


RESEARCH ARTICLE

Changes in perceived stress during the COVID-19 pandemic among American veterans

Jordan P. Davis¹  | John Prindle¹ | Shaddy K. Saba¹ | Denise D. Tran² | Daniel S. Lee² | Angeles Sedano² | Carl A. Castro¹ | Eric R. Pedersen²

¹Suzanne Dworak-Peck School of Social Work, University of Southern California, Los Angeles, California, USA

²Department of Psychiatry and Behavioral Sciences, University of Southern California, Keck School of Medicine, Los Angeles, California, USA

Correspondence

Jordan P. Davis, Suzanne Dworak-Peck School of Social Work, USC Center for Artificial Intelligence in Society, USC Center for Mindfulness Science, USC Institute for Addiction Science, University of Southern California, Los Angeles, CA, 90089, US.
Email: jordanpd@usc.edu

Funding information

National Institute on Alcohol Abuse and Alcoholism, Grant/Award Numbers: R01AA026575, R01AA026575-02S1

Abstract

American veterans are a population that suffer from both context specific stressors as well as many population-specific major-life events. The present exploratory study utilises a longitudinal cohort of 1230 U.S. veterans surveyed from February 2020 through February 2021. We sought to understand heterogeneity in perceived stress, using growth mixture modelling, over this time period, how COVID-specific factors such as negative reactions to the pandemic, loneliness, and employment disruptions influence perceived stress trajectories, and how veterans vary across distal outcomes including posttraumatic stress disorder (PTSD), pain, depression, sleep problems, physical health, and alcohol use disorder. Results revealed a 4-class solution: Stable High, Stable Low, Steady Increasing, and Steady Decreasing classes. In terms of COVID specific factors, negative reactions to COVID were consistently associated with perceived stress for those in the Stable High and Steady Increasing classes whereas loneliness was associated with stress trajectories for all emergent classes. Finally, in terms of our distal outcomes, results showed a relatively robust pattern with veterans in the Stable High or Steady Increasing classes reporting worse scores across all outcomes including PTSD, pain, sleep problems, physical health, depression, and alcohol use disorder. Understanding the interplay between existing vulnerabilities, ongoing stressors, and behavioural health outcomes among veterans is crucial for prevention and intervention efforts.

KEYWORDS

combat, longitudinal, PTSD, stress, veterans

1 | INTRODUCTION

The concept of stress has been studied widely since Hans Selye's seminal work on the physiological consequences of stress. Stress has most commonly been viewed as a byproduct of a harmful external event or stimulus that negatively affects the individual (Lazarus, 1985). Stress can include major life events, but also more minor and common events, sometimes referred to as daily hassles or chronic strains. American veterans are a population that suffer from both daily hassles as well as veteran-specific major-life events including reintegration-

related daily stressors (e.g., financial or relationship problems) and combat residual stressors such as being exposed to bodily harm and witnessing death, which many veterans experience over multiple deployments. Over the last five decades research has focussed on perceptions of the event and its consequences (i.e., perceived stress), and has demonstrated a wide range of predictors of perceived stress as well as how perceived stress is associated with both short- and long-term detriments in social, physical, and psychological health (Flores et al., 2008; Liu et al., 2021; Luo et al., 2021). While it is known that major life events (i.e., combat-related stressors) can result in long-term

problems (e.g., development of posttraumatic stress disorder [PTSD]), few studies have focussed on longitudinal change in perceived psychological stress and how additional, ongoing, stressors affect these trajectories among veterans.

Perceived stress is distinguished from physiological stress such that it refers to the self-appraisal of ones' current life and circumstances as being stressful, such as a perceived lack of control over stressful events, a belief they will cause physical or psychological strain, and a sense that the situation is unpredictable (Cohen et al., 1983). Very early research on perceived stress by Lazarus and Folkman have argued that describing a person's level of stress based solely as a function of external events is inadequate because it does not consider the individual and the individual's appraisals (Lazarus & Folkman, 1984). Some have theorized that a global assessment of perceived stress is more likely to predict the impact of stress on health and well-being than measures of specific major or minor life events (Cohen et al., 1983). For example, among general populations, perceived stress is associated with worse mental health, including greater alcohol, drug, and tobacco use; higher levels of depression and anxiety; and worse physical health (e.g., greater risk of heart disease, sleep problems, and higher reports of physical pain (Golden-Kreutz et al., 2005; McHugh et al., 2020; Moitra et al., 2013; Wisnivesky et al., 2010)).

While preliminary evidence suggests veterans may be particularly susceptible to perceived stress and its negative effects, this area of study among veterans is still relatively nascent. In one study among male veterans with spinal cord injury, perceived stress was associated with depressive and anxiety symptoms and negatively associated with life satisfaction (Rintala et al., 2005). In one of the earliest studies assessing perceived stress and substance use among veterans, both women and men were more likely to describe their military duties as more stressful than their family or personal lives (Bray et al., 1999) and this perceived stress was associated with greater substance use, illicit drug use, and cigarette use. Others have reported similar results on stress among military men and women regarding perceived work stress, noting greater stress is associated with worsening mental health (Mota et al., 2011). Importantly, there is evidence that levels of perceived stress rise among many soldiers recently returning from deployment, and this may contribute to worse reported behavioural health (Kim et al., 2017).

The COVID-19 pandemic with its numerous psychosocial impacts is a clear example of an external event that has likely influenced individuals' levels of perceived stress. For example, as the number of confirmed COVID-19 cases and deaths increased, implementation of strict isolation measures, and closures of schools and workplaces, research has noted increases in levels of perceived stress (Chen et al., 2020). Recent research also reports heightened distress and psychiatric symptomology among adults during the pandemic (Gallagher et al., 2020; Liu et al., 2020; Rajkumar, 2020). Several hardships related specifically to the pandemic likely contributed to rises in substance use and mental health symptomology, including negative reactions to COVID-19 (e.g., stress, trouble sleeping, or relationships problems due to the pandemic), employment disruptions, and

loneliness (Fitzpatrick et al., 2020; McGinty et al., 2020; Witteveen & Velthorst, 2020). In addition to mental health problems, such as PTSD, veterans have particularly high rates of several conditions that may be exacerbated by COVID-19-related hardships, including depression, alcohol use disorder, physical pain, sleep problems, and other physical health problems (Colvonen et al., 2020; Liu et al., 2019; Nahin, 2017; Norman et al., 2018; Thomas et al., 2017).

1.1 | Present study

The present study, while exploratory in nature, set out to test a longitudinal model of perceived stress with three specific aims. The first aim is to explore heterogeneity in perceived stress among veterans during the first year of the COVID-19 pandemic. Because veterans likely vary in their experiences of past and current stressors, we expect substantial variation in trajectories of perceived stress over the course of the study. The second aim is to explore how COVID-19-specific factors, such as loneliness, negative reactions to the pandemic, and employment disruptions, were associated with perceived stress trajectories over time. We expect that COVID-specific factors will be associated with higher perceived stress trajectories. Finally, the third aim is to explore physical and psychological distal outcomes (at the final survey wave) and how these differ between individuals with differential emergent perceived stress trajectories. In particular, we sought to understand differences in alcohol use severity, self-reported sleep problems, physical health, pain, PTSD symptoms, and depressive symptoms between emergent stress trajectory classes.

2 | METHODS

2.1 | Procedures

Veterans aged 18–40 who had separated from the Air Force, Army, Marine Corps, and Navy were recruited over 4 weeks in February 2020 as part of a large survey study of veteran attitudes and health behaviour. This age group was selected as part of our broader work to inform prevention and intervention efforts with post-9/11 veterans soon after discharge and before behavioural health symptoms become chronic. Advertisements were displayed on social media websites (Facebook, Instagram) and military-specific social media websites and listservs (RallyPoint, We Are the Mighty). Participants consented to the study, which was approved by the local Institutional Review Board, and completed a 30-min survey on a secure website. They were given a \$20 Amazon gift card for participation. As with most online studies with widespread advertising, many potential participants clicked on the online ads, but most either did not pursue participation or were ineligible. Of the 5776 individuals who clicked on ads and reached the online consent form, 2750 (48%) did not pursue past the initial consent page. Ninety-four (2%) were screened and found to be ineligible (i.e., not within age range, not a US

veteran), while an additional 1077 (19%) attempted to access the study once it was no longer accepting participants due to reaching the participant quota. Overall, 1855 (32%) consented to be a part of the study and completed the survey. We ran a series of internal checks we have developed over the course of our online survey work with veterans (Pedersen et al., 2015; Pedersen et al., 2017) to remove participants when it was unclear whether they were actually veterans. These checks included monitoring inconsistent responses between items within and across surveys (e.g., branch, rank, pay grade matches), examining instances when it appeared the participant was carelessly responding to items (e.g., completed the survey too quickly, selected the same response option throughout the survey), and when they attempted to access the survey multiple times (e.g., by reviewing IP addresses). These checks removed 625 individuals from the sample. A detailed flow chart with this information can be found in Figure 1.

The final sample was composed of 1230 veteran participants at baseline. Participants were invited to complete three follow-up surveys over the course of the pandemic. They were sent follow-up surveys via email at 6-month (August 2020; $N = 1025$; 83.3% retention from baseline), 9-month (November 2020; $N = 1006$; 81.8% retention from baseline), and 12-month (February 2021;

$N = 1005$; 81.7% retention from baseline). Participants were given a \$30, \$40, and \$50 Amazon gift card for the 6-, 9-, and 12-month surveys, respectively. Data were collected via Qualtrics.

2.2 | Participants

On average, participants were 34.5 years old with 88.7% identifying as male. The sample was majority White (79.3%) with 10.9% Hispanic, 7.3% Black, 1.1% Asian, and 1.5% multiracial/other respondents. See Table 1 for more information on participant demographics.

