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The Influence of Symptoms of Anger on Pain Intensity and Activity Intolerance

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Abstract

This study assessed the association of anger, anxiety, and depression, and cognitive bias with pain and activity tolerance among patients with a musculoskeletal illness or injury expected to last more than a month. 102 Patients completed emotional thermometers to quantify symptoms of anger, anxiety, depression; the abbreviated Pain Catastrophizing Scale; a pain intensity scale; Patient-Reported Outcomes Measurement Information System (PROMIS) Physical Function Computer Adaptive Test; the Spielberger State-Trait Anxiety Inventory and demographic questionnaires. Controlling for potential confounding in multivariable analysis we found greater activity intolerance was associated with retired work-status and greater depressive symptoms, but not with greater symptoms of anger. In addition, greater pain intensity was associated with greater symptoms of depression and greater catastrophic thinking, but not with greater symptoms of anger. Anger emotions do not contribute to symptom intensity and activity intolerance in musculoskeletal illness. Attention can be directed at addressing psychological distress and cognitive bias.

Keywords Pain intensity · Anger · Depression · Anxiety · Orthopaedics

Level of evidence Level III

Introduction

There is growing recognition that people with more symptoms of depression tend to have greater daily limitations due to pain (Arnow et al., 2006; Bair et al., 2003). It is estimated that up to 70% of people diagnosed with a depressive disorder have persistent daily pain (Bair et al., 2003; Demyttenaere et al., 2007; Gureje et al., 2008). Symptoms of depression may be more prevalent among people with musculoskeletal injury or disease than in the general population (Crichlow et al., 2006; De Moraes et al., 2010; Kessler et al., 2003). There is a bidirectional relationship between symptoms of depression and the duration and intensity of pain associated with musculoskeletal illness or injury (De Heer et al., 2014; Lindberg et al., 2016; Trief et al., 2006).

The World Health Organization International Classification of Functioning, Disability and Health defines disability as a multidimensional construct involving a dynamic interaction between body function and structures, limitations of activity and participation restrictions and also environmental and personal factors associated with the relevant health conditions (Fox et al., 2015; Kostanjsek, 2011). Management strategies that anticipate and treat mental and social health opportunities could improve comfort and function (Callahan et al., 2005; Greco et al., 2004). Greater acknowledgement of the value of assessing symptoms of anger, depression and anxiety, as well as the degree of catastrophic thinking among people with musculoskeletal illness may support decision- and policymaking regarding the provision of psychological and social therapies as part of care. Understanding the

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relationship between symptoms like pain and anger emotions is also important for economic reasons, since pain and depression are a source of substantial health care costs (Rayner et al., 2016).

This study assessed the association of symptoms of anger, anxiety and depression, and cognitive bias (catastrophic thinking) with pain intensity and activity tolerance among patients with a painful musculoskeletal illness or injury expected to last more than a month.

Materials and Methods

Study Design

Patients who visited one of several participating orthopaedic offices were invited to participate. A research assistant not involved in patient care recruited patients directly after their visit to the office. Inclusion criteria were new and return patients with persistent pain from musculoskeletal illness or injury, aged 18–89 years, and English fluency and literacy. Exclusion criteria included patients with illness expected to cause pain for less than 30 days and patients who were unable to complete enrollment forms. We were granted a waiver of informed consent and completion of the questionnaires implied consent.

Measures

Patients completed the following questionnaires: (1) age, gender, race/ethnicity, marital status, level of education, work status; (2) Pain intensity using the Numeric Rating Scale; (3) Emotional thermometers to assess anxiety, depression, and anger; (4) the abbreviated Pain Catastrophizing Scale (PCS-4); (5) the Patient-Reported Outcomes Measurement Information System (PROMIS) Physical Function (PF) Computer Adaptive Test (CAT); and (6) the Spielberger State-Trait Anxiety Inventory (STAI-6).

Pain intensity using a numeric rating scale assessed pain by asking patients to rate their pain from 0 (no pain) to 10 (the worst pain ever).

