective factors were selected based on the significant correlates of loneliness identified from our previous study (Straus et al., 2021) as well as previous literature on loneliness prior to (Anderson and Thayer, 2018; Leigh-Hunt et al., 2017; Wang et al., 2018) and during the COVID-19 pandemic (Bu et al., 2020; Luchetti et al., 2020; van Tilburg et al., 2020).

2. Materials and methods

2.1. Participants

Data were analyzed from the NHRVS, a nationally representative prospective survey of U.S. military veterans. A total of 4,069 veterans completed the Wave 1 (median completion date: 11/21/2019) survey prior to the first documented COVID-19 cases in the US and 3,078 (75.6%) completed a Wave 2 1-year follow-up (median completion date: 11/14/2020) survey. The Wave 1 survey will be referred to "pre-pandemic survey" and Wave 2 survey will be referred to "peri-pandemic survey." Details of the study, including the recruitment protocol, has been described previously (Hill et al., in press). Briefly, the NHRVS sample was drawn from KnowledgePanel®, a survey research panel of more than 50,000 U.S. households maintained by Ipsos, a survey research firm. To ensure generalizability of the results to the U.S. veteran population, poststratification weights were computed based on the demographic distribution of veterans in the Veterans Supplement of the U.S. Census Current Population Survey. The study protocol was approved by the Human Subjects Subcommittee of the VA Connecticut Healthcare System, and all participants provided informed consent.

2.2. Measures

2.2.1 Loneliness. Loneliness was assessed using a three-item measure adapted from the UCLA Loneliness Scale-Revised (Hughes et al., 2004). This scale evaluates three aspects of loneliness: the degree to which one feels left out, isolated, and experiences a lack of companionship in a three-point Likert scale (1 for *hardly ever*, 2 for *some of the time*, or 3 for *often*; total score range = 3–9). Given that distributions of loneliness scores was zero-inflated, non-normal, and positively skewed (Kolmogorov-Smirnov test statistic = 0.254 and 0.275 for pre- and peri-pandemic loneliness scores, both p's < 0.001), loneliness was operationalized as a dichotomous variable; *often lonely* (i.e., score of 3 on any item) or *not often lonely* (i.e., *hardly ever* or *some of the time*; i.e., score of <3 on all items). This approach to operationalizing feeling lonely often has been used in prior work (Perissinotto et al., 2012; Straus et al., 2021), and identified 94.7% and 95.7% of veterans with a cut score ≥6 (Steptoe et al., 2013; Mullen et al., 2019; Groarke et al., 2020) at both the pre- and peri-pandemic assessments, respectively (the remaining 5.3% and 4.3% of veterans in the often lonely groups had scores of 5). Using these operationalizations, the sample was further classified into four subgroups: no loneliness (i.e., *not often lonely* at both pre- and peri-pandemic assessments), increased loneliness (i.e., *not often lonely* at pre-pandemic assessment but *often lonely* at peri-pandemic assessment), decreased loneliness (i.e., *often lonely* at pre-pandemic assessment but *not often lonely* at peri-pandemic assessment), and persistent loneliness (i.e., *often lonely* at both pre- and peri-pandemic assessments).

Table 1 presents a detailed description of measures used to assess sociodemographic characteristics, pre-pandemic risk and protective factors and pandemic-related variables.

Table 1
Sociodemographic and potential risk and protective factors examined in relation to loneliness in U.S. veterans.

