



Original Investigation | Psychiatry

# Association Between Predeployment Optimism and Onset of Postdeployment Pain in US Army Soldiers

Afton L. Hassett, PsyD; Joseph A. Fisher, PhD; Loryana L. Vie, PhD; Whitney L. Kelley, MPH; Daniel J. Clauw, MD; Martin E. P. Seligman, PhD

## Abstract

**IMPORTANCE** Pain after deployment is a major health care concern. While risk factors have been previously studied, few studies have explored protective factors.

**OBJECTIVE** To examine the prospective association between predeployment optimism and the onset of new pain after deployment in US Army soldiers.

**DESIGN, SETTING, AND PARTICIPANTS** This prospective longitudinal cohort study examined US Army soldiers (active duty, Reserve, and National Guard) who deployed to Afghanistan or Iraq between February 12, 2010, and August 29, 2014, and completed the necessary psychological and health assessments before and after deployment. Analyses were performed in the Person-Event Data Environment between July 2016 and November 2018. This study relied exclusively on existing, secondary Army data. Of the 413 763 Army soldiers who met the specified deployment criteria, 385 925 soldiers were missing 1 or more of the required assessment forms. Of the remaining 27 838 soldiers who were examined for eligibility, 7104 soldiers were excluded because of preexisting back pain, joint pain, or frequent headaches. These exclusions resulted in a final analytic sample of 20 734 eligible soldiers.

**MAIN OUTCOMES AND MEASURES** This study examined new reports of pain after deployment, including new back pain, joint pain, and frequent headaches.

**RESULTS** Among 20 734 US Army soldiers (87.8% male; mean [SD] age, 29.06 [8.42] years), 37.3% reported pain in at least 1 new area of the body after deployment: 25.3% reported new back pain, 23.1% reported new joint pain, and 12.1% reported new frequent headaches. As a continuous measure, each 1-U increase in optimism was associated with 11% lower odds of reporting any new pain after deployment, even while adjusting for demographic, military, and combat factors (odds ratio, 0.89; 95% CI, 0.86-0.93). Tertile analyses revealed that compared with soldiers with high optimism (lowest odds of new pain) soldiers with low optimism had 35% greater odds of reporting new pain in any of the 3 sites evaluated (odds ratio, 1.35; 95% CI, 1.21-1.50). In addition, a larger increase in risk of new pain was observed when comparing the moderate-optimism and low-optimism groups rather than the high-optimism and moderate-optimism groups.

**CONCLUSIONS AND RELEVANCE** Higher levels of optimism were associated with lower odds of reporting new pain after deployment, over and above other common determinants of pain, including demographic and military characteristics and combat experiences. Soldiers with low levels of optimism before deployment could benefit from programs geared toward enhancing optimism.

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## Key Points

**Question** Are higher levels of predeployment optimism among US Army soldiers associated with fewer reports of new pain after deployment?

**Findings** Among 20 734 US Army soldiers in this longitudinal cohort study, optimism was associated with 11% lower odds of reporting new postdeployment pain, even while adjusting for demographic, military, and combat factors, including traumatic experiences and combat injury. In addition, 37.3% of soldiers reported pain in at least 1 new area of the body after deployment.

**Meaning** The findings suggest that soldiers with low levels of predeployment optimism may be at greater risk of developing new postdeployment pain and may benefit from scalable interventions designed to increase optimism.

Author affiliations and article information are listed at the end of this article.

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## Introduction

Pain affects more Americans than coronary heart disease, diabetes, and cancer combined, at an estimated cost of \$635 billion per year.<sup>1</sup> Yet, the consequences of chronic musculoskeletal pain may be even more profoundly experienced in military personnel after deployment.<sup>2</sup> For example, military musculoskeletal injuries result in more than 1 million medical encounters each year, and musculoskeletal and connective tissue disorders are the most common reason for medical evacuation of deployed personnel.<sup>2,3</sup>

Studies<sup>4-8</sup> of veterans who served in Operation Enduring Freedom, Operation Iraqi Freedom, or Operation New Dawn have shown that from 40% to more than 80% report experiencing chronic pain after deployment. More than half of these soldiers describe pain that is moderate to severe<sup>6,8</sup> occurring predominantly in the back, legs, shoulders, neck, and head.<sup>5,7</sup> Such pain is frequently reported as lasting longer than 1 year, with more than half experiencing pain almost every day, if not constantly.<sup>6</sup> Chronic pain in veterans is associated with other significant problems, such as functional disability, vocational limitations, family discord, greater health care use, traumatic brain injury, and psychiatric comorbidities, including posttraumatic stress disorder (PTSD), major depressive disorder, and substance abuse that includes opioid misuse.<sup>5,8-13</sup>

Determining who might be at risk for chronic pain after deployment is essential. Previous studies have shown that in soldiers deployed to Afghanistan and Iraq the following characteristics are associated with postdeployment pain: older age (>30 years),<sup>6</sup> being married or previously married,<sup>6</sup> exposure to combat<sup>6,14</sup> (especially injury during combat<sup>6</sup>), duty involving heavy physical labor,<sup>6</sup> and PTSD and other psychiatric conditions.<sup>6,15</sup> Demographic and combat factors are rarely modifiable, and PTSD and other psychiatric comorbidities tend to be the sequelae of deployment<sup>16</sup> rather than useful predeployment determinants of the development of pain. By reframing the question to instead assess what potentially modifiable predeployment characteristics are associated with fewer instances of postdeployment pain, new targets for treatment may be identified.

Although traumatic deployment events experienced during combat often precede PTSD,<sup>17,18</sup> depression and substance abuse,<sup>19,20</sup> and reports of postdeployment physical symptoms, including pain,<sup>21</sup> these stressful experiences do not always result in negative outcomes. Many individuals are resilient to the potentially deleterious effects of combat, despite negative exposures. Therefore, it is important to understand what modifiable factors protect these soldiers from persistent negative outcomes following deployment, such as the development of chronic pain. One promising protective factor to explore is optimism. Optimism has been found to be a significant determinant of a wide range of positive physical health outcomes,<sup>22-24</sup> including decreased pain sensitivity,<sup>25</sup> enhanced conditioned pain modulation,<sup>26</sup> lower risk for the development of chronic postsurgical pain,<sup>27</sup> and better overall quality of life in adults and children with chronic pain.<sup>28</sup> Among active duty soldiers, greater baseline levels of optimism have recently been linked to lower odds of being diagnosed as having PTSD, depression, anxiety, and adjustment disorders over a 2-year follow-up period.<sup>29</sup>

Much of the previous research evaluating postdeployment health concerns has been limited by the use of cross-sectional data from small studies of treatment-seeking veterans. Herein, the Person-Event Data Environment, a secure and comprehensive Army cloud-based data repository and analysis platform,<sup>30,31</sup> was used to explore the overall prevalence of postdeployment pain and to investigate optimism as a determinant of the onset of new postdeployment pain in a robust sample of soldiers. Therefore, the objectives of this study were (1) to evaluate the incidence of new postdeployment pain in a large sample of soldiers who served in Operation Enduring Freedom, Operation Iraqi Freedom, or Operation New Dawn and (2) to assess whether having high levels of optimism before deployment is associated with a decreased likelihood of reporting new pain after deployment. We hypothesized that optimism would buffer the often deleterious effects of deployment and be related to decreased odds of reporting new pain, accounting for combat and other deployment experiences.