2.3 | Measures

Sociodemographic characteristics and history of stress exposure. At baseline participants self-reported sex (male, female), race/ethnicity, and age, which were included as covariates in models. All participants also reported their annual household income selecting from 7 options ranging from 1 (less than 10,000) to 7 (200,000 or more). We also controlled for severity of combat exposure using a composite

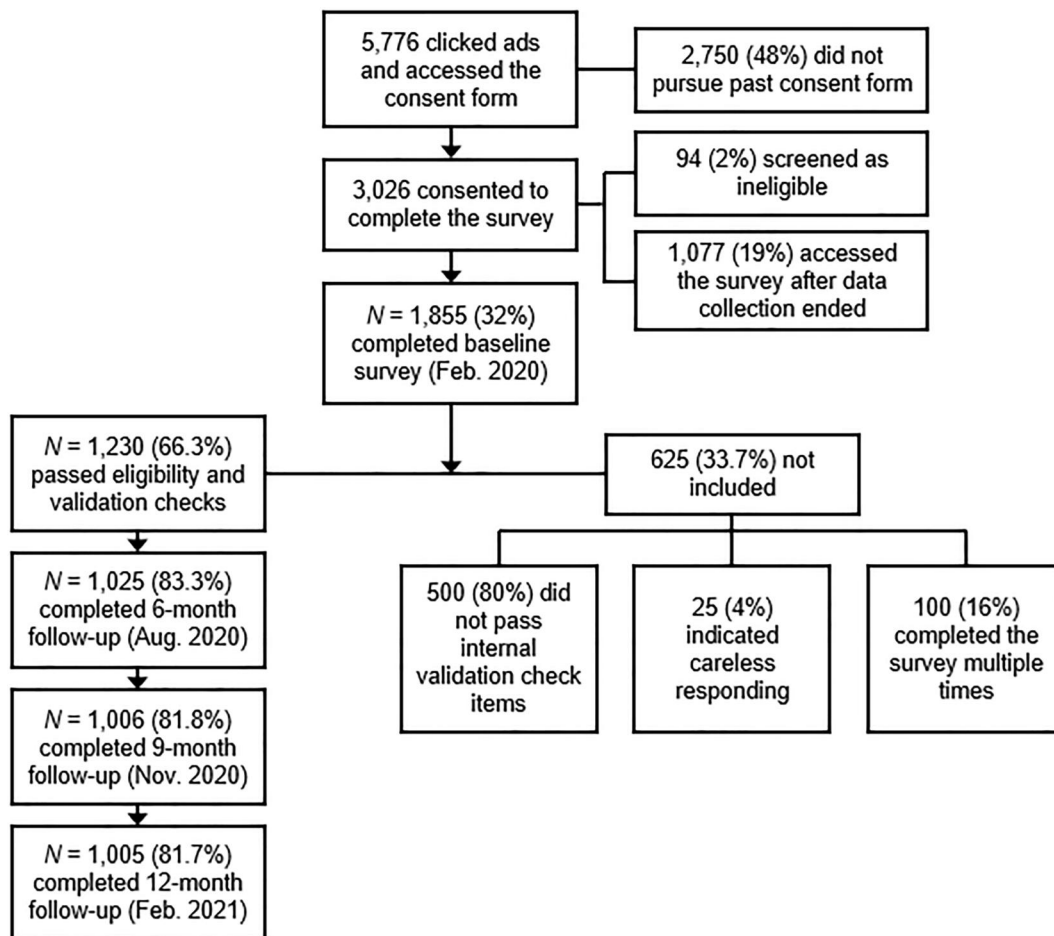


FIGURE 1 Sample recruitment and follow-up flow chart

TABLE 1 Sociodemographic characteristics and study variables

| Variable | M(SD) or N (%) |
|---|----------------|
| Age | 34.5 (3.67) |
| Sex (male) | 1091 (88.7%) |
| Race/ethnicity | |
| White | 975 (79.3%) |
| Hispanic/Latino/a | 134 (10.9%) |
| Black | 90 (7.3%) |
| Asian | 13 (1.1%) |
| Multiracial/other | 18 (1.5%) |
| Current marital status | |
| Married | 53 (4.3%) |
| Divorced | 3 (0.2%) |
| Widowed | 14 (1.1%) |
| Separated | 73 (5.9%) |
| Never married | 3 (0.2%) |
| Other | 1087 (88.1%) |
| Combat scale | 5.02 (2.35) |
| Years served | 8.95 (8.95) |
| Adverse childhood experiences | 0.98 (1.76) |
| Behavioural and physical health distal outcomes at 12-month | |
| PTSD | 22.0 (15.8) |
| Depression | 7.73 (4.92) |
| Sleep | 8.53 (5.10) |
| Physical health | 6.52 (4.91) |
| AUDIT | 14.9 (6.72) |
| Pain | 74.0 (26.5) |
| COVID-19 time-varying Co-variates | |
| Negative reactions to COVID-19 at 6-month follow up | 1.22 (0.49) |
| Negative reactions to COVID-19 at 9-month follow up | 1.28 (0.64) |
| Loneliness at 6-month follow-up | 48.8 (7.07) |
| Loneliness at 9-month follow-up | 36.84 (10.12) |
| Loneliness at 12-month follow-up | 37.47 (10.71) |
| Employment disruptions at 6-month follow-up | 477 (38.8%) |
| Employment disruptions at 9-month follow-up | 499 (40.57%) |
| Employment disruptions at 12-month follow-up | 671 (54.55%) |
| Perceived stress | |
| Stress at baseline (past month) | 14.6 (6.85) |
| Stress at 6-month follow-up (past month) | 14.9 (5.72) |
| Stress 9-month follow-up (past month) | 13.4 (6.44) |
| Stress at 12-month follow-up (past month) | 13.5 (6.31) |

Note: Continuous variable ranges: all alcohol use and binge drinking variables are past 30-day (0–30); negative reactions to COVID-19 (0–4); loneliness (20–80); employment disruptions (0–1); combat scale (0–11); adverse childhood experiences (0–4).

Abbreviations: AUDIT, Alcohol Use Disorder Identification Test; PTSD, Posttraumatic Stress Disorder.

measure of 12 items from prior work with veterans (Schell & Marshall, 2008). A summed score of self-reported adverse childhood experiences (Felitti et al., 1998) were used. Four items from the original Adverse Childhood Experiences Study were used that covered experiences of sexual, physical, emotional abuse, and neglect. Participants responded with 'yes' or 'no' to each item.

Perceived stress. Participants responded to 10 items on the perceived stress scale (Cohen & Williamson, 1988) at all waves. Each item asked participants to rank how often they experienced each of the items in the past month on a Likert scale from never (0) to very often (5). Example items include 'how often have you been upset because of something that happened unexpectedly?', 'how often have you felt nervous or stressed?', and 'how often have you been able to control irritations in your life?' (reverse scored). A summed score was created for each wave ($\alpha_{\text{mean}} = 0.76$) with higher scores associated with greater stress.

2.4 | Distal outcomes at the 12-month survey wave

Posttraumatic Stress Disorder. PTSD symptom severity was assessed using the 20-item Posttraumatic Stress Disorder Checklist for DSM-5 (PCL-5; Bovin et al., 2016) participants indicated how often they were bothered by 20 PTSD symptoms in the past month from not at all (0) to extremely (4). The PCL-5 yields a total sum score ranging from 0 to 80, with a score of 31–33 representing optimal sensitivity and acceptable specificity for detecting PTSD. The measure had a reliability estimate of $\alpha = 0.91$ in the current sample.

Pain. Pain was assessed using the Pain Outcomes Questionnaire, a 19-item inventory that measures pain on the following dimensions: intensity, mobility, activities of daily living, vitality, negative affect, and fear. The Pain Outcomes Questionnaire was developed and validated with veterans engaged in pain treatment at VA facilities. The Pain Outcomes Questionnaire yields a sum score from 0 to 190 and had a reliability estimate of $\alpha = 0.91$ in the current sample.

Depression. Symptoms of depression were assessed with the Patient Health Questionnaire 8-item. Depressive symptoms (e.g., feeling down, depressed, or hopeless) were rated over the past 2 weeks from not at all (0) to nearly every day (3). Responses were summed for a total score ranging from 0 to 24, with a score of 10 or higher representing a high degree of sensitivity and specificity for likely major depressive disorder (Kroenke et al., 2009). The measure had a reliability estimate of $\alpha = 0.85$ in the sample.

Sleep problems. Sleep was assessed with the 7-item Insomnia Severity Index, which measures severity of sleep problems and the impact of insomnia over the past month. Respondents were asked to rate each item on a 5-point Likert scale from 'no problem' (0) to 'very severe problem' (4). Responses were summed for a total score ranging from 0 to 28, with higher scores indicating more sleep problems and a score of 10 or higher indicating likely insomnia with high sensitivity and specificity. The reliability estimate in our sample was $\alpha = 0.75$.

Physical health. Physical health was assessed with the 15-item Patient Health Questionnaire-15 (Kocalevent et al., 2013).

Respondents were asked to rate how bothered they have been by specific physical health problems such as nausea, feeling tired, sleep troubles, and physical pain (e.g., stomach pain, back pain, headaches). Items were rated either 'not bothered at all' (0), 'bothered a little' (1), or 'bothered a lot' (2). Responses were summed for a total score from 0 to 30 with higher scores indicating more physical health problems, with a score of 10 or above indicating at least medium physical health symptom severity per the scale's developers (Kroenke et al., 2002). The reliability estimate in our sample was $\alpha = 0.81$.

Alcohol Use Disorder Identification Test. The 10-item Alcohol Use Disorder Identification Test (AUDIT) was used to assess risk for alcohol use disorder. The AUDIT is a screening measure for alcohol use disorder, and assess typical frequency and quantity of alcohol use, binge drinking, and negative alcohol-related consequences and yields a summed score from 0 to 40. Scores of 16 and above represent optimal sensitivity and acceptable specificity for detecting likely alcohol use disorder (Babor et al., 2001) ($\alpha = 0.79$).

