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Differences in the Relationships Among Catastrophic Cognition, Negative Emotions and Physical and Psychological Quality of Life in Patients with Traumatic Orthopedic Injuries

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Abstract

Background: There is a complex relationship between PC, negative emotions (anxiety and depression), and Quality of Life (QoL) in patients with Traumatic Orthopedic Injuries (TOIs), and these values may alter QoL independently but through several mechanisms. The above issues are not yet clear in patients with TOIs. Therefore, our aim was to investigate the associations among Pain Catastrophizing (PC), anxiety, depression and QoL in patients and to further explore the underlying mechanisms of these associations.

Methods: The study was a survey study. We used a convenience sampling method and recruited participants with TOIs in China (N=204).

Results: (i) Among the negative psychological factors, PC is the strongest negative predictor of physical QoL in patients with TOIs, followed by depression ($P < 0.05$). (ii) Anxiety and depression have a stronger impact on psychological QoL than does PC when PC and negative emotions coexist ($P < 0.05$). (iii) Pain-related fear acts as an intermediary in the link between PC and both physical and psychological QoL (effect = 2.06, 95% CI = 0.43 to 3.86, effect = 1.84, 95% CI = 0.002 to 3.91), with anxiety playing a mediating role in the relationship between PC and psychological QoL in patients with TOIs (effect = -1.11, 95% CI = - 2.43 to - 0.10).

Conclusions: To improve QoL, clinical staff should assess TOI patients' catastrophic cognitive and affective factors before surgery to identify and screen those at high risk of physical and psychological QoL impairment for treatment.

Keywords: Quality of life; Psychological care; Traumatic orthopedic injuries; Pain catastrophizing; Affective factors

Introduction

Quality of Life (QoL), which includes physical ability, social participation and mental health, is an important indicator of a patient's health [1]. Despite the use of objective markers of surgical success, patients with Traumatic Orthopedic Injuries (TOIs) reported being dissatisfied with improvements in QoL outcomes. Previous studies have reported that approximately 24.72% of individuals with TOI suffer from diminished physical capabilities postsurgery [2], 59.09% experience reduced self-care capabilities [3], and as many as 80% endure acute pain [4,5]. Moreover, patients with TOIs may be in social isolation due to loss of work and some indispensable life activities [6]. All of these factors (postoperative physical function, acute pain, impaired ability to perform activities of daily living, and delayed return to work) may lead to a deterioration in QoL. As a result, the QoL of patients with TOIs may be more severely impaired than that of other populations. Consequently, comprehending and enhancing QoL is deemed essential for alleviating symptoms, providing care, and rehabilitating patients with TOI. Psychological factors are closely related to the QoL of patients and have received attention from healthcare professionals in recent years [7-9]. A large body of research has shown the contributions of cognitive factors, such as Pain Catastrophizing (PC)

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[10,11], to individual QoL. PC is a cognitive process conceived as the helpless tendency to exaggerate and ruminate on actual or anticipated experiences of pain [10]. PC is related to affective disturbance and increased pain intensity, thereby negatively affecting physical function recovery [12], and may be a strong predictor of QoL in patients with TOI. Second, mental health symptoms, with a focus on anxiety and depression [13,14], have long been associated with poor disease coping strategies and clinical outcomes in patients [11,15]. Patients with TOIs can experience high levels of negative emotions, the most common of which are anxiety and depression.

Approximately 53.17% and 51.59% of TOI patients reported experiencing anxiety and depression, respectively [14]. Increased levels of anxiety and depression are associated with symptom burden and poorer sleep quality [15,16], which can lead to poor treatment outcomes, all of which can also negatively impact QoL for patients with TOI. Owing to the high incidence of anxiety and depression among TOI patients during the perioperative period, as well as the associated health problems, it is necessary to focus on anxiety and depression.