## Methods

This study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guidelines. The study examined a subset of US Army active duty, Reserve, and National Guard soldiers who deployed to Afghanistan or Iraq between February 12, 2010, and August 29, 2014, for more than 1 day and no longer than 15 months. Additional study inclusion criteria were as follows: (1) they completed the Global Assessment Tool, a self-report questionnaire assessing psychosocial functioning taken annually by soldiers,<sup>32,33</sup> in the year before their deployment (and indicated through an electronic "opt-in" procedure that their responses could be used for research purposes and linked to other data sources); (2) they completed Periodic Health Assessments in the year before their deployment and in the 15 months after their deployment; and (3) they completed the Post-Deployment Health Assessment in the month after their deployment. The University of Pennsylvania Institutional Review Board and a Department of Defense Human Research Protection Official reviewed and approved this study.

## Measures

### Optimism

Four optimism items from the Global Assessment Tool, adapted from the revised Life Orientation Test,<sup>34</sup> were asked on a 5-point Likert-type scale ranging from 1 (strongly disagree) to 5 (strongly agree). Items included the following: "In uncertain times, I usually expect the best"; "I rarely count on good things happening to me" (reverse scored); "Overall, I expect more good things to happen to me than bad"; and "If something can go wrong for me, it will" (reverse scored). Internal consistency was acceptable ( $\alpha = .72$ ). Continuous optimism represented the mean of the 4 items. In addition, soldiers were grouped into the following optimism tertiles: low (1.00-2.75), moderate (3.00-3.75), and high (4.00-5.00). Because of the distribution of optimism scores and an interest in ensuring that the low group actually reflected low levels of optimism, the low group contained a smaller percentage of the sample (8.0%) compared with the moderate (39.9%) and high (52.1%) groups.

### New Pain

Pain reports were culled from soldiers' postdeployment Periodic Health Assessment. The items asked "Do you or have you ever had [with separate responses for back pain, joint pain, and frequent headaches]" (yes or no)? We also created a composite measure that reflected any new back, joint, or headache pain (yes or no).

### Combat Measures

Combat intensity assessed the occurrence (yes or no) of the following 5 potentially traumatic events during deployment: encountered dead bodies or saw people killed or wounded, felt in great danger of being killed, engaged in direct combat involving discharging a weapon, experienced a blast or explosion, and experienced a vehicular crash. Responses were summed, with higher scores indicating reporting more combat stressors. Combat injury (single item) assessed whether a soldier reported being wounded, injured, assaulted, or otherwise hurt during his or her deployment (yes or no). Combat intensity and combat injury, which were assessed on the Post-Deployment Health Assessment, were thought to serve as surrogates for PTSD and other psychiatric comorbidities and were expected to be strongly associated with greater odds of reporting new postdeployment pain.

### Health Measures

Baseline chronic pain was culled from soldiers' predeployment Periodic Health Assessment. Soldiers reported whether they currently had or had ever had chronic pain (yes or no). We adjusted for chronic pain at baseline because having an existing pain condition has long been associated with an increased likelihood of developing more painful conditions.<sup>35-37</sup> Because smoking has been identified as a unique risk factor in chronic pain,<sup>38,39</sup> nicotine status, which was obtained from soldiers'

predeployment Periodic Health Assessment, was included to capture whether soldiers reported smoking tobacco products, dipping, or chewing (yes or no).

### Demographic and Military Characteristics

Demographic and military characteristics were obtained from Defense Manpower Data Center administrative records. Covariates included age (scaled in decades), sex (male vs female), race/ethnicity (non-Hispanic white vs other), marital status (married vs not married), educational attainment (up through high school vs more than high school), branch (active duty, Reserve, or National Guard), rank (officer vs enlisted), whether a soldier had previously deployed (yes vs no), and deployment location (Afghanistan or Iraq). Demographic characteristics (eg, race/ethnicity) were initially obtained through self-report, whereas military characteristics (eg, rank) were obtained through official records. Self-reported race/ethnicity information was dichotomized for the present analyses and was included to account for commonly observed differences.<sup>40,41</sup>

### Statistical Analysis

Analyses were performed in the Person-Event Data Environment between July 2016 and November 2018 using SAS Enterprise Guide (version 7.12; SAS Institute Inc). This study relied exclusively on existing, secondary Army data. We used binomial logistic regression to examine the association between continuous optimism and new pain (separate models examined any pain, back pain, joint pain, and frequent headaches), adjusting for covariates, which were entered into the model simultaneously. We repeated these analyses, replacing continuous optimism with optimism tertiles. To obtain all 3 pairwise comparisons, we first modeled high optimism as the reference group and then moderate optimism as the reference group. Multicollinearity diagnostics did not detect any problems.

Post hoc analyses tested for optimism by sex interactions and, separately, optimism by marital status interactions. Statistically significant interactions (2-sided  $P < .05$ ) were followed up with stratified analyses to clarify the nature of the interaction.

To test for possible bias, we examined whether there were any systematic differences between soldiers who did and did not report back, joint, or headache pain at baseline (ie, excluded vs included). In addition, we compared soldiers in the analytic sample with soldiers who were excluded because of missing assessments.

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## Results

### Participants

Of the 413 763 Army active duty, Reserve, and National Guard soldiers who deployed to Afghanistan or Iraq between February 12, 2010, and August 29, 2014 (>1 day and  $\leq 15$  months), 385 925 soldiers (93.3%) were missing 1 or more of the required assessment forms. Of the remaining 27 838 soldiers who were examined for eligibility, 7104 soldiers (25.5%) were excluded because they reported predeployment back pain, joint pain, or frequent headaches. These exclusions yielded a final analytic sample of 20 734 eligible soldiers. **Figure 1** shows a flowchart of the sample selection in this study.

### Anticipating New Postdeployment Pain

Among 20 734 US Army soldiers (87.8% male; mean [SD] age, 29.06 [8.42] years), 37.3% reported pain in at least 1 new area of the body after deployment: 25.3% reported new back pain, 23.1% reported new joint pain, and 12.1% reported new frequent headaches. The results of McNemar tests indicated that new back pain and joint pain were reported more frequently than new frequent headaches. Approximately half of the sample (52.1%) reported high optimism, 39.9% reported moderate optimism, and 8.0% reported low optimism. Additionally, both stressful combat experiences (46.4%) and combat injuries (20.2%) were fairly common. A summary of sample characteristics is listed in **Table 1**.

As a continuous measure, each 1-U increase in optimism was associated with 11% lower odds of reporting any new pain after deployment (odds ratio [OR], 0.89; 95% CI, 0.86-0.93) (Table 2). Examining the pain areas separately revealed that optimism was associated with 8% lower odds of developing new back pain (OR, 0.92; 95% CI, 0.88-0.96) and 8% lower odds of developing new joint pain (OR, 0.92; 95% CI, 0.88-0.96). However, we did not observe a significant statistical association between optimism and new frequent headaches after deployment (OR, 0.96; 95% CI, 0.91-1.02).