2.5 | Time-varying covariates

Negative reactions to COVID-19. On the 6- and 9-month survey, participants were asked how often they felt negative reactions to the pandemic related to emotional, stress, sleep, and relationships using 9 items from prior work on the COVID-19 pandemic ((Johns Hopkins Bloomberg School of Public Health, 2020; Pedersen et al., 2021)). Items such as 'was stressed by the restrictions on leaving home' and 'felt that your social relationships were suffering' when considering the pandemic over the past 3 months were rated from 'not at all' (0) to 'a great deal' (4). The mean of the nine items yielded composite score measure suggesting greater negative reactions to the pandemic, with a mean reliability of $\alpha = 0.77$ across the 6- and 9-month surveys.

Loneliness. At 6-, 9-, and 12-month, loneliness was measured with the 20-item UCLA Loneliness Scale (Russell, 1996). The scale assessed general loneliness by asking participants questions such as 'do you feel alone,' 'how often do you feel close to people,' and 'how often do you feel left out' (1 = never to 4 = always). A sum score was calculated ranging from 20 to 80, with a mean reliability of $\alpha = 0.82$ across the 6-, 9-, and 12-month surveys.

Employment disruptions. 2 items from the Epidemic-Pandemic Impact Inventory assessed disruptions in employment at 6-, 9-, and 12-month. Participants indicated if they (1) were laid off from a job or had to close their own business or (2) had to reduce work hours or were furloughed due to the pandemic. Participants were coded as having experienced employment disruptions if they indicated a positive response to either of these items.

2.6 | Analytic plan

We employed a model building process that addressed each aim of the current study (see Table S1 for full correlation table). To address

Aim 1, we used growth mixture modelling to assess profiles of perceived stress during the first year of the COVID-19 pandemic. Growth mixture models identify unobserved sub-populations that share patterns of longitudinal change within larger populations (Ram & Grimm, 2009). This is in contrast to simple latent growth models, which give a single average growth estimate, a single estimate of variance within the growth parameter, and assume a uniform influence of covariates. Thus, latent growth modelling assumes that all individuals are drawn from a single population with common growth parameters. Growth mixture models relax this assumption and allow for variation in growth parameters across unobserved populations. Growth mixture models also allow for variation in growth trajectories, resulting in separate growth models for each emergent latent class, which have unique parameter estimates (e.g., means, variance) as well as varying effects of covariates ((See Figures S1–4) for a visual example based on our final model solution). We used log likelihood ratio tests to assess the need for random linear slopes. To assess which model best fit the data, we considered several model fit indicators including: reductions in negative two log likelihood ($-2LL$), Akaike Information Criteria (AIC), Bayesian Information Criteria (BIC), the sample size adjusted Bayesian Information Criteria (aBIC) and non-significant Lo-Mendell-Rubin adjusted likelihood ratio test (LMRT), and bootstrapped likelihood ratio test (BLRT) values. Once the best fitting model was defined, the logits of class membership were set to ensure classes were not influenced by inclusion of covariates (e.g., class membership does not shift or change).

To address Aim 2, we entered both our time-invariant covariates as well as our time-varying covariates to our model. Once the control variables were entered, we then built a model around our three time-varying covariates of interest: negative reactions to COVID-19, loneliness, and employment disruptions. At each time point, we regressed each of our time-varying covariates onto the contemporaneously observed perceived stress variables for each of the emergent classes (see Figure 2 for conceptual model). This allowed us to determine the associations between negative reactions to COVID-19 (note: this was only assessed at the 6- and 9-month time points and not at the 12-month follow-up), loneliness, and employment disruptions on perceived stress classes over time, above and beyond the effects of the underlying growth model and our time-invariant covariates. To do this, we first introduced time-varying covariates as freely estimated predictors within each class (e.g., each time-varying covariate across all emergent classes were allowed to be freely estimated). We then tested this model against one where time-varying covariates were constrained to be equal over time, systematically, within classes. Here, each time-varying covariate was constrained from the first emergent class to the last and tested against the prior nested model. For example, constraining effects of loneliness to be equal within Class 1 (compared to the model in which all time-varying covariates were freely estimated), then constraining effects of negative reactions to COVID-19 to be equal within Class 1, and comparing to the previous model (constrained loneliness), and finally, constraining effects of

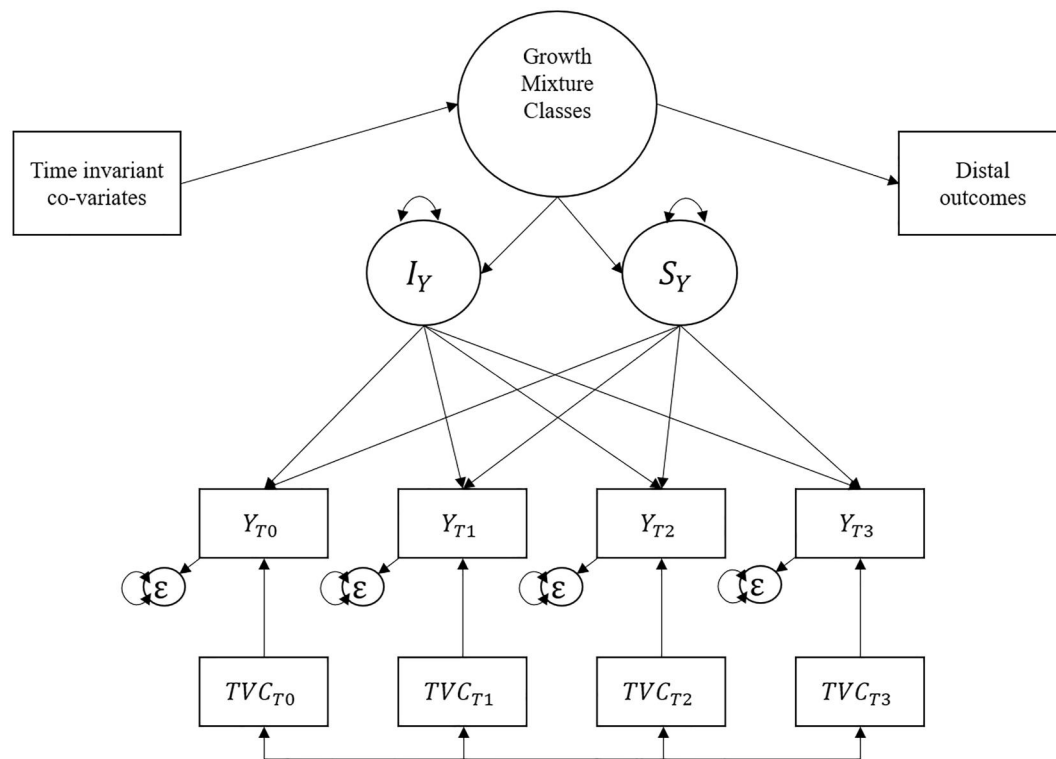


FIGURE 2 Conceptual model for perceived stress using a growth mixture model with time-invariant and time-varying covariates predicting distal outcomes. Here we represent all time-varying covariates as a single 'TVC' variable for parsimony, note the model includes three TVCs: negative reactions to COVID-19, loneliness, and employment disruptions

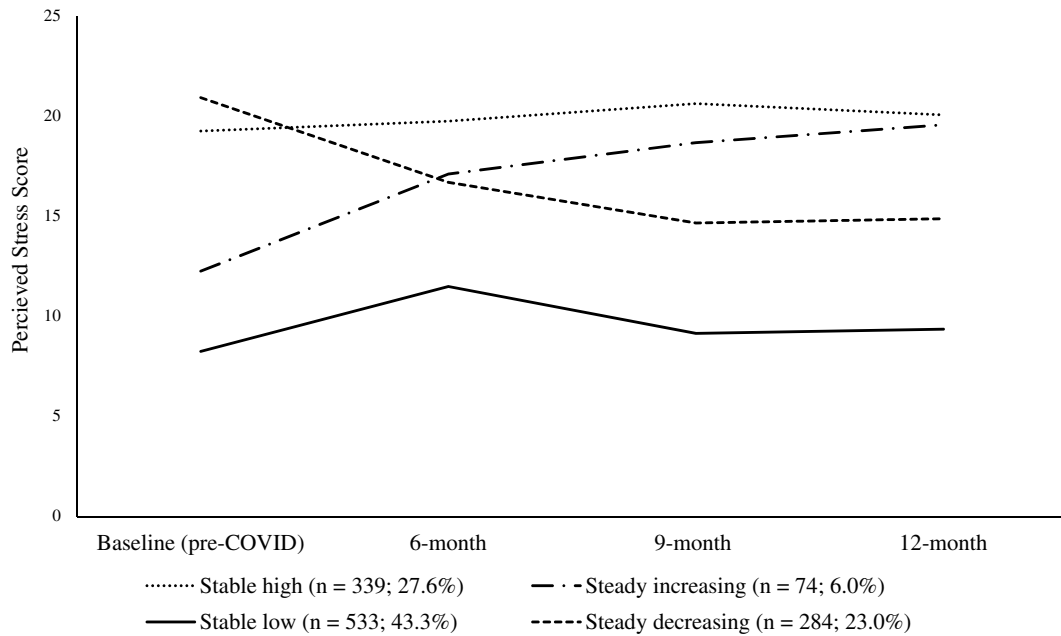
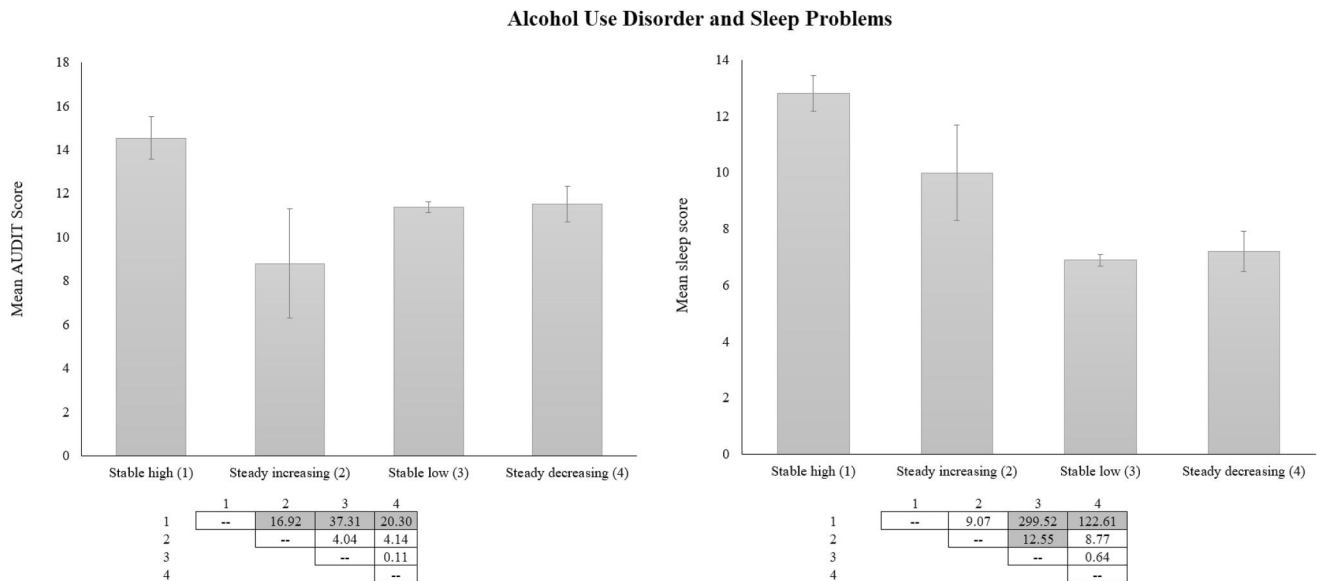