Although previous studies have also demonstrated a link between PC, anxiety, depression, and QoL in patients with TOIs [11,12,14], there is still a gap in evidence. First, the relationships among cognition appraisal factors (e.g., PC), emotional factors (anxiety, depression) and QoL are complex in patients with TOI. PC, anxiety, and depression may independently influence QoL in patients with TOIs [17,18]. In addition, while negative cognitive and emotional factors (e.g., anxiety or depression) may independently affect QoL in patients with TOI, PC and negative affective factors (anxiety, depression) may coexist in individuals [19], and both are associated with poorer QoL than if they are alone [20,21]. In the case of negative emotions, the influence of PC on QoL can increase dramatically, leading to cumulative effects. Furthermore, the differences in the coexistence of PC and negative emotions may also have varying impacts on the QoL dimension [20,22]. Given the combined effects of these adverse psychological factors, healthcare professionals focusing on one risk factor may mask or underestimate the true severity of impairment in the QoL of patients with TOIs. Accordingly, understanding the interplay of negative cognitive and emotional factors could identify patients at high risk of impaired QoL after traumatic fractures more accurately.

In addition, explaining how these negative cognitive and emotional factors work together could help develop personalized early interventions on the basis of the unique characteristics of patients with TOI. The Fear Avoidance Model (FAM) is the primary psychological framework for understanding pain [23]. It posits that pain catastrophizing and pain-related fears (including avoidance and raising awareness of pain) can lead to emotional distress and intensify the severity of pain[23].

Moreover, negative emotion, the core emotional process of pain-related fear in the FAM, may be bidirectional with fear of pain: it may be a precipitant for pain-related fear [3,24]. Despite its relevance, there have been no reports of possible associations between PC, pain-related fear and these mental health outcomes. Consequently, we used the FAM as the theoretical model for this study and incorporated pain-related fear as a key factor in our analysis to elucidate the relationships among PC, negative emotions and QoL. We hypothesize that an individual's PC reaching an elevated state might trigger negative emotions, potentially leading to avoidance behaviors and poor outcomes.

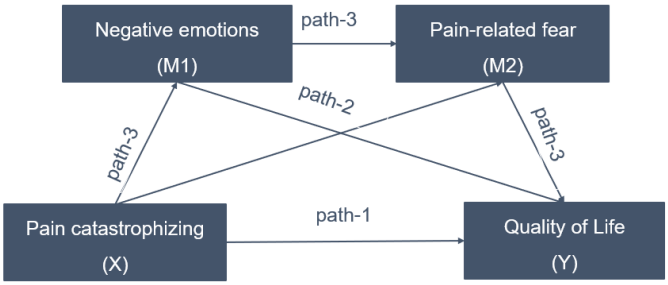

Figure 1: The chain-mediated path model in this study.
Note: Hypothesis 1, PC, emotional factors (anxiety, depression) are negative predictors of quality of life in patients with TOI (see path-1, path-2).
Hypothesis 2, the emotional factors (anxiety, depression) and pain-related fear mediated the association between PC and quality of life in patients with TOI (see path-3, PC→ anxiety/depression→ pain-related fear→ quality of life).
X, independent variable; Y, dependent variable; M, mediating variables.

Overall, there is a complex relationship between PC, negative emotions (anxiety and depression), and QoL in patients with TOIs, and these values may alter QoL independently but through several mechanisms. The above issues are not yet clear in patients with TOIs. Therefore, our aim was to investigate the associations among PC, anxiety, depression and QoL in patients and to further explore the underlying mechanisms of these associations. We constructed a chain-mediated model based on the FAM to investigate the relationships among PC, anxiety, depression and QoL in patients with TOI. We propose 2 hypotheses in this study (Figure 1).

Hypothesis 1: PC and negative emotions (anxiety and depression) are predictors of QoL in patients with TOIs.

Hypothesis 2: Negative emotions (anxiety and depression) and pain-related fear mediate the associations between PC and QoL in patients with TOIs.

Methods

Study Design

The study was a survey study. It followed the STROBE guidelines for cross-sectional studies (see supplementary materials 1).

Ethical Considerations

The study received the approval of the Clinical Research Ethics Committee of the First Affiliated Hospital, College of Medicine, Zhejiang University. All patients were fully informed about the study aims and asked to sign the informed consent form on a voluntary basis. If they needed to interrupt the study, we agreed to withdraw and continue to provide medical consulting services. Furthermore, they were also assured about the confidentiality of the data.