For the emotional thermometers we used a numeric rating scale measuring anxiety, depression, and anger presented as a thermometer graphic. Patients were asked to mark the number (0–10) that best describes how much emotional upset they have been experiencing in the past week, including the day of enrollment. The overall score can range from 0 (None) to 10 (Extreme).

The PCS-4 was used to measure catastrophic thinking, a less effective cognitive coping strategy based on misinterpretation of nociception (Bot et al., 2013). The questionnaire consists of four questions, which are answered on a 5-point Likert scale, from "0- Not at all" to "4- All the time". The total scores range from 0 to 16 with higher scores indicating more catastrophic thinking.

PROMIS Physical Function measures the activity tolerance by assessing the patient's ability to accomplish physical activities ranging from low-impact tasks (e.g. dressing) to high-impact physical activities (e.g. running) (Cella et al., 2010; Hung et al., 2011; Overbeek et al., 2015). Based on prior questions, PROMIS is using CAT algorithms to assign subsequent questions (Cella et al., 2010). With higher scores indicating better physical function, with a mean of 50 for the general United States population (Hung et al., 2011; Nota et al., 2016; Overbeek et al., 2015).

The STAI-6 was used for measuring anxiety. Originally, the STAI measuring state anxiety consists of 20 items (Marteau & Bekker, 1992). The six-item short form of the STAI-6 produces scores similar to those obtained using the full scale (Marteau & Bekker, 1992). It gives 6 statements: "I feel calm", "I am tense", "I feel upset", "I am relaxed", "I feel content", and "I am worried". The statements are answered on a 4-point Likert scale, from 1 "Not at all" to 4 "Very much". To calculate the final score, the scores of the 'positive' statements like calm, were turned around, so a score of 1 becomes a score of 4. Then, to compare with the original questionnaire, the score is divided by 6 and multiplied by 20, resulting in a score between 20 and 80, with a higher score indicating more anxiety.

All questionnaires were completed on a tablet via secure, HIPAA-compliant electronic platform: REDCap (Research Electronic Data Capture: a secure web-based application for building and managing online surveys and databases) (Harris et al., 2009).

Study Population

A total of 102 patients completed the questionnaires. The patients had a mean age of 50 ± 16 years old (range 18–83) and forty-eight (47%) patients were men (Appendix 1).

Statistical Analysis

The distributions of continuous variables and assumptions concerning normality were assessed to determine the appropriateness of the statistical tests. Descriptive statistics are presented as mean ± standard deviation (range) in case of normally distributed continuous variables and median (interquartile range) for non-normally distributed variables, and number (percentage) for discrete variables. Bivariate analyses were conducted to test the association of each explanatory variable with pain intensity and activity tolerance. We used Pearson and Spearman correlation coefficient for continuous variables, t-tests for dichotomous variables, and one-way analysis of variance (ANOVA) for categorical variables. Variables with $p < 0.10$ were included

in a multivariable linear regression model with pain intensity and activity tolerance. The regression coefficient (β) indicates the change in the value of a dependent variable corresponding to the unit change in the independent variable. The higher the absolute value of the coefficient, the stronger the effect of the relationship. There are no fixed cut off scores. Adjusted R-squared (R^2) values indicate the amount of variability in the dependent variable that the model accounts for. Semipartial R^2 expresses the specific variability of a given independent variable in the model. We considered $p < 0.05$ significant.

An a priori power analysis indicated that a sample of 92 subjects would provide 90% statistical power, with an expected moderate association (power 0.30) in bivariate analysis between anger and pain intensity, with alpha set at 0.05. To account for 10% of incomplete data, we aimed for a sample size of 101 patients.

Results

Factors Associated with Pain Intensity

In bivariate analysis, among other factors, anger was associated with pain intensity (*r* 0.23, $p = < 0.001$, Table 1). After bivariate analysis, we controlled for potential confounding in multivariable analysis and found greater pain intensity was associated with lower scores on the depression thermometer (β −0.28; 95% CI −0.47 to 0.09; $p = 0.004$; Semipartial R^2 0.04) and greater catastrophic thinking (β 0.36; 95% CI 0.25 to 0.47; $p < 0.001$; Semipartial R^2 0.20; Table 2), but not with anger (β 0.10; 95% CI −0.11 to 0.30; $p < 0.001$).