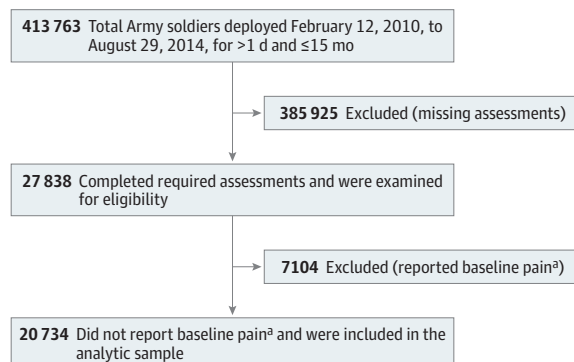
We next modeled optimism tertiles (Table 3) and found that compared with soldiers with high optimism (lowest odds of new pain) soldiers with low optimism had the following characteristics: 35% greater odds of any new pain (OR, 1.35; 95% CI, 1.21-1.50), 30% greater odds of new back pain (OR, 1.30; 95% CI, 1.16-1.46), 21% greater odds of new joint pain (OR, 1.21; 95% CI, 1.07-1.38), and 18% greater odds of new frequent headaches (OR, 1.18; 95% CI, 1.01-1.38). In addition, we observed a larger increase in odds of new pain when comparing the moderate-optimism and low-optimism groups rather than the high-optimism and moderate-optimism groups.

Associations between demographic characteristics and new pain are summarized in Table 2 and Table 3. Being older and being married were associated with increased odds of reporting new postdeployment pain. Women were more likely to report any new pain or new frequent headaches; for women and men, reporting chronic pain at baseline was associated with greater odds of reporting any new pain, new back pain, or new joint pain after deployment. In addition, being injured while deployed and reporting stressful combat experiences were each associated with greater odds of reporting new pain after deployment. In contrast, being an officer (vs an enlisted soldier) and deploying to Iraq (vs Afghanistan) were each associated with reduced odds of reporting new pain after deployment. Of the soldiers who reported new pain in all 3 areas, a disproportionate number (63.3%) were National Guard soldiers compared with active duty (19.7%) and Reserve (17.0%) soldiers.

**Tests of Moderation**

We also tested interactions between optimism and sex and, separately, between optimism and marital status. We did not observe any statistically significant interactions between optimism and sex or between optimism and marital status in relation to any new pain, new back pain, or new joint pain. However, we observed a statistically significant interaction between optimism and marital status in association with new frequent headaches (OR, 0.85; 95% CI, 0.76-0.95). Stratified analyses (Figure 2) revealed that greater optimism was associated with lower odds of reporting frequent headaches after deployment among married soldiers (OR, 0.89; 95% CI, 0.83-0.97) but not unmarried soldiers (OR, 1.05; 95% CI, 0.96-1.14).

Figure 1. Flow Diagram of the Sample Selection



<sup>a</sup> Baseline pain refers to back pain, joint pain, or frequent headaches before deployment.

## Sample Generalization

Compared with soldiers in the analytic sample (N = 20 734), soldiers excluded for reporting predeployment back pain, joint pain, or frequent headaches (n = 7104) were slightly less optimistic (3.87 vs 3.72, respectively) and older (29.1 vs 33.8 years, respectively). Soldiers who reported predeployment pain were more likely to be married (70.4% vs 50.5%), have more than a high school

**Table 1. Distribution of Demographic, Military, and Health Covariates Among 20 734 US Army Soldiers**

| Variable                                 | Value          |
|--|----------------|
| Optimism, mean (SD) <sup>a</sup>         | 3.87 (0.75)    |
| Age, mean (SD), y                        | 29.06 (8.42)   |
| Combat intensity, mean (SD) <sup>b</sup> | 0.85 (1.13)    |
| Sex, No. (%)                             |                |
| Male                                     | 18 205 (87.80) |
| Female                                   | 2529 (12.20)   |
| Race/ethnicity, No. (%)                  |                |
| Non-Hispanic white                       | 14 020 (67.62) |
| Nonwhite                                 | 6714 (32.38)   |
| Marital status, No. (%)                  |                |
| Married                                  | 10 464 (50.47) |
| Not married                              | 10 270 (49.53) |
| Education, No. (%)                       |                |
| ≤High school                             | 14 032 (67.68) |
| >High school                             | 6702 (32.32)   |
| Use tobacco, No. (%)                     |                |
| No                                       | 13 759 (66.36) |
| Yes                                      | 6975 (33.64)   |
| Predeployment chronic pain, No. (%)      |                |
| No                                       | 20 592 (99.32) |
| Yes                                      | 142 (0.68)     |
| Branch, No. (%)                          |                |
| Active duty                              | 7491 (36.13)   |
| Reserve                                  | 4390 (21.17)   |
| National Guard                           | 8853 (42.70)   |
| Rank, No. (%)                            |                |
| Officer                                  | 2993 (14.44)   |
| Enlisted                                 | 17 741 (85.56) |
| Previously deployed, No. (%)             |                |
| No                                       | 12 711 (61.31) |
| Yes                                      | 8023 (38.69)   |
| Deployment location, No. (%)             |                |
| Afghanistan                              | 16 052 (77.42) |
| Iraq                                     | 4682 (22.58)   |
| Injured while deployed, No. (%)          |                |
| No                                       | 16 555 (79.84) |
| Yes                                      | 4179 (20.16)   |

<sup>a</sup> Optimism was adapted from the revised Life Orientation Test<sup>34</sup> and assessed on a 5-point Likert-type scale ranging from 1 (strongly disagree) to 5 (strongly agree).

<sup>b</sup> Combat intensity assessed the occurrence (yes or no) of the following 5 potentially traumatic events during deployment: encountered dead bodies or saw people killed or wounded, felt in great danger of being killed, engaged in direct combat involving discharging a weapon, experienced a blast or explosion, and experienced a vehicular crash. Responses were summed, with higher scores indicating reporting more combat stressors.

education (42.1% vs 32.3%), report predeployment chronic pain (16.5% vs 0.7%), be active duty (58.5% vs 36.1%), or have previously deployed (70.7% vs 38.7%) compared with soldiers in the analytic sample. In addition, soldiers with predeployment pain were less likely than those in the analytic sample to be in the National Guard (24.7% vs 42.7%) or be enlisted (79.9% vs 85.7%). All other demographic differences were negligible (<5% difference). In addition, a comparison between the analytic sample and the sample excluded because of missing assessments revealed that, aside from differences in branch (active duty soldiers were more likely to be missing assessments), the 2 groups were fairly comparable.

