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Original Research

Patterns of Change in Pain-related Physical, Mental, and Social Health Outcomes in a Military Population

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ABSTRACT

Objective: Military persons frequently experience pain conditions stemming from noncombat and combat injuries. This study assessed the patterns of change over time and the associations of pain intensity and interference with physical, mental, and social health domains in a military sample.

Methods: A secondary analysis of Pain Assessment Screening Tool and Outcomes Registry (PASTOR) was conducted using data collected over 10 months. Participants selected for analysis completed ≥3 assessments with an interval of ≥14 days between assessments. The Defense and Veterans Pain Rating Scale (DVPRS) measured average and worst pain intensity, and Patient-Reported Outcomes Measurement Information System (PROMIS®) T-scores measured pain and health outcomes.

Results: The sample (N = 190) majority reported being active duty (96%); serving in the U.S. Army (93%); and being enlisted (86%). The percent difference from assessment one to assessment three showed improvement for DVPRS average pain (−4.85%) and worst pain

(−2.16%), and PROMIS Pain Interference T-score (−1.98%). Improvements were observed for all PROMIS outcomes except depression. The Defense and Veterans Pain Rating Scale average and worst pain intensity and PROMIS pain interference were strongly correlated with physical function. Multilevel models showed that an increase in average and worst pain, and pain interference were associated with a decrease in satisfaction with social roles.

Conclusion: Analysis identified patterns of change over time in physical, mental, and social health outcomes, as well as associations important to understanding the complexities of pain. This work has implications for pain management nursing in ambulatory settings where ongoing collection and analyses of multivariable outcomes data can inform clinical care.

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Military populations experience a broad spectrum of pain conditions resulting from noncombat and combat injuries. While precise overall estimates of pain among active duty (AD) service members remain unknown, many receive pain treatment. Recent data show that for the Army, nonsteroidal anti-inflammatory drugs (NSAIDs) were prescribed to 69% of personnel in 2006, 77% in 2011, and 82% in 2014 (Walker et al., 2017), which is higher than the U.S. general population. The National Health Interview Survey data suggest 9.1% of adults ≥18 years of age were regularly using NSAIDs in 2005, and 12.8% in 2010 (Zhou et al., 2014). For opioid prescribing, 1,516,979 AD service members filled 7,119,945 opioid prescriptions between 2006 and 2014 either in military treatment facilities or through TRICARE coverage (Kazanis et al., 2018), although prescrib-

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ing for long-term opioids has trended downward in more recent years (Office of the Secretary of Defense, 2019).

Military and veteran patient populations with pain struggle with biopsychosocial aspects of pain, including physical functioning (Young-McCaughan et al., 2017), sleep-related impairment (Brown et al., 2013; Lippa et al., 2015; Young-McCaughan et al., 2017), depression (Lippa et al., 2015; Young-McCaughan et al., 2017), generalized anxiety (Higgins et al., 2014; Young-McCaughan et al., 2017), and anger (Lombardo et al., 2005). Persistent pain and its interference with normal roles have a deteriorating effect on relationships, occupation, social functioning (Closs, Staples, Reid, I, Bennett, & Briggs, 2009; Hadjistavropoulos et al., 2011; Harris et al., 2003), and satisfaction with social roles (Cook et al., 2017).

Bolstering its commitment to pain management, the U.S. Army established Interdisciplinary Pain Management Centers (IPMCs) at each Army medical center. These IPMCs offer a variety of complementary and integrative pain services as well as conventional pain management treatments (Flynn et al., 2017). Using an existing Pain Assessment Screening Tool and Outcomes Registry (PASTOR) database obtained from a military IPMC, the aims of this study were to: (1) describe the patterns of change over time (from assessment one to assessment three) in pain intensity, pain interference, physical function, fatigue, sleep-related impairment, depression, anxiety, anger, and satisfaction with social roles, and examine minimally important differences (MIDs) in the AD military population using responder analysis; and (2) examine the effects of pain intensity and pain interference over time on satisfaction with social roles, controlling for physical function, fatigue, sleep-related impairment, depression, anxiety, and anger. PASTOR measures used in this study represent outcomes that are part of the physical, mental, and social health domains of PROMIS.