FIGURE 3 Final four-class solution for perceived stress growth mixture classes. baseline (pre-COVID) assessed in February 2020; 6-month assessed August 2020; 9-month assessed November 2020; 12-month assessed February 2021



Note. Figure vertical bars represent mean values on the measures for each of the indicated groups. Higher scores represent higher AUDIT score (greater alcohol use problems) and worse sleep. Values in boxes indicate chi-square values between indicated groups. Shaded values are significant at $p < .001$, which reflects an applied Bonferroni correction.

FIGURE 4 Means, confidence intervals, and chi-square values assessing differences in alcohol use disorder and sleep problems by emergent classes. *Note.* Figure vertical bars represent mean values on the measures for each of the indicated groups. Higher scores represent higher AUDIT score (greater alcohol use problems) and worse sleep. Values in boxes indicate chi-square values between indicated groups. Shaded values are significant at $p < 0.001$, which reflects an applied Bonferroni correction

employment disruptions to be equal within Class 1 and comparing to the previous model (constrained negative reactions to COVID-19). This process was repeated for all emergent classes, until all constraints were tested. We used difference in negative two log

likelihood ratio tests to determine if constrained versus freely estimated model fit the data best. Doing this allowed us to test if each of our time-varying covariates had consistent, stronger, or weaker influences over time within each class. A final model was

estimated employing all decisions [in Table S2] on constraints for each class.

After determining the best fitting model for our time-varying covariates, we then introduced distal outcomes to our model (Aim 3). To do this, we used the manual three-step auxiliary BCH approach, which uses a pseudo-class Wald chi-square test to assess mean differences in our behavioural and physical health outcomes between classes, over and above the effects of our time-varying covariates and time-invariant covariates. In this model, we also included prior scores (from baseline) on all of our distal outcomes as control variables to ensure appropriate adjustment by class membership.

Given growth mixture modelling is exploratory, by nature, we did not have any a priori hypotheses about number of emergent classes. However, for the time varying co-variables we posit that the majority will have positive (i.e., greater stress), contemporaneous, effects on stress. Further, while we have no a priori hypotheses about emergent stress trajectory classes, those veterans in higher risk stress classes will be associated with worse distal outcomes (e.g., worse sleep, greater alcohol use disorder outcomes etc.).

2.7 | Missing data

Differences by baseline characteristics also existed between those who were present at baseline but missing at the final time point (Table S3). For instance, those who were missing tended to be more likely to be female, to be non-White relative to White, not Army relative to Army, and married relative to non-married. These missing veterans were also separated from service for less length of time, had a little more combat exposure, had greater adverse childhood

experiences, greater PTSD, greater depressive symptoms, more insomnia problems, more physical health problems, and more pain symptoms at baseline than those present at baseline and outcome timepoints. In an attempt to address missing data and given the methodology being used, we imputed missing data for the time varying co-variables. To do this, we used multiple imputation methods ($k = 10$ data sets). Thus, given all participants were included in subsequent analyses and the co-variables we included aid in accounting for differences in attrition, we believe we have limited bias in our sample.

3 | RESULTS

3.1 | Class enumeration

To address Aim 1, we estimated a series of growth mixture models, which were fit to the data starting with a one-class model solution. Fit indices for the perceived stress growth mixture models can be found in Table S2. The non-significant VLRT, LRT, and BLRT values for the five-class solution indicated a four-class solution fit the data best. We also plotted the aBIC values to determine any plateau points, which indicated a plateau between the 4 and 5 class solution, further indicating the 4-class solution as the best fitting.

Figure 3 presents plots for each of the four classes. The *Stable High* class represented 27.6% ($n = 339$) of participants. Within this class, participants reported the highest perceived stress scored across the study period. Veterans in this class had very little movement, remaining relatively high and consistent in perceived stress. The *Stable Low* class represented 43.3% ($n = 533$) of the sample. Veterans in this class had the lowest reported perceived stress

TABLE 2 Model fit statistics for constraining time-varying covariates within emergent perceives stress classes

| Model description | -2LL | df | Δ -2LL | Δ df | Chi-square test | Interpretation | Decision |
|--|-----------|----|---------------|-------------|-----------------|---------------------|-----------------|
| All fully free | 25,820.29 | 48 | | | | | |
| Constrain loneliness class 1 | 25,877.45 | 46 | 57.15 | 2 | 0.0000 | Significantly worse | Freely estimate |
| Constrain negative COVID attitudes class 1 | 25,878.64 | 45 | 1.19 | 1 | 0.2745 | Not worse | Constrain |
| Constrain economic hardship class 1 | 25,885.75 | 43 | 7.11 | 2 | 0.0286 | Significantly worse | Freely estimate |
| Constrain loneliness class 2 | 25,896.43 | 41 | 10.67 | 2 | 0.0048 | Significantly worse | Freely estimate |
| Constrain negative COVID attitudes class 2 | 25,896.43 | 40 | 0.004 | 1 | 0.9496 | Not worse | Constrain |
| Constrain economic hardship class 2 | 25,899.09 | 38 | 2.65 | 2 | 0.2650 | Not worse | Constrain |
| Constrain loneliness class 3 | 25,899.28 | 36 | 0.19 | 2 | 0.9066 | Not worse | Constrain |
| Constrain negative COVID attitudes class 3 | 25,900.02 | 35 | 0.73 | 1 | 0.3916 | Not worse | Constrain |
| Constrain economic hardship class 3 | 25,915.08 | 33 | 15.06 | 2 | 0.0005 | Significantly worse | Freely estimate |
| Constrain loneliness class 4 | 25,917.72 | 31 | 2.64 | 2 | 0.2663 | Not worse | Constrain |
| Constrain negative COVID attitudes class 4 | 25,920.91 | 30 | 3.18 | 1 | 0.0743 | Not worse | Constrain |
| Constrain economic hardship class 4 | 26,157.76 | 28 | 236.85 | 2 | 0.0000 | Significantly worse | Freely estimate |

Note: Interpretation is based on results of the chi-square test. A significant test would indicate the constraint resulted in a significantly worse model fit. Abbreviations: df, degrees of freedom; Δ , change.

TABLE 3 Effect of time-varying covariates on emergent perceived stress class membership

| | Stable high (n = 339; 27.6%) | Steady increase (n = 74; 6.0%) | Steady decrease (n = 284; 23.0%) | Stable low (n = 533; 43.3%) |
|--------------------------------|---------------------------------|-----------------------------------|-------------------------------------|--------------------------------|
| Time-varying covariates | | | | |
| Negative reactions to COVID-19 | | | | |
| 6-month follow-up | 2.90 [2.19, 3.62] | 1.92 [0.89, 2.97] | -0.81 [-1.64, 0.004] | 0.01 [-0.52, 0.55] |
| 9-month follow-up | 2.90 [2.19, 3.62] | 1.92 [0.89, 2.97] | -0.81 [-1.64, 0.004] | 0.01 [-0.52, 0.55] |
| 12-month follow-up | - | - | - | - |
| Loneliness | | | | |
| 6-month follow-up | -0.07 [-0.10, -0.04] | 0.11 [0.05, 0.16] | 0.04 [0.001, 0.08] | 0.06 [0.04, 0.08] |
| 9-month follow-up | -0.05 [-0.09, -0.01] | 0.13 [0.06, 0.20] | 0.04 [0.001, 0.08] | 0.06 [0.04, 0.08] |
| 12-month follow-up | 0.05 [-0.02, 0.10] | 0.18 [0.09, 0.26] | 0.04 [0.001, 0.08] | 0.06 [0.04, 0.08] |
| Employment disruptions | | | | |
| 6-month follow-up | 0.26 [-0.67, 1.19] | -1.05 [-2.43, 0.42] | -3.06 [-4.78, -1.34] | 1.07 [0.40, 1.74] |
| 9-month follow-up | -0.46 [-1.36, 0.43] | -1.05 [-2.43, 0.42] | -0.47 [-1.80, 0.86] | -0.46 [-0.96, 0.05] |
| 12-month follow-up | -0.41 [-1.37, 0.55] | -1.05 [-2.43, 0.42] | 1.12 [-0.23, 2.46] | 0.23 [-0.38, 0.84] |
| Model fit criteria | | | | |
| AIC | | 25,213.617 | | |
| BIC | | 25,505.112 | | |
| aBIC | | 25,324.056 | | |
| Entropy | | 0.90 | | |

Note: Bold indicates confidence interval does not include 0 or 1. Effects of the time-varying covariates are represented by traditional beta (B) coefficients and represent the effect of the time-varying covariate on the contemporaneous outcome above the underlying growth model.

