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The buffering role of positive affect on the association between pain intensity and pain related outcomes

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HIGHLIGHTS

- Positive affect moderated the association between pain and depression.
- Positive affect moderated the association between pain and negative affect.
- Interventions increasing positive affect may benefit chronic pain patients.

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ABSTRACT

Objectives: Chronic pain is a significant problem worldwide and is associated with significant elevations in negative affect, depressive symptoms, sleep problems, and physical dysfunction. Positive affect could potentially buffer the impact of pain on patient functioning. If it does, then positive affect could be directly targeted in treatment to benefit individuals with chronic pain. The purpose of this study was to test for such moderating effects.
Methods: This was a cross-sectional study, we administered measures of pain intensity, depressive symptoms, sleep problems, pain interference, and positive and negative affect to 100 individuals with chronic back or knee pain in a single face-to-face assessment session.
Results: The associations between pain intensity and negative affect, and between pain intensity and depressive symptoms were moderated by positive affect. This moderation effect was explained by the fact that participants with low positive affect evidenced strong associations between pain intensity and both depression and negative affect; participants with high positive affect, on the other hand, evidenced weak and non-significant associations between pain intensity and both depression and negative affect. Positive affect did not moderate the associations between pain intensity and either sleep problems or pain interference.
Conclusion: The findings are consistent with the possibility that positive affect may buffer the impact of pain intensity on negative affect and depressive symptoms. Longitudinal and experimental research is needed to determine the potential benefits of treatments that increase positive affect on negative affect and depressive symptoms in chronic pain populations.
Implications: The study findings suggest the possibility that "positive psychology" interventions which increase positive affect could benefit individuals with chronic pain by reducing the impact of pain on negative outcomes. Research to test this possibility is warranted.

1. Introduction

Chronic pain is a significant problem worldwide, with research showing a median prevalence rate of 15% in adult populations [1]. Moreover, chronic pain becomes more common as people age [2], so its overall prevalence is expected to increase as the population ages. Chronic pain is also often accompanied by negative affect [3], depression [3,4], sleep problems [5–7], and physical dysfunction [8,9]. Although chronic pain, negative affect, depression, sleep problems and physical dysfunction can have individual negative impacts, when occurring together, their combined impact on overall suffering is likely amplified [10,11]. Thus, identifying factors that may diminish the known connections between pain and pain-related outcomes remains an important goal.

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One factor that could potentially buffer the effects of chronic pain on negative affect, depression, sleep problems and physical dysfunction is global positive affect. Positive affect reflects the extent to which individuals feel energetic, enthusiastic, cheerful, active, and alert [12]. Some investigators have conceptualized positive affect as an important psychological resource that could be enhanced and serve as a resource to buffer the negative effects of stressful situations [13,14]. For example, Fredrickson's broaden-and-build theory proposes that positive affect broadens people's mind sets which builds enduring personal resources that can function as reserves to be drawn on later to manage future threats [15]. This suggests the possibility that people with chronic pain who experience more positive emotions may be more resilient than people with less positive emotions when experiencing pain. Thus, positive affect could "buffer" the negative impact of pain, such that those with more positive affect would show weaker associations between pain and negative outcomes, such as depression, sleep difficulties, and pain interference.

Pain researchers have begun to examine the potential roles of positive affect in adjustment to chronic pain. For example, research shows that measures of positive affect are associated negatively with pain intensity [16–18], negative affect (particularly so during times of high pain) [19], depression [20,21], sleep dysfunction [22], and physical dysfunction [23–26] in individuals with chronic pain. While these results are consistent with the possibility that positive affect could have direct benefits on pain-related outcomes, few studies have investigated the *moderating* (or buffering) role of positive affect on the relationship between pain intensity and pain-related outcomes; that is, whether positive affect buffers the negative impact of pain.