Methods

A secondary analysis was conducted using longitudinal PASTOR data collected over a 10-month period from patients referred to the Madigan Army Medical Center IPMC, Tacoma, Washington, for specialty pain care. Exempt status approval was granted by the Madigan Institutional Review Board for the parent study, "Retrospective Evaluation of Relationships among Pain Correlates and Psychometric Evaluation of the Measures that Estimate Them" (Research Protocol #215049). PASTOR is a standardized pain assessment system that incorporates the Defense and Veterans Pain Rating Scale (DVPRS), Patient-Reported Outcomes Measurement Information System (PROMIS) measures, and other clinical information relevant to pain (Cook et al., 2014). Preliminary research on PASTOR has validated its utility in informing provider-patient encounters in routine clinical pain care (Cook et al., 2014; Cook et al., 2017; Flynn et al., 2017). The analytical approaches to PASTOR data in this paper build on studies by Cook et al. (2017) and Flynn et al. (2017) to advance the science of managing pain in the military population.

Participants and Procedures

All participants in the PASTOR database were referred to the IPMC for pain care by their primary care providers or, less frequently, by medical or surgical specialists. Data collection occurred from May 27, 2014-March 31, 2015. Patients were ≥18 years of age and able to read and write in English. Patients with cognitive impairments or physical limitations that precluded their ability to complete a computer-based survey were excluded from the study. As patients were oriented to the IPMC, they were instructed on the PASTOR data entry system and informed that IPMC providers may use the patient-reported outcomes system to develop individualized treatment plans and to monitor their responses to pain therapies. Completion of PASTOR was encouraged but not a requirement for continued care.

Patients completed PASTOR at the time of enrollment and timing of subsequent assessments coincided with patient visits and/or the need to monitor the effectiveness of pain therapies. Participants could access PASTOR from personal devices, or a kiosk located in the pain center. Reminders were sent prior to each appointment to encourage completion of all PASTOR data prior to arrival at the pain center.

The Madigan IPMC PASTOR database included 640 enrolled patients completing ≥1 PASTOR assessment. For this study, participants were selected for analysis if they completed ≥3 assessments with an interval of ≥14 days between assessments. A threshold of three assessments was determined to be a minimum number potentially capable of demonstrating a pattern of change in outcomes over time (Singer & Willet, 2003). An interval of ≥14 days between assessments was recommended by clinicians directly involved in care of participants because it was assumed that intervals of <14 days would be more a retest of the prior measure rather than a measure of treatment response. All dates for PASTOR assessments were evaluated, and only those assessments sequenced ≥14 days apart were included in analysis. Assessments <14 days from the prior assessment were removed and the subsequent completed assessment was used.

Measures

The PASTOR database used in this study contained PROMIS measures of Pain Interference, Physical Function, Fatigue, Sleep-related Impairment, Depression, Anxiety, Anger, Satisfaction with Social Roles, and the DVPRS 11- point numeric rating scale for pain average and worst intensity. Responses to items in each PROMIS measure, except Physical Function, were framed over the past seven days. Physical Function items required a response to current capabilities "Are you able to…"; DVPRS pain intensity items for average and worst intensity involved recall over the past seven days. PASTOR incorporates Computer Adaptive Test (CAT) to improve the accuracy of response options tailored to respondents through sophisticated algorithms presenting only individual-specific relevant items based on previous responses, thus also reducing item burden (Cella et al., 2007; Cella et al., 2010).

PROMIS measures are scientifically sound, efficient, and flexible (Cella et al., 2010), with robust evidence to support acceptable psychometric properties with general populations and diverse clinical samples (Askew et al., 2016; Cella et al., 2016; Cook et al., 2016; Cook et al., 2017; Hahn et al., 2016; Schalet et al., 2016). A validation study of PASTOR with a military population treated in an IPMC further established reliability and validity for PROMIS measures (Cook et al., 2017). Similarly, the DVPRS 0-10 numeric rating scale has undergone rigorous psychometric testing with military and veteran samples in inpatient and outpatient settings (Buckenmaier et al., 2013; Nassif et al., 2015; Polomano et al., 2016).

Item responses for PROMIS measures include categorical Likert scales. Scores for response options were converted to an overall T-score (continuous level data with mean of 50 and standard deviation of 10). Interpretation of PROMIS measures is dependent on the nature of the concept and whether items representing the concept are worded positively or negatively. A higher T-score consistently indicates more of the concept being measured. For a positively worded PROMIS measure such as Physical Function, a positive change in scores over time signifies improvement (greater physical function), whereas for a negatively worded measure such as Fatigue, a negative change signifies improvement (less fatigue).

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PROMIS measures that are negatively worded include: Pain Interference, Fatigue, Depression, Anger, Anxiety, and Sleep-related Impairment; Physical Function and Satisfaction with Social Roles are positively worded (HealthMeasures, 2018).