Abbreviations: aBIC, sample size adjusted Bayesian information criteria; AIC, Akaike information criteria; BIC, Bayesian information criteria.

throughout the study period. Veterans in the Stable Low class showed a small uptick in perceived stress between baseline (pre-COVID-19) and the first follow up (August 2020); however, they reported a return to near baseline levels by February 2021 (1-year post-COVID-19). The *Steady Increasing* class represented 6% (n = 74) of the sample. Veterans in this class showed a marked increase in perceived stress from baseline to the 6-month follow-up, which continued to increase over the study period. Finally, the *Steady Decreasing* class represented 23% (n = 284) of the sample. Veterans in this class reported the highest reported perceived stress pre-COVID-19 but marked decreases over the study period.

3.2 | Time invariant covariates

Differences in classes by income, combat, sex, and race were observed. For more details, please refer to Table S4. Regarding sex differences, relative to the males, females were more likely to be in the *Steady Decreasing* class (OR = 2.22) versus the *Stable High*. Those reporting greater ACEs is associated with greater odds of being in the *Steady Increasing* (OR = 1.31) and *Steady Decreasing* (OR = 1.42) class relative to *Stable High*. Relative to White veterans, non-White veterans were more likely to be associated with the *Steady Increasing* class

(OR = 2.28) compared to the *Stable High*. Finally, those with greater combat exposure were more likely to be associated with the *Steady Decreasing* class (OR = 1.38) than *Stable High* class.

3.3 | COVID-19-specific time-varying covariates

To address Aim 2, we then began fitting a series of models where we introduced our three time-varying covariates: negative reactions to COVID-19, loneliness, and employment disruptions (see Table 2 for model fit). In our final model (see Table 3 for final model estimates), those in the *Stable High* class, negative reactions to COVID-19 were constrained to be equal and resulted in an increase in perceived stress (B = 2.90). Loneliness was allowed to be freely estimated and resulted in less stress at the 6-month (B = -0.07) and 9-month follow-up (B = -0.05), but this effect faded at the 12-month follow-up (i.e., not significant). Employment disruptions, which were freely estimated, was not associated with contemporaneous perceived stress at any time point.

For those in the *Steady Increasing* class, effects of negative reactions to COVID-19 were constrained to be equal and had associated with increased perceived stress (B = 1.92). Loneliness, which was allowed to be freely estimated, also had a gradual increasing

effect on perceived stress over time (6-month: $B = 0.11$; 9-month: $B = 0.13$; 12-month: $B = 0.18$) Wald test of parameter constraints between the 6-month and 12-month surveys (Wald value = 5.14 (1), $p = 0.02$) indicated that effects of loneliness were significantly different, indicating an increasing effect of loneliness on stress for those in the Steady Increasing class. No significant effects for employment disruptions were detected. For those in the Steady Decreasing class, effects of loneliness were consistent (constrained to be equal) and associated with increased effects on contemporaneous perceived stress over time ($B = 0.04$). Negative reactions to COVID-19 and employment disruptions did not have significant contemporaneous associations with perceived stress.

Similar results for the *Stable Low* class emerged, with loneliness having a consistent (constrained to be equal) effect on perceived stress over time ($B = 0.06$). The only other effect for the *Stable Low* class to emerge was the effect of employment disruptions, which increased stress at the 6-month follow-up ($B = 1.07$).

3.4 | Distal outcomes

To address our third aim, we added distal outcomes to the final model. Here, the distal outcomes were entered as auxiliary variables, which produces pair-wise mean comparisons across all emergent classes, controlling for our time-invariant predictors and time-varying covariates. Figures 4–6 display mean levels for all distal outcomes as well as Wald Chi-square difference tests. Bonferroni corrections were used for all pairwise comparisons ($p < 0.001$). For AUDIT scores

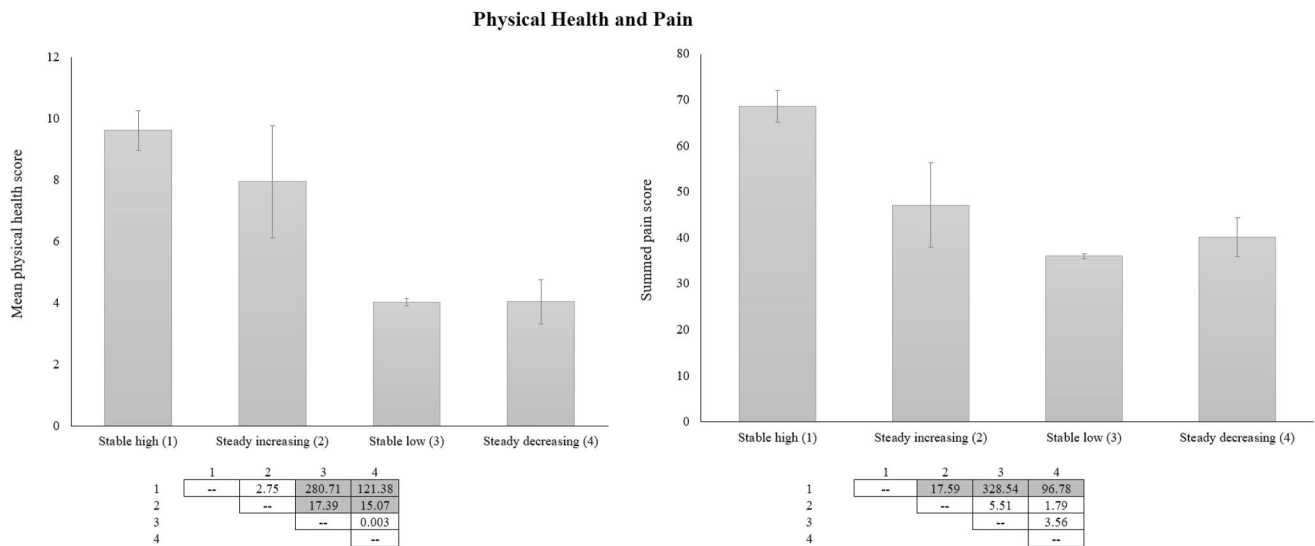
(Figure 4), those in the *Stable High* class reported the highest AUDIT scores, which were significantly higher than all other classes. For sleep (Figure 4), those in the *Stable High* and *Stable Increasing* classes reported the worst sleep problems. While no differences emerged between those in the *Steady Increasing* and *Stable High*, participants in the *Stable High* class had significantly worse sleep problems relative to the *Stable Low* and *Steady Decreasing* class and those in the *Steady Increasing* class had significantly worse sleep problems compared to those in the *Stable Low* class.

In terms of physical health (Figure 5), those in the *Stable High* and *Steady Increasing* classes reported the worst physical health. Participants in both the *Stable High* and *Steady Increasing* classes reported worse physical health compared to the *Stable Low* and *Steady Decreasing* classes. For pain (see Figure 5), similar to AUDIT, those in the *Stable High* class reported the highest pain which was significantly different than all other classes.

For PTSD (Figure 6), veterans in the *Stable High* class reported the greatest number of symptoms which were significantly higher than all other classes. For depression (Figure 6), those veterans in the *Stable High* class reported the greatest number of symptoms and were significantly higher than all other classes. No other differences emerged across PTSD and depression.

4 | DISCUSSION

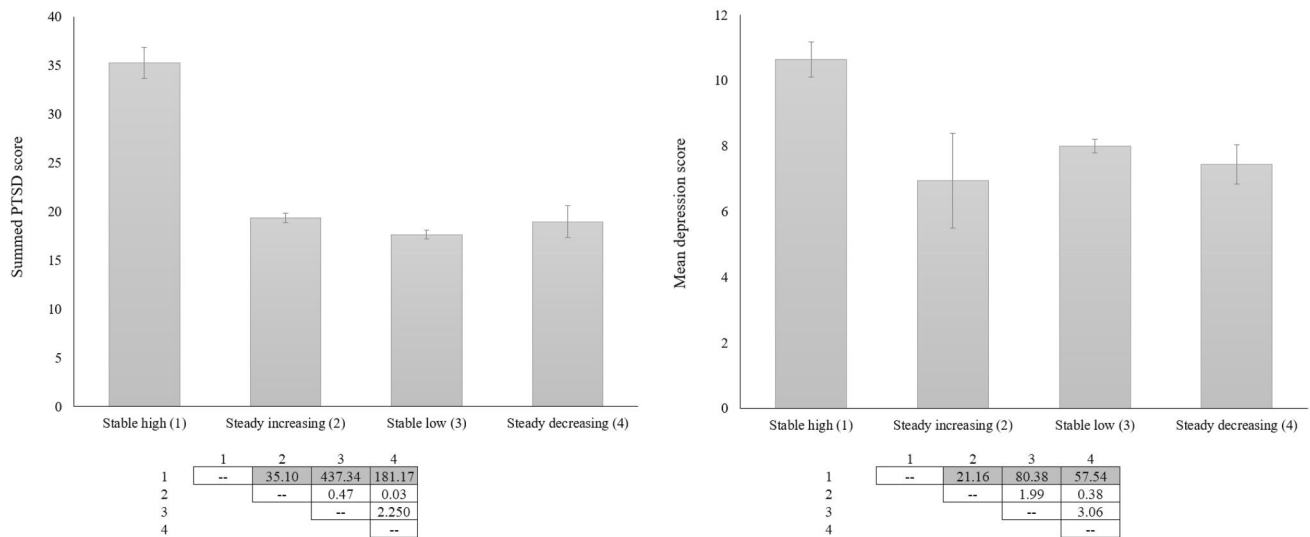
Wrote that stress is a nonspecific response that the body makes to any demand, in which the stressor is the agent that produces it, and if



Note. Figure vertical bars represent mean values on the measures for each of the indicated groups. Higher scores represent greater physical health problems and pain symptoms. Values in boxes indicate chi-square values between indicated groups. Shaded values are significant at $p < .001$, which reflects an applied Bonferroni correction.

