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Changes in mental health among U.S. military veterans during the COVID-19 pandemic: A network analysis

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ABSTRACT

Increases of symptoms of posttraumatic stress disorder (PTSD), anxiety and depression have been observed among individuals exposed to potentially traumatic events in the first months of the COVID-19 pandemic. Similarly, associations among different aspects of mental health, such as symptoms of PTSD and suicidal ideation, have also been documented. However, studies including an assessment prior to the onset and during the height of the pandemic are lacking. We investigated changes in symptoms of PTSD, depression, anxiety, suicidal ideation, and posttraumatic growth in a population-based sample of 1232 U.S. military veterans who experienced a potentially traumatic event during the first year of the pandemic. Symptoms were assessed prior to (fall/winter 2019) and one year into the pandemic (fall/winter 2020). We compared changes in symptom interrelations using network analysis, and assessed their associations with pandemic-related PTSD and posttraumatic growth symptoms. A subtle increase in psychopathological symptoms and a decrease in posttraumatic growth was observed one year into the pandemic. The peripandemic network was more densely connected, and pandemic-related PTSD symptoms were positively associated with age, anxiety, worst-event PTSD symptoms, and pandemic-related posttraumatic growth. Our findings highlight the resilience of veterans exposed to a potentially traumatic event during the first year of a pandemic. Similarly, the networks did not fundamentally change from prepandemic to one year into the pandemic. Despite this relative stability on a group level, individual reactions to potentially traumatic events could have varied substantially. Clinicians should individualize their assessments but be aware of the general resilience of most veterans.

1. Introduction

The COVID-19 pandemic has challenged the physical and mental health of the population around the world (Ghebreyesus, 2020). Despite dismal forecasts at the beginning of the pandemic (Reger et al., 2020), recent studies on the prevalence of symptoms of mental disorders during the pandemic have revealed a more nuanced picture. Indeed, some studies found the level of symptoms of anxiety and depression in the general population to varying in conjunction with the number of COVID-19 cases during the first months of the pandemic (Bendau et al., 2021; Twenge et al., 2021) or based on pre-existing vulnerabilities (Tsai et al., 2021). One year into the pandemic, anxiety and depressive symptom burden has mostly returned to prepandemic levels (Fischer et al., 2023; Knudsen et al., 2021; Robinson et al., 2022). Interestingly, the number of deaths by suicides in the same time period even decreased in multiple countries (Pirkis et al., 2021; Tanaka and Okamoto, 2021).

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U.S. military veterans are a unique population for investigating the impact of the COVID-19 pandemic on mental health. Veterans are older compared to the general adult U.S. population and more likely to have chronic physical and mental health conditions (Hoerster et al., 2012). Furthermore, the prevalence of mental disorders and suicidal behavior is higher among veterans (Nichter et al., 2019), as are multiple detrimental social determinants of poorer mental health (e.g., loneliness (Straus et al., 2021) and homelessness (Tsai et al., 2020)). Therefore, veterans are at increased risk of adverse health outcomes related to COVID-19 infection and stressors. Moreover, many of these pre-existing characteristics may also represent risk factors for negative mental health outcomes related to the pandemic (Zheng et al., 2020). On the other hand, veterans are also more experienced in dealing with potentially traumatic events and stressful life events (Tsai et al., 2016), and often report positive psychological changes after coping with the consequences of such events (Pietrzak et al., 2010, 2021). These positive changes are more formally conceptualized as posttraumatic growth (PTG; (Calhoun and Tedeschi, 2006). PTG can manifest as cognitively, for example as a sense of personal strength but also in actions (Hobfoll et al., 2007; Tedeschi and Calhoun, 2004). Importantly, PTG is distinct from resilience (Levine et al., 2009). Although, resilience is a multifaceted concept that encompasses various aspects across different domains of life, it is commonly understood as the ability to adapt and thrive in the face of adversity and trauma (Southwick et al., 2014). Increased levels of PTG have been linked with lower severity and lower probability of a diagnosis of post-traumatic stress disorder (PTSD) following new traumatic life events (Tsai et al., 2016), as well as improved psychological functioning (Tsai et al., 2015). Therefore, despite having risk factors for adverse mental health outcomes, veterans may also be more resilient than the general population with regard to coping with stressors such as those imposed by the COVID-19 pandemic.