Statistical analysis

IBM SPSS statistical software version 24.0 (Armonk, New York) was used to perform data analyses. A multilevel modeling (MLM) approach to power analysis was performed. To attain a desired power of 80% given $\alpha = 0.05$ and a standardized effect size of 0.40 (moderate), we estimated approximately 200 participants would be required. ANOVA and Chi-squared tests were used from the 190 patients completing at least three PASTOR assessments targeted for this study versus the 450 patients with fewer than three assessments. The psychometric properties of PASTOR (PROMIS and DVPRS) were evaluated for use in the Military Health System (MHS) setting. Cook et al. (2017) established several types of validity for PASTOR PROMIS using samples drawn from the Madigan Army Medical Center IPMC, the same setting for the current study.

To describe patterns of change over time in pain intensity, pain interference, physical function, fatigue, sleep-related impairment, depression, anxiety, anger, and satisfaction with social roles in AD military (N = 190), percent change was calculated for all eight variables between the first assessment (A1) and the third assessment (A3). For each patient, DVPRS average pain intensity score from A1 was subtracted from A3, then divided by the A1 score and multiplied by 100: [(DVPRS A3 score – DVPRS A1 score)/(DVPRS A1 score) * 100)]. Similarly, for each PASTOR PROMIS measure, PROMIS T-scores from A1 were subtracted from A3 then divided by A1 scores and multiplied by 100: [(T-score A3 – T-score A1)/(T-score A1) * 100)]. The scores generated by the above formula were used for correlation matrix. The matrix was constructed using Pearson's Product Moment correlation coefficient (r) to examine the magnitude of associations for percent change between A1 and A3 for: DVPRS pain intensity (average and worst) and PROMIS Pain Interference, and the PROMIS measures (Physical Function, Fatigue, Sleep-related Impairment, Depression, Anxiety, Anger, and Satisfaction with Social Roles and Activities).

Responder analyses were conducted to determine the percentage of patients who experienced clinically meaningful improvements in pain intensity and PROMIS measures over time, using proposed MIDs for each measure. Page (2014) contends that clinical researchers should report clinically meaningful results, as these add value to evidence-based decision-making in clinical care and further our understanding of responses to treatment. Clinically meaningful differences are among those parameters, such as effect size, confidence intervals, and magnitude-based inferences, and should be considered in evaluating clinically relevant measures (Page, 2014). In cancer patients, Yost et al. (2011) established MID values for PROMIS measures of pain interference, physical function, depression, anxiety, and fatigue ranging from 3.75-5 points, and those values were used to estimate MIDs for this analysis (Yost et al., 2011). For PROMIS measures without empiric MID data, the MID was estimated to be 5 points, corresponding to one-half of a standard deviation. Because of the high number of participants in assessments one-three and a sharp drop-off in number with subsequent assessments, responder analyses were conducted by comparing assessment three with baseline. The percentage of patients achieving a minimally important change was reported.

Analysis for Aim 2 examined the correlation between pain intensity and pain interference over time and satisfaction with social roles, controlling for physical function, fatigue, sleep-related impairment, depression, anxiety, and anger. Three MLM were constructed to predict satisfaction with social roles, two separate models based on average and worst pain intensity, and one model based on pain interference. Multilevel modeling with repeated measures at ≥3 time points (which included time-varying covariates, a covariate whose value can change over time) was used to test changes over time in satisfaction with social roles T-scores. In this study, it is clinically relevant to build the covariates into the model because these add meaning and clarity to variable relationships. Fixed effects are reported for physical function, fatigue, sleep-related impairment, depression, anxiety, anger, and time. The random effect was the intercepts, which is the magnitude of between person differences on the intercept (at baseline), and the random error was the residuals (i.e., intra-individual variability) unique to each individual for satisfaction with social roles. Recognizing that there was a significant decrease in sample size after the third assessment, an additional analysis was conducted for A1-A3 only. A Bonferroni correction was made to address the possibility of an inflated Type I error rate. Using a conservative experiment-wise alpha level of 0.05, the per comparison alpha was set at 0.0167 (0.05/3).

Our strategy to build covariates into statistical models is aligned with recommendations from the Initiative on Methods, Measurement, and Pain Assessment in Clinical Trials (IMMPACT), a national effort to develop consensus reviews and recommendations for clinical trials (Dworkin et al., 2008). Variables, such as demographic and clinical, can play an important role in interpreting what magnitude of change is important (Dworkin et al., 2008). Some covariates vary over time and that variation needs to be accounted for in reporting multivariable outcomes over time. Even the smallest changes in outcomes can be of importance to patients and clinicians.