**Table 2. Association Between Continuous Optimism and Incident Postdeployment Pain**

| Variable                   | Odds Ratio (95% CI) |                  |                  |                        |
|----------------------------|---------------------|------------------|------------------|------------------------|
|                            | Any New Pain        | New Back Pain    | New Joint Pain   | New Frequent Headaches |
| Optimism                   | 0.89 (0.86-0.93)    | 0.92 (0.88-0.96) | 0.92 (0.88-0.96) | 0.96 (0.91-1.02)       |
| Age, in decades            | 1.35 (1.29-1.40)    | 1.18 (1.13-1.23) | 1.41 (1.34-1.48) | 1.13 (1.06-1.20)       |
| Sex                        |                     |                  |                  |                        |
| Male                       | 1 [Reference]       | 1 [Reference]    | 1 [Reference]    | 1 [Reference]          |
| Female                     | 1.25 (1.14-1.36)    | 1.07 (0.97-1.19) | 0.90 (0.81-1.01) | 1.93 (1.71-2.17)       |
| Race/ethnicity             |                     |                  |                  |                        |
| Non-Hispanic white         | 1 [Reference]       | 1 [Reference]    | 1 [Reference]    | 1 [Reference]          |
| Nonwhite                   | 1.06 (0.99-1.13)    | 1.13 (1.05-1.21) | 1.07 (1.00-1.15) | 1.26 (1.15-1.38)       |
| Marital status             |                     |                  |                  |                        |
| Not married                | 1 [Reference]       | 1 [Reference]    | 1 [Reference]    | 1 [Reference]          |
| Married                    | 1.12 (1.05-1.20)    | 1.14 (1.06-1.22) | 1.09 (1.01-1.17) | 1.21 (1.10-1.33)       |
| Education                  |                     |                  |                  |                        |
| ≤High school               | 1 [Reference]       | 1 [Reference]    | 1 [Reference]    | 1 [Reference]          |
| >High school               | 0.98 (0.90-1.06)    | 1.03 (0.95-1.12) | 0.96 (0.88-1.05) | 0.88 (0.79-0.99)       |
| Use tobacco                |                     |                  |                  |                        |
| No                         | 1 [Reference]       | 1 [Reference]    | 1 [Reference]    | 1 [Reference]          |
| Yes                        | 1.16 (1.09-1.24)    | 1.16 (1.08-1.25) | 1.14 (1.06-1.23) | 1.02 (0.93-1.12)       |
| Predeployment chronic pain |                     |                  |                  |                        |
| No                         | 1 [Reference]       | 1 [Reference]    | 1 [Reference]    | 1 [Reference]          |
| Yes                        | 2.51 (1.76-3.58)    | 1.65 (1.17-2.34) | 3.04 (2.16-4.27) | 1.48 (0.94-2.33)       |
| Branch                     |                     |                  |                  |                        |
| Active duty                | 1 [Reference]       | 1 [Reference]    | 1 [Reference]    | 1 [Reference]          |
| Reserve                    | 0.76 (0.70-0.82)    | 0.88 (0.80-0.97) | 0.77 (0.69-0.84) | 0.98 (0.86-1.11)       |
| National Guard             | 0.93 (0.87-1.00)    | 1.12 (1.04-1.21) | 1.10 (1.02-1.19) | 1.44 (1.30-1.59)       |
| Rank                       |                     |                  |                  |                        |
| Enlisted                   | 1 [Reference]       | 1 [Reference]    | 1 [Reference]    | 1 [Reference]          |
| Officer                    | 0.80 (0.73-0.89)    | 0.80 (0.72-0.90) | 0.85 (0.76-0.96) | 0.68 (0.58-0.79)       |
| Previously deployed        |                     |                  |                  |                        |
| No                         | 1 [Reference]       | 1 [Reference]    | 1 [Reference]    | 1 [Reference]          |
| Yes                        | 1.08 (1.01-1.15)    | 1.08 (1.00-1.16) | 1.04 (0.97-1.12) | 0.99 (0.90-1.09)       |
| Deployment location        |                     |                  |                  |                        |
| Afghanistan                | 1 [Reference]       | 1 [Reference]    | 1 [Reference]    | 1 [Reference]          |
| Iraq                       | 0.82 (0.76-0.88)    | 0.77 (0.72-0.84) | 0.74 (0.68-0.81) | 0.67 (0.60-0.75)       |
| Combat intensity           | 1.14 (1.11-1.17)    | 1.11 (1.08-1.14) | 1.08 (1.05-1.12) | 1.14 (1.10-1.18)       |
| Injured while deployed     |                     |                  |                  |                        |
| No                         | 1 [Reference]       | 1 [Reference]    | 1 [Reference]    | 1 [Reference]          |
| Yes                        | 2.15 (2.01-2.32)    | 1.79 (1.66-1.93) | 1.95 (1.81-2.11) | 1.64 (1.49-1.81)       |

## Discussion

Few studies have assessed instances of new pain in military personnel after deployment. In the present study of 20 734 Army soldiers who deployed to Afghanistan or Iraq, 37.3% reported experiencing at least 1 new area of pain after deployment, with new back pain (25.3%) and new joint pain (23.1%) described more often than new frequent headaches (12.1%). A major strength of this study was the large sample size, which enabled us to obtain accurate point estimates and narrow 95% CIs. In addition, although only a subset of the population completed the health assessments