A growing literature has examined changes in veterans' mental health during the COVID-19 pandemic. Similar to the general population, the prevalence of symptoms of depression, posttraumatic stress disorder (PTSD), and alcohol use disorder among veterans remained relatively stable (Hill et al., 2021; Na et al., 2021a). Symptoms of anxiety were found to increase slightly in a nationally representative sample of the U.S. veteran population, but only among middle-aged veterans (Hill et al., 2021). Overall, the prevalence of suicidal ideation (SI) decreased one year into the pandemic (Nichter et al., 2021), and remained lower at a three-year follow-up (Fischer et al., in press). However, a more detailed analysis of SI in veterans with pre-existing mental disorders revealed multiple risk factors for SI during the pandemic, including increased severity of symptoms of mental disorders, lower income, and COVID-19 infection (Na et al., 2021b). In contrast to previous studies showing protective effects of PTG to exposure to new traumatic events (Tsai et al., 2016), prepandemic PTG did not predict psychological adjustment to pandemic-related stressors (Park et al., 2022), but was associated with pandemic-related PTG (Na et al., 2021c). Collectively, these studies suggest that, at a population level, the mental health of veterans has remained relatively stable during the pandemic. However, these studies did not investigate how different aspects of mental health are interrelated with each other and how this may have changed during the pandemic. Elucidation of interactions among various facets of mental health outcomes could provide insights into the complex dynamics of changes in veterans' mental health during the pandemic, and inform timely prevention and intervention efforts to mitigate risk of mental health problems in this population.

A network analytic approach is particularly suited to study interrelationships among aspects of mental health (Borsboom, 2017), and can be used to evaluate changes in these aspects between two timepoints. This approach has increasingly been used to investigate a variety of mental disorders, including PTSD (Birkeland et al., 2020; Duek et al., 2020), and how they relate to other aspects of mental health, for example PTG before but also during the COVID-19 pandemic (Ganai et al., 2022). It has also been applied broadly in the context of pandemic-related research. For example, to evaluate the association between psychopathological symptoms and exposure to patients with COVID-19 (Weilenmann et al., 2021), to assess changes in symptoms of PTSD after the onset of the pandemic (e.g. (Chen et al., 2022; Yang et al., 2023),) or to study how symptoms networks differ between individuals who experienced a pandemic-related or another potential traumatic event (PTE) (Williamson et al., 2021). To date, however, only one network study compared pre- and peripandemic networks of symptoms of mental disorders. Using data from the Brazilian Longitudinal Study of Health, the authors compared how the structure of a symptom network changed across three survey waves (2008–2010, 2017–2019 and 2020). They found no major changes between the two prepandemic networks, but a denser network (i.e., more, and stronger relationships between the included symptoms) during the pandemic (Suen et al., 2022). According to the network theory, this implies that the assessed psychopathologies co-occurred more frequently during the pandemic, for example that individuals who experienced anxiety were more likely to also experience depression than prior to the pandemic.

There are several notable gaps in the literature on the effects of the COVID-19 pandemic on the mental health of veterans, as well as in the general network literature on COVID-19. First, it is currently unclear how different aspects of mental health and their interplay are affected by a PTE during a pandemic, and what additional effect preexisting mental disorders may have (Tsai et al., 2023). Second, the network literature on this topic is limited by single time point assessments (Cheung et al., 2021) or changes *during* the pandemic (Di Blasi et al., 2021), as opposed to pre-to peripandemic changes. Third, most network studies only included general symptoms of mental disorders or distress but did not assess whether they were related to the COVID-19 pandemic or other stressors. Consequently, it is unclear whether these symptoms are linked to a particular event or reflective of changes in general psychological distress.

To address these knowledge gaps, we analyzed data from a large, population-based cohort of U.S. military veterans (Fischer et al., 2023) who completed measures of PTSD, depressive, anxiety symptoms, SI and PTG prior to- and one year into the pandemic. We used network analyses to investigate the interplay between these aspects of mental health before and during the pandemic.