Participants and Samples

We used a convenience sampling method and recruited patients with TOIs in orthopedic wards from a National Medical Centre in China. Participants were included in this study if they (i) met the diagnostic criteria for "Guidelines for the Diagnosis and Treatment of TOI of China (Published in 2020)" and needed surgical treatment [25]; (ii) were ≥18 years or older; and (iii) were able to read and write in Chinese and were able to provide written informed consent. Participants were excluded if they (i) experienced trauma complicated by brain or spinal cord injury;

(ii) had a long-term history of chronic pain; (iii) had cognitive and/or neurological disorders that could strongly interfere with the surveys; or (iv) had a severe disease that hampered data collection or unstable presentation at the time (indicating a picture of shock or sepsis). (v) Participants were excluded if the overall completion rate of all assessments was less than 80%.

According to the a priori sample size calculation by G*power 3.1 (G*power use. Google search), with an anticipated effect size of 0.15, a 5% significance level, and 80% power, the minimum sample size was 114. A total of 204 TOI patients were included.

Data Collection Procedures

The data were collected during the perioperative period of patients with TOI between August 2022 and September 2023, and the details are summarized below. (i) In the preoperative stage, we collected the sociodemographic and clinical characteristics of the participants via author-designed questionnaires. The participants were asked to complete the Pain Catastrophizing Scale (PCS), Hospital Anxiety and Depression Scale (HADS), and the Tampa Scale for Kinesiophobia (TSK). (ii) When the participants were discharged, we informed them that they needed to be followed up after 2 weeks. During outpatient follow-up, a 12-item short-form health survey was employed to assess QoL from discharge to follow-up. To ensure the accuracy of survey data, terminologies that were difficult for participants to understand, such as medical jargon or acronyms, were avoided during data collection.

Measures

(i) Participants' sociodemographic and clinical characteristics

An author-designed questionnaire was used to collect the sociodemographic characteristics and clinical characteristics of patients with TOIs, including age, sex, marital status, employment status, educational level, living conditions, Body Mass Index (BMI), comorbidities and postoperative pain. The 17-item age-adjusted Charlson Comorbidity Index (ACCI) was used to characterize the impact of age and comorbidities on disease progression in patients [26]. Each comorbidity has a possible score of 1, 2, 3, or 6; the total score ranges from 0--36, and a higher score indicates a greater risk for complications. The participants were asked to provide the pain intensity they experienced via a Numerical Rating Scale (NRS), ranging from 0 ('no pain') to 10 ('pain as bad as you can imagine'), accompanied by the instructions 'Please rate your pain by indicating the number that best describes your pain on average in the last 24 hours' [27]. The NRS has demonstrated good validity in examining pain intensity in previous research in China [27]. We measured pain intensity at 4 time points during the perioperative period, including immediately after surgery, 24 hours after surgery, 48 hours after surgery, and at discharge. A related study indicated that postoperative pain can be divided into 'immediate early (first 8 hours)', 'early (12--24 hours)', and 'late early' periods (48--72 hours) [28]. Therefore, we calculated the average NRS score of patients at the 4 time points as a covariate of postoperative pain.

(ii) Pain Catastrophizing Scale

The Pain Catastrophizing Scale (PCS) was developed by Sullivan et al. and measures thoughts and feelings that individuals might experience when they are in pain [10]. It is a self-report instrument with 13 items, and each item uses a 5-point Likert scale for responses ranging from 0 ('not at all') to 4 ('all the time'), and the total score ranges from 0--52. Higher scores indicate greater PC with more negative attitudes toward pain. The PCS includes 3 subscales: rumination (4 items), magnification (3 items), and helplessness (6 items). We used the Chinese version of the PCS [29], the validity and reliability of which were tested by Shen et al. Cronbach's alpha coefficients were 0.87, 0.85, 0.62, and 0.65 for the total score and the 3 subscales, helplessness, magnification, and rumination, respectively.

(iii) Hospital Anxiety and Depression Scale

The Hospital Anxiety and Depression Scale (HADS) is a 14-item scale, with 7 items measuring anxiety (anxiety subscale, HADS-A) and 7 items measuring depression (depression subscale, HADS-D) [30]. Symptoms of anxiety and depression were considered clinically relevant at a cutoff score ≥ 8 for each subscale. We used the Chinese version of the HADS to assess patients' anxiety and depression symptoms [31]. The Cronbach's alpha coefficients of the anxiety and depression subscales were 0.92 and 0.84, respectively [31].