Factors Associated with Activity intolerance

After bivariate analysis (Table 3), we controlled for potential confounding in multivariable analysis and found retired in comparison with employed work-status (β −11.1; 95% CI −19.7 to −2.45; $p = 0.012$; Semipartial R^2 0.02) and greater symptoms of depression (β −2.86; 95% CI −4.32 to − 1.40; $p < 0.001$; Semipartial R^2 0.12; Table 4) were associated with greater activity intolerance. Greater symptoms of anger were not significantly associated with greater activity intolerance.

Discussion

The relationship of thoughts, emotions, and circumstances to symptom intensity and magnitude of limitations is increasingly well documented. The first aim of this study was to evince the association of anger with pain intensity and activity tolerance. Also, this study of patients with musculoskeletal illness used a different set of psychological measures to try to confirm known relationships.

Our results should be interpreted in light of some limitations. First, the findings are best applied to patients with a painful musculoskeletal illness or injury expected to last more than a month and may not be generalizable to patients with other (musculoskeletal) pathology. Second, there is a possibility of selection bias. The initial study intended to study the effectiveness of self-compassion exercises, but the second evaluation proved infeasible. People willing to participate in a clinical trial of self-compassion exercises may differ in important ways from the general population.

The lack of association of anger and activity intolerance is interesting because there is a consistent relationship between mood and thoughts, for example depression, with pain intensity and activity tolerance. (Arnow et al., 2006;

Table 1 Bivariate analyses of factors associated with pain intensity

Variables	Pain	*p* value
Age in years *(r)*	−0.02	0.87
Sex		
Women	5.2 ± 2.7	0.94
Men	5.2 ± 2.4	
Race/Ethnicity		
White	4.6 ± 2.4	**< 0.001**
Non-white	6.6 ± 2.5	
Marital status		
Married / Unmarried couple	5.2 ± 2.6	0.27
Divorced / Separated / Widowed	5.9 ± 2.5	
Single	4.6 ± 2.3	
Education		
High school or less	6.4 ± 2.8	**0.021**
2-year college	5.2 ± 3.1	
4-year college	4.3 ± 2.0	
Post-college graduate degree	5.0 ± 2.3	
Work status		
Employed	5.5 ± 2.5	0.18
Retired	4.4 ± 2.4	
Unemployed / Unable to work / Other	4.7 ± 3.2	
Emotion thermometer		
Anxiety *(r)*	0.44	**< 0.001**
Depression *(r)*	0.19	0.05
Anger *(r)*	0.34	**< 0.001**
PCS-4 *(r)*	0.65	**< 0.001**
PROMIS Physical Function *(r)*	−0.16	0.12
STAI-6 *(r)*	0.41	**< 0.001**

Bold indicates statistically significant difference; Pearson and Spearman correlation indicated by *r*; Continuous variables as mean ± standard deviation, unless otherwise indicated

PROMIS Patient-Reported Outcomes Measurement Information System, *PCS* Pain Catastrophizing Scale, *STAI* State-Trait Anxiety Inventory

Table 2 Multivariable linear regression analyses of factors associated with Pain Intensity

Dependent variables	Retained variables	Regression coefficient [β] (95% Confidence interval)	Standard error	*p* value	Semi-partial R^2	Adjusted R^2
Pain	Race					0.51
	White	Reference value				
	Non-white	0.83 (0.01 to 1.7)	0.43	0.054		
	Education					
	High school or less	Reference value				
	2-year college	−0.94 (−2.1 to 0.25)	−1.57	0.12		
	4-year college	−0.47 (−1.5 to 0.55)	−0.91	0.36		
	Post-college graduate degree	0.09 (−0.93 to 1.1)	−0.17	0.87		
	Emotion Thermometer					
	Anxiety *(r)*	0.13 (−0.05 to 0.32)	1.42	0.16		
	Depression *(r)*	−0.28 (−0.47 to 0.09)	−2.99	**0.004**	0.04	
	Anger *(r)*	0.10 (−0.11 to 0.30)	0.93	0.36		
	PCS-4 *(r)*	0.36 (0.25 to 0.47)	6.41	**< 0.001**	0.20	
	STAI-6 *(r)*	0.02 (−0.02 to 0.05)	1.03	0.31		