2. Materials and methods

2.1. Sample

Data were drawn from the 2019–2020 National Health and Resilience in Veterans Study (NHRVS), a longitudinal study of a nationally representative sample of U.S. military veterans. The NHRVS was conducted from November 18, 2019 to December 19, 2020 and consisted of two survey waves: Wave 1 was completed prior to the onset of the COVID-19 pandemic in the U.S. (completion prior to January 01, 2020, median completion date 11/21/2019) and a one-year follow-up Wave 2 was conducted during the COVID-19 pandemic (median completion date 11/14/2020). For the remaining of the article, Wave 1 will be referred to as "prepandemic" and Wave 2 as "peripandemic." The NHRVS sample was drawn from KnowledgePanel®, a research panel of more than 50 000 U.S. households maintained by Ipsos. The sampling methodology has been described in greater detail elsewhere (Nichter et al., 2021; Tsai et al., 2020). A total of 7860 veterans were initially approached to participate in the NHRVS, 4069 (51.8%) completed the prepandemic survey and 3030 (38.5%) the peripandemic survey. Of those, 1255 reported a PTE during the pandemic. Twenty-three individuals had missing data and were therefore excluded from the analysis. This resulted in a final sample size of 1232 veterans. Informed written consent was obtained from all participants. The NHRVS was approved by the Human Subjects Committee of the Veterans Affairs Connecticut Healthcare System.

2.2. Assessments

2.2.1. Demographic information

Sociodemographic characteristics included age, sex, race/ethnicity, education, marital/partnered status, and annual household income.

2.2.2. Trauma exposure

Exposure to potentially traumatic events at the prepandemic and peripandemic assessments was assessed using the Life Events Checklist for DSM-5 (LEC-5 (Weathers et al., 2013)), a self-report screening measure that assesses direct (i.e., happened to me) and indirect (i.e., witnessed, learned about, part of job) exposure to 16 potentially traumatic events (PTEs) and an "other" event not listed.

2.2.3. Posttraumatic stress

Symptoms of PTSD in relation to veterans' 'worst' event on the LEC-5 were assessed with the PTSD Checklist for DSM-5 (PCL-5 (Blevins et al., 2015)). The PCL-5 is comprised of 20 items corresponding with the DSM-5 symptoms of PTSD. The severity of each symptom in the past month is rated on a 4-point scale (ranging from 0 = "not at all" to 3 = "extremely") and summed to yield a total score of 0–80, with higher scores reflecting greater severity. Cronbach's alpha for the full PCL-5 was 0.96 at both the prepandemic and peripandemic assessments. Cronbach's alpha for the corresponding clusters (B to E) was 0.91, 0.89, 0.90, and 0.87 for the prepandemic and 0.90, 0.88, 0.90, and 0.87 for the peripandemic assessment.

Pandemic-related symptoms of PTSD were assessed using the abbreviated 4-item version of the PCL-5 (Geier et al., 2020). Items are rated on 4-point scale (ranging from 0 = "not at all" to 3 = "extremely"), with the total score ranging from 0 to 16. The following specifier was used to assess pandemic-related symptoms (example: "*Thinking about the Coronavirus/COVID-19 pandemic, please indicate how much you have been bothered by repeated, disturbing, and unwanted memories of the pandemic*"). Cronbach's alpha was 0.74.

2.2.4. Depression and anxiety

The Patient Health Questionnaire (PHQ)-4 was used to assess symptoms of major depressive disorder (MDD) and generalized anxiety disorder (GAD) in the last two weeks (Kroenke et al., 2009), each assessed by two items rated on a 4-point scale (ranging from 0 = "not at all" to 3 = "Nearly every day"). Cronbach's alpha for the PHQ-2 was 0.87 (prepandemic) and 0.85 (peripandemic), and for the GAD-2 0.86 (prepandemic) and 0.87 (peripandemic).

2.2.5. Suicidal ideation

Past-year SI was assessed using item 2 of the Suicide Behaviors Questionnaire-Revised (SBQ-R; Osman et al., 2001) "*How often have you thought about killing yourself in the past year?*" Response options range from 'Never' (0) to 'Very Often' (5 or more times); SI was operationalized as endorsing suicidal thoughts 1 or more times in the past year.