(iv) Tampa Scale for Kinesiophobia

The Tampa Scale for Kinesiophobia (TSK) was developed by Woby et al. to measure patients' pain-related fear [32]. It is a self-report instrument with 11 items, each item uses a 4-point Likert scale for responses ranging from 1 ('not at all') to 4 ('all the time'), and the total score ranges from 11--44. Higher scores indicate greater fear of pain. The TSK consists of 4 dimensions: hazard perception, exercise fear, exercise avoidance, and dysfunction. We used the Chinese version of the TSK, whose validity and reliability were tested by Cai, L. B. et al [24]. The Cronbach's alpha coefficient was 0.883. After contacting Cai, L. B. et al., we obtained permission from the author to use the Chinese version of the TSK [24].

(v) The 12-item Short-Form Health Survey

The 12-item Short-Form Health Survey (SF-12) was adopted to evaluate QoL. The SF-12 adequately reflects individual expectations and experiences of life. The scale evaluates two aspects: physical QoL and psychological QoL. It can be further divided into eight dimensions: physical function and general health. The responses were divided into three categories: (1) from 1 ('all the time') to 6 ('not at all'); (2) from 1('no influence') to 5 ('great impact'); and (3) 'yes' and 'not'. The crude score of each dimension was calculated first, and then the total score was calculated via standardization, with the score ranging from 0 ~100. We used the Chinese version of the SF-12, whose validity and reliability were tested by Xiao, H. M et al [33]. The Cronbach's alpha coefficient was 0.805[33]. We obtained permission from the author to use the Chinese version of the SF-12.

Outcome Variables

The primary outcome of this study was QoL at 2 weeks after discharge in patients with TOIs.

Data Analysis

Data analyses were performed via SPSS version 26.0 for Windows 11 (IBM Corp., Armonk, NY, USA). A value of $P<0.05$, which was determined via a two-tailed test, was considered statistically significant.

The sequence mean method was used to replace the miss-

ing values with variable averages. Descriptive statistics were used to describe the participants' sociodemographic and clinical characteristics, as well as their scale scores. The assumption of normality was tested via skewness and kurtosis. Continuous variables with a normal distribution are presented as the mean (M) and Standard Deviation (SD), and those with a skewed distribution are presented as the median and 25~75% Interquartile Range (IQR).

The steps of statistical inference are as follows: (i) A t test was employed to assess differences between TOI patients with negative psychological states and those without. (ii) Linear regression analysis (stepwise) was used to determine the impact of PC and emotional factors (anxiety, depression) on QoL in TOI patients. Scatter plots were used to preliminarily test whether there was a linear relationship between the independent and dependent variables before regression analysis was conducted. The equivariance of the data was examined via residual scatter plots, and normality was examined via residual normal distribution plots and P–P plots. We evaluated data independence via the Durbin–Watson test, which ranges from 0 ~ 4, indicating that the data are independent. Adjusted R-square tests and F-statistics were used to fit the regression model, and adjusted Odds Ratios (ORs) and 95% Confidence Intervals (CIs) were reported in the regression models. The assumption of multicollinearity was tested via the Variance Inflation Factor (VIF). (iii) Pearson correlation analysis was conducted to explore the associations between PC, anxiety, depression, pain-related fear and QoL in TOI patients to preliminarily determine whether the variables were suitable for mediating effect analysis. (iv) We used the bootstrap test Model 7 to evaluate the chain-mediated effect of negative emotions and pain-related fear on the association between PC and QoL. The bootstrap test was carried out according to a program set by the PROCESS macro of IBM SPSS. Given a bootstrap sample with 5000 and bias-corrected samples, bootstrapping was used to calculate the 95% CI for the correlation coefficients. If the 95% CI for effect coefficients did not contain 0, the mediating effect was considered statistically significant.

Results

Participant Characteristics

The participants' sociodemographic and clinical characteristics are presented in Table 1. The 204 patients with TOIs who completed all questionnaires were included in the analyses and had a mean age of 46.43 years (SD = 14.21). A total of 63.24% of the participants were male. The majority of participants also reported being married (76.96%) or employed (74.02%).

QoL differences between groups

Table 2 presents the physical and psychological QoL differences between the health psychology group and the negative psychology group. The prevalence rates of PC, anxiety and depression symptoms among patients with TOIs were 29.41% (60/204), 55.88% (114/204), and 53.92% (110/204), respectively. There was a significant difference in physical and psychological QoL between the two groups (P<0.01). Compared with patients with TOIs in the health psychology group, TOI patients with symptoms such as PC, anxiety and depression had lower physical and psychological QoL.