FIGURE 5 Means, confidence intervals, and chi-square values assessing differences in physical health and pain by emergent classes. Note. Figure vertical bars represent mean values on the measures for each of the indicated groups. Higher scores represent greater physical health problems and pain symptoms. Values in boxes indicate chi-square values between indicated groups. Shaded values are significant at $p < 0.001$, which reflects an applied Bonferroni correction

Posttraumatic Stress Disorder and Depression



Note. Figure vertical bars represent mean values on the measures for each of the indicated groups. Higher scores represent more severe PTSD and depression symptoms. Values in boxes indicate chi-square values between indicated groups. Shaded values are significant at $p < .001$, which reflects an applied Bonferroni correction.

FIGURE 6 Means, confidence intervals, and chi-square values assessing differences in PTSD and depression by emergent classes. *Note.* Figure vertical bars represent mean values on the measures for each of the indicated groups. Higher scores represent more severe PTSD and depression symptoms. Values in boxes indicate chi-square values between indicated groups. Shaded values are significant at $p < .001$, which reflects an applied Bonferroni correction

the body is exposed to stressors for prolonged periods of time, can procure long-term negative consequences. The COVID-19 pandemic has taken a toll on the psychological well-being of many people across the world. In particular, American veterans are a group who have unique stressors that may exacerbate perceived stress during the COVID-19 pandemic. The current study is among the first to assess changes in perceived stress, among veterans. Further, our study notes incremental differences in changes to perceived stress when considering important factors relevant to COVID-19, such as loneliness, negative reactions to COVID-19, and employment disruptions, as well as differential effects of perceived stress trajectories on important distal outcomes including physical and psychological health.

Overall, the present study shows significant heterogeneity in perceived stress during the first year of the COVID-19 pandemic. Results from the current study show emergence of four distinct perceived stress trajectories. Because our first wave of data in this longitudinal study was collected pre-COVID, we can see how the COVID-19 pandemic influences trajectories of stress change across time for latent subgroups of veterans. Prior research on general samples have noted increased stress and anxiety throughout the COVID-19 pandemic (Salari et al., 2020). However, our results show heterogeneity in trajectories of stress that both react and do not react to pandemic-specific factors. For example, in the *Steady Increasing* class, we can see a relatively large jump in perceived stress from baseline to the 6-month follow up (nearly a 1 standard deviation increase) and a steady increase in stress throughout the follow-up

period. Thus, it seems that individuals in this class, while starting out relatively low on stress pre-pandemic, had the largest increase in stress during the first 6-month of the COVID-19 pandemic in the United States. Perceived stress among this class continued to increase throughout the 12-month mark – matching that of the *Stable High* stress class. On the other hand, the *Steady Decreasing* class had the highest stress pre-COVID-19 with a large decrease during the first 6-months of COVID-19 (a 4-point drop), with a steady decline over the 1-year follow-up. The *Stable High* class, however, does not seem to have a ‘reaction’ to COVID-19 given little fluctuation during the first 6-month and thereafter in perceived stress. While veterans are known to experience many types of stressors and may have been particularly vulnerable to stressors associated with COVID-19, the pandemic seems to have had varying effects on perceived stress among veterans. Our results indicate multiple trajectories of perceived stress where some appear to be increasing in perceived stress during the pandemic while others are decreasing or staying at pre-pandemic levels. Though results of control variables (e.g., our time invariant covariates) were not shown for parsimony, adverse childhood experiences were associated with higher odds of being in the *Steady Decreasing* and *Steady Increasing* compared to the *Stable High* classes, and combat exposure was associated with higher odds of being in the *Steady Decreasing* compared to the *Stable High* class. Thus, it appears that veterans who experience greater combat exposure or more childhood adversity may not respond in a similar way to daily life stressors, which has a direct effect on long-term psychological and physical health. This notion has been shown among nationally

represented samples such that individuals who experience greater childhood adversity have worse mental health (e.g., depression, PTSD) and stress outcomes (Green et al., 2010). Though the research in this area is still developing, this may be because early life adversities alter the stress response system, such that long-term stress coping capacity may be disrupted (Koss & Gunnar, 2018).

As we were able to extract differential trajectories of perceived stress during the first year of COVID-19 among veterans, our second aim was to explore how specific COVID-19 factors can explain the variation in perceived stress over time. In particular, we show that negative reactions to COVID have a large and consistent effect on perceived stress for those in the *Stable High* and *Steady Increasing* classes. Fear and anxiety about the virus itself as well as the macro-economic effects of local and national shutdowns may have influenced psychological well-being. Fear and negative reactions to a pandemic is the most prevalent psychological response but has been differentiated from other natural disasters (Esterwood & Saeed, 2020). Typically, fear and negative reactions to a threat can increase survival and can result in evolutionarily adaptive safety actions such as hygiene, distancing, and avoiding public spaces (Coelho et al., 2020). However, long periods of isolation, uncertainty, and potential financial problems (e.g., loss of work or reduced hours), disruption of daily routine, and having close family member or friends' contract COVID-19 can increase the level of fear and have harmful and negative effects on psychological and physical health. In fact, in a recent meta-analysis, a moderate association ($r = 0.47$) was noted between fear and negative reactions to COVID-19 and stress (Şimşir et al., 2021).

While negative reactions to COVID-19 were only associated with greater perceived stress for the *Stable High* and *Steady Increasing* classes, loneliness emerged as a robust predictor of stress trajectories for all emergent classes. For those in the *Steady Increasing* class, loneliness had an increasing and positive effect on stress over the course of the study. For those in the *Steady Decreasing* and *Stable Low* classes, loneliness had a consistent and positive effect on stress. Recent work assessing loneliness on a variety of behavioural health outcomes notes that individuals reporting higher loneliness also reported worsening mental health symptoms (particularly depression) throughout the COVID-19 period (Creese et al., 2021). In a recent narrative review across 41 studies, loneliness was associated with poor mental health (Ingram et al., 2020). The implementation of stay-at-home orders and repeated, long, quarantine orders were mandated to slow the rate of infection before a vaccine or treatment was developed. However, there is concern that limiting social contact and general social activities will increase feelings of loneliness, especially among vulnerable groups (E. D. Miller, 2020; G. Miller, 2020). For those veterans who are reporting increasing stress during the study period, it seems that loneliness is exacerbating the problem, while those with decreasing and low stress seem to be less affected by loneliness; however, the effect is relatively small and constant (i.e., does not change). There is enormous variation in individuals' ability to handle isolation and someone who is already having problems with mental health (e.g. depression, anxiety) or substance use may be particularly vulnerable. However, opposite of

this, our results show that loneliness has a small but *negative* association early in the pandemic for veterans reporting *Stable High* perceived stress. This is in contrast to studies and recent work noting that loneliness due to COVID-19 is associated with worse outcomes across a variety of domains (Creese et al., 2021; McGinty et al., 2020). However, some recent work among a representative sample of American adults noted no change in loneliness during the pandemic and, on the contrary, some groups reported decreased loneliness (Luchetti et al., 2020). Further, social connectedness may have increased during the early months of the pandemic as people initiated more frequent online or video chats. It may be that veterans who have reportedly high stress were able to adapt and generate greater social connections and thus counteracting effects of loneliness, especially in the early months of the pandemic. In contrast to the *Stable High* class, which had slightly decreasing loneliness, the subgroup of veterans in the *Steady Increasing* class may be coping poorly with stress (e.g., isolating) indicated by the positive association between loneliness and perceived stress, which seems to strengthen over time leading to increases in perceived stress. It may also be the case that some of the individuals with stable high perceived stress actually experienced relief due to fewer social demands being placed on them during the pandemic.

In addition to the present study noting differential effects of time-varying COVID-specific effects on stress trajectories, we also sought to understand how veterans differed on several behavioural health outcomes. Results showed a relatively robust pattern. Veterans in the *Stable High* or *Steady Increasing* classes reported worse scores across all outcomes, compared to individuals in the *Stable Low* and *Steady Decreasing* classes. In particular, veterans in the *Stable High* class had higher AUDIT, pain, PTSD, and depression scores compared to nearly all other classes. The only outcomes that these veterans did not differ from all classes were sleep and physical health, in which those in the *Steady Increasing* class reported similar sleep and physical health scores. However, both the *Stable High* and *Steady Increasing* classes did have worse sleep and physical health scores than the *Stable Low* and *Steady Decreasing* classes. While there is a relatively large and robust literature linking perceived stress to worse psychological and physical health outcomes (Golden-Kreutz et al., 2005; McHugh et al., 2020; Moitra et al., 2013; Wisnivesky et al., 2010), very little research has explored this among veterans. The majority of studies among veterans exploring differences in psychological and physical health outcomes have focussed on common liabilities such as combat exposure, early childhood adversities, and military specific traumatic events such as military sexual trauma (Davis et al., 2021; Nichter et al., 2020). The present study extends this prior work by focussing on both common liabilities as well as time-varying covariates in association with long-term behavioural health outcomes.