**Table 3. Association Between Optimism (Tertiles) and Incident Postdeployment Pain<sup>a</sup>**

| Variable                          | Odds Ratio (95% CI) |                  |                  |                        |
|-----------------------------------|---------------------|------------------|------------------|------------------------|
|                                   | Any New Pain        | New Back Pain    | New Joint Pain   | New Frequent Headaches |
| <b>Optimism</b>                   |                     |                  |                  |                        |
| Moderate (reference is high)      | 1.11 (1.04-1.18)    | 1.04 (0.98-1.12) | 1.07 (1.00-1.15) | 1.02 (0.93-1.11)       |
| Low (reference is high)           | 1.35 (1.21-1.50)    | 1.30 (1.16-1.46) | 1.21 (1.07-1.38) | 1.18 (1.01-1.38)       |
| Low (reference is moderate)       | 1.21 (1.09-1.36)    | 1.24 (1.10-1.40) | 1.14 (1.00-1.29) | 1.16 (0.99-1.36)       |
| Age, in decades                   | 1.34 (1.29-1.40)    | 1.18 (1.12-1.23) | 1.41 (1.34-1.47) | 1.13 (1.06-1.20)       |
| <b>Sex</b>                        |                     |                  |                  |                        |
| Male                              | 1 [Reference]       | 1 [Reference]    | 1 [Reference]    | 1 [Reference]          |
| Female                            | 1.24 (1.14-1.36)    | 1.07 (0.97-1.18) | 0.90 (0.81-1.01) | 1.93 (1.71-2.17)       |
| <b>Race/ethnicity</b>             |                     |                  |                  |                        |
| Non-Hispanic white                | 1 [Reference]       | 1 [Reference]    | 1 [Reference]    | 1 [Reference]          |
| Nonwhite                          | 1.06 (0.99-1.13)    | 1.13 (1.05-1.21) | 1.07 (1.00-1.15) | 1.26 (1.15-1.38)       |
| <b>Marital status</b>             |                     |                  |                  |                        |
| Not married                       | 1 [Reference]       | 1 [Reference]    | 1 [Reference]    | 1 [Reference]          |
| Married                           | 1.12 (1.05-1.20)    | 1.14 (1.06-1.22) | 1.09 (1.01-1.17) | 1.21 (1.10-1.33)       |
| <b>Education</b>                  |                     |                  |                  |                        |
| ≤High school                      | 1 [Reference]       | 1 [Reference]    | 1 [Reference]    | 1 [Reference]          |
| >High school                      | 0.98 (0.91-1.06)    | 1.03 (0.95-1.12) | 0.96 (0.88-1.05) | 0.89 (0.79-0.99)       |
| <b>Use tobacco</b>                |                     |                  |                  |                        |
| No                                | 1 [Reference]       | 1 [Reference]    | 1 [Reference]    | 1 [Reference]          |
| Yes                               | 1.16 (1.09-1.24)    | 1.16 (1.08-1.25) | 1.14 (1.06-1.23) | 1.02 (0.93-1.12)       |
| <b>Predeployment chronic pain</b> |                     |                  |                  |                        |
| No                                | 1 [Reference]       | 1 [Reference]    | 1 [Reference]    | 1 [Reference]          |
| Yes                               | 2.51 (1.76-3.57)    | 1.65 (1.16-2.34) | 3.04 (2.16-4.27) | 1.48 (0.94-2.33)       |
| <b>Branch</b>                     |                     |                  |                  |                        |
| Active duty                       | 1 [Reference]       | 1 [Reference]    | 1 [Reference]    | 1 [Reference]          |
| Reserve                           | 0.76 (0.70-0.82)    | 0.88 (0.80-0.97) | 0.76 (0.69-0.84) | 0.98 (0.86-1.11)       |
| National Guard                    | 0.93 (0.87-1.00)    | 1.12 (1.04-1.21) | 1.10 (1.02-1.19) | 1.44 (1.30-1.59)       |
| <b>Rank</b>                       |                     |                  |                  |                        |
| Enlisted                          | 1 [Reference]       | 1 [Reference]    | 1 [Reference]    | 1 [Reference]          |
| Officer                           | 0.80 (0.72-0.89)    | 0.80 (0.71-0.89) | 0.85 (0.76-0.96) | 0.68 (0.58-0.79)       |
| <b>Previously deployed</b>        |                     |                  |                  |                        |
| No                                | 1 [Reference]       | 1 [Reference]    | 1 [Reference]    | 1 [Reference]          |
| Yes                               | 1.08 (1.01-1.16)    | 1.08 (1.00-1.16) | 1.04 (0.97-1.13) | 0.99 (0.90-1.09)       |
| <b>Deployment location</b>        |                     |                  |                  |                        |
| Afghanistan                       | 1 [Reference]       | 1 [Reference]    | 1 [Reference]    | 1 [Reference]          |
| Iraq                              | 0.82 (0.76-0.88)    | 0.77 (0.71-0.84) | 0.74 (0.68-0.81) | 0.70 (0.60-0.75)       |
| Combat intensity                  | 1.14 (1.11-1.17)    | 1.11 (1.08-1.14) | 1.08 (1.05-1.12) | 1.14 (1.09-1.18)       |
| <b>Injured while deployed</b>     |                     |                  |                  |                        |
| No                                | 1 [Reference]       | 1 [Reference]    | 1 [Reference]    | 1 [Reference]          |
| Yes                               | 2.15 (2.00-2.31)    | 1.78 (1.65-1.92) | 1.95 (1.80-2.11) | 1.64 (1.49-1.81)       |

<sup>a</sup> This model was run with high optimism as the reference group and again with moderate optimism as the reference group to obtain all 3 pairwise comparisons. However, this did not change any of the estimates for the covariates.



required for inclusion in this study, the study sample was fairly representative of the 2010 Army active duty population<sup>42</sup> (sample vs population): officers (14.4% vs 16.8%), female (12.2% vs 13.4%), 25 years or younger (45.0% vs 41.2%), and married (50.5% vs 58.7%).

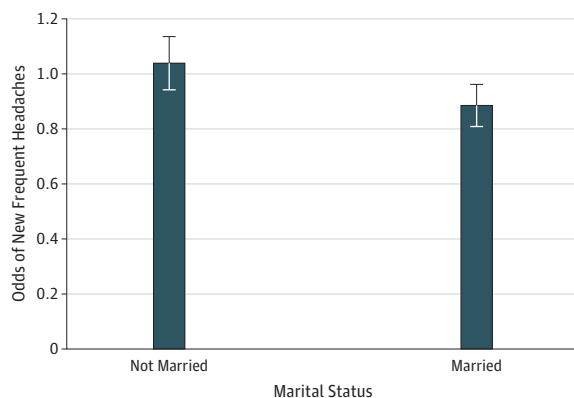
In regard to optimism, the soldiers were remarkably optimistic, with 52.1% reporting high levels of optimism before deployment. Furthermore, greater predeployment optimism was associated with significantly lower odds of reporting new postdeployment pain (particularly any, back, and joint pain), even while adjusting for other important pain-related factors, such as combat intensity, combat injuries, baseline chronic pain, nicotine use, and key demographic and military characteristics. As such, every 1-U increase in optimism was independently associated with 11% lower odds of reporting new pain in any of the 3 bodily areas evaluated. Moreover, the least optimistic soldiers had 35% greater odds of reporting a new instance of pain compared with those with the highest levels of optimism. The difference between the soldiers with moderate levels of optimism and those with the highest levels was not, for the most part, statistically significant, suggesting that extremely high levels of optimism may not be necessary to experience benefit.

Similar to prior research,<sup>6</sup> we found that being older and being married were associated with reporting pain after deployment. Furthermore, we observed a number of associations between military characteristics and odds of reporting new postdeployment pain. For example, enlisted soldiers were more likely to report new postdeployment pain compared with officers. This may in part be because in the combat theater, senior officers (and some noncommissioned officers) are typically responsible for strategic planning, whereas enlisted soldiers are typically responsible for riskier and more physically demanding tasks (eg, combat patrols, convoy operations, and ensuring that routes are clear of improvised explosive devices). In addition, compared with active duty soldiers, National Guard soldiers had a higher odds of reporting new postdeployment back pain, joint pain, or frequent headaches, whereas Reserve soldiers had lower odds of reporting new pain in these areas. This may in part be because National Guard soldiers tend to engage in direct combat, whereas Reserve soldiers tend to perform combat support and service duties (less risky assignments), and active duty soldiers serve in a wide variety of roles, including direct combat, combat support, and combat service.

This study also revealed that soldiers who deployed to Iraq had a reduced odds of reporting new pain relative to soldiers who deployed to Afghanistan. During the study deployment time frame (February 12, 2010, to August 29, 2014), walking patrols were fairly common. Poor infrastructure in Afghanistan (eg, lack of good roads and walking paths), coupled with extreme temperatures, may explain in part the more frequent new pain reported by soldiers who deployed to Afghanistan compared with Iraq.