Linear Regression Model

Table 3 presents the linear regression analysis used to test

Table 1: Socio-demographic and clinical characteristics of participants (N = 204).

Characteristics	Frequency	Percentage
	(N)	(%)
Gender		
Male	129	63.24
Female	75	36.76
Age (years) †	46.43 ± 14.21	
Marital status		
Married	157	76.96
Unmarried	39	19.12
Divorced	7	3.43
Widowed	1	0.49
Job		
Employed	151	74.02
Unemployed	20	9.80
Retired	33	16.18
Education		
Primary school and below	40	19.61
Junior high school	63	30.88
High school or professional school	68	33.33
College degree and above	33	16.18
Living		
With spouse	11	5.39
With parents	34	16.67
With children	20	9.80
Alone	123	60.29
Rest	16	7.84
Trauma site		
Bones of free upper limb	80	39.21
Shoulder girdle	23	11.27
Bones of free lower limb	98	48.04
Belvic girdle	3	1.47
BMI (kg/cm^2)		
Weight loss (≤18.4)	13	6.37
Normal (18.5~23.9)	110	53.92
Overweight (24~27.9)	51	25.00
Obesity (≥ 28)	30	14.71
ACCI (score)		
Mild (0~2)	180	88.23
Moderate (3~4)	23	11.27
Severe (≥ 5)	1	0.50
Anesthesia approach		
General anesthesia	111	54.41
Non-general anesthesia	7	3.43
Compound anesthesia	86	42.16
Opioids use after surgery		
Yes	146	71.57
No	58	28.43
NRS (score) †		
Immediate after surgery	0.33 ± 0.70	
At 24-h after surgery	2.68 ± 1.57	
At 48-h after surgery	2.22 ± 1.76	
At discharge	0.96 ± 1.02	

Abbreviations: BMI: Body Mass Index; h: Hour; ACCI: Age-Adjusted Charlson Comorbidity Index; NRS: Numerical Rating Scale.
Note: †the values were presented the mean and standard deviation.

Table 2: Physical and psychological QoL differences between groups.

	Health psychology group	Negative psychology group	
PC	(PCS scores ＜ 38)	(PCS scores ≥ 38)	
	(N=144)	(N=60)	
Physical QoL	208.66 (82.30)	154.76 (67.78)	**
Psychological QoL	229.70 (82.63)	176.67 (83.36)	*
Anxiety	HADS-A scores ＜8	HADS-A scores ≥8	
	(N=90)	(N=114)	
Physical QoL	212.54 (85.65)	177.31 (75.75)	**
Psychological QoL	241.90 (79.98)	192.25 (84.76)	**
Depression	HADS-D scores ＜8	HADS-D scores ≥8	
	(N=94)	(N=110)	
Physical QoL	214.17 (84.61)	174.55 (75.29)	*
Psychological QoL	251.06 (84.98)	182.47 (73.84)	**

Note: QoL, quality of life; *, P＜0.05; **, P＜0.01.

the impacts of PC and negative emotions on QoL. After controlling for social demographic and clinical factors, regardless of the negative emotional state of patients with TOI, PC remained a negative predictor of physical QoL. TOI patients who had higher PC had poorer physical QoL (β = - 0.34, - 0.34, - 0.29, and - 0.29, respectively; see models 1, 2, 3, and 4). When PC, anxiety, and depression were included in the regression model, depression was a stronger negative predictor of physical QoL than anxiety was (β = - 0.22, see Model-4).

After controlling for covariates, the level of PC was a significant negative predictor of psychological QoL (β = - 0.34, P < 0.01; see Model-5). In cases where PC and anxiety are present together in patients with TOIs, anxiety becomes a significant negative predictor (β = - 0.35, P < 0.05; see Model-6), whereas PC's predictive role in psychological QoL is no longer significant (P > 0.05). When PC and depression coexisted among patients with TOIs, PC and depression were significant negative predictors of psychological QoL (β = - 0.24 and - 0.42, respectively, P < 0.05; Model-7). When patients with TOI experience all negative psychological factors at once, the levels of anxiety and depression are significant predictors of their psychological QoL (P < 0.05). Those with higher anxiety and depression in TOI showed reduced psychological quality of life (β = - 0.27 and - 0.42, respectively, see Model-8), whereas PC levels could not predict psychological QoL among patients with TOI (P > 0.05).