Results

Sample Characteristics

The following descriptive statistics are reported as valid percentages based on the number of participants that answered a specific demographic question, as not all participants answered every demographic question. The 190 participants in the sample consisted of 16% women (n = 31) and 84% men (n = 159). The participants had a mean age of 35.06 years (SD = 8.62). A majority of the sample reported being AD (96%, n = 178); serving in the U.S. Army (93%, n = 170); and being enlisted (86%, n = 157). Seventy-five percent (n = 141) of the sample reported being married. Most of the sample reported having some college or technical degree (54%, n = 102), with fewer having a college degree (15%, n = 29) or an advanced degree (9%, n = 16). Fifty-seven percent (n = 108) of respondents stated that their pain limits the number of hours they can work per week. Fifty-six percent of the patients reported their injury as pre-, during, or post-deployment, related at 11% (n = 21), 37% (n = 69), and 8% (n = 14), respectively. The average time period between the first and last assessment in the 10-month time period was 18.85 weeks.

To assess whether the 190 patients in this analysis were an unbiased representation of the full sample, the 450 excluded patients were compared with the 190 eligible patients. ANOVA was performed and found that there was no statistically significant difference in age between the two groups F (1, 638) = 2.21, $p = .138$, $\eta^2 = 0.003$ (excluded patients' mean age of 36.43 years; SD = 11.47; median 34). A Chi-squared test for independence was conducted to compare sociodemographic variables and there was no significant difference between groups for sex, education, rank, number of hours pain limited ability to work per day, and when injury occurred in relation to deployment. Statistically significant differences were evident for military status (χ^2 (4) = 24.412, $p <$ .001) and branch of service (χ^2 (5) = 11.320, $p = .045$), which may

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Table 1
Descriptive Data for PASTOR PROMIS Measures and DVPRS Average Pain Intensity by Assessment

PASTOR PROMIS Measures	Assessment 1			Assessment 2			Assessment 3			Assessment 4		
	n	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD
Physical Function[a]	189	39.98	5.84	173	39.87	5.47	176	39.98	6.23	98	39.67	6.05
Fatigue[a]	189	58.39	9.23	173	58.55	8.49	176	57.99	8.99	98	58.22	9.34
Sleep-related Impairment[a]	189	60.30	8.30	173	60.57	8.61	176	59.70	9.09	98	59.29	10.44
Depression[a]	189	51.40	9.55	171	51.82	9.98	175	52.05	10.10	97	52.33	9.48
Anxiety[a]	189	56.04	9.15	171	56.04	10.15	175	55.23	10.35	96	56.30	9.74
Anger[a]	189	55.45	10.82	171	55.37	10.69	175	54.39	11.24	96	54.75	11.53
Pain Interference[a]	189	64.30	5.10	173	63.12	5.34	176	62.83	6.20	99	62.48	6.39
Satisfaction with Social Roles	189	39.61	6.80	169	39.61	6.37	175	39.44	6.89	95	40.35	6.30
Average Pain Intensity[b]	186	5.80	1.43	172	5.45	1.45	173	5.32	1.73	101	5.16	1.75
PASTOR PROMIS Measures	Assessment 5			Assessment 6[c]			Assessment 7[c]			Assessment 8[c]		
	n	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD
Physical Function[a]	46	40.79	7.70	16	38.42	4.22	7	40.50	4.26	2	46.11	5.66
Fatigue[a]	46	55.99	10.91	16	61.75	7.37	7	59.23	9.89	2	53.26	15.23
Sleep-related Impairment[a]	46	57.43	10.42	16	59.62	9.90	7	60.07	6.71	2	56.54	15.13
Depression[a]	46	51.30	10.64	16	53.53	10.87	7	49.35	9.90	2	48.22	17.45
Anxiety[a]	46	54.38	11.01	16	58.56	11.38	7	52.86	7.67	2	52.79	24.64
Anger[a]	46	51.77	13.04	16	56.89	11.43	7	48.04	12.11	2	44.39	14.48
Pain Interference[a]	46	61.57	7.29	16	64.81	6.53	7	63.34	5.21	2	59.78	9.12
Satisfaction with Social Roles[a]	46	40.14	8.84	16	37.19	4.72	7	36.96	6.56	2	41.10	4.06
Average Pain Intensity[b]	46	5.09	2.00	16	5.25	1.29	7	5.29	1.98	2	3.0	1.41

[a] Patient-Reported Outcomes Measurement Information System (PROMIS®) T-scores measure.
[b] 0-10 numeric Defense and Veterans Pain Rating Scale (DVPRS).
[c] Sample sizes are ≤16.