Bold indicates statistically significant difference; Only the semipartial R^2 of significant variables is displayed

PCS Pain Catastrophizing Scale, *STAI* State-Trait Anxiety Inventory

Bair et al., 2003; Briet et al., 2016; De Heer et al., 2014; Demyttenaere et al., 2007; Dunn et al., 2018; Gureje et al., 2008; Hayek et al., 2017; Reiter et al., 2018; Trief et al., 2006) Although there was a significant association between anger and pain intensity in bivariate analysis, in multivariable analysis the association was negative which suggests that anger is important, but not as important as psychological distress. Anger may just be one manifestation of distress.

The association between symptoms of depression and worse physical function in bivariate analysis is consistent with prior research (Arnow et al., 2006; Bair et al., 2003; Dunn et al., 2018; Trief et al., 2006). For example, in a study among 5807 patients in primary care, of the patients meeting criteria for an estimated diagnosis of major depression, 41% reported having disabling pain, compared to 10% of the patients that did not (Arnow et al., 2006). The association between retired work status and physical function can be explained by the fact these people are older in general. Although this study did not show a correlation between age and physical function, previous studies did (Briet et al., 2016; Reiter et al., 2018). For example, older patients with lateral ankle sprain did have significantly more limitations three weeks after the injury than younger patients (Briet et al., 2016).

The association between greater pain intensity and higher level of depression is also consistent with prior research. Previous research among different type of diseases found an association between greater pain intensity and greater symptoms of depression and greater catastrophic thinking. For example among patients with musculoskeletal pain as ankle and neck pain as well as chest pain in patients with coronary artery disease (Arnow et al., 2006; Bair et al., 2003; Briet et al., 2016; De Heer et al., 2014; Demyttenaere et al., 2007; Gureje et al., 2008; Hayek et al., 2017; Reiter et al., 2018; Sewell et al., 2018). The relationship with catastrophic thinking is particularly

Table 3 Bivariate analyses of factors associated with Activity Tolerance

Variables	PROMIS PF	*p* value
Age in years *(r)*	−0.15	0.12
Sex		
Women	31 ± 20	0.31
Men	35 ± 18	
Race/Ethnicity		
White	33 ± 20	0.96
Non-white	33 ± 18	
Marital status		
Married / Unmarried couple	36 ± 19	0.11
Divorced / Separated / Widowed	26 ± 20	
Single	31 ± 18	
Education		
High school or less	36 ± 19	0.75
2-year college	30 ± 20	
4-year college	33 ± 18	
Post-college graduate degree	31 ± 21	
Work status		
Employed	35 ± 19	**0.038**
Retired	23 ± 18	
Unemployed / Unable to work / Other	36 ± 17	
Pain *(r)*	−0.16	0.12
Emotion Thermometer		
Anxiety *(r)*	−0.16	0.12
Depression *(r)*	−0.43	**< 0.001**
Anger *(r)*	−0.13	0.18
PCS-4 *(r)*	−0.20	**0.043**
STAI-6 *(r)*	−0.12	0.24

Bold indicates statistically significant difference; Pearson and Spearman correlation indicated by *r*; Continuous variables as mean ± standard deviation, unless otherwise indicated

PROMIS Patient-Reported Outcomes Measurement Information System, *PF* Physical Functions, *PCS* Pain Catastrophizing Scale, *STAI* State-Trait Anxiety Inventory

strong and, notably, the full model accounted for half the variation in pain intensity with zero information about the site or severity of pathophysiology. For example, among 115 patients women with pelvic pain, catastrophic thinking was associated with pain levels (Sewell et al., 2018) and patients with a higher level of catastrophic thinking who had to undergo spine surgery, had significantly higher pain scores postoperatively (Dunn et al., 2018).