The Chain Mediating Effect

The correlations of the main variables are shown in Supplementary material 2. Significant negative relationships were observed between PC, anxiety, depression, and pain fear and both physical and psychological QoL. The results of linear regression analysis led us to employ Bootstrap Model 7 to investigate the following: (1) depression and pain-related fear influenced the link between PC and physical QoL in patients with TOI; (2) the association between PC and psychological QoL in patients with TOI was influenced by anxiety/depression and pain-related fear. The results of the chain-mediated effects are presented in Table 4.

Model 9 shows that the chain-mediated effect was only partially significant. Specifically, only pain-related fear played a mediating role in the relationship between PC and physical QoL (effect = 2.06, 95% CI = 0.43 to 3.86), whereas the combined mediation of depression and pain-related fear was not significant (effect 95% CI= -0.01 to 0.08; see Figure 2).

Model-10 revealed that only anxiety mediated the relation-

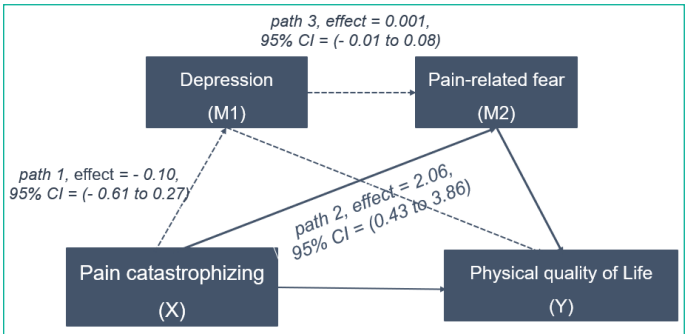

Figure 2: The chain mediation effect of model-9.
Note: Path 1, Pain Catastrophizing→Depression→ Physical quality of life.
→Path 2, Pain CatastrophizingPain-related fear→Physical quality of life.
Path 3, Pain Catastrophizing→ Depression→ Pain-related fear →Physical quality of life.
X, independent variable; Y, dependent variable; M, mediating variables. Solid line indicates significant path, and dotted line indicates insignificant path.

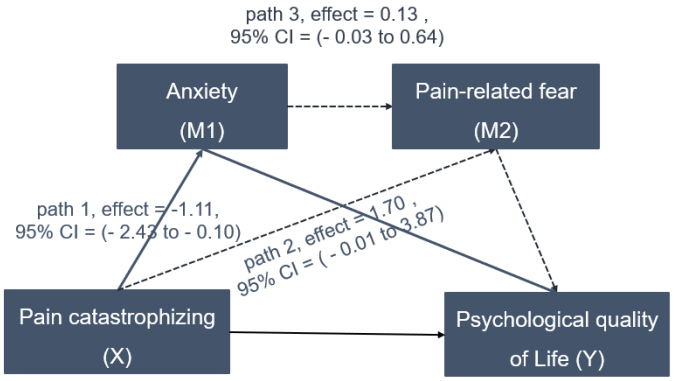

Figure 3: The chain mediation effect of model-10.
Note: Path 1, Pain Catastrophizing→Anxiety→ Psychological quality of life.
Path 2, Pain Catastrophizing→Pain-related fear→Psychological quality of life.
Path 3, Pain Catastrophizing→ Anxiety→ Pain-related fear → Psychological quality of life.
X, independent variable; Y, dependent variable; M, mediating variables. Solid line indicates significant path, and dotted line indicates insignificant path.