Table 2
Descriptive Data for Percent Difference Between Assessment One and Assessment Three

PASTOR PROMIS Measures	N valid (N = 190)	Mean	Standard Deviation	Range
Physical Function[a]	176	0.91	12.43	−27.06 to 55.70
Fatigue[b]	176	−0.19	14.39	−45.56 to 46.00
Sleep-related Impairment[b]	176	−0.58	14.86	−44.61 to 54.13
Depression[b]	175	1.36	15.05	−35.48 to 58.38
Anxiety[b]	175	−1.48	14.21	−44.17 to 64.78
Anger[b]	175	−0.94	16.85	−40.70 to 76.84
Satisfaction with Social Roles[a]	175	0.94	16.82	−41.25 to 63.11
Pain Interference[b]	176	−1.97	8.43	−34.29 to 28.22
DVPRS average pain[c]	170	−4.85	32.06	−83.33 to 150.00
DVPRS worst pain[c]	168	−2.16	36.22	−83.33 to 300.00

Note. SD = standard deviation; Missing data ranged from 14-22.
[a] PROMIS Physical Function and Satisfaction with Social Roles are positively worded measures, therefore, a positive change in scores over time represents an improvement (i.e., greater physical function)
[b] PROMIS Fatigue, Sleep-related Impairment, Depression, Anxiety, Anger and Pain Interference are negatively worded, therefore, a negative change over time represents an improvement (i.e., less fatigue, less sleep-related impairment etc.)
[c] A negative change in scores represents an improvement

be due to the large percentage of AD Army personnel in the original dataset.

Percent Change and Correlations

All patients in this analysis (N = 190) had at least three assessments; however, 161 participants had three consecutive assessments and 29 had nonconsecutive assessments for the first three assessments. Descriptive data for PASTOR PROMIS measures and DVPRS average pain intensity are presented in Table 1.

The degree of change in all variables between baseline and the third PASTOR assessment was quite modest. However, the direction of change was an improvement in all outcomes except depression, where there was a worsening over time (Table 2). It is noteworthy that (as shown in Table 1) the mean depression score was the only measure within the normal range (≤54.9) at baseline and at every subsequent time point. Correlation coefficients between percent change from assessment one to assessment three for average and worse pain intensity, and pain interference with selected PROMIS measures appear in Table 3. The moderate and large correlations between these percent change variables are highlighted here. For average pain, percent change in mean score was negatively correlated with physical function ($r = -0.333$, $p < .001$) and satisfaction with social roles ($r = -0.349$, $p < .001$) (i.e., decrease in pain intensity was associated with improvement in physical function and satisfaction with social roles). For worst pain, percent change was negatively correlated with physical function ($r = -0.372$, $p < .001$) and satisfaction with social roles ($r = -0.338$, $p < .001$). For pain interference, percent change was negatively correlated with physical function ($r = -0.617$, $p < .001$) and satisfaction with social roles ($r = -0.381$, $p < 0.001$) and positively correlated with fatigue ($r = 0.364$, $p < .001$), sleep-related impairment ($r = 0.338$, $p < .001$), and depression ($r = 0.304$, $p < .001$). Correlations of percent change were also conducted for average pain, worst pain, and pain

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Table 3
Correlation Matrix of Percent Change for DVPRS Average Pain Intensity (Over the Past 7 Days), DVPRS Worst Pain Intensity (Over the Past 7 Days), and PROMIS Pain Interference (Over the Past 7 Days) and PROMIS Measures from Assessment One to Assessment Three

	DVPRS Average Pain	DVPRS Worst pain	Pain Interference	Physical function	Fatigue	Sleep-related impairment	Depression	Anxiety	Anger
Physical Function	0.333[a]	−0.372[a]	−0.617[a]						
Fatigue	0.201[b,c]	0.136[c]	0.364[a]	−0.225[b,c]					
Sleep-Related Impairment	0.196[c,d]	0.183[c,d]	0.338[a]	−0.293[a,c]	0.552[a]				
Depression	0.037[c]	0.047[c]	0.304[a]	−0.180[c,d]	0.401[a]	0.426[a]			
Anxiety	0.094[c]	0.114[c]	0.158[c,d]	−0.186[b,c]	0.185[b,c]	0.252[a,c]	0.574[a]		
Anger	0.160[c,d]	0.037[c]	0.054[c]	−0.002[c]	0.291[a,c]	0.305[a]	0.450[a]	0.561[a]	
Satisfaction with Social Roles	−0.349[a]	−0.338[a]	−0.381[a]	0.388[a]	−0.112[c]	−0.180[c,d]	−0.108[c]	0.031[c]	0.148[c,d]