In regard to combat experiences, we found that combat injuries and stressful combat events were common (20.2% and 46.4%, respectively) and associated with new postdeployment pain. That

Figure 2. Optimism and Odds of Reporting New Frequent Headaches by Marital Status



The odds ratio for not married was 1.05 (95% CI, 0.96-1.14); married, 0.89 (95% CI, 0.83-0.97). Error bars indicate 95% CIs.

combat experiences were determinants of new pain has been previously shown<sup>43-45</sup> and is intuitive (physical injury and acute pain can transition into chronic pain), while PTSD and other psychiatric comorbidities are common correlates of pain.<sup>46</sup> Herein, combat experiences were used as a surrogate for PTSD and other psychiatric comorbidities because these traumatic experiences typically precede the manifestation of psychiatric sequelae.<sup>16</sup> Despite the robust association between the onset of new postdeployment pain and key demographic, military, and combat experiences, predeployment optimism remained significantly associated with new postdeployment pain.

No studies to date have explored the prospective association between optimism and postdeployment pain in military personnel. Although data from the Global Assessment Tool have been shown to differentiate Army Rangers from non-Rangers (Rangers demonstrate greater optimism, engagement, and organizational trust and lower levels of depression, catastrophizing, and loneliness),<sup>47</sup> the postdeployment associations with optimism have yet to be reported. Others have shown that optimism is associated with better health outcomes in diverse patient populations, including cardiovascular disease,<sup>23</sup> diabetes,<sup>48</sup> and even mortality from multiple causes.<sup>49</sup> Therefore, the protective association between optimism and pain is not surprising given that high optimism has been associated with decreased pain and better quality of life in civilian populations when pain is present.<sup>27,28</sup> Herein, we add the protective association between optimism and the development of pain in soldiers after deployment.

Optimism is generally considered a trait, although it has been estimated that optimism is only about 25% heritable.<sup>50</sup> Therefore, optimism can be learned and is thus a modifiable factor.<sup>51</sup> Previous studies<sup>52-54</sup> have shown that straightforward interventions can result in higher levels of optimism. For example, interventions can include imagining and writing about a vision of one's best possible self (ie, the person we would like to be)<sup>52,53</sup> or imagery training to increase positive appraisals of ambiguous social situations as opposed to anticipating the worst possible outcome.<sup>54</sup> Furthermore, interventions that promote the expression of gratitude and teach meditation and mindfulness practices, as well as more structured interventions like cognitive behavior therapy that more directly challenge catastrophic thinking, can promote optimism.<sup>55</sup>

## Limitations

This study has some limitations. First, the assessment of new areas of pain was limited by the number of areas that were assessed both before and after deployment. The 3 areas selected are those where pain is commonly observed but by no means were exhaustive; therefore, our rates of new pain may underestimate the true number of soldiers with new postdeployment pain. Second, neither the duration nor the intensity of pain was assessed; therefore, the overall influence, chronicity, and severity of the pain are not known. Third, this study only examined reports of new pain within 15 months of returning from deployment. The extent to which optimism is associated with pain over a longer follow-up remains unknown. Fourth, as with all research, we were only able to examine soldiers who completed the necessary assessments and allowed their responses to be used for research purposes. However, the study sample was representative of the 2010 Army active duty population.<sup>42</sup> Fifth, we did not adjust for psychiatric disorders, such as PTSD, in the present analyses. However, we adjusted for potentially traumatic experiences during deployment, which have consistently been linked to PTSD,<sup>56-58</sup> along with comorbid psychiatric disorders, such as depression and anxiety disorders.<sup>59-61</sup>

## Conclusions

Reducing instances of new pain after deployment is critical because 37.3% of soldiers herein reported at least 1 new area of pain. Over and above other common determinants of pain after deployment, including demographic and military characteristics and combat experiences, higher levels of optimism were associated with lower odds of reporting new pain. Data from Army psychological

assessments like the Global Assessment Tool could be used to identify soldiers with low levels of optimism who may benefit from programs geared toward enhancing optimism. In current and future conflicts, these strategies could help diminish the consequences of pain, one of the most common and costly outcomes of deployment.

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**Corresponding Author:** Afton L. Hassett, PsyD, Chronic Pain and Fatigue Research Center, University of Michigan, 24 Frank Lloyd Wright Dr, Lobby M, Ann Arbor, MI 48106 ([afton@med.umich.edu](mailto:afton@med.umich.edu)).

**Author Affiliations:** Chronic Pain and Fatigue Research Center, University of Michigan, Ann Arbor (Hassett, Clauw); Positive Psychology Center, University of Pennsylvania, Philadelphia (Fisher, Vie, Kelley, Seligman); Research Facilitation Laboratory/Army Analytics Group, Monterey, California (Fisher, Vie, Kelley).

**Author Contributions:** Dr Fisher and Ms Kelley had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

*Concept and design:* Hassett, Fisher, Vie, Seligman.

*Acquisition, analysis, or interpretation of data:* Hassett, Fisher, Vie, Kelley, Clauw.

*Drafting of the manuscript:* Hassett, Fisher, Vie, Kelley.

*Critical revision of the manuscript for important intellectual content:* Hassett, Vie, Clauw, Seligman.

*Statistical analysis:* Fisher, Vie, Kelley.

*Obtained funding:* Clauw, Seligman.

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*Supervision:* Hassett, Vie.

