# Does Pain Self-efficacy Moderate the Association of Psychosocial Factors With the Health-related Quality of Life of Patients Scheduled for Lumbar Spine Surgery?

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**Objectives:** This study aimed to investigate the moderating role of pain self-efficacy (SE) in the association of multiple psychosocial factors with the health-related quality of life (HRQOL) of patients scheduled for lumbar spine surgery.

**Methods:** This cross-sectional study analyzed 258 patients scheduled for lumbar spine surgery. Data were collected preoperatively using validated tools to measure HRQOL, pain , pain intensity, anxiety and depression, fear of movement, pain catastrophizing, and central sensitization symptoms. Hierarchical multiple regression analysis and simple slope tests were performed to assess the associations of psychosocial factors with HRQOL and the moderating effects of pain SE on these relationships.

**Results:** The final model explained 43.8% of the HRQOL variance. Significant interactions were noted between pain SE and pain intensity ($P < 0.01$), anxiety ($P < 0.01$), fear of movement ($P < 0.05$), and pain catastrophizing ($P < 0.01$). The negative associations of these psychological factors with HRQOL were significant only in the low pain self-efficacy group, whereas these associations were attenuated to nonsignificant levels in the high pain SE group.

**Discussion:** In this cross-sectional study, different associations between psychosocial factors and HRQOL were observed based on pain SE levels in patients awaiting lumbar spine surgery. This finding suggests that pain SE assessment may help identify high-risk patients who need additional preoperative psychological support.

**Key Words:** pain self-efficacy, Psychological risk factors, preoperative assessment, prehabilitation, spine surgery

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Over the past 2 decades, the number of lumbar spine surgeries has increased worldwide, including in the United States and Japan.[1,2] Although surgery is often effective, 20% to 40% of patients still experience persistent pain and reduced health-related quality of life (HRQOL) postoperatively.[3] Psychosocial factors, such as anxiety, depression, pain catastrophizing, and fear of movement, have received increased attention as potential determinants of this variability in postoperative outcomes.[4–7] These factors are explained within the fear-avoidance model, which describes a maladaptive cycle that increases pain-related fear and avoidance behaviors, ultimately leading to functional disability and reduced HRQOL.[8]

Prehabilitation programs have been developed to address these psychosocial factors preoperatively. However, a recent systematic review by Janssen et al[9] found that cognitive-behavioral therapy interventions provide no additional benefit over usual care, although the evidence level was low. One possible explanation for this limited effectiveness is the insufficient consideration of individual differences in psychological responses.[10] Enhancing intervention efficacy depends on identifying which specific patient subgroups might benefit from targeted psychological support and which protective mechanisms represent modifiable therapeutic targets.[11] Understanding how these protective resources moderate the impact of risk factors at baseline provides the theoretical foundation necessary to develop such tailored preoperative approaches.

Pain self-efficacy (SE)—confidence in one's ability to perform activities despite pain—has emerged as a potentially important protective factor in chronic pain management.[12–14] Studies in nonsurgical cases have shown that higher SE levels may buffer the negative effects of catastrophic thinking and fear-avoidance behaviors on pain chronification and functional decline.[15–18] However, previous research has typically examined the moderating effect of pain SE on individual psychological factors in isolation. This methodological approach is limited because psychological risk factors rarely exist independently but rather coexist within the fear-avoidance model, potentially creating a cumulative psychological burden that influences outcomes more strongly than any single factor in isolation.[19,20] Furthermore, these potential protective relationships have yet to be investigated within the unique clinical context of patients scheduled for lumbar spine surgery, a population with distinct treatment expectations and clinical characteristics.

Therefore, this study aimed to investigate the moderating role of pain self-efficacy in the relationships between multiple psychological factors and HRQOL among patients scheduled for lumbar spine surgery. Based on previous findings in nonsurgical populations, we hypothesized that higher pain self-efficacy levels would attenuate the negative effects of psychological factors on HRQOL. By identifying these moderating relationships at baseline, this cross-sectional study provides valuable insights for preoperative risk assessment and establishes a crucial foundation for

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determining which protective mechanisms effectively mitigate psychological risk factors. This understanding will guide the selection of potential intervention targets before investing resources in longitudinal research.

## MATERIALS AND METHODS

### Study Design and Ethical Considerations

This was a cross-sectional study conducted to examine the associations between psychosocial factors and HRQOL, and to investigate the moderating effects of pain SE in patients scheduled for lumbar spine surgery. All assessments were completed on the day before surgery. The study protocol was approved by the Ethics Committee of our hospital, and the research was conducted in accordance with the Declaration of Helsinki. Written informed consent was obtained from all participants after they received a detailed explanation of the study procedures.

### Sample Size

The sample size was determined using G*Power version 3.1.[21] Based on previous studies on the moderating effects of pain SE,[15,18] a small-to-moderate effect size ($f^2=0.10$) was assumed because the interaction effects are generally more difficult to detect than the main effects. For a hierarchical multiple regression analysis with 17 independent variables (main effects and interaction terms), the power level was set at 0.80 and the alpha level at 0.05, following the standard recommendations for behavioral research. The calculation indicated that at least 212 participants would be required to detect the hypothesized effect. To ensure robust findings and account for potential dropouts or missing data, our goal was to recruit at least 250 participants.