Sociodemographic characteristics	Age (continuous), gender (dichotomous: male vs female), race (dichotomous: White, non-Hispanic vs Black, non-Hispanic, Hispanic, or bi/multi-racial or other race), education (dichotomous: college graduate or higher vs up to high school diploma), marital status (dichotomous: married/living with partner vs unmarried), income (dichotomous: $60,000 or more vs less than $60,000) and employment (dichotomous: working vs retired).
Risk factors	
Current psychological distress	MDD – measured using the two depressive symptoms of the PHQ-4 occurring in the past two weeks; a score ≥3 was indicative of a positive screen for MDD (Kroenke et al., 2009); PTSD – assessed with the PTSD Checklist for DSM-5; a score ≥33 was indicative of a positive screen for PTSD (Weathers et al., 2013a); GAD – assessed with the two generalized anxiety items of the PHQ-4 occurring in the past two weeks; a score ≥3 was indicative of a positive screen for GAD (Kroenke et al., 2009).
Current AUD/DUD	AUD was assessed using the AUDIT, a validated measure used to screen for AUD. The AUDIT consists of 10 questions that assess severity of alcohol consumption and consequences and yield a total score ranging from 0 to 40. A score of 8 or higher was indicative of a positive screen for AUD (Bohn et al., 1995). Drug use severity was assessed with the questions from the Screen of Drug Use (Tiet et al., 2015): "How many days in the past year have you used non-prescription drugs?" A response of 7 or more days on this question was indicative of a positive screen for DUD; if the response to this question is 6 or fewer days, a response of 2 or more days to the question "How many days in the past 12 months have you used drugs more than you meant to?" is indicative of a positive screen for DUD.
Adverse childhood experiences	Score on Adverse Childhood Experiences Questionnaire (Felitti et al., 1998).
Cumulative trauma burden	Count of potentially traumatic events on the Life Events Checklist for DSM-5 (Weathers et al., 2013b).
Lifetime suicide attempt	Positive endorsement to the following question: "Have you ever tried to kill yourself?"
Current mental health treatment	Positive endorsement of current treatment with psychotropic medication and/or psychotherapy or counseling: "Are you currently taking prescription medication for a psychiatric or emotional problem?", "Are you currently receiving psychotherapy or counseling for a psychiatric or emotional problem?"
Cognitive functioning	Cognitive functioning was assessed by the Medical Outcomes Study Cognitive Functioning Scale (Stewart et al., 1992)
Number of medical conditions	Sum of number of medical conditions endorsed in response to question: "Has a doctor or healthcare professional ever told you that you have any of the following medical conditions?" (e.g., arthritis, cancer, diabetes, heart disease, asthma, kidney disease). Range: 0–24 conditions.
Any disability	Any disability in activities of daily living and activities of daily living. The following questions were asked: "At the present time, do you need help from another person to do the following?" (e.g., bathe; walk around your home or apartment; get in and out of chair), "At the present time, do you need help from another person to do the following?" (e.g., pay bills or manage money; prepare bills; get dressed). Endorsement of any of these activities

Table 1 (*continued*)