4.1 | Strengths and limitations

Our sample of veterans, while large enough to enable advanced statistical analyses, is not representative, which limits

generalisability to broader veteran samples – particularly to those who do not use social media and those who were unable to participate in the study due to COVID specific factors (infection, employment interruption etc.). Furthermore, the general U.S. veteran population is older on average than our post-9/11 sample as it includes veterans of prior conflicts, our sample may differ on key behavioural health indicators (e.g., ours is relatively high in AUD; Straus et al., 2020). While a major strength of this study is that it is longitudinal, it is still an observational study, which limits the ability to make causal inferences about the effects of time-varying covariates on perceived stress, and the effect of perceived stress on behavioural health outcomes. Nonetheless, our work provides a novel look at perceived stress among a group high in stressful experiences, during a rare world-wide event which may have ubiquitously prompted stress to wide ranging degrees. While in the early months of the pandemic, many suggested vulnerable groups such as veterans would fare poorly due to COVID-19 related stressors (Murphy et al., 2020), our data tell a somewhat different story. While many indeed had high and stable perceived stress, and it increased in some, many veterans reported either low and stable, or decreasing perceived stress (albeit, still high in the latter group). Our work begins to clarify what might exacerbate perceived stress among these different groups of veterans, though future studies should work to replicate results in non-pandemic periods. We also note links between perceived stress trajectories and distal behavioural health outcomes. In line with theories of stress and its appraisal that predict differential responses and outcomes to stressors, our results point to a need for clinicians and researchers to be aware of and explore the interplay between existing vulnerabilities, psychological appraisal, ongoing stressors, and behavioural health outcomes among veterans. Efforts should be made to engage veterans with high or increasing perceived stress in intervention and prevention efforts, considering the range of potential physical and mental health outcomes. Furthermore, the psychosocial determinants of resiliency in the face of stressors should be explored among veterans considering many are doing better than expected.

ACKNOWLEDGEMENT

This research was funded by grant R01AA026575 from the National Institute on Alcohol Abuse and Alcoholism (NIAAA), supplement R01AA026575-02S1, and a Keck School of Medicine COVID-19 Research Funding Grant awarded to Eric R. Pedersen.

CONFLICT OF INTEREST

The authors report no conflicts of interest.

HUMAN SUBJECTS

All procedures have been approved by the lead author's institution.

DATA AVAILABILITY STATEMENT

Data are currently not publicly available given this is an ongoing study.

ORCID

Jordan P. Davis  <https://orcid.org/0000-0002-6108-4936>

REFERENCES

- Babor, T. F., Biddle-Higgins, J. C., Saunders, J. B., & Monteiro, M. G. (2001). *Audit: The alcohol use disorders identification test: Guidelines for use in the primary health care*. World Health Organization.
- Bovin, M. J., Marx, B. P., Weathers, F. W., Gallagher, M. W., Rodriguez, P., Schnurr, P. P., & Keane, T. M. (2016). Psychometric properties of the PTSD checklist for diagnostic and statistical manual of mental disorders-fifth edition (PCL-5) in veterans. *Psychological Assessment, 28*(11), 1379–1391. <https://doi.org/10.1037/PAS0000254>
- Bray, R. M., Fairbank, J. A., & Marsden, M. E. (1999). Stress and substance use among military women and men. *The American Journal of Drug and Alcohol Abuse, 25*(2), 239–256. <https://doi.org/10.1081/ADA-100101858>
- Chen, B., Li, Q., Zhang, H., Zhu, J., Yang, X., Wu, Y., Chen, Z., Li, F., & Wang, H. (2020). The psychological impact of COVID-19 outbreak on medical staff and the general public. *Current Psychology, 1*–9. <https://doi.org/10.1007/s12144-020-01109-0>
- Coelho, C. M., Suttiwan, P., Arato, N., & Zsido, A. N. (2020). On the nature of fear and anxiety triggered by COVID-19. *Frontiers in Psychology, 11*, 581314. <https://doi.org/10.3389/fpsyg.2020.581314>
- Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior, 24*(4), 385–396. <https://doi.org/10.2307/2136404>
- Cohen, S., & Williamson, G. (1988). Perceived stress in a probability sample of the United States. (S.Spacapan & Oskamp S., Eds.). In *Newbury park*. [https://www.scirp.org/\(S{351jmbntvnsjt1aadkposzje}\)/reference/ReferencesPapers.aspx?ReferenceID=1186085](https://www.scirp.org/(S{351jmbntvnsjt1aadkposzje})/reference/ReferencesPapers.aspx?ReferenceID=1186085)
- Colvonen, P. J., Almklov, E., Tripp, J. C., Ulmer, C. S., Pittman, J. O. E., & Afari, N. (2020). Prevalence rates and correlates of insomnia disorder in post-9/11 veterans enrolling in VA healthcare. *Sleep (New York, N.Y.), 43*(12), 1–zsa119. <https://doi.org/10.1093/sleep/zsaa119>
- Creese, B., Khan, Z., Henley, W., O'Dwyer, S., Corbett, A., Vasconcelos Da Silva, M., Mills, K., Wright, N., Testad, I., Aarsland, D., & Ballard, C. (2021). Loneliness, physical activity, and mental health during COVID-19: A longitudinal analysis of depression and anxiety in adults over the age of 50 between 2015 and 2020. *International Psychogeriatrics, 33*(5), 505–514. <https://doi.org/10.1017/S1041610220004135>
- Davis, J. P., Lee, D. S., Saba, S., Fitzke, R. E., Ring, C., Castro, C. C., & Pedersen, E. R. (2021). Applying polyvictimization theory to veterans: Associations with substance use and mental health. *Psychology of Addictive Behaviors, 36*(2), 144–156. <https://doi.org/10.1037/ADB0000781>
- Esterwood, E., & Saeed, S. A. (2020). Past epidemics, natural disasters, COVID19, and mental health: Learning from history as we deal with the present and prepare for the future. *Psychiatric Quarterly, 91*(4), 1121–1133. <https://doi.org/10.1007/s11126-020-09808-4>
- Felitti, V. J., Anda, R. F., Nordenberg, D., Williamson, D. F., Spitz, A. M., Edwards, V., & Marks, J. S. (1998). Relationship of childhood abuse and household dysfunction to many of the leading causes of death in adults: The Adverse Childhood Experiences (ACE) Study. *American Journal of Preventive Medicine, 14*(4), 245–258. [https://doi.org/10.1016/S0749-3797\(98\)00017-8](https://doi.org/10.1016/S0749-3797(98)00017-8)
- Fitzpatrick, K. M., Harris, C., & Drawve, G. (2020). Fear of COVID-19 and the mental health consequences in America. *Psychological Trauma, 12*(S1), S17–S21. <https://doi.org/10.1037/tra0000924>
- Flores, E., Tschann, J. M., Dimas, J. M., Bachen, E. A., Pasch, L. A., & Groat, C. L. de (2008). Perceived discrimination, perceived stress, and mental and physical health among mexican-origin adults. *Hispanic*