### Participants

The study enrolled patients with lumbar spinal stenosis or lumbar disk herniation who were scheduled for spine fusion surgery or decompression procedures at our institution between April 2021 and March 2023. Patients were eligible if they were at least 20 years old and could read and write Japanese. Exclusion criteria included lumbar vertebrae fracture or dislocation, spinal tumors, previous lumbar spine surgery, severe psychiatric disorders such as schizophrenia, bipolar disorder, or severe depressive disorder requiring hospitalization or intensive psychiatric care, cognitive impairments including dementia, and neurological conditions such as multiple sclerosis or cerebrovascular incidents. Patients with missing questionnaire responses were also excluded to ensure data integrity. To ensure comprehensive representation, all patients who met the eligibility criteria during the study were invited to participate in the study. All participants received standard preoperative pain management at our institution. This typically included NSAIDs, acetaminophen, and muscle relaxants as needed for pain control. Pregabalin or gabapentin was prescribed for patients with neuropathic symptoms, and tramadol was occasionally used for severe pain.

### Measures

The following patient-reported outcome measures were evaluated on the day before surgery for all participants: (1) EuroQol 5-dimensions (EQ-5D) for HRQOL, (2) 4-item pain intensity measure (P4) for pain intensity, (3) shortened version of the pain SE questionnaire (PSEQ) for pain SEself-efficacy, (4) Hospital Anxiety and Depression Scale (HADS) for anxiety and depression, (5) shortened version of the Tampa Scale for Kinesiophobia (TSK) for fear of movement, (6) shortened version of the pain catastrophizing scale (PCS) for pain catastrophizing, and (7) shortened version of the Central Sensitization Inventory (CSI) for central sensitization (CS)-related symptoms. Age, sex, body mass index, and diagnosis were extracted from the medical records.

#### Health-related Quality of Life

HRQOL was assessed using the Japanese version of the EQ-5D.[22] The EQ-5D consists of 5 dimensions: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. Each dimension is rated on a 3-level scale, reflecting no problems, some problems, or extreme problems. Scores range from 0 (equivalent to death) to 1 (full health), with higher scores indicating better health-related quality of life. The Japanese version of the EQ-5D has demonstrated strong reliability and validity, with Cronbach alpha reported at 0.87.[22]

#### Pain Intensity

Pain intensity was assessed using the P4 pain scale.[23] The P4 consists of 4 items that assess pain intensity in the morning, afternoon, evening, and with activity over the past 2 days. Each item is rated on an 11-point numeric rating scale from 0 (no pain) to 10 (pain as bad as it can be). Total scores range from 0 to 40, with higher scores indicating greater pain intensity. The P4 was selected because it provides comprehensive pain intensity assessment while maintaining brevity, allowing us to minimize participant burden within our extensive psychosocial assessment battery. The P4 has demonstrated good internal consistency (Cronbach alpha = 0.90) and test-retest reliability (ICC = 0.78), with superior reliability and greater sensitivity to change compared with single-item Numeric Pain Rating Scales.[23]

#### Pain Self-Efficacy

Pain SEy was assessed using the 2-item shortened Japanese version of the PSEQ.[24] Each item is rated on a 7-point scale from 0 (not at all confident) to 6 (completely confident), yielding a total score ranging from 0 to 12. Higher total scores indicate greater degrees of pain self-efficacy in functioning despite pain. Previous research has shown good internal consistency for the shortened Japanese version of the PSEQ (Cronbach alpha = 0.81).[24]

#### Anxiety and Depression

Anxiety and depressive symptoms were evaluated using the Japanese version of the (HADS).[25] The HADS consists of 2 subscales: anxiety (HADS-A) and depression (HADS-D), each containing 7 items. Each item is rated on a 4-point scale from 0 to 3, yielding total scores ranging from 0 to 21 for each subscale. Higher scores indicate greater severity of anxiety or depressive symptoms. The 2-factor structure of the Japanese version of the HADS has been confirmed, with good internal consistency for both the anxiety (Cronbach alpha = 0.81) and depression subscales (Cronbach alpha = 0.76).[25]

#### Fear of Movement

Fear of movement was measured using the 11-item shortened Japanese version of the TSK.[26] Each item is rated on a scale from 1 (strongly disagree) to 4 (strongly agree), with total scores ranging from 11 to 44. Higher total scores reflect greater fear of movement. The shortened Japanese version of the TSK has demonstrated established reliability with excellent internal consistency (Cronbach alpha = 0.919) in previous research.[26]

### Pain Catastrophizing

Pain catastrophizing was assessed using the 6-item shortened Japanese version of the PCS.[27] Each item is rated on a scale from 0 (not at all) to 4 (all the time), yielding a total score ranging from 0 to 24. Higher total scores indicate greater degrees of pain catastrophizing. Previous research has demonstrated satisfactory reliability and internal consistency for the shortened Japanese version of the PCS (Cronbach alpha = 0.90).[27]

### Central Sensitization-related Symptoms

In this study, the shortened Japanese version of the CSI[28] was used as a supplementary psychological measure. Although this scale was originally developed to assess CS-related symptoms, recent meta-analytic evidence[29] indicates that it primarily captures psychological constructs rather than directly measuring neurophysiological sensitization mechanisms. The shortened Japanese version of the CSI consists of 5 domains: (1) emotional distress, (2) urological and general symptoms, (3) muscle symptoms, (4) headache and jaw symptoms, and (5) sleep disturbance.[28] The shortened version comprises 9 items, each rated on a scale from 0 (none) to 4 (always), yielding a total score ranging from 0 to 36. A greater total score signifies increased severity of CS-related symptoms. Previous research has demonstrated robust internal consistency for this shortened version (Cronbach alpha = 0.80).[28]