2.2.6. Posttraumatic growth

PTG in relation to one's 'worst' traumatic event on the LEC-5 at the prepandemic and peripandemic assessments was assessed using the Posttraumatic Growth Inventory-Short Form (PTGI-SF (Cann et al., 2010),). The PTGI-SF consists of 5 subscales (personal strength, relating to others, new possibilities, spiritual change, and appreciation of life), each of which is assessed with two items rated on a 6-point scale (ranging from 0 = "I did not experience this change" to 5 = "I experienced this change to a very great degree"). The summed total score ranges from 0 to 50 and higher scores indicate greater PTG. PTGI-SF' Cronbach's alpha was 0.91 in both the prepandemic and the peripandemic assessments.

Pandemic-related PTG was assessed using an adapted version of the PTGI-SF (Cann et al., 2010), which asked: "*Please indicate the degree to which you experienced these changes in your life as a result of the COVID-19 pandemic*." Cronbach's alpha of the adapted PTGI-SF was 0.91.

2.3. Statistical analyses

We only considered complete data due the listwise deletion of missing data in network models. All non-network analyses were performed two-tailed and the significance level for all tests was determined as alpha = .05. All analyses were carried out in the R statistical environment (R Core Team, 2020). The annotated analytic code including information about the used packages are provided as supplementary material.

2.3.1. Demographic characteristics and mental health variables

Categorical data were described with frequency and weighted prevalence. Ordinal items were described using the mean and standard deviation. To assess differences between the two timepoints, chi-square-tests and paired Wilcoxon rank-sum tests were used with the effect size being *r* (0.10–0.3 corresponding to a small effect, 0.30–0.5 to a medium effect).

2.3.2. Network analysis

We used network analysis to examine associations among variables assessing different aspects of mental health. We estimated one network for the prepandemic and one for the peripandemic assessment. In order to examine the impact of pandemic related symptoms of PTSD and PTG, we estimated an additional network, expanding the peripandemic network with these pandemic-related variables. The analytic procedure was the same for all networks. First, due to the inclusion of categorical, ordinal, and continuous variables, we estimated mixed graphical models (mgm (Haslbeck and Waldorp, 2020),). In the resulting visualization of the networks, nodes represent variables and edges pairwise relationships between the variables; in the case of two continuous variables, the edge corresponds to a partial correlation. The individual edges can be compared to beta weights in a multiple regression analysis in which one node is the outcome and all other nodes are the predictor variables. In a network the individual regression analyses are linked and standardized and thus the resulting edges are expressed as partial correlations and not beta weights (Epskamp and Fried, 2018). To estimate the networks, an L1-penalized regression based on Least Absolute Shrinkage and Selection Operator (LASSO) was used. LASSO sets the weight of very small edges to zero, excluding them from furtherer analysis, and thus reducing the false positive rate (Haslbeck and Waldorp, 2020; Tibshirani, 1996). More specifically, we used a so-called "EBIC model selection" with gamma = 0.5 and the"AND"rule(Isvoranu and Epskamp, 2021).The resulting networks were characterized using the network centrality index "expected influence," which corresponds to the absolute sums of all edges' weights of a given node capturing the influence of positive and negative edges to determine centrality of a node (Robinaugh et al., 2016). Second, stability and reliability of the networks were assessed using bootstrapping procedures implemented in the package *bootnet* (Epskamp and Fried, 2018). These results are outlined in the supplementary materials. Third, we used the NetworkComparisonTest (NCT) to test for differences between the prepandemic and the peripandemic network (van Borkulo et al., 2022).

3. Results

3.1. Sample characteristics

Table 1 shows sample characteristics. Overall, the median age of participants was 62 (IQR = 57–74) years. The majority were male (n = 1061; 86.8%) and non-Hispanic White (n = 979, 80.0%). A detailed list documented specific exposures to potentially traumatic events and is provided in the supplement (Table S1).

Table 1
Participant characteristics.

Variable	Overall (N = 1223)	
	n	Range or %
Age, Median (IQR)	62	57–74
Male gender	1061	86.8
College graduate or higher education	590	48.2
Married or in a relationship	885	72.4
Household income >60 k annually	746	61.0
Race/ethnicity		
White, non-Hispanic	979	80.0
Black, non-Hispanic	89	7.3
Hispanic	105	8.6
Other, Bi/Multi-racial	50	4.1

Note. IQR = Interquartile range.