- Journal of Behavioral Sciences*, 30(4), 401–424. <https://doi.org/10.1177/0739986308323056>
- Gallagher, M. W., Zvolensky, M. J., Long, L. J., Rogers, A. H., & Garey, L. (2020). The impact of Covid-19 experiences and associated stress on anxiety, depression, and functional impairment in American adults. *Cognitive Therapy and Research*, 44(6), 1043–1051. <https://doi.org/10.1007/s10608-020-10143-y>
- Golden-Kreutz, D. M., Thornton, L. M., Gregorio, S. W.-D., Frierson, G. M., Jim, H. S., Carpenter, K. M., & Andersen, B. L. (2005). Traumatic stress, perceived global stress, and life events. *Health Psychology*, 24(3), 288–296. <https://doi.org/10.1037/0278-6133.24.3.288>
- Green, J. G., McLaughlin, K. A., Berglund, P. A., Gruber, M. J., Sampson, N. A., Zaslavsky, A. M., & Kessler, R. C. (2010). Childhood adversities and adult psychiatric disorders in the national comorbidity survey replication I: Associations with first onset of DSM-IV disorders. *Archives of General Psychiatry*, 67(2), 113–123. <https://doi.org/10.1001/archgenpsychiatry.2009.186>
- Ingram, I., Kelly, P. J., Deane, F. P., Baker, A. L., Goh, M. C. W., Raftery, D. K., & Dingle, G. A. (2020). Loneliness among people with substance use problems: A narrative systematic review. *Drug and Alcohol Review*, 39(5), 447–483. <https://doi.org/10.1111/DAR.13064>
- Johns Hopkins Bloomberg School of Public Health. (2020). Mental health survey items from the COVID-19 and mental health measurement working group. *Department of Mental Health at Johns Hopkins Bloomberg School of Public Health*. https://www.elizabethstuart.org/files/MH_survey-items-request_03_20.pdf
- Kim, H. M., Levine, D. S., Pfeiffer, P. N., Blow, A. J., Marchiondo, C., Walters, H., & Valenstein, M. (2017). Postdeployment suicide risk increases over a 6-month period: Predictors of increased risk among midwestern army national guard soldiers. *Suicide and Life-Threatening Behavior*, 47(4), 421–435. <https://doi.org/10.1111/SLTB.12303>
- Kocalevent, R.-D., Hinz, A., & Brähler, E. (2013). Standardization of a screening instrument (PHQ-15) for somatization syndromes in the general population. *BMC Psychiatry*, 13(1), 91. <https://doi.org/10.1186/1471-244X-13-91>
- Koss, K. J., & Gunnar, M. R. (2018). Annual research review: Early adversity, the hypothalamic–pituitary–adrenocortical axis, and child psychopathology. *Journal of Child Psychology and Psychiatry*, 59(4), 327–346. <https://doi.org/10.1111/jcpp.12784>
- Kroenke, K., Spitzer, R. L., & Williams, J. B. W. (2002). The PHQ-15: Validity of a new measure for evaluating the severity of somatic symptoms. *Psychosomatic Medicine*, 64(2), 258–266. <https://doi.org/10.1097/00006842-200203000-00008>
- Kroenke, K., Strine, T. W., Spitzer, R. L., Williams, J. B. W., Berry, J. T., & Mokdad, A. H. (2009). The PHQ-8 as a measure of current depression in the general population. *Journal of Affective Disorders*, 114(1–3), 163–173. <https://doi.org/10.1016/J.JAD.2008.06.026>
- Lazarus, R. S. (1985). The psychology of stress and coping. *Issues in Mental Health Nursing*, 7(1–4), 399–418. <https://doi.org/10.3109/01612848509009463>
- Lazarus, R. S., & Folkman, S. (1984). *Stress, appraisal, and coping* [Book]. Springer Publishing Company.
- Liu, C. H., Zhang, E., Wong, G. T. F., Hyun, S., & Hahm, H. (2020). Factors associated with depression, anxiety, and PTSD symptomatology during the COVID-19 pandemic: Clinical implications for U. S. young adult mental health [Article]. *Psychiatry Research*, 290, 113172. <https://doi.org/10.1016/j.psychres.2020.113172>
- Liu, S., Lithopoulos, A., Zhang, C.-Q., Garcia-Barrera, M. A., & Rhodes, R. E. (2021). Personality and perceived stress during COVID-19 pandemic: Testing the mediating role of perceived threat and efficacy. *Personality and Individual Differences*, 168, 110351. <https://doi.org/10.1016/J.PAID.2020.110351>
- Liu, Y., Collins, C., Wang, K., Xie, X., & Bie, R. (2019). The prevalence and trend of depression among veterans in the United States. *Journal of Affective Disorders*, 245, 724–727. <https://doi.org/10.1016/J.JAD.2018.11.031>
- Luchetti, M., Lee, J. H., Aschwanden, D., Sesker, A., Strickhouser, J. E., Terracciano, A., & Sutin, A. R. (2020). The trajectory of loneliness in response to COVID-19. *American Psychologist*, 75(7), 897–908. <https://doi.org/10.1037/amp0000690>
- Luo, J., Zhang, B., Willroth, E. C., Mroczek, D. K., & Roberts, B. W. (2021). The roles of general and domain-specific perceived stress in healthy aging. *Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, 77(3), 536–549. <https://doi.org/10.1093/geronb/gbab134>
- McGinty, E. E., Presskreischer, R., Han, H., & Barry, C. L. (2020). Psychological distress and loneliness reported by US adults in 2018 and April 2020. *JAMA : The Journal of the American Medical Association*, 324(1), 93–94. <https://doi.org/10.1001/jama.2020.9740>
- McHugh, R. K., Sugarman, D. E., Meyer, L., Fitzmaurice, G. M., & Greenfield, S. F. (2020). The relationship between perceived stress and depression in substance use disorder treatment. *Drug and Alcohol Dependence*, 207, 107819. <https://doi.org/10.1016/j.drugalcdep.2019.107819>
- Miller, E. D. (2020). Loneliness in the era of COVID-19. *Frontiers in Psychology*, 0, 2219. <https://doi.org/10.3389/FPSYG.2020.02219>
- Miller, G. (2020). Social distancing prevents infections, but it can have unintended consequences. *Science (American Association for the Advancement of Science)*. <https://doi.org/10.1126/science.abb7506>
- Moitra, E., Anderson, B. J., & Stein, M. D. (2013). Perceived stress and substance use in methadone-maintained smokers. *Drug and Alcohol Dependence*, 133(2), 785–788. <https://doi.org/10.1016/j.drugalcdep.2013.08.010>
- Mota, N. P., Medved, M., Wang, J., Asmundson, G. J. G., Whitney, D., & Sareen, J. (2011). Stress and mental disorders in female military personnel: Comparisons between the sexes in a male dominated profession [Article]. *Journal of Psychiatric Research*, 46(2), 159–167. <https://doi.org/10.1016/j.jpsychires.2011.09.014>
- Murphy, D., Williamson, C., Baumann, J., Busuttill, W., & Fear, N. T. (2020). Exploring the impact of COVID-19 and restrictions to daily living as a result of social distancing within veterans with pre-existing mental health difficulties [Article]. *BMJ Military Health*, 168(1), 29–33. <https://doi.org/10.1136/bmjilitary-2020-001622>
- Nahin, R. L. (2017). Severe pain in veterans: The effect of age and sex, and comparisons with the general population. *The Journal of Pain*, 18(3), 247–254. <https://doi.org/10.1016/J.JPAIN.2016.10.021>
- Nichter, B., Hill, M., Norman, S., Haller, M., & Pietrzak, R. H. (2020). Associations of childhood abuse and combat exposure with suicidal ideation and suicide attempt in U.S. Military veterans: A nationally representative study. *Journal of Affective Disorders*, 276, 1102–1108. <https://doi.org/10.1016/J.JAD.2020.07.120>
- Norman, S. B., Haller, M., Hamblen, J. L., Southwick, S. M., & Pietrzak, R. H. (2018). The burden of co-occurring alcohol use disorder and PTSD in U.S. military veterans: Comorbidities, functioning, and suicidality. *Journal of the Society of Psychologists in Addictive Behaviors*, 32(2), 224–229. <https://doi.org/10.1037/ADB0000348>
- Pedersen, E. R., Davis, J. P., Fitzke, R. E., Lee, D. S., & Saba, S. (2021). American veterans in the era of COVID-19: Reactions to the pandemic, posttraumatic stress disorder, and substance use behaviors. *International Journal of Mental Health and Addiction*, 1–16. <https://doi.org/10.1007/s11469-021-00620-0>
- Pedersen, E. R., Helmuth, E. D., Marshall, G. N., Schell, T. L., PunKay, M., & Kurz, J. (2015). Using facebook to recruit young adult veterans: Online mental health research. *JMIR Research Protocols*, 4(2), e63. <https://doi.org/10.2196/resprot.3996>
- Pedersen, E. R., Naranjo, D., & Marshall, G. N. (2017). Recruitment and retention of young adult veteran drinkers using facebook. *PLoS One*, 12(3), e0172972. <https://doi.org/10.1371/journal.pone.0172972>

- Rajkumar, R. P. (2020). COVID-19 and mental health: A review of the existing literature. *Asian Journal of Psychiatry*, 52, 102066. <https://doi.org/10.1016/j.ajp.2020.102066>
- Ram, N., & Grimm, K. J. (2009). Methods and measures: Growth mixture modeling: A method for identifying differences in longitudinal change among unobserved groups. *International Journal of Behavioral Development*, 33(6), 565–576. <https://doi.org/10.1177/0165025409343765>
- Rintala, D. H., Robinson-Whelen, S., & Matamoros, R. (2005). Subjective stress in male veterans with spinal cord injury. *Journal of Rehabilitation Research and Development*, 42(3), 291–304. <https://doi.org/10.1682/JRRD.2005.10.0155>
- Russell, D. W. (1996). UCLA loneliness scale (version 3): Reliability, validity, and factor structure. *Journal of Personality Assessment*, 66(1), 20–40. https://doi.org/10.1207/s15327752jpa6601_2
- Salari, N., Hosseini-Far, A., Jalali, R., Vaisi-Raygani, A., Rasoulpoor, S., Mohammadi, M., & Khaledi-Paveh, B. (2020). Prevalence of stress, anxiety, depression among the general population during the COVID-19 pandemic: A systematic review and meta-analysis. *Globalization and Health*, 16(11), 1–11. <https://doi.org/10.1186/S12992-020-00589-W>
- Schell, T. L., & Marshall, G. N. (2008). Survey of individuals previously deployed for OEF/OIF. In T. Tanielian, & L. H. Jaycox (Eds.), *Invisible wounds of war: Psychological and cognitive Injuries, their consequences, and services to assist recovery*. RAND.
- Şimşir, Z., Koç, H., Seki, T., & Griffiths, M. D. (2021). The relationship between fear of COVID-19 and mental health problems: A meta-analysis. *Death Studies*, 46(3), 1–9. <https://doi.org/10.1080/07481187.2021.1889097>
- Straus, E., Norman, S. B., & Pietrzak, R. H. (2020). Determinants of new-onset alcohol use disorder in U.S. military veterans: Results from the national health and resilience in veterans study. *Addictive Behaviors*, 105, 106313. <https://doi.org/10.1016/J.ADDBEH.2020.106313>
- Thomas, M. M., Harpaz-Rotem, I., Tsai, J., Southwick, S. M., & Pietrzak, R. H. (2017). Mental and physical health conditions in US combat veterans: Results from the national health and resilience in veterans study. *The Primary Care Companion for CNS Disorders*, 19(3). <https://doi.org/10.4088/PCC.17M02118>
- Wisnivesky, J. P., Lorenzo, J., Feldman, J. M., Leventhal, H., & Halm, E. A. (2010). The relationship between perceived stress and morbidity among adult. *Inner-City Asthmatics*, 47(1), 100–104. <https://doi.org/10.3109/02770900903426989>
- Witteveen, D., & Velthorst, E. (2020). Economic hardship and mental health complaints during COVID-19. *Proceedings of the National Academy of Sciences - PNAS*, 117(44), 27277–27284. <https://doi.org/10.1073/pnas.2009609117>

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Davis, J. P., Prindle, J., Saba, S. K., Tran, D. D., Lee, D. S., Sedano, A., Castro, C. A., & Pedersen, E. R. (2022). Changes in perceived stress during the COVID-19 pandemic among American veterans. *Stress and Health*, 1–15. <https://doi.org/10.1002/smi.3153>