Sociodemographic characteristics	Age (continuous), gender (dichotomous: male vs female), race (dichotomous: White, non-Hispanic vs Black, non-Hispanic, Hispanic, or bi/multi-racial or other race), education (dichotomous: college graduate or higher vs up to high school diploma), marital status (dichotomous: married/living with partner vs unmarried), income (dichotomous: $60,000 or more vs less than $60,000) and employment (dichotomous: working vs retired).
	was indicative of having a disability (Hardy and Gill, 2004).
Protective factors	
Personality factors	Assessed using the Ten-Item Personality Inventory (TIPI; Gosling, Rentfrow, & Swann, 2003), a 10-item self-report brief measure of the "Big Five" personality traits of emotional stability (anxious vs confident and calm), extraversion (outgoing vs reserved), openness to experience (imaginative and inventive vs cautious and routine-like), agreeableness (friendly and cooperative vs detached), and conscientiousness (efficient and organized vs careless).
Purpose in life	Score on Purpose in Life Test-Short Form (Schulenberg et al., 2010).
Dispositional optimism	Score on single-item measure of optimism from Life Orientation Test-Revised (Scheier et al., 1994); "In uncertain times, I usually expect the best"; (rating 1 = strongly disagree to 7 = strongly agree).
Community integration	Perceived level of community integration: "I feel well integrated in my community (e.g., regularly participate in community activities); " (rating 1 = strongly disagree to 7 = strongly agree).
Religiosity/spirituality	Score on the Duke University Religion Index (DUREL; Koenig and Büssing, 2010).
Change variables (from pre-pandemic to peri-pandemic)	Changes in psychological distress
COVID-19 variables (peri-pandemic)	COVID infection status (self, or household/non-household member) using a questionnaire developed by the National Center for PTSD. COVID-related worries, social restriction stress, financial stress, and relationship difficulties were assessed based on the Coronavirus Health Impact Survey (NIMH Intramural Research Program, 2020). COVID-related worries (e.g., "In the past month, how worried have you been about being infected with coronavirus?"); COVID-social restriction stress (e.g., "How stressful have these changes in social contacts been for you?"); COVID-related financial hardship (e.g., "In the past month, to what degree have changes related to the pandemic created financial problems for you or your family?"); COVID-related relationship difficulties (e.g., "Has the quality of the relationships between you and members of your family changed?"); and COVID-related social engagement (e.g., "In the past month, how many people, from outside of your household, have you had an in-person conversation with?"). COVID-related PTSD symptoms were assessed using the 4-item PTSD Checklist for DSM-5 (Geier et al., 2020) (score range = 0–16; sample item: "Thinking about the Coronavirus/COVID-19 pandemic, please indicate how much you have been bothered by repeated, disturbing, and unwanted memories of the pandemic"); a score ≥5 is indicative of a positive screen for PTSD.

AUD = alcohol use disorder, AUDIT=Alcohol Use Disorders Identification Test, ADL = activities of daily living, COVID = coronavirus disease, DSM-5 = Diagnostic and Statistical Manual of Mental Disorders, 5th edition, DUD = drug use disorder, GAD = generalized anxiety disorder, IADL = instrumental activities of

daily living, MDD = major depressive disorder, PHQ = patient health questionnaire, PTSD = posttraumatic stress disorder, SUD = substance use disorder.

2.3. Statistical analysis

Data analyses proceeded in three steps. First, chi-square and analyses of variance (ANOVA) were conducted to compare sociodemographic, psychosocial and health-related characteristics between the four subgroups of veterans. Second, a binary multivariable logistic regression analysis with a data-driven estimation method (Backward Wald) was conducted to identify pre-pandemic, peri-pandemic, and pre-to-peri-pandemic changes in risk and protective factors that independently differentiated increased loneliness vs. no loneliness, and persistent loneliness vs. decreased loneliness subgroups; we employed an inclusive approach to variable selection by entering variables that differed at the p < 0.05 level in bivariate analyses into these models. The two comparisons were chosen to identify correlates of loneliness that may be most clinically relevant. Third, relative importance analyses of significant correlates of symptomatic loneliness courses were conducted to identify which explained the majority of variance in these courses.

3. Results

3.1. Baseline characteristics and prevalence of loneliness course

The average age of participants was 62.2 years (SD = 15.7: range 22–99); the majority were male (90.2%), and White, non-Hispanic (78.1%), and 35.0% were combat veterans. At baseline, 17.3% of veterans endorsed feeling *often lonely* compared to 15.9% of veterans at the peri-pandemic assessment. A McNemar test revealed that in the full sample of 3,078 veterans, the prevalence of loneliness decreased during the pandemic (p = 0.032).

Table 2 presents the prevalence of loneliness at the pre-pandemic and peri-pandemic assessments. Loneliness significantly decreased from 17.3% pre-pandemic to 15.9% peri-pandemic in the full sample, as well as among female veterans (31.1% pre-pandemic to 25.1% peri-pandemic), and veterans aged 18–44 years (30.6%–25.1%). There was a decreasing trend in veterans aged 45–64 years (24.6%–21.5%).

Table 3 displays pre-pandemic characteristics of veterans in the four longitudinal courses of loneliness. Overall, 5.4% of veterans experienced increased loneliness compared to 6.4% who experienced decreased loneliness. A total of 10.6% experienced persistent loneliness. All of the variables assessed except education status, COVID-19 infection and knowing someone who died by COVID-19 infection differed among the four subgroups.