Note. All the variables are percent change variables and the correlations are between the percent change variables. A correlation coefficient of 0.10 is considered small; a correlation coefficient of 0.30 is considered moderate; and a correlation coefficient of 0.50 or larger is considered large. Cohen, J. *Statistical power analysis for the behavioral sciences (2nd ed.)*. New Jersey: Lawrence Erlbaum Associates; 1988.
[a] Two tailed significance ≤ .001
[b] Two tailed significance ≤ .01
[c] Correlation coefficient of > 0.30
[d] Two tailed significance ≤ .05

Table 4
Minimum Important Differences (MIDs) from Assessment One to Assessment Three

PASTOR PROMIS Measures	N valid (missing)		MID T-Score Change (Points)[a]	Percent with MID T-Score Change Improvement[b]		Percent with MID T-Score Change Worsening[b]	
Physical Function	176	(14)	5	15.91%	n = 28	17.05%	n = 30
Fatigue	176	(14)	4	30.68%	n = 54	26.71%	n = 47
Sleep-related Impairment	176	(14)	5	24.43%	n = 43	19.89%	n = 35
Depression	175	(15)	3.75	26.29%	n = 46	29.71%	n = 52
Anxiety	175	(15)	3.75	37.14%	n = 65	20.57%	n = 36
Anger	175	(15)	5	29.7%	n = 52	19.43%	n = 34
Pain Interference	176	(14)	5	20.45%	n = 36	9.09%	n = 16
Satisfaction with Social Roles	175	(15)	5	18.18%	n = 32	18.75%	n = 33

[a] Flynn DM, Cook K, Kallen M, et al. Use of the Pain Assessment Screening Tool and Outcomes Registry in an Army interdisciplinary pain management center, Lessons learned and future implications of a 10-month beta test. *Mil Med.* 2017;182(3-4)(suppl):167-174.
[b] At or exceeds the MID T-score change threshold.

interference: average pain and worst pain ($r = 0.384$, $p < .001$); average pain and pain interference ($r = 0.432$, $p < .001$); and worst pain and pain interference ($r = 0.412$, $p < .001$).

Responder Analysis

The effects of clinically meaningful changes in PROMIS measures were assessed using MIDs in T-scores from assessment one to assessment three. Table 4 reports the percent of patients with available data who reached or exceeded the MID in either direction over time, indicating an improvement or worsening of the PROMIS outcome. Table 4 is intended to present changes in patient-reported outcomes, i.e., improvement or worsening of outcomes. We believe that these findings can be useful for comparisons of data from other clinical settings and populations. The variable with the greatest percentage of patients reporting important improvement was anxiety, where 37.14% (n = 65) of the sample (N = 175) had a 3.75 or higher point decrease in T-scores. Anxiety also had the greatest percent difference between improvement and worsening (17%). Depression had the highest percent of patients worsening over time, 29.71% (n = 52), with a similar percentage improving over time, 26.29% (n = 46). Although there was only a 3% difference between improvement and worsening, it is important to recognize the change in depression over time.

Multilevel Modeling

Three separate MLMs tested the association of (1) average pain, (2) worst pain, and (3) pain interference with satisfaction with social roles, controlling for time and the six covariates (physical function, fatigue, sleep-related impairment, depression, anxiety, and anger [Table 5]). Overall, results of the analysis show that an increase in average or worst pain intensity or pain interference is associated with a decrease in satisfaction with social roles ($p < .001$). A one-unit increase on average and worst pain intensity is associated with a decrease of 0.68 and 0.61, respectively, in satisfaction with social roles T-score. A one-unit increase in pain interference T-score is associated with a decrease of 0.28 in satisfaction with social roles T-score. For the variables of interest, the results of the A1-A3 analysis are very similar to the results from the full data analysis (Table S1).

