

## Longitudinal Interactions of Pain and Posttraumatic Stress Disorder Symptoms in U.S. Military Service Members Following Blast Exposure

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**Abstract:** Military personnel returning from conflicts in Iraq and Afghanistan often endorse pain and posttraumatic stress disorder (PTSD) symptoms, either separately or concurrently. Associations between pain and PTSD symptoms may be further complicated by blast exposure from explosive munitions. Although many studies have reported on the prevalence and disability associated with polytraumatic injuries following combat, less is known about symptom maintenance over time. Accordingly, this study examined longitudinal interactive models of co-occurring pain and PTSD symptoms in a sample of 209 military personnel (mean age = 27.4 years, standard deviation = 7.6) who experienced combat-related blast exposure. Autoregressive cross-lagged analysis examined longitudinal associations between self-reported pain and PTSD symptoms over a 1-year period. The best-fitting covariate model indicated that pain and PTSD were significantly associated with one another across all assessment periods,  $\chi^2(3) = 3.66, P = .30$ , Tucker-Lewis index = .98, comparative fit index = 1.00, root mean squared error of approximation = .03. PTSD symptoms had a particularly strong influence on subsequent pain symptoms. The relationship between pain and PTSD symptoms is related to older age, race, and traumatic brain injury characteristics. Results further the understanding of complex injuries among military personnel and highlight the need for comprehensive assessment and rehabilitation efforts addressing the interdependence of pain and co-occurring mental health conditions.

**Perspective:** This longitudinal study demonstrates that pain and PTSD symptoms strongly influence one another and interact across time. These findings have the potential to inform the integrative assessment and treatment of military personnel with polytrauma injuries and who are at risk for persistent deployment-related disorders.

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Significant numbers of military personnel returning from Operations Enduring Freedom, Iraqi Freedom, and New Dawn (OEF/OIF/OND) endorse pain and posttraumatic stress disorder (PTSD) symptoms, often concurrently. Estimates show that up to 20% of OEF/OIF/OND veterans meet criteria for PTSD,<sup>14,32</sup> and upwards of 81% of OEF/OIF/OND veterans report ongoing or new pain following their military service.<sup>10,21</sup> Further, these symptoms frequently co-occur, representing a common polytrauma cluster of injuries. Polytrauma injuries are often associated with exposure to blasts, such as those caused by improvised explosive devices and other

explosive munitions.<sup>35</sup> Blast exposures have resulted in a complex array of outcomes for military personnel, including psychiatric disorders and pain.<sup>9,21</sup> Research evidence suggests that rates of pain and PTSD among OEF/OIF/OND veterans<sup>10,14,21,32</sup> are elevated in comparison to civilian samples,<sup>12,13,18,19,30,33</sup> highlighting the need for comprehensive research and clinical interventions focused on military and veteran populations. Moreover, the comorbidity of pain and PTSD is related to greater affective distress, higher levels of life interference, greater disability, and higher health care utilization than for individuals with either disorder independently.<sup>26,42,44</sup> The high comorbidity and complexity of these conditions complicates the understanding of their etiology, clinical presentation, and treatment.

Etiologic models of pain and co-occurring mental health disorders purport a complex interaction of biological and psychosocial factors. Prevalence of pain symptoms increases with age<sup>8,27</sup> and may also vary among demographic characteristics such as education,<sup>27</sup> socioeconomic status,<sup>1</sup> and gender.<sup>17</sup> Complaints of pain are commonly reported in patients who have experienced traumatic life events, suggesting that lifetime exposure to trauma and stress may be an important risk factor for pain disorders<sup>13,40,44</sup> However, other studies have not fully supported these risk and comorbidity models,<sup>23</sup> suggesting that correlates of pain and stress-related disorders, including PTSD, may not be fully understood. Several theoretical models propose connections between pain and PTSD,<sup>2,9,16,39</sup> which consider the interactive contributions of cognitive, emotional, and behavioral responses that mutually reinforce both conditions. For example, PTSD symptoms may reduce pain tolerance, thereby influencing emotional distress, promoting avoidance behaviors, and increasing perceived disability levels.<sup>2,44</sup> However, less is known regarding the interaction of PTSD and pain symptoms in the context of blast injuries; additional blast-related consequences such as traumatic brain injury (TBI) may complicate the understanding of etiology, assessment, and course of treatment in the context of comorbid pain and PTSD.<sup>35</sup>

Existing work on the co-occurrence of pain and PTSD has primarily relied on cross-sectional prevalence studies, and longitudinal examinations of these conditions are few in number.<sup>12,16,39</sup> For example, although previous work has supported a longitudinal relationship between pain and PTSD symptoms, results regarding the direction of causality<sup>12</sup> and predictive influence of these symptoms over extended follow-up periods<sup>16</sup> have been mixed. Further longitudinal study is needed to provide a more comprehensive understanding of symptom onset and maintenance, particularly within the context of polytraumatic injury, TBI, and military samples.

The lines of research concerning comorbidity, etiology, and longitudinal associations of pain and PTSD have provided a foundation for further work in this area and highlight the need for nuanced analysis of the temporal relationship between pain and PTSD symptoms. The

present study investigates the longitudinal course of pain and PTSD symptoms in a sample of active duty military service members and veterans following blast exposure. This study addresses several gaps in the literature by examining longitudinal associations between pain and PTSD symptoms within the context of combat-related blast injuries and by using an autoregressive methodology to examine the temporal associations between these variables and relevant covariates (ie, age, race, injury characteristics). Based on previous research supporting an interactive model of pain and PTSD symptoms, we hypothesized that 1) pain and PTSD symptoms would be significantly associated over time, 2) pain symptoms would predict subsequent PTSD symptoms, 3) PTSD symptoms would predict subsequent pain symptoms, and 4) the relationship between pain and PTSD symptoms would be impacted by the covariates of age, race, and severity of blast exposure.

## Methods

Data were collected as part of an ongoing Congressionally Directed Medical Research Program–funded investigation of postcombat injuries from blast exposure during OEF/OIF/OND. Eligible military service members and veterans had a blast experience within the past 2 years while deployed in OEF/OIF/OND. The participants were assessed at 3 time points over a 1-year period: baseline (Time 1 [T1]), after 6 months (Time 2 [T2]), and after 12 months (Time 3 [T3]). The baseline assessment is defined as the time at which the participant entered the study, and the average time between the date of the worst identified blast exposure and the initial assessment period was 519.0 days (standard deviation [SD] = 541.1).

## Procedure

The relevant institutional review boards approved this study, and informed consent was obtained after the details of the study were thoroughly explained to participants. All participants completed a series of questionnaires. Although many were enrolled at clinics, the research evaluations were separate from clinical care or compensation and pension processes. Research staff supervised completion of all the questionnaires and provided additional instructions as needed.

## Participants

Participants were military service members and veterans recruited via letters, through advertisements, and from ambulatory health care clinics at a mid-Atlantic VA Medical Center and at several Army and Marine Corps bases located in the mid-Atlantic region of the United States. For the present analyses, participants who reported at least 1 blast experience during combat were included in the study (N = 209). The sample consisted of 202 men and 7 women, who were on average 27.4 years of age (SD = 7.6) at the baseline assessment. Many of the respondents reported more than 1 deployment location (Table 1).

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