### Statistical Analyses

All statistical analyses were performed using HAD version 18,[30] a psychostatistical analysis application operating on Microsoft Excel. Descriptive statistics were calculated for participant characteristics, with continuous data expressed as means (SD) and categorical data as counts (percentages). To evaluate the potential multicollinearity among the variables included in the regression models, a correlation analysis was performed, and the variance inflation factors (VIF) were calculated. Correlations with values higher than r = 0.70 were indicative of potential multicollinearity, and VIF values > 5 were deemed problematic. To further mitigate multicollinearity, all explanatory variables were centered before the analysis. Hierarchical multiple regression analyses were performed to examine both the direct associations between psychosocial factors and HRQOL and the potential moderating effects of pain SE on these relationships. This hierarchical approach incorporates interaction terms and is widely recognized as a robust method for examining moderating effects in health research.[31–33] Analyses were performed using complete-case data, including only participants with no missing values on variables included in the final regression models. The dependent variable was HRQOL measured by the EQ-5D. First, demographic variables (age, sex, BMI, and diagnosis) and pain intensity (P4) were entered as covariates. Second, anxiety (HADS-A), depression (HADS-D), fear of movement (TSK), PCS, and CS-related symptoms (CSI) were incorporated to evaluate their unique associations with HRQOL. Third, pain SE (PSEQ) and its interaction terms with P4, HADS-A, HADS-D, TSK, PCS, and CSI were included to investigate the moderating role of pain SE. For significant interactions, simple slope analyses were performed to examine the moderating effects more specifically. Following the established methodology for moderation analysis,[31] the conditional associations between psychological factors and HRQOL were calculated at low (–1 SD) and high (+1 SD) pain SE levels. Significance was set at $P < 0.05$ for all analyses.

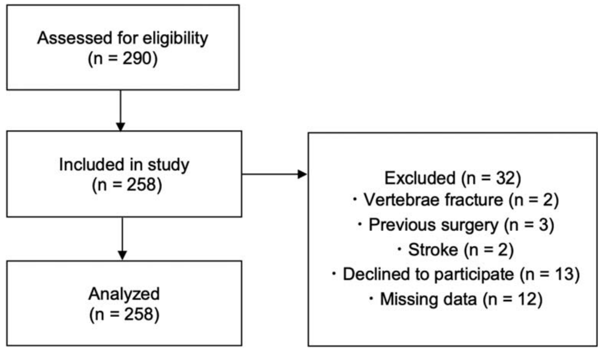


**FIGURE 1.** Flow diagram of participant selection.

## RESULTS

### Participant Characteristics

Overall, 290 participants met the eligibility criteria, of whom 258 were included in the final analysis after excluding 32 participants (12 for missing data and 20 for other reasons; Fig. 1). A comparison of basic demographic characteristics (age, sex, and diagnosis) between the 12 participants excluded due to missing data and the 258 included participants revealed no significant differences ($P > 0.05$ for all comparisons). The study population comprised 111 females (43.0%) and 147 males (57.0%). Participants had a mean (SD) age of 62.85 (14.91) years and a mean (SD) body mass index of 24.14 (4.50) kg/m². Most participants were diagnosed with lumbar spinal stenosis (n = 216, 83.7%), and the remaining participants had lumbar disk herniation (n = 42, 16.3%). The baseline characteristics of the study population are detailed in Table 1.

### Hierarchical Multiple Regression Analysis

A correlation analysis among the independent variables revealed low to moderate correlations, ranging from r = 0.10 to 0.65, with no correlations exceeding the threshold of r = 0.70 (Appendix 1, Supplemental Digital Content 1, http://links.lww.com/CJP/B195). The VIF values ranged from 1.0 to 3.3, confirming the absence of significant multicollinearity. These findings ensure that the regression coefficients in the hierarchical multiple regression model can be estimated without the influence of multicollinearity. Table 2 presents the results of the hierarchical multiple regression analysis of the associations of psychosocial factors with HRQOL and the moderating effects of pain SE. In step 1, demographic variables and pain intensity were incorporated as independent variables. These variables accounted for 20.5% of the HRQOL variance ($\Delta R^2 = 0.205$, $P < 0.01$). Among these, pain intensity (B = −0.006 [95% CI: −0.009 to −0.005], $P < 0.01$) demonstrated a significant association. In step 2, the psychosocial factors were included as independent variables. The inclusion of these variables contributed an additional 16.8% to the HRQOL variance

**TABLE 1.** Characteristics of the Study Population (n = 258)

| Variable | |
|---|---|
| Age (y), mean (SD) | 62.85 (14.91) |
| Sex (n of female, %) | 111 (43.0) |
| BMI, mean (SD) | 24.14 (4.50) |
| Diagnosis, n (%) | |
| Lumbar spinal stenosis | 216 (83.70) |
| Lumbar disk herniation | 42 (16.30) |
| Scheduled surgical procedure, n (%) | |
| TLIF | 140 (54.3) |
| XLIF | 40 (15.5) |
| Laminoplasty | 46 (17.8) |
| MD | 32 (12.4) |
| EQ-5D (0–1), mean (SD) | 0.57 (0.15) |
| P4 (0–40), mean (SD) | 20.46 (10.00) |
| PSEQ (0–12), mean (SD) | 6.67 (6.67) |
| HADS-A (0–21), mean (SD) | 5.85 (3.61) |
| HADS-D (0–21), mean (SD) | 5.78 (3.56) |
| TSK (11–44), mean (SD) | 27.10 (5.33) |
| PCS (0–24), mean (SD) | 14.75 (5.80) |
| CSI (0–36), mean (SD) | 12.55 (6.20) |

BMI indicates body mass index; CSI, Central Sensitization Inventory; EQ-5D, EuroQol 5-dimensions; HADS-A, Hospital Anxiety and Depression Scale for Anxiety; HADS-D, Hospital Anxiety and Depression Scale for Depression; MD, microendoscopic discectomy; P4, 4-item pain intensity measure; PCS, Pain Catastrophizing Scale; PSEQ, PainSself-Efficacy Questionnaire; TLIF, Transforaminal Lumbar Interbody Fusion; TSK, Tampa Scale for Kinesiophobia; XLIF, extreme lateral interbody fusion.