Anger emotions do not contribute independently to symptom intensity and activity intolerance in musculoskeletal illness. The consistent relationship between mood (e.g. symptoms of depression) and thoughts (e.g. catastrophic thinking) and pain intensity and activity tolerance is consistent with the biopsychosocial illness paradigm and is not unique to musculoskeletal illness. While the evidence for the biopsychosocial illness paradigm is increasing, consistent, and convincing, current management strategies continue to adhere more to the biomedical model of illness, thinking mostly of medical and surgical interventions to address pathophysiology. The attention of biopsychosocial illness can be limited to addressing psychological distress and cognitive bias. Future research can address incorporating noticing (diagnosis) of social and mental health opportunities, making them comfortable topics of conversation, and developing interventions to alleviate symptoms and improve physical function by cultivating elevated mood and healthier thoughts.

Table 4 Multivariable linear regression analyses of factors associated with Activity Tolerance

Dependent variable	Retained variables	Regression coefficient [β] (95% Confidence interval)	Standard error	P value	Semi-partial R^2	Adjusted R^2
PROMIS Physical Function	Work status					0.21
	Employed	Reference value				
	Retired	−11.1 (−19.7 to −2.45)	4.3	**0.012**	0.02	
	Unemployed / Unable to work / Other	−1.42 (−11.9 to 9.07)	5.3	0.78		
	Emotion Thermometer					
	Depression *(r)*	−2.86 (−4.32 to −1.40)	0.74	**< 0.001**	0.12	
	PCS-4 *(r)*	−0.06 (−0.95 to 0.84)	0.45	0.90		

Bold indicates statistically significant difference; Only the semipartial $R.^2$ of significant variables is displayed

PROMIS Patient-Reported Outcomes Measurement Information System, *PF* Physical Function, *PCS* Pain Catastrophizing Scale

Appendix 1

See Table 5.

Table 5 Patient and clinical characteristics

Variables	$N = 102$
Age in years	50 ± 16 (18–83)
Men	48 (47)
Race/Ethnicity	
White	74 (73)
Non-white	28 (27)
Marital status	
Married / Unmarried couple	59 (58)
Divorced / Separated / Widowed	19 (19)
Single	24 (24)
Education	
High school or less	27 (27)
2-year college	15 (15)
4-year college	31 (30)
Post-college graduate degree	29 (29)
Work status	
Employed	70 (69)
Retired	20 (20)
Unemployed / Unable to work / Other	12 (12)
Pain	5.2 ± 2.6 (0–10)
Emotion Thermometer	
Anxiety	4 (2–7)
Depression	2 (0–4)
Anger	1 (0–3)
PCS-4	6 (3–10)
PROMIS Physical Function	33 ± 19 (1–69)
STAI-6	40 (30–50)
Calm	3 (2–4)
Tense	2 (1–3)
Upset	1 (1–2)
Relaxed	3 (2–3)
Content	3 (2–4)
Worried	2 (1–2)

Continuous variables as mean ± standard deviation (range) or median (interquartile range [IQR]); Discrete variables as number (percentage)

PROMIS Patient-Reported Outcomes Measurement Information System, *PCS* Pain Catastrophizing Scale, *STAI* State-Trait Anxiety Inventory

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Data Availability Data is available on request.

Code Availability Not applicable.

Declarations

Conflict of interest Yvonne Versluijs, David Bandell, Joost Kortlever, David Ring declare that they have no conflict of interest. David Ring has or may receive payment or benefits from Skeletal Dynamics, Wright Medical for elbow implants, Deputy Editor for Clinical Orthopaedics and Related Research, Universities and Hospitals, Lawyers outside the submitted work.

Ethical Approval The institutional review board approved this study.

Human and Animal Rights This study has been approved by the appropriate ethics committee and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments.

Consent to Participate We granted a waiver of documentation of informed consent, as consent was indicated when the patients completed te questionnaires.

Consent for Publication Not applicable.

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