Of the 2,532 veterans who did not endorse feeling lonely often at the

pre-pandemic assessment, 164 (6.3%) developed loneliness during the pandemic. Of the 521 veterans who reported feeling lonely often at the pre-pandemic assessment, 196 (37.9%) denied feeling lonely during the pandemic.

3.2. Multivariable logistic regression analyses

Table 4 presents the results of the multivariable logistic regression analyses. *Increased loneliness vs. no loneliness.* Multivariable logistic regression and relative importance analyses showed that, relative to those who experienced no loneliness, veterans who experienced increased loneliness were less likely to be married/partnered (21.1% relative variance explained [RVE]), reported lower purpose in life (13.2% RVE), scored lower on a measure of cognitive functioning (13.1% RVE), were more likely to report greater adverse childhood experiences (12.1% RVE) and endorsed greater exacerbation of psychological distress (11.1% RVE) during the pandemic. Post-hoc analyses revealed that veterans who experienced increased loneliness reported greater severity of confusion (OR = 0.98, 95%CI = 0.97–0.99, p = 0.001) and executive dysfunction (OR = 0.98, 95%CI = 0.97–0.99, p = 0.021) at the pre-pandemic assessment.

Persistent loneliness vs. decreased loneliness. Relative to the veterans who experienced decreased loneliness during the pandemic, veterans who endorsed persistent loneliness were more likely to screen positive for major depressive disorder, generalized anxiety disorder, and/or PTSD at the pre-pandemic assessment (36.1% RVE), were less likely to be married/partnered (17.8% RVE), and endorsed greater COVID-19-related social restriction stress (20.2% RVE) and financial stress (15.2% RVE).

4. Discussion

Results of this study revealed that nearly one-in-six veterans reported feeling lonely often during the COVID-19 pandemic. However, one silver lining is that contrary to grim forecasts of increased loneliness during the COVID-19 pandemic, results of this study suggest that the pre-to-peri-pandemic prevalence of loneliness among US veterans decreased from 17.3% to 15.9%. Furthermore, the prevalence of veterans who were lonely prior to, but not during, the pandemic was six-fold higher than the prevalence of veterans who developed loneliness during the pandemic (37.9% vs. 6.3%). This finding is consistent with our previous work that reported stable or mildly decreased prevalence of alcohol use disorder and suicidal behavior during the COVID-19 pandemic (Na et al., 2021; Nichter et al., 2021). This decrease was significant among female but not male veterans, which is largely driven by female veterans being younger than male veterans. Indeed, younger veterans aged 18–44, who had the highest pre-pandemic prevalence of loneliness, reported a significant decrease in loneliness, while these prevalences were stable in older veterans. This finding is also consistent with the results of our previous study on pandemic-related changes in suicidal ideation in this cohort (Nichter et al., 2021). Being married or partnered, having greater baseline purpose in life and lower cognitive functioning were associated with increased loneliness, whereas baseline depression/anxiety/PTSD, not being married/partnered, and pandemic-related social restriction and financial stressors were linked to persistent loneliness.

One possible explanation for the overall decrease in prevalence of loneliness in younger veterans compared to the relatively stable prevalence of loneliness in older veterans is that younger veterans may have been better at soliciting social support during the pandemic. This may have been due to their familiarity to virtual technologies, such as virtual meetings or applications (e.g., Zoom, Facetime, etc.) or telemedicine appointments (Barney et al., 2020). Another plausible explanation is that older veterans may have been more adherent to the social distancing recommendations relative to younger veterans who are conferred lower risk to severe illness when infected with COVID-19.

Table 2
Longitudinal trends in loneliness from pre-to post-pandemic in U.S. military veterans.