($\Delta R^2$ = 0.168, $P < 0.01$). Significant associations were observed for pain SE (B = 0.015 [95% CI: 0.010-0.021], $P < 0.01$), fear of movement (B = −0.006 [95% CI: −0.009 to −0.002], $P < 0.01$), and pain catastrophizing (B = −0.005 [95% CI: −0.008 to −0.001], $P < 0.01$). In step 3, interaction terms between pain self-efficacy and other variables were introduced, accounting for an additional 6.5% of HRQOL variance ($\Delta R^2$ = 0.065, $P < 0.01$). Significant associations were found for pain intensity (B = −0.006 [95% CI: −0.007 to −0.004], $P < 0.01$), pain self-efficacy (B = 0.016 [95% CI: 0.010-0.021], $P < 0.01$), fear of movement (B = −0.006 [95% CI: −0.010 to −0.003], $P < 0.01$), and pain catastrophizing (B = −0.004 [95% CI: −0.007 to −0.001], $P < 0.05$). In addition, significant interaction effects were observed between pain self-efficacy and pain intensity (B = 0.001 [95% CI: 0.000-0.001], $P < 0.01$), anxiety (B = 0.004 [95% CI: 0.002-0.006], $P < 0.01$), fear of movement (B = 0.001 [95% CI: 0.000-0.002], $P < 0.05$), and pain catastrophizing (B = 0.002 [95% CI: 0.001-0.003], $P < 0.01$). This final model explained 43.8% of the HRQOL variance.

**TABLE 2.** Hierarchical Multiple Regression Analysis Examining Associations Between Psychosocial Factors and Health-related Quality of Life (n = 258)

| | Step 1 (B) | Step 2 (B) | Step 3 (B) |
|---|---|---|---|
| Age | −0.001 | 0.000 | 0.000 |
| Sex | −0.017 | −0.019 | −0.013 |
| BMI | 0.000 | 0.001 | 0.001 |
| Diagnosis | 0.000 | 0.001 | 0.001 |
| P4 | −0.006** | −0.006** | −0.006** |
| PSEQ | | 0.015** | 0.016** |
| HADS-A | | −0.003 | −0.002 |
| HADS-D | | −0.006 | −0.004 |
| TSK | | −0.006** | −0.006** |
| PCS | | −0.005** | −0.004* |
| CSI | | 0.002 | 0.002 |
| P4*PSEQ | | | 0.001** |
| HADS-A*PSEQ | | | 0.004** |
| HADS-D*PSEQ | | | −0.001 |
| TSK*PSEQ | | | 0.001* |
| PCS*PSEQ | | | 0.002** |
| CSI*PSEQ | | | −0.001 |
| $R^2$ | 0.205** | 0.373** | 0.438** |
| $\Delta R2$ | 0.205 | 0.168 | 0.065 |

*$P < 0.05$.
**$P < 0.01$.
BMI indicates body mass index; CSI, Central Sensitization Inventory; EQ-5D, EuroQol 5-dimensions; HADS-A, Hospital Anxiety and Depression Scale for Anxiety; HADS-D, Hospital Anxiety and Depression Scale for Depression; P4, 4-item pain intensity measure; PCS, Pain Catastrophizing Scale; PSEQ, Pain Self-Efficacy Questionnaire; TSK, Tampa Scale for Kinesiophobia.

## Simple Slope Tests

Simple slope tests were performed to examine the moderating effect of pain SE on the relationship between psychosocial factors and HRQOL, focusing on factors that exhibited significant interaction effects on the hierarchical multiple regression analysis. These analyses aimed to identify whether the strength of these associations differed between participants with low pain SE (PSEQ-1 SD) and high pain SE (PSEQ +1 SD). Table 3 presents the detailed results of the simple slope test, showing the EQ-5D scores and regression coefficients for each psychosocial factor stratified by pain SE levels. Figures 2–5 illustrate the interaction effects for pain intensity, anxiety, fear of movement, and pain catastrophizing, respectively. For pain intensity, the negative association with HRQOL was stronger in the low pain self-efficacy group (B = −0.008 [95% CI: −0.010 to −0.006], $P < 0.001$) than in the high pain self-efficacy group (B = −0.004 [95% CI: −0.006 to −0.002], $P$ = 0.001). For anxiety, the negative association with HRQOL was significant in the low pain SE group (B = −0.012 [95% CI: −0.020 to −0.005], $P$ = 0.002), whereas the association was weaker and not significant in the high pain SE group (B = 0.008 [95% CI: −0.001 to 0.016], $P$ = 0.068). For fear of movement, the negative association with HRQOL was significant in the low pain SE group (B = −0.010 [95% CI: −0.015 to −0.005], $P < 0.001$), whereas the association was weaker and not significant in the high pain SE group (B = −0.003 [95% CI: −0.007 to 0.002], $P$ = 0.204). Lastly, for pain catastrophizing, the negative association with HRQOL was significant in the low pain SE group (B = −0.008 [95% CI: −0.012 to −0.04], $P < 0.001$); however, the association was attenuated and not significant in the high pain SE group (B = −0.001 [95% CI: −0.006 to 0.004], $P$ = 0.714).