We were able to identify only five studies that have addressed this issue. Three studies found that, among patients with osteoarthritis, rheumatoid arthritis and fibromyalgia, positive affect buffered the effects of pain on negative affect [18,21,27]. However, in a separate study involving patients with fibromyalgia, positive affect failed to moderate the associations between pain and negative affect [28]. In another study, and among patients with knee osteoarthritis, those with high positive affect and high pain reported similar physical activity levels as those without pain, and these two groups had significantly higher physical activity levels than those with low positive affect and high pain [29]. However, to our knowledge no one has yet examined the moderating impact of positive affect on the associations between pain and depression, sleep quality, and pain interference.

The aim of this study was to fill this knowledge gap by testing for a moderating role of positive affect between pain intensity and four domains (negative affect, depressive symptoms, sleep problems, and pain interference) in a sample of individuals with chronic pain. Given the available research findings, cited previously, we hypothesized that positive affect would buffer the negative effects of pain intensity.

2. Materials and methods

2.1. Design

We used a cross-sectional design to test the study hypotheses. Individuals with chronic pain completed a questionnaire assessing their depressive symptoms, sleep problems, pain interference, pain intensity, and positive and negative affect in a single assessment session.

2.2. Participants

A convenience sample of 101 individuals with chronic pain were recruited through referrals from the National University Hospital's (NUH) Orthopedic Spine Clinic, Anesthesia Pain Clinic and the Rheumatology Clinic. Participants were patients of the referring physicians attending their medical appointments. Doctors referred participants according to the following inclusion and exclusion criteria. Inclusion criteria: (1) have a diagnosis by the referring physician of either primarily chronic low back or chronic knee pain (pain lasting for ≥3 months); (2) report an average low back/knee average pain intensity of 4 or greater on a 0–10 Numerical Rating Scale; (3) be at least 21 years old; and (4) be able read, speak, and write in English. Exclusion criteria were: (1) evidence of cognitive impairments (e.g., dementia, intellectual disability) that would interfere with the ability to provide informed consent or complete the study measures; and (2) severe psychiatric or psychological symptoms that would interfere with participation.

2.3. Procedures

Potential participants were identified by clinic physicians and then screened again for eligibility by a research assistant stationed temporarily at the clinic. The research assistant described the study procedures to the potential participant, and interested and eligible participants were asked to sign an informed consent form. Participants were then asked to complete a packet of paper-and-pencil questionnaires assessing depressive symptoms, sleep problems, pain interference, pain intensity, and positive and negative affect. Upon completion, participants were paid 50 Singapore dollars (i.e., about 37 US dollars or 33 euros). Ethical approval was obtained from the National Healthcare Group Domain Specific Review Board.

2.4. Measures

2.4.1. Average pain intensity

Participants were asked to rate their average pain over the last 7 days using the Numerical Rating Scale (0 = "*No pain*", 10 = "*The most intense pain imaginable*"). Numerical Ratings Scales of pain intensity have a great deal of evidence supporting their reliability and validity [30].

2.4.2. Positive and negative affect

Positive and negative affect was measured using the Positive and Negative Affect Scale (PANAS; [12]). The PANAS consists of two 10-item lists of positive and negative affect descriptors (e.g., "*Excited*", "*Strong*", "*Guilty*", "*Afraid*"). Respondents were asked to indicate the extent that they experienced each affect descriptor during the past few weeks on 5-point Likert scales (from "*Very slightly or not at all*" to "*Extremely*"). Scores for the two scales assessing positive and negative affect can range from 10 to 50, with higher scores representing higher levels of each affect domain. A significant level of stability over an 8-week time frame and extensive validity data (e.g., factorial and external validity) for this scale have been reported [12]. The internal consistency of the PANAS Positive and Negative Affect scales in the current sample (Cronbach's alphas) were 0.88 and 0.90, respectively, indicating adequate to excellent reliability.

2.4.3. Depressive symptoms

Depressive symptoms were assessed using the Patient Health Questionnaire-9 (PHQ-9; [31]). The PHQ-9 asked respondents to rate the frequency the nine symptoms of depression over the past 2 weeks on 4-point Likert scales ("*Not at all*" to "*Nearly every day*") that reflect the nine DSM-IV criteria for major depression [32]. PHQ-9 scores can range from 0 to 27 with higher scores representing greater symptom severity. This scale has been widely used in clinical and research settings and thus much evidence supporting its validity is available [33–35]. Also, a strong correlation between Beck's Depression Inventory II and the PHQ-9 has been reported,

$r = 0.84$, $p < 0.001$ suggesting good convergent validity [36]. The reliability (internal consistency) of the PHQ-9 scale in the current sample was 0.92, indicating excellent reliability.