	Pre-Pandemic		Post-Pandemic		
	N	Weighted prevalence	N	Weighted prevalence	P value
Full Sample	521	17.3%	489	15.9%	0.032
Age					
18-44	56	30.6%	47	25.1%	0.004
45-64	237	24.6%	205	21.5%	0.055
65 or older	228	11.5%	237	11.7%	0.88
Gender					
Male	415	16.0%	397	15.1%	0.14
Female	106	31.1%	92	25.1%	0.036

Table 3
Sociodemographic, clinical and pandemic-related characteristics of veterans by loneliness status.

	1 No loneliness n = 2,368 (56.7%)	2 Increased loneliness n = 164 (5.4%)	3 Decreased loneliness n = 196 (6.4%)	4 Persistent loneliness n = 325 (10.6%)	Test of Difference	p
	Weighted mean (SD) or n (weighted %)					
Sociodemographic and Military Factors						
Age	65.00 (14.28)	61.62 (14.02)	56.36 (14.15)	54.37 (14.36)	66.52	<0.001
Male gender	2158 (93.1)	138 (90.3)	156 (84.7)	259 (85.0)	37.81	<0.001
White, non-Hispanic race/ethnicity	1987 (79.9)	135 (79.9)	152 (75.0)	248 (76.5)	15.27	0.002
College graduate or higher	1104 (35.1)	82 (32.5)	79 (32.8)	132 (29.8)	3.93	0.269
Married/Partnered	1876 (79.6)	98 (68.2)	105 (60.2)	129 (45.1)	198.09	<0.001
Annual household income $60K+	1508 (63.0)	94 (62.3)	98 (59.5)	140 (45.8)	35.02	<0.001
Pre-Pandemic Risk Factors						
Current MDD, GAD, and/or PTSD	116 (5.5)	18 (14.9)	50 (27.2)	133 (44.5)	470.43	<0.001
Current AUD and/or DUD	286 (14.2)	29 (22.6)	56 (33.7)	61 (19.1)	55.53	<0.001
Adverse childhood experiences	1.16 (1.65)	2.49 (2.58)	2.24 (2.23)	2.51 (2.40)	79.82	<0.001
Lifetime potentially traumatic events	8.31 (7.80)	9.62 (8.51)	11.56 (9.64)	11.38 (9.64)	20.41	<0.001
Lifetime suicide attempt	40 (2.2)	9 (5.3)	16 (7.7)	29 (10.2)	64.01	<0.001
Current mental health treatment	157 (6.7)	25 (18.3)	45 (21.0)	93 (33.6)	236.58	<0.001
Cognitive functioning	93.00 (11.00)	85.11 (20.00)	83.35 (15.93)	78.46 (23.23)	129.68	<0.001
Number of medical conditions	2.79 (2.03)	3.77 (2.56)	3.49 (2.21)	3.30 (2.43)	18.24	<0.001
Any disability	237 (10.4)	34 (21.4)	34 (16.8)	79 (22.6)	52.96	<0.001
Pre-Pandemic Protective Factors						
Purpose in life	22.39 (3.99)	20.17 (4.31)	18.14 (4.81)	16.06 (5.64)	242.72	<0.001
Dispositional optimism	5.36 (1.25)	4.67 (1.47)	4.34 (1.56)	3.74 (1.67)	160.39	<0.001
Religiosity/spirituality	9.71 (4.04)	9.27 (3.94)	8.31 (4.20)	8.42 (4.10)	14.85	<0.001
Personality Characteristics						
Extraversion	3.98 (1.39)	3.50 (1.29)	3.44 (1.73)	2.68 (1.40)	82.76	<0.001
Agreeableness	5.20 (1.16)	4.88 (1.19)	4.54 (1.23)	4.45 (1.30)	51.29	<0.001
Conscientiousness	5.95 (1.02)	5.62 (1.28)	5.36 (1.20)	5.30 (1.33)	46.57	<0.001
Emotional stability	5.55 (1.14)	5.02 (1.39)	4.49 (1.36)	4.12 (1.68)	152.10	<0.001
Openness to experiences	4.84 (1.15)	4.58 (1.26)	4.57 (1.16)	4.51 (1.28)	10.33	<0.001
Pandemic-Related Variables						
Infected with COVID-19	164 (7.8)	14 (9.7)	24 (12.8)	30 (8.0)	6.56	0.087
Household member infected with COVID-19	136 (6.6)	15 (14.4)	20 (12.4)	26 (8.3)	20.12	<0.001
Non-household member infected with COVID-19	956 (40.4)	71 (43.4)	92 (44.9)	161 (49.4)	10.14	0.017
Know someone who died by COVID-19 infection	137 (5.6)	9 (7.1)	9 (5.1)	22 (6.3)	1.00	0.800
COVID-19-related disease worries	−0.015 (0.994)	0.279 (1.029)	−0.083 (0.980)	0.026 (1.025)	4.48	0.004
COVID-19-related social restriction stress	−0.066 (0.940)	0.121 (0.984)	0.118 (1.092)	0.212 (1.184)	9.61	<0.001
COVID-19-related socioeconomic stress	−0.102 (0.871)	0.197 (0.984)	0.192 (1.267)	0.542 (1.463)	43.85	<0.001
COVID-19-related relationship difficulties	−0.057 (0.943)	0.130 (0.929)	0.170 (1.010)	0.162 (1.336)	7.80	<0.001
COVID-19-related PTSD symptoms	244 (10.6)	34 (18.8)	30 (16.4)	80 (22.3)	42.67	<0.001
Pre- to Peri-Pandemic Change Variables						
Increase in psychological distress	−0.035 (0.536)	0.133 (0.836)	−0.302 (0.952)	0.045 (1.068)	14.829	<0.001