# DISCUSSION

This cross-sectional study found that the associations between multiple psychosocial factors and HRQOLs differed based on pain SE levels in patients scheduled for lumbar spine surgery. Specifically, higher pain self-efficacy levels showed a direct positive association with HRQOL and were associated with weaker negative relationships between of pain intensity, anxiety, fear of movement, and pain catastrophizing with HRQOL. These findings suggests that among preoperative patients with spinal disorders, higher pain SE is associated with a more favorable psychosocial profile—a novel observation in this surgical population.

**TABLE 3.** Simple Slope Analysis Examining the Relationship Between Psychosocial Factors and Health-related Quality of life Stratified by Pain Self-efficacy levels (n = 258)

| Factor | PSEQ level | EQ-5D Score at low factor level (-1 SD) | EQ-5D Score at high factor level (+1 SD) | B | *P* |
|---|---|---|---|---|---|
| P4 | Low (−1 SD) | 0.617 | 0.461 | −0.008 | < 0.001 |
| | High (+1 SD) | 0.665 | 0.587 | −0.004 | 0.001 |
| HADS-A | Low (−1 SD) | 0.584 | 0.494 | −0.012 | 0.002 |
| | High (+1 SD) | 0.598 | 0.654 | 0.008 | 0.068 |
| TSK | Low (−1 SD) | 0.591 | 0.487 | −0.01 | < 0.001 |
| | High (+1 SD) | 0.641 | 0.611 | −0.003 | 0.204 |
| PCS | Low (−1 SD) | 0.587 | 0.491 | −0.008 | < 0.001 |
| | High (+1 SD) | 0.621 | 0.631 | −0.001 | 0.714 |

EQ-5D indicates EuroQol 5-dimensions; HADS-A, Hospital Anxiety and Depression Scale for Anxiety; P4, 4-item pain intensity measure; PCS, Pain Catastrophizing Scale; PSEQ, Pain SelfEfficacy Questionnaire; TSK, Tampa Scale for Kinesiophobia.

Our findings contribute to understanding the fear-avoidance model in spinal patients by highlighting pain SE as a potential moderating factor in the psychological mechanisms. The traditional fear-avoidance framework[8] describes a progression where pain catastrophizing leads to fear, which in turn promotes avoidance behaviors and ultimately functional decline, but does not fully address the observed variability in outcomes among patients with similar catastrophizing thoughts and fear-avoidance beliefs. Our results show that psychological factors such as pain catastrophizing and fear of movement are associated differently with HRQOL depending on pain SE levels: stronger negative associations appear in patients with low pain self-efficacy, while these associations are weaker in those with high self-efficacy. These observations suggests that the fear-avoidance model might be better considered as a conditional process rather than a universal pathway—a perspective that aligns with previous cross-sectional findings in chronic pain populations.[18,34] Examining these relationships in surgical candidates adds important context for understanding how fear-avoidance processes may operate differently in this specific clinical population.

Notably, this study revealed the differences in associations based on pain self-efficacy levels across multiple psychological domains, including pain intensity, pain catastrophizing, fear of movement, and anxiety. The addition of interaction terms to our model yielded a significant increase in the explained variance ($\Delta R^2 = 0.065$, $P < 0.01$), which exceeds the threshold of $\Delta R^2 > 0.02$–$0.03$ proposed by Zhonglin and Baojuan[35] as meaningful for moderation effects in behavioral research, highlighting both its significance and practical relevance. While previous research has typically examined the moderating effect of pain SE on individual psychological factors in isolation, our study adopted a more comprehensive approach by concurrently analyzing pain SE's moderating effects across multiple psychological variables within the fear-avoidance model. This approach offers a more integrative understanding of how protective factors function within the complex psychological processes that patients experience, thereby extending beyond the conventional approach of previous studies that focused solely on individual variables.

The findings of this study have important implications for clinical practice, particularly in preoperative risk

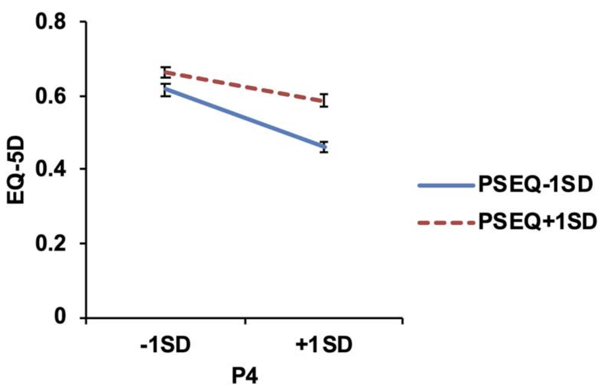


**FIGURE 2.** Interaction graph illustrating the relationship between pain intensity (P4) and health-related quality of life (EQ-5D) for individuals with low and high pain self-efficacy. The *x*-axis represents P4 scores at ±1 SD, with higher values (+1 SD) indicating greater pain intensity. The *y*-axis represents EQ-5D scores, with higher values reflecting better quality of life. The steeper slope for the low pain self-efficacy group (PSEQ –1 SD, B = –0.008, *P* < 0.001) indicates a stronger negative association between P4 and EQ-5D compared with the high pain self-efficacy group (PSEQ +1 SD, B = –0.004, *P* = 0.001). EQ-5D, EuroQol 5-dimensions; P4, 4-item pain intensity measure; PSEQ, Pain self-efficacy questionnaire.