2.4.4. Sleep problems

Sleep problems were assessed using the Medical Outcome Study (MOS) Sleep Scale [37]. This scale consists of 12 questions, of which 9 can be used to create a Sleep Problem Index Score (SPI), with a possible range of 0–100 [37]. Higher scores represent more sleep problems. With the MOS Sleep Scale, respondents are asked to rate the frequency or time (depending on the item) of sleep problems during the past 4 weeks. Among these 9 questions, 8 questions ask the respondent to indicate the frequency of the sleep problem item on 6-point Likert scales ("*All of the time*" to "*None of the time*") and 1 question asks the respondent to indicate the time it usually takes them to fall asleep on a 5-point Likert scale ("*0–15 minutes*" to "*More than 60 minutes*"). Each response is transformed to a possible range of 0–100 and the average is used to determine the Sleep Problem Index (SPI). The SPI has been found to be reliable in individuals with chronic pain with internal consistency coefficient estimates of 0.72 or higher [38–40]. In the current study, the internal consistency was 0.69, indicating questionable reliability for this measure in our sample. Because this level of reliability was inconsistent with (and lower than) that found in other studies with individuals with chronic pain, we examined the items more carefully, and found that the elimination of the item asking about the time it takes the respondent to fall asleep would increase the reliability of the scale to 0.82. We therefore used the scale score derived without this item for all subsequent analyses.

2.4.5. Pain interference

Pain interference was measured using the four-item Pain Interference Short Form of the Patient-Reported Outcomes Measurement Information System (PROMIS) [41]. The items selected asked participants to rate the magnitude of pain interference with day-to-day activities, work around the home, ability to participate in social activities, and enjoyment of life. Each question is rated on a 5-point Likert scale ("*Not at all*" to "*Very much*"), and the items are summed to create a raw score that can range from 4 to 20. Like all PROMIS measures, the Pain Interference raw score can be converted to a standardized *t*-score representing the domain of interest, with a mean of 50 and standard deviation of 10 in the normative sample [41]. The internal consistency of the 4-item scale used here was 0.90, indicating excellent reliability.

2.5. Data analysis

The number and percent (for categorical variables) or means and standard deviations (for continuous variables) of the demographic and study variables were first computed for descriptive purposes. Next, we computed the inter-correlations among the study variables. We then performed a series of four hierarchical regression analyses to test the study hypotheses. In these analyses, pain intensity was entered in the first step. Next, PANAS positive affect scores was entered. Finally, the pain intensity × positive affect interaction term was then entered in the third step. A significant interaction effect indicates that a moderation effect is present [42]. To help understand the nature of any significant moderation effects that emerged, we planned to perform a median split on the positive affect scores, and then compute Pearson's correlations between pain intensity and the criterion variable involved for each level of positive affect. Bonferroni correction was applied to control for alpha inflation associated with multiple tests; that is, a *p*-value of <0.0125 (0.05/4) was used to determine significance.

Table 1
Demographic and descriptive variables for the study sample.

	Mean (SD)	Number (percent)
Age (years)	48.27 (15.85)	
Sex		
Men		53 (53%)
Women		47 (47%)
Race/ethnicity		
Chinese		64 (64%)
Malay		10 (10%)
Indian		20 (20%)
Other race/ethnicity		6 (6%)
Marital status		
Married, living together		59 (59%)
Married, living separately		3 (3%)
Divorced		6 (6%)
Single		28 (28%)
Widow/widower		4 (4%)
Employment status		
Full time		50 (50%)
Part time		6 (6%)
Retired		18 (18%)
Homemaker		11 (11%)
Unemployed		3 (3%)
Not working due to pain		12 (12%)