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## REFERENCES

1. Institute of Medicine. *Relieving Pain in America: A Blueprint for Transforming Prevention, Care, Education, and Research*. Washington, DC: National Academy of Sciences; 2011.
2. US Army Public Health Center. 2017 *Health of the Force*. [https://phc.amedd.army.mil/Periodical%20Library/2017HealthoftheForceReportWeb\\_Printer.pdf](https://phc.amedd.army.mil/Periodical%20Library/2017HealthoftheForceReportWeb_Printer.pdf). Published 2017. Accessed November 13, 2018.
3. Cohen SP, Brown C, Kurihara C, Plunkett A, Nguyen C, Strassels SA. Diagnoses and factors associated with medical evacuation and return to duty for service members participating in Operation Iraqi Freedom or Operation Enduring Freedom: a prospective cohort study. *Lancet*. 2010;375(9711):301-309. doi:10.1016/S0140-6736(09)61797-9
4. Cifu DX, Taylor BC, Carne WF, et al. Traumatic brain injury, posttraumatic stress disorder, and pain diagnoses in OIF/OEF/OND Veterans. *J Rehabil Res Dev*. 2013;50(9):1169-1176. doi:10.1682/JRRD.2013.01.0006
5. Lew HL, Cifu DX, Crowder T, Hinds SR. National prevalence of traumatic brain injury, posttraumatic stress disorder, and pain diagnoses in OIF/OEF/OND Veterans from 2009 to 2011. *J Rehabil Res Dev*. 2013;50(9):xi-xiv. doi:10.1682/JRRD.2013.09.0212
6. Toblin RL, Quartana PJ, Riviere LA, Walper KC, Hoge CW. Chronic pain and opioid use in US soldiers after combat deployment. *JAMA Intern Med*. 2014;174(8):1400-1401. doi:10.1001/jamainternmed.2014.2726
7. Gironde RJ, Clark ME, Massengale JP, Walker RL. Pain among veterans of Operations Enduring Freedom and Iraqi Freedom. *Pain Med*. 2006;7(4):339-343. doi:10.1111/j.1526-4637.2006.00146.x
8. Phillips KM, Clark ME, Gironde RJ, et al. Pain and psychiatric comorbidities among two groups of Iraq and Afghanistan era Veterans. *J Rehabil Res Dev*. 2016;53(4):413-432. doi:10.1682/JRRD.2014.05.0126
9. Bosco MA, Murphy JL, Clark ME. Chronic pain and traumatic brain injury in OEF/OIF service members and Veterans. *Headache*. 2013;53(9):1518-1522.
10. Forman-Hoffman VL, Peloso PM, Black DW, Woolson RF, Letuchy EM, Doebbeling BN. Chronic widespread pain in veterans of the first Gulf War: impact of deployment status and associated health effects. *J Pain*. 2007;8(12):954-961. doi:10.1016/j.jpain.2007.07.003
11. Helmer DA, Chandler HK, Quigley KS, Blatt M, Teichman R, Lange G. Chronic widespread pain, mental health, and physical role function in OEF/OIF veterans. *Pain Med*. 2009;10(7):1174-1182. doi:10.1111/j.1526-4637.2009.00723.x
12. Lewis JD, Wassermann EM, Chao W, Ramage AE, Robin DA, Clauw DJ. Central sensitization as a component of post-deployment syndrome. *NeuroRehabilitation*. 2012;31(4):367-372.
13. Ramirez S, Bebarta VS, Varney SM, Ganem V, Zarzabal LA, Potter JS. Misuse of prescribed pain medication in a military population: a self-reported survey to assess a correlation with age, deployment, combat illnesses, or injury? *Am J Ther*. 2017;24(2):e150-e156. doi:10.1097/MJT.0000000000000141
14. Granado NS, Pietrucha A, Ryan M, et al. Longitudinal assessment of self-reported recent back pain and combat deployment in the Millennium Cohort Study. *Spine (Phila Pa 1976)*. 2016;41(22):1754-1763. doi:10.1097/BRS.0000000000001739
15. Uomoto JM, Esselman PC. Traumatic brain injury and chronic pain: differential types and rates by head injury severity. *Arch Phys Med Rehabil*. 1993;74(1):61-64.
16. Wells TS, LeardMann CA, Fortuna SO, et al; Millennium Cohort Study Team. A prospective study of depression following combat deployment in support of the wars in Iraq and Afghanistan. *Am J Public Health*. 2010;100(1):90-99. doi:10.2105/AJPH.2008.155432
17. Ramchand R, Schell TL, Karney BR, Osilla KC, Burns RM, Caldarone LB. Disparate prevalence estimates of PTSD among service members who served in Iraq and Afghanistan: possible explanations. *J Trauma Stress*. 2010;23(1):59-68.
18. Vasterling JJ, Proctor SP, Friedman MJ, et al. PTSD symptom increases in Iraq-deployed soldiers: comparison with nondeployed soldiers and associations with baseline symptoms, deployment experiences, and postdeployment stress. *J Trauma Stress*. 2010;23(1):41-51.
19. Quartana PJ, Wilk JE, Balkin TJ, Hoge CW. Indirect associations of combat exposure with post-deployment physical symptoms in U.S. soldiers: roles of post-traumatic stress disorder, depression and insomnia. *J Psychosom Res*. 2015;78(5):478-483. doi:10.1016/j.jpsychores.2014.11.017
20. Hoopsick RA, Vest BM, Homish DL, Homish GG. Combat exposure, emotional and physical role limitations, and substance use among male United States Army Reserve and National Guard soldiers. *Qual Life Res*. 2018;27(1):137-147. doi:10.1007/s11136-017-1706-2
21. Finan PH, Quartana PJ, Smith MT. Positive and negative affect dimensions in chronic knee osteoarthritis: effects on clinical and laboratory pain. *Psychosom Med*. 2013;75(5):463-470. doi:10.1097/PSY.0b013e31828ef1d6

22. Rasmussen HN, Scheier MF, Greenhouse JB. Optimism and physical health: a meta-analytic review. *Ann Behav Med*. 2009;37(3):239-256. doi:10.1007/s12160-009-9111-x
23. DuBois CM, Lopez OV, Beale EE, Healy BC, Boehm JK, Huffman JC. Relationships between positive psychological constructs and health outcomes in patients with cardiovascular disease: a systematic review. *Int J Cardiol*. 2015;195:265-280. doi:10.1016/j.ijcard.2015.05.121
24. Schiavon CC, Marchetti E, Gurgel LG, Busnello FM, Reppold CT. Optimism and hope in chronic disease: a systematic review. *Front Psychol*. 2017;7:2022. doi:10.3389/fpsyg.2016.02022
25. Goodin BR, Glover TL, Sotolongo A, et al. The association of greater dispositional optimism with less endogenous pain facilitation is indirectly transmitted through lower levels of pain catastrophizing. *J Pain*. 2013;14(2):126-135. doi:10.1016/j.jpain.2012.10.007
26. Goodin BR, Kronfli T, King CD, Glover TL, Sibille K, Fillingim RB. Testing the relation between dispositional optimism and conditioned pain modulation: does ethnicity matter? *J Behav Med*. 2013;36(2):165-174. doi:10.1007/s10865-012-9411-7
27. Sobol-Kwapinska M, Bąbel P, Plotek W, Stelcer B. Psychological correlates of acute postsurgical pain: a systematic review and meta-analysis. *Eur J Pain*. 2016;20(10):1573-1586. doi:10.1002/ejp.886
28. Goodin BR, Bulls HW. Optimism and the experience of pain: benefits of seeing the glass as half full. *Curr Pain Headache Rep*. 2013;17(5):329. doi:10.1007/s11916-013-0329-8
29. Shrestha A, Cornum BGR, Vie LL, Scheier LM, Lester MAJPB, Seligman MEP. Protective effects of psychological strengths against psychiatric disorders among soldiers. *Mil Med*. 2018;183(suppl\_1):386-395. doi:10.1093/milmed/usx189
30. Vie LL, Griffith KN, Scheier LM, Lester PB, Seligman ME. The Person-Event Data Environment: leveraging big data for studies of psychological strengths in soldiers. *Front Psychol*. 2013;4:934. doi:10.3389/fpsyg.2013.00934
31. Vie LL, Scheier LM, Lester PB, Ho TE, Labarthe DR, Seligman ME. The U.S. Army Person-Event Data Environment: a military-civilian big data enterprise. *Big Data*. 2015;3(2):67-79. doi:10.1089/big.2014.0055
32. Peterson C, Park N, Castro CA. Assessment for the U.S. Army Comprehensive Soldier Fitness program: the Global Assessment Tool. *Am Psychol*. 2011;66(1):10-18. doi:10.1037/a0021658
33. Vie LL, Scheier LM, Lester PB, Seligman MEP. Initial validation of the U.S. Army Global Assessment Tool. *Mil Psychol*. 2016;28(6):468-487. doi:10.1037/mil0000141
34. Scheier MF, Carver CS, Bridges MW. Distinguishing optimism from neuroticism (and trait anxiety, self-mastery, and self-esteem): a reevaluation of the Life Orientation Test. *J Pers Soc Psychol*. 1994;67(6):1063-1078. doi:10.1037/0022-3514.67.6.1063
35. Clauw DJ. Fibromyalgia: a clinical review. *JAMA*. 2014;311(15):1547-1555. doi:10.1001/jama.2014.3266
36. Aaron LA, Buchwald D. A review of the evidence for overlap among unexplained clinical conditions. *Ann Intern Med*. 2001;134(9, pt 2):868-881. doi:10.7326/0003-4819-134-9\_Part\_2-200105011-00011
37. Hudson JI, Pope HG. The concept of affective spectrum disorder: relationship to fibromyalgia and other syndromes of chronic fatigue and chronic muscle pain. *Baillieres Clin Rheumatol*. 1994;8(4):839-856. doi:10.1016/S0950-3579(05)80051-2
38. Goesling J, Brummett CM, Meraj TS, Moser SE, Hassett AL, Ditte JW. Associations between pain, current tobacco smoking, depression, and fibromyalgia status among treatment-seeking chronic pain patients. *Pain Med*. 2015;16(7):1433-1442. doi:10.1111/pme.12747
39. Shiri R, Karppinen J, Leino-Arjas P, Solovieva S, Viikari-Juntura E. The association between smoking and low back pain: a meta-analysis. *Am J Med*. 2010;123(1):87.e7-87.e35. doi:10.1016/j.amjmed.2009.05.028
40. Hardt J, Jacobsen C, Goldberg J, Nickel R, Buchwald D. Prevalence of chronic pain in a representative sample in the United States. *Pain Med*. 2008;9(7):803-812. doi:10.1111/j.1526-4637.2008.00425.x
41. Nahin RL. Estimates of pain prevalence and severity in adults: United States, 2012. *J Pain*. 2015;16(8):769-780. doi:10.1016/j.jpain.2015.05.002
42. US Department of Defense. *Demographics 2010: Profile of the Military Community*. <http://download.militaryonesource.mil/12038/MOS/Reports/2010-Demographics-Report.pdf>. Published 2010. Accessed December 10, 2018.
43. McLean SA, Clauw DJ, Abelson JL, Liberzon I. The development of persistent pain and psychological morbidity after motor vehicle collision: integrating the potential role of stress response systems into a biopsychosocial model. *Psychosom Med*. 2005;67(5):783-790. doi:10.1097/01.psy.0000181276.49204.bb
44. McLean SA, Williams DA, Clauw DJ. Fibromyalgia after motor vehicle collision: evidence and implications. *Traffic Inj Prev*. 2005;6(2):97-104. doi:10.1080/15389580580590931545