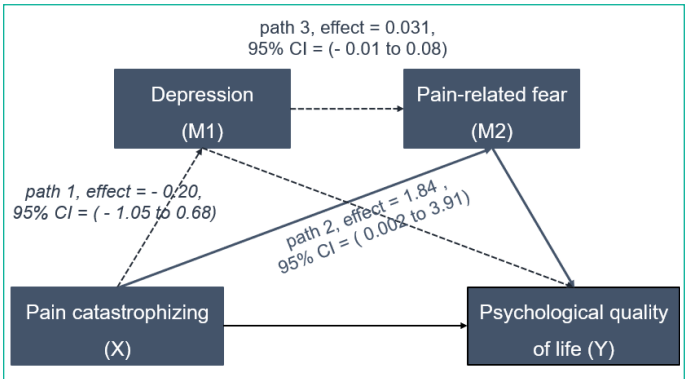

Figure 4: The chain mediation effect of model-11.
Note: Path 1, Pain Catastrophizing→Depression→Psychological quality of life.
Path 2, Pain CatastrophizingPain-related fear→ Psychological quality of life.
Path 3, Pain Catastrophizing→Depression→ Pain-related fear→ Psychological quality of life.
X, independent variable; Y, dependent variable; M, mediating variables. Solid line indicates significant path, and dotted line indicates insignificant path.

Table 3: Linear regression analysis to test the impacts of PC and negative emotions on QoL (N = 204).

Model (predictors → dependent variable)	β	95% CI	P	t
Model-1 (to test PC → Physical QoL)				
Constant	/	297.62 to 441.11	<0.05	10.18
PCS (scores)	-0.34	-2.82 to -1.07	<0.05	-4.38
Age (years)	-0.29	-2.65 to -0.70	<0.05	-3.41
Marital status	-0.23	-57.77 to -8.12	<0.05	-2.62
Adjusted R^2	0.18			
F-statistics	6.88 (P=0.01)			
D-W value	1.93			
Model-2 (to test PC + anxiety → Physical QoL)				
Constant	/	297.62 to 441.11	<0.05	10.18
PCS (scores)	-0.34	-2.82 to -1.07	<0.05	-4.38
Age (years)	-0.29	-2.65 to -0.70	<0.05	-3.41
Marital status	-0.23	-57.77 to -8.12	<0.05	-2.62
Adjusted R^2	0.18			
F-statistics	6.88 (P=0.01)			
D-W value	6.93			
Model-3 (to test PC + depression → Physical QoL)				
Constant	/	328.36 to 474.65	<0.05	10.86
PCS (scores)	-0.29	-2.54 to -0.78	<0.05	-3.74
HADS-D (scores)	-0.22	-8.70 to -1.69	<0.05	-2.93
Age (years)	-0.31	-2.71 to -0.81	<0.05	-3.65
Marital status	-0.21	-55.19 to -6.77	<0.05	-2.53
Adjusted R^2	0.22			
F-statistics	6.41(P=0.013)			
D-W value	1.87			
Model-4 (to test PC + anxiety + depression → Physical QoL)				
Constant	/	328.36 to 474.65	<0.05	10.86
PCS (scores)	-0.29	-2.54 to -0.78	<0.05	-3.74
HADS-D (scores)	-0.22	-0.70 to -1.69	<0.05	-2.93
Age (years)	-0.31	-2.71 to -0.81	<0.05	-3.65
Marital status	-0.24	-55.19 to -6.77	<0.05	-2.53
Adjusted R^2	0.24			
F-statistics	6.41 (P=0.013)			
D-W value	1.87			
Model-5 (to test PC → Psychological QoL)				
Constant	/	241.09 to 301.64		17.72
PCS (scores)	-0.34	-2.93 to -1.04		-4.13
Adjusted R^2	0.10			
F-statistics	17.09 (P=0.01)			
D-W value	2.29			
Model-6 (to test PC + anxiety → Psychological QoL)				
Constant	/	238.24 to 289.24		20.45
HAD-A (scores)	-0.35	-7.62 to -2.94		-4.47
Adjusted R^2	0.12			
F-statistics	19.96 (P=0.01)			
D-W value	2.21			
Model-7 (to test PC + depression → Psychological QoL)				
Constant	/	299.64 to 369.64		18.91
PCS (scores)	-0.24	-2.34 to -0.59		-3.32
HADS-D (scores)	-0.42	-13.89 to -6.76		-5.73
Adjusted R^2	0.27			
F-statistics	11.00 (P=0.01)			
D-W value	2.28			
Model-8 (to test PC + anxiety + depression → Psychological QoL)				
Constant	/	296.38 to 360.94		20.13
HAD-A (scores)	-0.27	-6.15 to -1.83		-3.65
HAD-D (scores)	-0.42	-13.72 to -6.64		-5.68
Adjusted R^2	0.28			
F-statistics	13.31 (P=0.01)			
D-W value	2.22			

Abbreviations: PCS: Pain Catastrophizing Scale; HADS: The Hospital Anxiety and Depression Scale; HADS-A: Anxiety Subscales and HADS-D, depression subscales; Physical QoL, the 12-items short form health survey-physical component summary; Psychological QoL, the 12-items short-form health survey mental component summary; β, standardized coefficient of β; R^2, adjusted R^2-value; F-statistics.