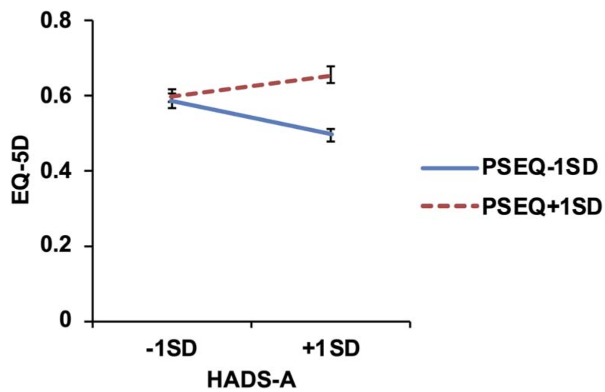


**FIGURE 3.** Interaction graph illustrating the relationship between anxiety (HADS-A) and health-related quality of life (EQ-5D) for individuals with low and high pain self-efficacy. The *x*-axis represents HADS-A scores at ±1 SD, with higher values (+1 SD) indicating greater levels of anxiety. The *y*-axis represents EQ-5D scores, with higher values reflecting better quality of life. The steeper slope for the low pain self-efficacy group (PSEQ –1 SD, B = –0.012, *P* = 0.002) indicates a stronger negative association between HADS-A and EQ-5D compared with the high pain self-efficacy group (PSEQ +1 SD, B = 0.008, *P* = 0.068). EQ-5D, EuroQol 5-dimensions; HADS-A, Hospital Anxiety and Depression Scale for Anxiety; PSEQ, Pain Self-Efficacy Questionnaire.

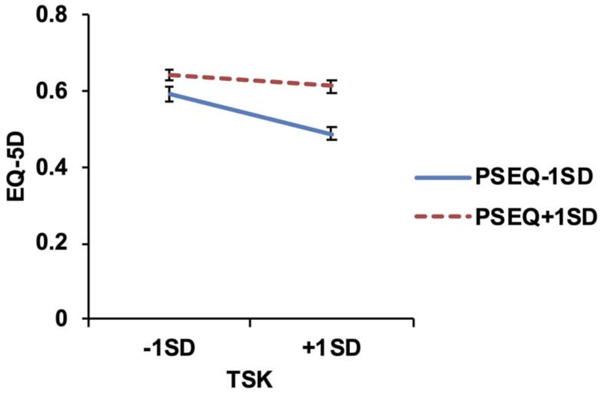


**FIGURE 4.** Interaction graph illustrating the relationship between kinesiophobia (TSK) and Health-Related Quality Of Life (EQ-5D) for individuals with low and high pain self-efficacy. The *x*-axis represents TSK scores at ±1 SD, with higher values (+1 SD) indicating greater levels of kinesiophobia. The *y*-axis represents EQ-5D scores, with higher values reflecting better quality of life. The steeper slope for the low pain self-efficacy group (PSEQ −1 SD, B = −0.010, $P < 0.001$) indicates a stronger negative association between TSK and EQ-5D compared with the high pain self-efficacy group (PSEQ +1 SD, B = −0.003, $P = 0.204$). EQ-5D indicates EuroQol 5-dimensions; TSK, Tampa Scale for Kinesiophobia; PSEQ, Pain Self-Efficacy Questionnaire.

stratification and intervention planning in lumbar spine surgery. Although a study showed that patients with high psychological risk factors often benefit from prehabilitation programs,[11] the present study suggests a more targeted approach based on pain SE assessment. To identify those most likely to benefit from intensive psychological support, patients should be screened for both pain SE and psychological risk factors. Specifically, the combination of low pain SE and high psychological distress levels may help identify patients requiring more comprehensive

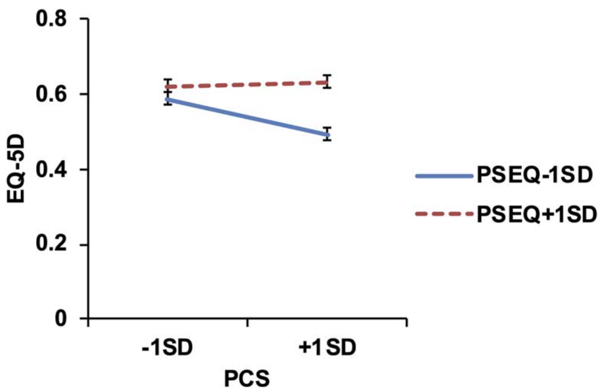


**FIGURE 5.** Interaction graph illustrating the relationship between catastrophizing (PCS) and health-related quality of life (EQ-5D) for individuals with low and high pain self-efficacy. The *x*-axis represents PCS scores at ±1 SD, with higher values (+1 SD) indicating greater levels of catastrophizing. The *y*-axis represents EQ-5D scores, with higher values reflecting better quality of life. The steeper slope for the low pain self-efficacy group (PSEQ −1 SD, B = −0.008, $P < 0.001$) indicates a stronger negative association between PCS and EQ-5D compared with the high pain self-efficacy group (PSEQ +1 SD, B = −0.001, $P = 0.714$). EQ-5D, EuroQol 5-dimensions; PCS, Pain Catastrophizing Scale; PSEQ, Pain Self-Efficacy Questionnaire.

intervention. Moreover, addressing pain SE might be considered in treatment approaches in preoperative interventions, potentially offering a more efficient approach to addressing multiple psychological risk factors simultaneously. Recent evidence supports several effective strategies to enhance pain SE, including exercise interventions, pain neuroscience education, cognitive- behavioral techniques, multicomponent interventions combining physical and psychological approaches, and digital self-management tools.[36–38] These evidence-based strategies could be incorporated into preoperative programs and tailored to individual patient needs. Future randomized controlled trials are warranted to evaluate whether stratified preoperative interventions based on pain SE levels can effectively prevent poor surgical outcomes and reduce the risk of the development of chronic postoperative pain.