3. Results

3.1. Sample characteristics

A total of 101 participants were enrolled in the study. One of these was excluded from the analyses, as this participant's questionnaire had a substantial amount of missing data. The characteristics of the 100 remaining participants in the study are listed in Table 1. Means and standard deviations of the study variables in the sample are presented in Table 2. As can be seen, the sample consisted of patients with moderate pain intensity [43] and mild depression [31]. Consistent with the sample being recruited from medical clinics that treat patients with pain, they endorsed relatively high levels of pain interference (approximately one SD above normative values) on the PROMIS pain interference measure [41]. As there are no established cut-off values for the PANAS or MOS sleep scales, it is not possible to classify the participants with respect to their affect or sleep quality.

3.2. Regression and correlational analysis

Inter-correlations among study variables in the sample are presented in Table 3. As can be seen, in the sample as a whole, pain intensity was associated moderately to strongly with pain interference and depression. It was also associated moderately with sleep problems and negative affect, but showed a very weak (and non-significant) association with positive affect. Negative affect was associated moderately to strongly with all of the study variables. Positive affect was less consistently associated with the other study

Table 2
Means and standard deviations of the study variables.

	Mean (SD)
Pain intensity (0–10 NRS)	5.38 (2.07)
Positive affect (PANAS)	28.22 (7.86)
Negative affect (PANAS)	19.76 (7.82)
Depressive symptoms (PHQ-9)	7.20 (6.74)
Sleep problems (SPI)	40.76 (24.17)
Pain interference (PROMIS)	60.29 (7.31)

Note: NRS, Numerical Rating Scale; PANAS, Positive and Negative Affect Schedule; PHQ-9, Patient Health Questionnaire-9; SPI, Sleep Problem Index; PROMIS, Patient-Reported Outcomes Measurement Information System.

Table 3
Inter-correlations among study variables.

	Pain intensity	Pain interference	Depression	Sleep problems	Positive affect	Negative affect
Pain intensity (NRS)	1	0.51**	0.46**	0.40**	0.04	0.28**
Pain interference (PROMIS)		1	0.44**	0.35**	−0.15	0.27**
Depression (PHQ-9)			1	0.66**	−0.34**	0.70**
Sleep problems (SPI)				1	−0.27**	0.53**
Positive affect (PANAS)					1	−0.25**
Negative affect (PANAS)						1

Note: NRS, Numerical Rating Scale; PANAS, Positive and Negative Affect Schedule; PHQ-9, Patient Health Questionnaire-9; SPI, Sleep Problem Index; PROMIS, Patient-Reported Outcomes Measurement Information System Pain Interference.
** $p < 0.0125$.

variables, but did demonstrate weak to moderate negative associations with sleep problems, depression, and negative affect.

Table 4 presents the results of the regression analysis using the measures of negative affect, depressive symptoms, sleep problems, and pain interference as criterion variables, pain intensity as the predictor, and positive affect as the potential moderator. Using negative affect as the criterion variable, the findings show a direct positive effect of pain intensity on negative affect in the first step ($t = 2.88$, $p < 0.0125$), as well as a direct negative effect of positive affect over and above pain intensity on negative affect in the second step ($t = -2.81$, $p < 0.0125$). In the third step, the pain intensity × positive affect interaction term was also statistically significant ($F(1, 96) = 11.11$, $p < 0.0125$) and explained 9% of the variance in negative affect, over and above pain intensity and positive affect. Among those with high positive affect, the association between pain intensity and negative affect was virtually nonexistent and not statistically significant ($r = 0.001$, p = NS). However, among those with low positive affect, the association between pain intensity and negative affect was large and statistically significant ($r = 0.54$, $p < 0.0125$). This interaction is depicted in Fig. 1.

With depressive symptoms as the criterion variable, the findings show a direct positive effect of pain intensity on depressive symptoms in the first step ($t = 5.10$, $p < 0.0125$), as well as a direct negative effect of positive affect over and above pain intensity on depressive symptoms in the second step ($t = -4.32$, $p < 0.0125$). In the third step, the pain intensity × positive affect interaction term was also statistically significant ($F(1, 96) = 10.66$, $p < 0.0125$) and explained 7% of the variance in depressive symptoms, over and above pain intensity and positive affect. Among those with high positive affect, the association between pain intensity and depressive symptoms was weak to moderate and not statistically significant ($r = 0.26$, p = NS). However, among those with low positive affect, the association between pain intensity and depressive symptoms was large and statistically significant ($r = 0.69$, $p < 0.001$). This interaction is depicted in Fig. 2.