Discussion

In this analysis, when controlling for other relevant covariates, an increase in pain intensity (average and worst) and pain interference was significantly associated with a decrease in satisfaction with social roles. The findings align with the Cook et al. (2017) study using a larger PASTOR dataset that included 681 respondents and reported low levels of social functioning in the military pain population. More robust measures of social roles may be required to further differentiate these low levels of social satisfaction (Cook et al., 2017). Our analysis of percent change demonstrated trends in improvement from baseline for pain intensity, pain interference, physical function, fatigue, sleep-related impairment, anxiety, anger, and satisfaction with social roles. For this study, as measured on the DVPRS pain intensity scale, the percent change was larger for average pain, with a decrease of 5%, than for worst pain, which decreased by 2%. Although noteworthy, this change is considerably less than the 30% or greater improvement in pain intensity considered to be clinically meaningful (Farrar et al., 2001). The direction for the 1.4%

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Table 5
Multilevel Models for DVPRS Average Pain Intensity, DVPRS Worst Pain Intensity, and PROMIS Pain Interference on Satisfaction with Social Roles

Pain Intensity: Average pain				
Fixed Effects	Coefficient (SE)	95% CI Lower bound	95% CI Upper Bound	*p* value
Intercept	38.33 (3.60)	31.27	45.39	<.001
Time	−0.006 (.123)	−0.25	0.24	=.959
Depression	−0.09 (.04)	−0.16	−0.01	=.024
Anger	0.06 (.03)	0.00	0.12	=.045
Fatigue	−0.09 (.04)	−0.16	−0.02	=.015
Physical Function	0.37 (.05)	0.28	0.47	<.001
Sleep-related impairment	−0.05 (.03)	−0.12	0.02	=.139
Anxiety	−0.02 (.04)	−0.09	0.06	=.683
Average Pain	−0.68 (.16)	−1.00	−0.37	<.001
Random Effects				
residual	16.49 (1.06)	14.54	18.69	<.001
intercept	11.08 (1.71)	8.18	15.00	<.001
ICC .40				
Pain Intensity: Worst pain				
Fixed Effects	Coefficient (SE)	95% CI Lower bound	95% CI Upper Bound	*p* value
Intercept	39.08 (3.59)	32.02	46.13	<.001
Time	−0.02 (.12)	−0.27	0.22	=.856
Depression	−0.07 (.04)	−0.14	0.00	=.067
Anger	0.05 (.03)	−0.01	0.11	=.129
Fatigue	−0.10 (0.04)	−0.17	−0.03	=.005
Physical Function	0.37 (0.05)	0.28	0.47	<.001
Sleep-related impairment	−0.06 (0.03)	−0.13	0.01	=.083
Anxiety	0.003 (0.04)	−0.07	0.08	=.925
Worst Pain	−0.61 (0.15)	−0.90	−0.32	<.001
Random Effects				
residual	16.69 (1.07)	14.73	18.92	<.001
intercept	10.80 (1.67)	7.97	14.62	<.001
ICC .39				
Pain Interference				
Fixed Effects	Coefficient (SE)	95% CI Lower bound	95% CI Upper Bound	*p* value
Intercept	52.87 (5.03)	43.00	62.75	<.001
Time	−0.08 (0.12)	−0.32	0.16	=.515
Depression	−0.06 (0.04)	−0.13	0.02	=.136
Anger	0.04 (0.03)	−0.02	0.10	=.147
Fatigue	−0.07 (0.04)	−0.14	−0.00	=.047
Physical Function	0.31 (0.05)	0.21	0.41	<.001
Sleep-related impairment	−0.05 (0.03)	−0.11	0.02	=.172
Anxiety	−0.00 (0.04)	−0.08	0.07	=.989
Pain Interference	−0.28 (0.06)	−0.39	−0.18	<.001
Random Effects				
residual	16.51 (1.05)	14.58	18.70	<.001
intercept	10.73 (1.66)	7.93	14.52	<.001
ICC 0.39				

Note. Dependent Variable: Satisfaction with Social Roles.
ICC = intraclass correlation; SE = standard error.

change in mean depression indicated a higher level of depressive symptoms over time. The clinical relevance of this is uncertain in this population, with mean baseline and follow-up depression scores in the normal (i.e., not depressed) range. Our findings highlight the need for further research on depressive symptoms and are supported by previous research, which suggests pain influences physical, mental, and social states, and changes do not occur in isolation (Closs, Staples, Reid, I, Bennett, & Briggs, 2009; Hadjistavropoulos et al., 2011; Harris et al., 2003; Karayannis et al., 2017; Sturgeon, et al., 2015a; Sturgeon et al., 2015b; Sturgeon et al., 2014). The observation of worsening mean depression is consistent with findings from an earlier study of PASTOR data.