Several limitations should be considered when interpreting the results of this study. First, the cross-sectional design precludes definitive causal inferences about the relationships among pain SE, psychological factors, and HRQOL. However, this design was appropriate for our initial investigation of potential protective mechanisms in the preoperative period because it allowed for the examination of complex moderation effects across multiple psychological domains in a well-defined clinical population. Moreover, the results align with theoretical frameworks and results of previous longitudinal studies in populations with chronic pain,[12,39] providing a foundation for future intervention studies. Second, the 2-item version of the PSEQ was used rather than the original 10-item version. Although the 2-item version has demonstrated acceptable internal consistency (Cronbach $\alpha = 0.81$),[24] it may not sufficiently capture the multidimensional nature of pain self-efficacy. Consequently, this limitation could influence the robustness of the observed interaction effects, particularly if the important self-efficacy dimensions were not fully assessed. Third, participants were recruited from a single institution, potentially limiting the generalizability of the results. Therefore, further longitudinal studies across multiple centers are needed to validate these relationships and examine how pain self-efficacy influences surgical outcomes over time.

## CONCLUSIONS

This cross-sectional study found that the associations between multiple psychosocial factors and HRQOLs differed based on pain SE levels in patients scheduled for lumbar spine surgery. Higher pain SE levels were associated with weaker negative relationships between pain intensity, anxiety, fear of movement, and pain catastrophizing with HRQOL. These patterns indicate that the role of pain SE in preoperative assessment warrants further investigation in comprehensive treatment approaches, though the cross-sectional nature of our study prevents us from establishing causality or treatment efficacy. Future prospective studies and randomized controlled trials should examine whether interventions targeting pain SE can effectively improve surgical outcomes, particularly for patients identified with the combination of low pain SE and high psychosocial risk factors. These findings provide a rationale for future studies investigating whether interventions targeting pain SE might improve surgical outcomes.