With sleep problems as the criterion variable, there was a direct positive effect of pain intensity on sleep problems in the first step ($t = 4.36$, $p < 0.0125$), as well as a direct negative effect of positive affect over and above pain intensity on sleep problems in the second step ($t = -3.25$, $p < 0.0125$). However, the pain intensity × positive affect interaction term did not contribute significantly to the prediction of sleep problems, when pain intensity and positive affect was controlled. It is of note that the results were essentially the same when the full scale (without elimination of any questions to increase reliability) was used.

Similarly, when pain interference was the criterion variable, we found a direct positive effect of pain intensity on pain interference in the first step ($t = 5.85$, $p < 0.0125$). However, neither positive affect nor the pain intensity × positive affect interaction term contributed significantly to the prediction of pain interference, when pain intensity was controlled.

4. Discussion

This study's findings provided some support for our hypotheses that positive affect buffers the effects of pain on function in individuals with chronic pain. Two (of four) significant moderation effects were observed, showing that more positive affect weakens the association between pain intensity and negative affect, and depression. These findings have important clinical implications.

4.1. Buffering effects regarding negative affect and depressive symptoms

Consistent with past research, we found that positive affect buffered the impact of pain on negative affect, and depressive

Table 4
Results of the regression analyses with positive affect as moderator.

Step	R^2	R^2 change	F change	β	t-Value
Criterion variable: negative affect					
1. Pain intensity	0.08	0.08	8.29**	1.05	2.88**
2. Positive affect	0.15	0.07	7.89**	−0.26	−2.81**
3. Pain intensity × positive affect	0.24	0.09	11.11**	−0.14	−3.33**
Criterion variable: depressive symptoms (PHQ-9)					
1. Pain intensity	0.21	0.21	26.00**	1.49	5.10**
2. Positive affect	0.34	0.13	18.64**	−0.31	−4.32**
3. Pain intensity × positive affect	0.41	0.07	10.66**	−0.11	−3.27**
Criterion variable: sleep problems (SPI)					
1. Pain intensity	0.16	0.16	19.05**	4.00	4.36**
2. Positive affect	0.25	0.08	10.55**	−0.76	−3.25**
3. Pain intensity × positive affect	0.27	0.02	3.07	−0.19	−1.75
Criterion variable: pain interference (PROMIS pain interference)					
1. Pain intensity	0.26	0.26	34.20**	1.79	5.85**
2. Positive affect	0.29	0.03	3.91	−0.16	−1.98
3. Pain intensity × positive affect	0.30	0.01	1.69	0.05	1.30