3.2. Mental health

Table 2 shows symptoms of worst event-related PTSD, MDD, and GAD, the proportion of veterans reporting SI, and the levels of worst event-related PTG. Before the pandemic, overall severity of psychopathological symptoms was relatively low. However, 156 (12.8%) of the veterans reported SI in the last year. One year into the pandemic, veterans reported significantly greater severity of psychopathology and lower levels of posttraumatic growth, with the former effect being small. The prevalence of SI was not significantly different from prior to the pandemic.

3.3. Network analysis

Figs. 1 and 2 show results of the network analysis. The prepandemic and peripandemic networks looked similar with positive associations between MDD, GAD, and PTSD symptoms. In both networks, SI was related positively to PTSD and MDD symptoms, and negatively with age. Regarding differences, the peripandemic network featured a negative association between age and GAD symptoms, and between PTG and symptoms of MDD, which were not found in the prepandemic network.

Table 2
Psychopathology before and during the pandemic.

	Prepandemic		Peripandemic		Test of Difference	Effect size (r)
	Mean	*SD*	Mean	*SD*	*P*	
Worst-Event Related posttraumatic stress disorder	10	14	11	13	<.001	0.17
Positive screen, n (%)	97	7.9	100	8.2		
Depression	0.78	1.38	0.89	1.37	<.001	0.14
Positive screen, n (%)	83	6.8	82	6.7		
Anxiety	0.75	1.33	0.98	1.43	<.001	
Positive screen, n (%)	71	5.8	100	8.2		0.20
Suicidal ideation, n (%)	156	12.8	144	11.8	0.46	
Posttraumatic Growth	14	5–24	8	2–18	<.001	0.35
Pandemic-related PTSD symptoms	–	–	1	0–3		
Pandemic-related posttraumatic growth	–	–	6	1–14		

Note. IQR = Interquartile range; Posttraumatic stress disorder = PCL-5 total score; Depression = PHQ-2 total score; Anxiety = GAD-2 total score; Posttraumatic Growth = PTGI-SF total score, Pandemic-related traumatic stress symptoms = adapted 4-item PTSD Checklist total score; Pandemic-related Posttraumatic Growth = adapted PTGI-SF total score, Positive screen = PCL-5 ≥ 33, PHQ-2 ≥ 3, GAD-3 ≥ 3.

Both networks were found to be robust (CS-Coefficient of 0.75 indicating the maximum possible). The significance tests also revealed that most edges were significantly different from at least half of the other edges, indicating substantial differences in the strength of different edges in the corresponding network (for more information see Figs. S1–S8). The invariance test and the global strength invariance test were not significant (M = 0.148, $p = 0.395$; S = 0.362, $p = 0.089$) indicating no significant differences between the two networks regarding their overall strength and composition of edges. Still, there were relevant differences regarding individual edges. For example, the association between age and GAD symptoms was stronger in the peripandemic network as was the association between MDD and PTSD symptoms (more results are shown in Table S2).

In the network including COVID-specific variables, pandemic-related PTSD symptoms were positively associated with worst event PTSD, GAD symptoms, pandemic-related posttraumatic growth and age. Pandemic-related posttraumatic growth was only related to pandemic-related PTSD symptoms and PTG. This network was also robust (CS-Coefficient of 0.75) with further results being detailed in the supplement (Figs. S9–S12).

4. Discussion

This is one of the first studies to examine how the onset of the COVID-19 pandemic affected mental health networks in a population-based sample of veterans exposed to a potentially traumatic event during the pandemic. We found relatively stable rates of symptoms of worst event-related PTSD, MDD and GAD one year into the pandemic as reflected by the small effects in the corresponding changes (Table 2). Moreover, we found stronger associations between these symptoms one year into the pandemic. Pandemic-related PTSD symptoms were specifically related to symptoms of worst event-related PTSD and GAD, but not MDD.