Note: AUD = alcohol use disorder, DUD = drug use disorder, GAD = generalized anxiety disorder, MDD = major depressive disorder, PTSD = posttraumatic stress disorder, SD = standard deviation.

Visiting older adults in their residences was prohibited or explicitly discouraged due to concerns of infection (van Tilburg et al., 2020). Further, older adults have shown the highest mortality rate relative to any other age group during the pandemic (Sharma, 2021) which may have led to greater likelihood of losing their loved ones and subsequent grief and loneliness (Sorrell, 2021) compared to younger veterans.

With regard to protective factors, being married/partnered was strongly associated with no loneliness and decreased loneliness during the pandemic. This finding aligns with previous literature supporting the protective effect of being married or partnered in loneliness (Stack, 1998). The mechanism of this association could be either socially causative (i.e., marriage/partnered buffers against loneliness) or socially selective (i.e., those who feel lonely are less likely to be married/partnered).

Greater pre-pandemic purpose in life also protected against increased loneliness during the pandemic. This finding accords with previous work, which posits loneliness and meaning of life as psychologically-bound constructs closely tied to sociality (Lambert et al., 2013; Stillman et al., 2009). Greater purpose in life has also been linked to more effective stress regulation (Ishida and Okada, 2006; van Reekum et al., 2007), and less emotional reactivity to negative stimuli (van Reekum et al., 2007). Consequently, veterans with higher purpose in life may have implemented adaptive coping strategies, such as soliciting social support (Hooker and Masters, 2014; Ishida and Okada, 2006; van Reekum et al., 2007) to help manage distress during the pandemic. Another potential mechanism is that greater purpose may help facilitate more efficient decision-making related to health behaviors (Dahl et al., 2020). For example, in a study of 220 sedentary adults, those who reported greater levels of purpose were able to accept conflicting yet beneficial health messages better compared to those with lower levels of purpose (Kang et al., 2019). Collectively, these findings suggest that clinical interventions to bolster purpose in life may help mitigate loneliness, and potentially prevent loneliness-related health conditions. For example, evidence-based psychological treatments such

Table 4
Results of logistic regression analyses of increased and decreased loneliness courses during the pandemic.