** $p < 0.0125$.

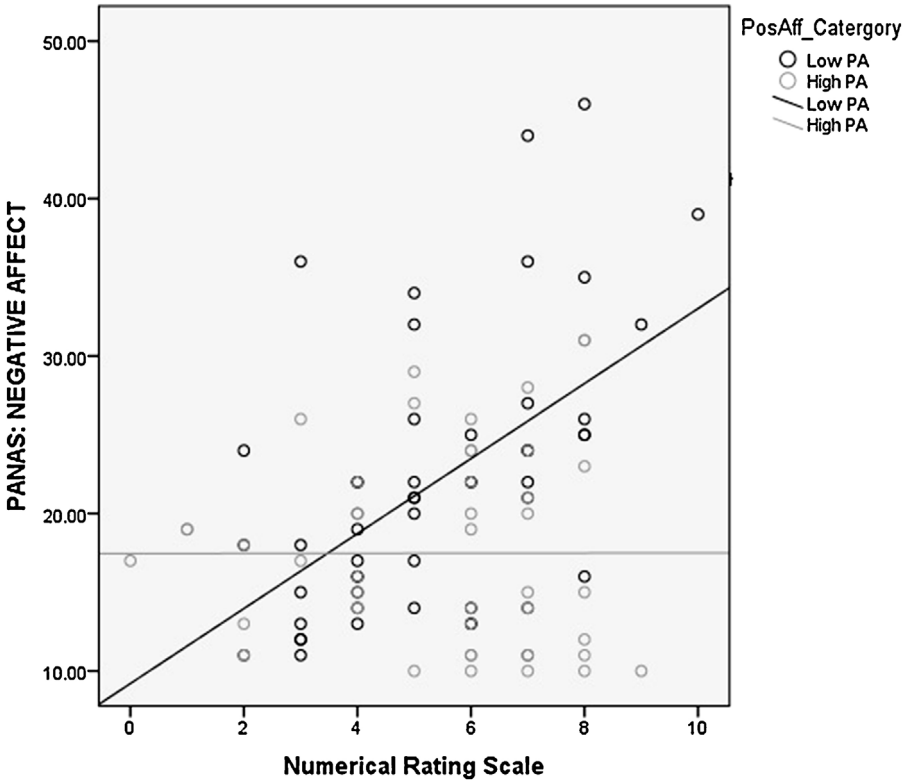

Fig. 1. Associations of pain with negative affect for different levels of positive affect.

symptoms [18,21,27]. The results from this and past studies suggest that positive affect may be thought of as a resource that could facilitate greater resilience during episodes of increased pain intensity. The resilient effect of positive affect may have resulted from the rise in the person's well-being, through changes in their cognitive appraisals of self-efficacy, through reframing of pain beliefs, through their own pain coping efforts, or through a boost in affective resources as proposed by Fredrickson's "broaden and build"

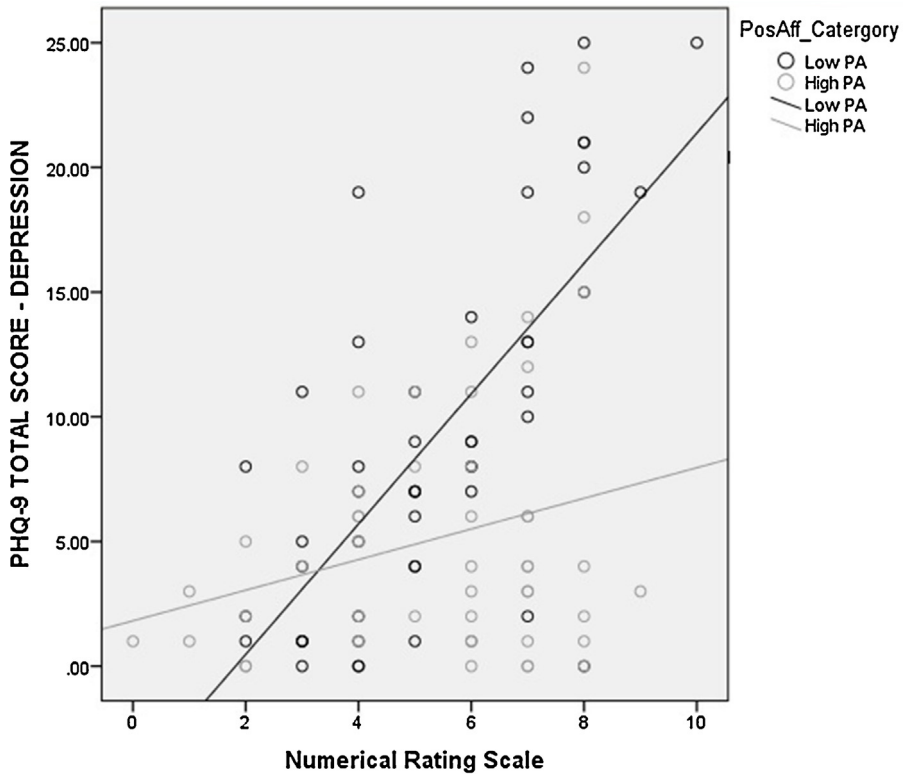

Fig. 2. Associations of pain with depressive symptoms for different levels of positive affect.

model [13]. It is important to note that the cross sectional nature of the data from the current study precludes us from being able to draw causal conclusions regarding these associations; it could be possible, for example, that positive affect moderates the effects of depressive symptoms and negative affect on pain intensity. Thus, further research is needed to determine if changes in positive affect increase patients' abilities to manage chronic pain, and if so, to identify the mechanisms by which positive affect has this protective effect.