Overall, symptoms of worst event-related PTSD, MDD, GAD, and SI remained relatively stable from pre-to peripandemic. While initial increases in symptoms of GAD and MDD were noted at the onset of the pandemic in correlation with the rise of COVID-19 cases (Twenge et al., 2021), accumulating evidence suggests only subtle changes in levels of general psychopathology one year into the pandemic, supporting our findings. This trend is observable not only in the general adult population in the general adult population (Robinson et al., 2022), but also among veterans (Hill et al., 2021). Furthermore, the symptoms and their change in our study and the literature (Robinson et al., 2022) were highly correlated and might therefore be reflective of generalized distress rather than individual psychopathological syndromes (Arbisi et al., 2012). These findings underscore the resilience of veterans facing a PTE during a global pandemic. Importantly, resilience does not imply that an individual is not affected by the onset of a new stressor, such as a PTE or the consequences of a global pandemic. Rather, it is generally understood as a process of adapting and coping with adversity (Southwick et al., 2014, 2015). The worsening of psychopathological symptoms at the beginning of the pandemic (Shevlin et al., 2020), during quarantine or lockdown measures (Di Blasi et al., 2021), does not contradict, but rather supports, the widespread presence of resilience in the adult population during the COVID-19 pandemic (Riehm et al., 2021). Importantly, the strength and effect of resilience may vary over time as it is a dynamic process (Southwick et al., 2015). For example, family support is positively associated with resilience (Pietrzak and Southwick, 2011), but might not be available at all times or for prolonged periods. Consequently, resilience (as well as psychopathological symptoms) might change over shorter time periods within the same individual, and between different individuals. Clinicians should be aware of this variability and actively explore the presence or absence of factors known to promote resilience (Armon et al., 2021). From a public health perspective, however, it is reassuring that the large majority of veterans showed resilience to a PTE during the first year of a global pandemic consistent with recent studies of subgroups of vulnerable

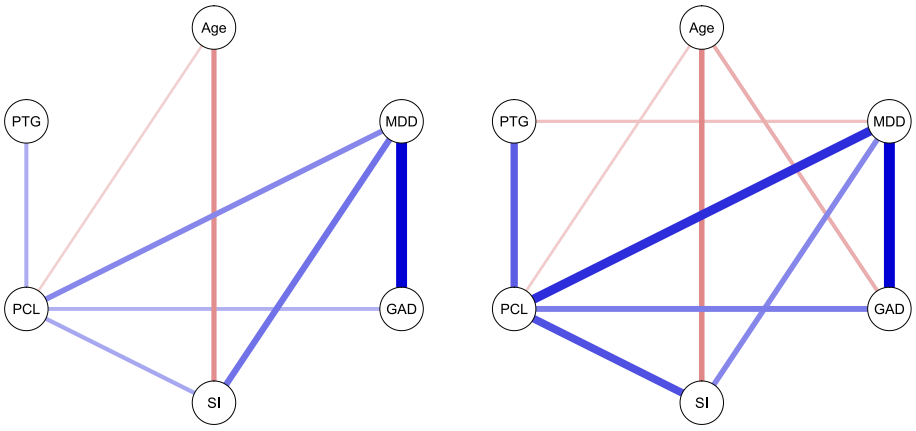

Fig. 1. Networks of veterans at prepandemic (shown on the left) and the network at peripandemic (shown on the right). Edges represent associations between the nodes (continuous/blue= positive, dashed/red = negative, grey/dotted = categorical, thickness = magnitude of the relationship); MDD = PHQ-2 total score; GAD = GAD-2 total score; SI = suicidal ideation; PCL = PCL-5 total score; PTG = posttraumatic growth. Title: Mental health network before and during the COVID-19 pandemic