	Increased loneliness vs. No loneliness		Persistent loneliness vs. Decreased loneliness	
	Adjusted odds ratio (95%CI)	Relative variance explained (%)	Adjusted odds ratio (95%CI)	Relative variance explained (%)
Sociodemographic and Military Factors				
Married/ partnered	0.33 (0.23–0.48) ***	21.1	0.46 (0.31–0.69) ***	17.8
Pre-Pandemic Risk Factors				
Adverse childhood experiences	1.16 (1.06–1.26) ***	12.9	1.11 (1.01–1.23)*	10.3
Health-Related Factors				
Current MDD, GAD, and/or PTSD	–	–	2.78 (1.67–4.62) ***	36.1
Current AUD and/or DUD	–	–	0.40 (0.25–0.65) ***	13.4
Number of medical conditions	1.11 (1.03–1.20)*	6.3	–	–
Cognitive functioning	0.98 (0.96–0.99) ***	13.1	–	
Pre-Pandemic Protective Factors				
Extraversion	0.83 (0.73–0.94) **	8.9	–	–
Emotional stability				
Purpose in life	0.94 (0.90–0.98) **	13.2	–	–
Pandemic-Related Variables				
COVID-19-related social restriction stress	1.29 (1.09–1.53) **	6.9	1.22 (1.00–1.47)*	20.2
COVID-19-related socioeconomic stress	–	–	1.26 (1.07–1.49) **	15.2
COVID-19-related relationship difficulties	1.19 (1.01–1.4)*	6.5	–	–
Pre- to Peri-Pandemic Change Variables				
Change in psychological distress	1.73 (1.36–2.19) ***	11.1	1.55 (1.22–1.99) ***	15.1

Note: AUD = alcohol use disorder, DUD = drug use disorder, GAD = generalized anxiety disorder, MDD = major depressive disorder, PTSD = posttraumatic stress disorder, SD = standard deviation.
* = p < 0.05, ** = p < 0.01, *** = p < 0.001.

as acceptance and commitment therapy (Hayes et al., 2006) may help bolster and enhance purpose in life.

Lower pre-pandemic cognitive functioning was also associated with increased loneliness during the pandemic. This finding extends our previous cross-sectional work demonstrating a link between loneliness and lower cognitive functioning prior to the pandemic (Straus et al., 2021). Specifically, greater severity of confusion and executive dysfunction were main drivers of this association. This finding is consistent with previous research, which similarly found that executive control is highly predictive of perceived loneliness even after controlling for depressive symptoms (Sin et al., 2021). Given that cognitive dysfunction is often linked to disability with activities of daily living (Forsell et al., 1994), it is possible that this association may be explained

in part by increased functional difficulties brought on by pandemic-related environmental changes, such as not being able to receive support due to increased social restrictions and lack of access to medical services. Further, previous research has demonstrated an association between executive dysfunction with emotional dysregulation (Coolidge et al., 2004; Montoliu et al., 2019), which may have in turn led to an increase in loneliness.

Pre-pandemic depression, anxiety, and PTSD were the strongest predictors of persistent loneliness, even after adjusting for increased psychological distress during the pandemic. A plausible mechanism of this finding is that persistence or exacerbation of symptoms of depression (e.g., anhedonia, avolition) or PTSD (e.g., detachment, avoidance) may lead to greater social isolation, which may in turn trigger greater loneliness. This finding has clinical relevance given that major depressive disorder and PTSD are well-known risk factors for suicidal behavior (Nichter et al., in press) and loneliness is also a robust predictor of suicidal behavior (Wang et al., 2018) and deaths by suicide (Conroy and Smith, 1983). Individuals with pre-existing psychiatric conditions have been identified as a high-risk group vulnerable to the negative effects of the COVID-19 pandemic (Gobbi et al., 2020; Yao et al., 2020). For example, in a study of 2,734 psychiatric patients worldwide, 2-of-3 endorsed worsening of psychiatric conditions (e.g., depression, PTSD) during the COVID-19 pandemic (Gobbi et al., 2020). Our finding supports results of these previous studies, and underscores the importance of ongoing efforts to monitor, and implement interventions to mitigate the negative psychological consequences of loneliness in veterans with pre-existing depression, anxiety and PTSD during the pandemic. The clinical implication of this finding is that clinicians may consider assessing loneliness in veterans with pre-existing depression, anxiety, and PTSD, and offer interventions to mitigate loneliness. For example, the VA offers a tele-support program called Compassionate Contact Corps (Taylor, 2021) to veterans who feel lonely, or socially isolated to talk regularly with trained volunteers via phone or video calls. Further expanding such novel efforts as well as traditional interventions (e.g., group therapy) to mitigate loneliness in high-risk veterans may help mitigate adverse mental health outcomes such as suicidal behavior.