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## REFERENCES


1. Martin BI, Mirza SK, Spina N, et al. Trends in lumbar fusion procedure rates and associated hospital costs for degenerative spinal diseases in the United States, 2004 to 2015. *Spine (Phila Pa 1976)*. 2019;44:369–376.
2. Kobayashi K, Ando K, Nishida Y, et al. Epidemiological trends in spine surgery over 10 years in a multicenter database. *Eur Spine J*. 2018;27:1698–1703.
3. Hébert JJ, Abraham E, Wedderkopp N, et al. Preoperative factors predict postoperative trajectories of pain and disability following surgery for degenerative lumbar spinal stenosis. *Spine (Phila Pa 1976)*. 2020;45:E1421–e1430.
4. Javeed S, Benedict B, Yakdan S, et al. Implications of preoperative depression for lumbar spine surgery outcomes: a systematic review and meta-analysis. *JAMA Netw Open*. 2024;7:e2348565.
5. Zhao Z, Li J, Zhang R, et al. The prognostic value of fear-avoidance beliefs on postoperative pain and dysfunction for lumbar degenerative disk disease: a meta-analysis. *Int J Rehabil Res*. 2023;46:3–13.
6. Alodaibi FA, Minick KI, Fritz JM. Do preoperative fear avoidance model factors predict outcomes after lumbar disc herniation surgery? A systematic review. *Chiropr Man Therap*. 2013;21:40.
7. Ashida Y, Miki T, Kondo Y, et al. Influence of radiological factors, psychosocial factors, and central sensitization-related symptoms on clinical symptoms in patients with lumbar spinal canal stenosis. *J Back Musculoskelet Rehabil*. 2024;37:369–377.
8. Vlaeyen JWS, Linton SJ. Fear-avoidance and its consequences in chronic musculoskeletal pain: a state of the art. *Pain*. 2000;85:317–332.
9. Janssen ERC, Punt IM, Clemens MJ, et al. Current prehabilitation programs do not improve the postoperative outcomes of patients scheduled for lumbar spine surgery: a systematic review with meta-analysis. *J Orthop Sports Phys Ther*. 2021;51:103–114.
10. Fors M, Öberg B, Lindbäck Y, et al. What mediates treatment effects in a presurgery physiotherapy treatment in surgical candidates with degenerative lumbar spine disorders? A mediation and conditional process analysis of the PREPARE Randomized Controlled Trial. *Clin J Pain*. 2021;37:168–176.
11. Lotzke H, Brisby H, Gutke A, et al. A person-centered prehabilitation program based on cognitive-behavioral physical therapy for patients scheduled for lumbar fusion surgery: a randomized controlled trial. *Phys Ther*. 2019;99:1069–1088.
12. Jackson T, Wang Y, Wang Y, et al. Self-efficacy and chronic pain outcomes: a meta-analytic review. *J Pain*. 2014;15:800–814.
13. Nicholas MK. The Pain Self-Efficacy Questionnaire: taking pain into account. *Eur J Pain*. 2007;11:153–163.
14. Coronado RA, Robinette PE, Henry AL, et al. Bouncing back after lumbar spine surgery: early postoperative resilience is associated with 12-month physical function, pain interference, social participation, and disability. *Spine J*. 2021;21:55–63.
15. Cheng ST, Leung CMC, Chan KL, et al. The relationship of self-efficacy to catastrophizing and depressive symptoms in community-dwelling older adults with chronic pain: a moderated mediation model. *PLoS One*. 2018;13:e0203964.
16. Woby SR, Urmston M, Watson PJ. Self-efficacy mediates the relation between pain-related fear and outcome in chronic low back pain patients. *Eur J Pain*. 2007;11:711–718.
17. Varela AJ, Van Asselt KW. The relationship between psychosocial factors and reported disability: the role of pain self-efficacy. *BMC Musculoskelet Disord*. 2022;23:21.
18. Kardash L, Wall CL, Flack M, et al. The role of pain self-efficacy and pain catastrophising in the relationship between chronic pain and depression: a moderated mediation model. *PLoS One*. 2024;19:e0303775.
19. Wideman TH, Sullivan MJ. Development of a cumulative psychosocial factor index for problematic recovery following work-related musculoskeletal injuries. *Phys Ther*. 2012;92:58–68.
20. Cholewicki J, Breen A, Popovich JM Jr., et al. Can biomechanics research lead to more effective treatment of low back pain? A point-counterpoint debate. *J Orthop Sports Phys Ther*. 2019;49:425–436.
21. Faul F, Erdfelder E, Lang AG, et al. G*Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behav Res Methods*. 2007;39:175–191.
22. Shiroiwa T, Ikeda S, Noto S, et al. Comparison of value set based on DCE and/or TTO data: scoring for EQ-5D-5L Health States in Japan. *Value Health*. 2016;19:648–654.
23. Spadoni GF, Stratford PW, Solomon PE, et al. The evaluation of change in pain intensity: a comparison of the P4 and single-item numeric pain rating scales. *J Orthop Sports Phys Ther*. 2004;34:187–193.
24. Adachi T, Enomoto K, Yamada K, et al. Evaluating the psychometric properties of two-item and four-item short forms of the Japanese Pain Self-Efficacy Questionnaire: a cross-sectional study. *J Anesth*. 2019;33:58–66.
25. Matsudaira T, Igarashi H, Kikuchi H, et al. Factor structure of the Hospital Anxiety and Depression Scale in Japanese psychiatric outpatient and student populations. *Health Qual Life Outcomes*. 2009;7:42.
26. Kikuchi N, Matsudaira K, Sawada T, et al. Psychometric properties of the Japanese version of the Tampa Scale for Kinesiophobia (TSK-J) in patients with whiplash neck injury pain and/or low back pain. *J Orthop Sci*. 2015;20:985–992.
27. Nishigami T, Mibu A, Tanaka K, et al. Psychometric properties of the Japanese version of short forms of the Pain Catastrophizing Scale in participants with musculoskeletal pain: A cross-sectional study. *J Orthop Sci*. 2017;22:351–356.
28. Nishigami T, Tanaka K, Mibu A, et al. Development and psychometric properties of short form of Central Sensitization Inventory in participants with musculoskeletal pain: a cross-sectional study. *PLoS One*. 2018;13:e0200152.
29. Adams GR, Gandhi W, Harrison R, et al. Do "central sensitization" questionnaires reflect measures of nociceptive sensitization or psychological constructs? A systematic review and meta-analyses. *Pain*. 2023;164:1222–1239.
30. Shimizu H. An introduction to the statistical free software HAD: suggestions to improve teaching, learning and practice data analysis. *J Media*. 2016;1:59–73.
31. Murphy KR, Aguinis H. Reporting interaction effects: visualization, effect size, and interpretation. *J Manag*. 2022;48:2159–2166.
32. Kondo Y, Higuchi D, Miki T, et al. Influence of pain self-efficacy and gender on disability in postoperative cervical myelopathy. *Pain Manag Nurs*. 2023;24:335–341.
33. Zhou X, Yang X-j, Chen S-y, et al. Relieving anxiety and depression symptoms through promoting organizational identity and mitigating family-work conflict among medical professionals in digital leadership. *BMC Public Health*. 2024;24:3563.
34. Karkkola P, Sinikallio S, Flink N, et al. Pain self-efficacy moderates the association between pain and somatization in a community sample. *Scand J Pain*. 2019;19:101–108.
35. Zhonglin W, Baojuan Y. Different methods for testing moderated mediation models: competitors or backups? *Acta Psychologica Sinica*. 2014;46:714–726.
36. Martinez-Calderon J, Flores-Cortes M, Morales-Asencio JM, et al. Which interventions enhance pain self-efficacy in people with chronic musculoskeletal pain? A systematic review with meta-analysis of randomized controlled trials, including over 12 000 participants. *J Orthop Sports Phys Ther*. 2020;50:418–430.
37. Rondon-Ramos A, Martinez-Calderon J, Diaz-Cerrillo JL, et al. Pain neuroscience education plus usual care is more effective than usual care alone to improve self-efficacy beliefs in people with chronic musculoskeletal pain: a non-randomized controlled trial. *J Clin Med*. 2020;9:2195.
38. Rasmussen CDN, Sandal LF, Holtermann A, et al. Effect of a smartphone self-management digital support system for low-back pain (selfBACK) among workers with high physical work demands—secondary analysis of a randomized controlled trial. *Scand J Work Environ Health*. 2024;50:613–621.
39. Hee SW, Patel S, Sandhu H, et al. Does pain self-efficacy predict, moderate or mediate outcomes in people with chronic headache; an exploratory analysis of the CHESS trial. *J Headache Pain*. 2024;25:77.


 

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