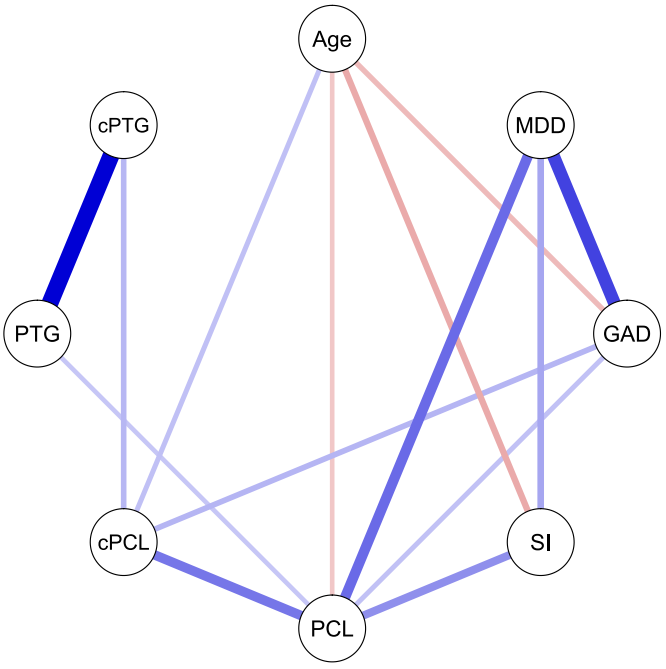

Fig. 2. Note. Network of veterans at peripandemic including COVID-specific variables. Edges represent associations between the nodes (continuous/blue= positive, dashed/red = negative, grey/dotted = categorical, thickness = magnitude of the relationship); MDD = PHQ-2 total score; GAD = GAD-2 total score; SI = suicidal ideation; PCL = PCL-5 total score; PTG = posttraumatic growth; cPCL = Pandemic-related traumatic stress symptoms; PTG = posttraumatic growth; cPTG = Pandemic-related posttraumatic growth. Title: Mental health networks during the pandemic including COVID-related symptoms of PTSD and posttraumatic growth

veterans (Wynn et al., 2022).

We observed relatively modest differences between the pre- and peripandemic networks. Nevertheless, the peripandemic network exhibited denser connections, stronger associations between symptoms of MDD and worst-event PTSD or GAD, and negative associations between symptoms of MDD and PTG as well as between age and GAD that were absent in the prepandemic network. It is not surprising that interrelations in the network changed only modestly given the stable levels of psychopathology one year into the pandemic. This finding aligns with a previous study on changes in psychopathology networks from pre-to peripandemic, reporting increased overall network density, but otherwise found only small changes (e.g., few additional edges (Suen et al., 2022)). Notably, the peripandemic network featured a negative association between age and anxiety, a surprising finding given the well-known risk factor of age for worse outcomes of a SARS-CoV-2 infection (Zheng et al., 2020). It is worth noting, however, that older adults often report less anxiety following PTE exposure (Ogle et al., 2013)), and also experience generally lower levels of anxiety and SI overall (De Leo et al., 2005; Wolitzky-Taylor et al., 2010). Thus, the negative association between age and symptoms of GAD may reflect the protective nature of age against anxiety, even during a pandemic with an increased risk for older adults. The comparison of the two networks is limited by the non-significance of the NCT invariance test and the global strength invariance test, which would indicate that the two networks did not differ from each other. However, the NCT has not been validated for the used networks and dependent data and thus no definitive statement about differences between the two networks can be made. Still, these further strengthens the argument that changes in the interrelations between psychopathological symptoms were few, or absent, one year into the pandemic.

The associations between pandemic-related symptoms of PTSD and other psychopathology were notably different from those between symptoms of worst-event PTSD and other psychopathology. Previous research has documented lower levels of symptoms of PTSD after a traumatic event in older adults (Acierno et al., 2006). This contrast to our findings might be due to the specific nature of the COVID-19 pandemic. Age is the strongest risk factor for a fatal outcome of a SARS-CoV-2 infection, as well as for lasting morbidity after recovery (Zheng et al., 2020). Although age was negatively associated with symptoms of GAD, this is likely moderated by the severity of PTEs during the pandemic and might therefore be associated with symptoms of pandemic-related PTSD. Furthermore, pandemic-related symptoms of PTSD were uniquely associated with symptoms of PTSD related to the worst traumatic event in life. One potential explanation might be that individuals diagnosed with PTSD are more likely to experience symptom worsening after exposure to additional potentially traumatic events (Schock et al., 2016). Extant biological research has attributed this to stress sensitization following an initial traumatic event, leading to amygdala hyperactivity and an increased sensitivity to additional traumatic stressors (Diamond and Zoladz, 2016).