In a study of 343 patients who completed a baseline and at least one follow-up PASTOR assessment, Flynn et al. (2017) reported a worsening of emotional states, including depression, which may have been due to a lack of perceived progress despite possible improvement in objective functional measures. In addition, it is likely that military members wanted to return to their unit and be physically fit to perform their assigned duties. Alternatively, the interval between the first and third PASTOR assessment may have been insufficient for patients to derive a therapeutic benefit from pain treatments. Li et al. (2021) conducted a secondary analysis of PASTOR data at the same facility which showed worsening of PASTOR measures during the initial 50 cumulative treatment hours, with subsequent improvement in depression and fatigue. This is an important area for further study and underscores the value of time-dependent evaluations of pain to determine the pattern and course of pain with military populations who often require prompt and aggressive pain interventions to facilitate optimal performance and return to duty.

Further, correlations among percent change showed that changes in the levels of pain intensity and pain interference were associated with percent changes in other outcomes of pain. Some of the strongest associations in this study were between pain intensity and pain interference, and physical function. Interestingly, these are the same three variables included in the National In-

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stitutes of Health Research Task Force (NIH RTF) impact score, a composite measure proposed to assess the effect of chronic musculoskeletal pain (Deyo et al., 2014). In addition to physical function, improvement in pain interference was correlated with an improvement in fatigue, sleep-related impairment, and anxiety. Combined, these findings support other studies suggesting pain intensity and chronic pain interfere with functioning, and pain outcomes should be viewed through a biopsychosocial lens (Clay et al., 2010; Harris et al., 2003; Sturgeon et al., 2015b).

The NIH RTF recommends conducting responder analyses, in addition to mean scores of outcome measures, to determine the proportion of individual patients who have meaningful improvement or worsening over time based on established MID T-score point changes (Deyo et al., 2014). A MID T-score change has been empirically established or proposed for each of the PROMIS measures used in this study, and ranges from 3.75-5 points (Flynn et al., 2017; Yost et al., 2011). Although it is acknowledged that the MID is not necessarily the same value in the direction for improvement and worsening, we used the MID for improvement to estimate the minimum threshold for meaningful worsening. In our study, it was possible to document a range of 15.9%-37.1% of patients showing an MID for improvement in PROMIS measures over time, and 9.1%-29.7% of patients having worse outcomes.

Limitations

Although we had three or more assessments for the longitudinal analysis, the 10-month time frame restricted the number of patients eligible for the study and limited the amount of data points collected. However, data collection with PASTOR continues and fortifies a more expansive database for further longitudinal research. Another limitation is the variability among individuals in length of time between assessments, and the length of time receiving specialty pain care, which may have implications for understanding relationships between pain factors and outcomes. There may be limits to generalizability, as this sample was drawn from an IPMC; therefore, the results may not generalize to patients who are not seeking specialized pain care. Additionally, because of the large percentage of AD Army personnel in the original data set, other military statuses and branches were not well-represented in this study, which may limit generalizability to other populations. The lack of statistical significance with some comparisons may be due to current PASTOR measures not being sensitive enough to detect the therapeutic benefits of pain treatments (Flynn et al., 2017), or due to insufficient sample sizes. Finally, we were not able to examine other factors, such as pain etiology, physical environment, current medications and other therapies, or comorbidities, which may have influenced PASTOR outcomes.

Conclusion

Military members present unique challenges to health care providers because of their potential or actual exposures to physical and psychological factors that contribute to injury rates and the onset of pain. This study expands the body of knowledge about the development and burden of pain in AD service members and advances knowledge of pain-related health problems, and associated physical, mental, and social health outcomes. Findings from this work support the value of the Pain Assessment Screening Tool and Outcomes Registry (PASTOR) in the assessment and tracking of pain-related biopsychosocial outcomes in both routine pain care and research. Multivariable pain outcomes are critical for determining the effectiveness of nursing and interprofessional pain treatment and informing plans of care. Moreover, data repositories, such as PASTOR, offer opportunities to collect and analyze uniform pain outcomes from military and veteran populations experiencing pain. These repositories can generate useful information to measure the effectiveness of pain interventions and rehabilitation at the point of care. The potential for widespread use of computerized screening tools to assess pain-related outcomes, including psychological well-being, also have implications for justifying the need for interprofessional and integrative pain care.

Disclaimer

The investigators have adhered to the policies for protection of human subjects as prescribed in 45 CFR 46. The views expressed are those of the authors and do not reflect the official policy of the Department of the Army, the Uniformed Services University of the Health Sciences, the Department of Defense, or the U.S. Government.

Conflict of interest

There are no conflicts of interest for all authors

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.pmn.2023.01.002.

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