45. Lanier PJ, Speirs J, Koehler L, Bader J, Abdelgawad A, Waterman BR. Predictors of persistent pain after fixation of distal clavicle fractures in an active military population. *Orthopedics*. 2018;41(1):e117-e126. doi:10.3928/01477447-20171127-02
46. Fishbain DA, Pulikal A, Lewis JE, Gao J. Chronic pain types differ in their reported prevalence of post-traumatic stress disorder (PTSD) and there is consistent evidence that chronic pain is associated with PTSD: an evidence-based structured systematic review. *Pain Med*. 2017;18(4):711-735.
47. Lester PB, Harms PD, Herian MN, Sowden WJ. A force of change: Chris Peterson and the US Army's Global Assessment Tool. *J Posit Psychol*. 2015;10(1):7-16. doi:10.1080/17439760.2014.927904
48. Puig-Perez S, Hackett RA, Salvador A, Steptoe A. Optimism moderates psychophysiological responses to stress in older people with type 2 diabetes. *Psychophysiology*. 2017;54(4):536-543. doi:10.1111/psyp.12806
49. Kim ES, Hagan KA, Grodstein F, DeMeo DL, De Vivo I, Kubzansky LD. Optimism and cause-specific mortality: a prospective cohort study. *Am J Epidemiol*. 2017;185(1):21-29. doi:10.1093/aje/kww182
50. Plomin R, Scheier MF, Bergeman CS, Pedersen NL, Nesselroade JR, McClearn GE. Optimism, pessimism and mental health: a twin/adoption analysis. *Pers Individ Dif*. 1992;13(8):921-930. doi:10.1016/0191-8869(92)90009-E
51. Kubzansky LD, Segerstrom SC, Boehm JK. Positive psychological functioning and the biology of health. *Soc Personal Psychol Compass*. 2015;9:645-660. doi:10.1111/spc3.12224
52. Peters ML, Flink IK, Boersma K, Linton SJ. Manipulating optimism: can imagining a best possible self be used to increase future expectancies? *J Posit Psychol*. 2010;5(3):204-211. doi:10.1080/17439761003790963
53. Meevissen YM, Peters ML, Alberts HJ. Become more optimistic by imagining a best possible self: effects of a two week intervention. *J Behav Ther Exp Psychiatry*. 2011;42(3):371-378. doi:10.1016/j.jbtep.2011.02.012
54. Murphy SE, Clare O'Donoghue M, Drazich EH, Blackwell SE, Christina Nobre A, Holmes EA. Imagining a brighter future: the effect of positive imagery training on mood, prospective mental imagery and emotional bias in older adults. *Psychiatry Res*. 2015;230(1):36-43. doi:10.1016/j.psychres.2015.07.059
55. Malouff JM, Schutte NS. Can psychological interventions increase optimism? a meta-analysis. *J Posit Psychol*. 2017;12(6):594-604. doi:10.1080/17439760.2016.1221122
56. Brewin CR, Andrews B, Valentine JD. Meta-analysis of risk factors for posttraumatic stress disorder in trauma-exposed adults. *J Consult Clin Psychol*. 2000;68(5):748-766. doi:10.1037/0022-006X.68.5.748
57. Ozer EJ, Best SR, Lipsey TL, Weiss DS. Predictors of posttraumatic stress disorder and symptoms in adults: a meta-analysis. *Psychol Bull*. 2003;129(1):52-73. doi:10.1037/0033-2909.129.1.52
58. Smith TC, Ryan MA, Wingard DL, Slymen DJ, Sallis JF, Kritz-Silverstein D; Millennium Cohort Study Team. New onset and persistent symptoms of post-traumatic stress disorder self reported after deployment and combat exposures: prospective population based US military cohort study. *BMJ*. 2008;336(7640):366-371. doi:10.1136/bmj.39430.638241.AE
59. Campbell DG, Felker BL, Liu CF, et al. Prevalence of depression-PTSD comorbidity: implications for clinical practice guidelines and primary care-based interventions. *J Gen Intern Med*. 2007;22(6):711-718. doi:10.1007/s11606-006-0101-4
60. Kroenke K, Spitzer RL, Williams JB, Monahan PO, Löwe B. Anxiety disorders in primary care: prevalence, impairment, comorbidity, and detection. *Ann Intern Med*. 2007;146(5):317-325. doi:10.7326/0003-4819-146-5-200703060-00004
61. Wanklyn SG, Pukay-Martin ND, Belus JM, St Cyr K, Girard TA, Monson CM. Trauma types as differential predictors of posttraumatic stress disorder (PTSD), major depressive disorder (MDD), and their comorbidity. *Can J Behav Sci*. 2016;48(4):296-305. Accessed November 13, 2018. doi:10.1037/cbs0000056