4.2. Lack of buffering effects regarding sleep quality and pain interference

Our hypotheses regarding the buffering effects of positive and negative affect on the associations between pain and both sleep quality and pain interferences were not supported. This was unexpected, as positive affect has been previously found to act as a buffer in a domain related to pain interference (physical activity) [29]. The null findings from our study may have been due to limited power in the current analyses related to the sample size, and the need to control for alpha inflation due to multiple statistical tests. However, it may also be the case that positive affect moderates the effect of pain only on outcome domains more closely linked to pain affect (e.g., negative affect and depressive symptoms). If this were the case, we might also anticipate that positive affect would also moderate the effects of pain on measures of other domains of psychological functioning, including positive function domains such as optimism and life satisfaction.

4.3. Possible clinical implications

The current findings have potential clinical implications. Previous research suggests that positive affect can attenuate pain [44–46], and may buffer the impact of pain on negative affect [18,21,27]. Our findings add to this research, and are consistent with the possibility (but do not prove) that increasing positive affect in individuals with chronic pain could potentially buffer the negative impact of pain on depressive symptoms. Psychosocial treatments for chronic pain have largely focused on reducing negative affect (e.g., CBT interventions), our findings suggest the potential that "positive psychology" interventions [45] may be of benefit to individuals with chronic pain by reducing the impact of pain on negative outcomes. Research to test this possibility is warranted.

4.4. Study limitations

There are several limitations of this study that should be considered when interpreting the results. First, the sample size was relatively small. While it is large enough to maintain an appropriate sample to predictor ratio in the regression equations, the relatively low sample size did not allow us to include covariates in the same equations. It would therefore be useful to examine the importance of positive affect as a moderator in larger samples if possible. Second, the use of a convenience sample may have biased the sample in some way that we do not know. As a result, we cannot be sure that the sample is representative of the population of individuals with chronic back and knee pain. Research examining these associations in additional samples would help to determine the generalizability of the findings. Third, our sample consisted primarily of patients with chronic low back or knee pain. Therefore, it is not known if our findings would generalize to populations with other forms of pain. This also supports the need to replicate the findings in additional chronic pain samples. Fourth, as positive affect has been found to be correlated with negative affect (particularly so during episodes of increased pain) and depression [19–21], there may be a conceptual overlap limiting the usefulness of positive affect as an explanatory construct for the variations in the associations between pain intensity with negative affect and depression. Fifth, our sample consisted mainly of participants with mild depression, which may have produced a floor effect (restriction of range in depression scores), limiting our ability to detect moderation effects. However, the fact that a moderation effect for positive affect emerged despite this supports the robustness of this effect. Whether or not this moderation effect would be even stronger in samples who endorse a wider range of depression scores will need to be determined in future research. Finally, as already mentioned, the cross sectional design of this study precludes our ability to draw of causal conclusions regarding the role that positive affect plays as a moderator. Experimental research designed to determine if treatments that target and impact positive affect produce changes in the association between pain and negative affect and depression is warranted.

4.5. Conclusions

Despite the study's limitations, it provides one of the few empirical evaluations of the moderating impact of positive affect on the associations between pain intensity and a number of key domains of pain and function in a sample of individuals with chronic pain. The findings suggest a moderating role for positive affect with respect to the impact of pain on negative affect and depressive symptoms. Future research will be needed to confirm the effectiveness of interventions that target positive affect to evaluate the causal nature of the associations found.

Ethical issues

Informed consent was obtained from all participants. Ethical approval was obtained from the National Healthcare Group Domain Specific Review Board.

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Conflicts of interest

None of the authors has any potential conflict of interest with the paper.

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