Finally, it is worth noting that the COVID-19 pandemic represents both a challenge and an opportunity for personal psychological growth. While many veterans experienced pandemic-related posttraumatic growth (PTG), average worst event-related PTG decreased from pre-to peripandemic. Network analysis revealed a strong positive association between pandemic-related and worst event-related PTG, as well as associations between symptoms of worst event PTSD and PTG, and symptoms of pandemic-related PTSD and PTG, but not between worst event PTSD and pandemic-related PTG or pandemic-related PTSD and worst-event PTG. Thus, our findings corroborate previous evidence indicating that many individuals experience pandemic-related PTG (Asmundson et al., 2021; Feingold et al., 2022) and that prepandemic

PTG may influence how people experience growth in response to the pandemic (Ganai et al., 2022; Na et al., 2021c). Moreover, existing research from prior to the pandemic suggest that PTSD and PTG are linked via symptoms of rumination (Ganai et al., 2022; Yuan et al., 2021) and intrusions (Kangaslampi et al., 2022) and future work is needed to elaborate the causal associations of these two constructs.

4.1. Limitations

The present study has several limitations. First, symptoms of mental disorders and SI were all evaluated using self-report questionnaires. Although these assessment instruments have been validated and used extensively, a structured clinical interview by a mental health professional might have increased the reliability of the assessments. Second, the presented analysis only included age as a demographic variable, thus limiting the generalization of our results (e.g., not accounting gender differences). Future work should aim to include demographic variables known to impact the associations between psychopathological symptoms. Third, although the data was drawn from a sample representative of the U.S. military veteran population, the conducted analyses did not include the necessary post-stratification weighting and may thus not be fully representative of this population. Nevertheless, analysis of a population-based cohort likely has greater generalizability than the convenience samples used in most previous COVID-19 network studies. Fourth, the PTE experienced by the study participants during the first year of the pandemic was not necessarily directly related to the COVID-19 pandemic. Future studies are needed to differentiate PTEs directly related to the pandemic and important moderators. Fifth, our focus on individuals exposed to a PTE during the first year of the pandemic limits the possibility of comparing symptom levels of individuals with and without such exposure. This comparison could provide valuable insights into how PTEs uniquely contribute to the psychopathological responses to a pandemic, necessitating further investigation in future research. Sixth, an abbreviated 4-item version of the PCL-5 was used to assess pandemic-related symptoms of PTSD. Although this measure has been validated, it's brevity does not allow us to directly compare pandemic-related and not pandemic-related symptoms of PTSD (Geier et al., 2020). Seventh, the Network Comparison Test used in the study has not been validated for the data structure and models used, and its results should be interpreted with caution. Further validation of the NCT for ordinal and categorical variables in psychopathology networks is urgently needed. Finally, the study only covers the first year of the pandemic, and future work should investigate changes in symptoms of mental disorders over consecutive years of the pandemic, and how the end of the pandemic may affect veterans' mental health and PTG.

4.2. Conclusion

This study is the first, to our knowledge, to investigate changes in psychopathology symptom networks over the course of the pandemic in a population-based sample of veterans. Results suggest that non-pandemic related psychopathological symptoms increased during the first year of the pandemic, but the changes were relatively small, and the levels of SI did not change significantly. Although experiences of and reaction to the COVID-19 pandemic can vary substantially over time and across individuals, these findings underscore the psychological resilience of veterans exposed to a potentially traumatic event during the first year of a new-onset pandemic. Future research should investigate whether the observed resilience on year into the pandemic sustains over the later phases of the pandemic and after its end.

Disclaimer

The views expressed in this article are those of the authors only and contents do not represent the views of the U.S. Department of Veterans Affairs or the U.S. Government.

Author contributions

Conceptualization: TRS, RHP, JT, PJN. Methodology: TRS, RHP. Investigation: TRS, OD, ZBZ, RHP, AM. Visualization: TRS, OD, ZBZ. Funding acquisition: IHR, RHP. Supervision: IHR, RHP, RvK. Writing – original draft: TRS, RHP. Writing – review & editing: All authors.

Declaration of competing interest

There are no conflict of interests.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jpsychires.2023.08.003.

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