Greater pandemic-related social restriction and financial stressors were also strong predictors of persistent loneliness during the pandemic. Previous studies have shown that greater pandemic-related stressors have been linked to psychiatric symptoms such as depression and anxiety (Bendau et al., 2020; Kujawa et al., 2020). For example, in a study of 450 adults in the US conducted during the early stage of the pandemic (May 2020), experiences of general life disruption, and financial and interpersonal strains were strongly associated with internalizing symptoms (Kujawa et al., 2020). The results of this study extend these results to a large, nationally representative sample of US veterans.

This study has limitations that must be noted. First, while nationally representative, our sample consisted predominantly of older, male, and White, non-Hispanic veterans. Thus, it is unclear whether the results may generalize to more diverse samples of veterans or non-veteran populations. Second, we used screening instruments to assess major depressive disorder, generalized anxiety disorder, and PTSD instead of structured clinical interviews; future research utilizing structured clinical interviews is needed to replicate the results reported herein. Third, although this was a longitudinal study, due to the cross-sectional nature of each survey, it is difficult to draw conclusions regarding temporal/ causal associations between factors associated with increased and persistent loneliness during the pandemic. Lastly, race/ethnicity and loneliness variables were dichotomized in our analyses. Further research using larger and better powered subsamples of racial/ethnic minority veterans and multi-dimensional measures of loneliness is needed to evaluate the generalizability of results to specific racial/ethnic sub-populations of veterans and specific facets of loneliness.

Results of this study provide the first-known population-based data on the prevalence and correlates of longitudinal courses of loneliness in US veterans during the COVID-19 pandemic. Collectively, results

suggest that veterans unmarried/partnered veterans and those with pre-pandemic depression, generalized anxiety, and PTSD, lower cognitive function, and greater pandemic-related social restriction and financial stressors, may be at heightened risk of experiencing loneliness during the pandemic. Veterans with such characteristics may require close monitoring, as well as clinical interventions to bolster protective psychosocial factors such as purpose in life. Assessing COVID-related stressors (e.g., the Coronavirus Health Impact Survey) (National Institute of Mental Health Intramural Research Program Mood Spectrum Collaboration and Child Mind Institute of the NYS Nathan S. Kline Institute for Psychiatric Research, 2020) may be useful in veterans with underlying major depressive disorder, generalized anxiety disorder, and PTSD. Further research is needed to replicate and extend these results to more diverse veteran and non-veteran populations; identify mechanisms leading to increased loneliness during the pandemic; and evaluate the efficacy of interventions targeting evidence-based risk and protective factors of loneliness, including both negative (e.g., depression, anxiety, PTSD symptoms) and salutogenic (e.g., purpose in life) factors.

Author statement

Peter J. Na assisted with the study conceptualization and design, analyzed the data and wrote the paper. Elizabeth Straus, Jack Tsai, and Sonya B. Norman collaborated in the writing and editing of the manuscript. Steven M. Southwick assisted in the study design and editing of the manuscript. Robert H. Pietrzak designed the study, analyzed the data, and collaborated in the writing and editing of the manuscript.

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Declaration of competing interest

None of the authors have any competing interests.

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