Note: Covariates include gender, age (years), age-adjusted charlson comorbidity (score), body mass index, trauma sites, and pain.

Table 4: The chain mediated effect of anxiety/depression and pain-related fear (N=204).

Path	Effect	Boot SE	Effect 95% CI
Model- 9			
1. PC→ Depression→ Physical QoL	-0.10	0.21	-0.61 to 0.27
2. PC→ Pain-related fear →Physical QoL	2.06	0.87	0.43 to 3.86
3. PC→ Depression→ Pain-related fear →Physical QoL	0.001	0.02	-0.01 to 0.08
Model- 10			
1. PC→ Anxiety→ Psychological QoL	-1.11	0.57	-2.43 to - 0.10
2. PC→ Pain-related fear →Psychological QoL	1.70	0.99	-0.01 to 3.87
3. PC→ Anxiety→ Pain-related fear →Psychological QoL	0.13	0.15	-0.03 to 0.64
Model- 11			
1. PC→ Depression→ Psychological QoL	-0.20	0.44	-1.05 to 0.68
2. PC→ Pain-related fear →Psychological QoL	1.84	1.01	0.002 to 3.91
3. PC→ Depression→ Pain-related fear →Psychological QoL	0.031	0.02	-0.01 to 0.08

Abbreviations: PC: Pain catastrophizing.
Note: If the 95% CI for effect coefficients did not contain 0, it indicated that the mediating effect was statistically significant.

ship between PC and psychological QoL in TOI patients (effect = -1.11, 95% CI= - 2.43 to -0.10), and the mediating effect path simultaneously mediated by anxiety and pain-related fear was not significant (effect 95% CI= -0.03 to 0.64; see Figure 3).

Model-11 revealed that pain-related fear was a crucial mediator in the relationship between PC and psychological QoL among patients with TOI (effect=1.84, 95% CI = 0.002 to 3.91), and the mediating effect path simultaneously mediated by depression and pain-related fear was not significant (effect 95% CI= - 0.01 to 0.08; see Figure 4).

Discussion

This is the first study to delve into the complex relationships among PC, negative emotional factors (anxiety and depression), and QoL in TOIs patients with coexisting negative psychological conditions, uncovering the fundamental processes among these variables. The main findings can be summarized as follows: (i) Among the negative psychological factors, PC is the strongest negative predictor of physical QoL in patients with TOIs, followed by depression. (ii) Anxiety and depression have a stronger impact on psychological QoL than does PC when PC and negative emotions coexist. (iii) Pain-related fear acts as an intermediary in the link between PC and both physical and psychological QoL, with anxiety playing a mediating role in the relationship between PC and psychological QoL in patients with TOIs. These findings extend previous research by providing an explanation for why an association exists between PC and QoL.

The study revealed that despite the negative emotional state of patients with TOIs, the level of PC was a negative predictor of physical QoL. Higher PC in TOIs patients was associated with poorer physical QoL, which is consistent with previous findings in older adults with osteoarthritis [34]. Patients suffer from PC symptoms, intense pain, challenges in performing everyday tasks [12], and physical activity after surgery [35]. Patients with TOIs have catastrophic cognitive patterns in the face of trauma and surgery, and patients often choose to avoid exercise to manage postoperative pain [35], further delaying the recovery outcomes of fractures and increasing the incidence of physi-

cal complications. In addition, a qualitative study conducted in China reported that TOI patients must rely on caregivers in their daily lives due to limitations in physical and weight-bearing activities (walk, climb stairs and washrooms) [12], which reduces their awareness of physical health. Good physical function is well documented as one of the most effective nonpharmacologic treatments for managing the orthopedic population [25], and sufficient physical activity can significantly improve the health outcomes of patients. Our findings emphasized that PC is the most important predictor of physical QoL among the negative psychological factors; consequently, prioritizing the evaluation and intervention of catastrophizing cognitive patterns before surgery may promote physical health in the perioperative period among patients with TOIs.

Another essential finding of this study was that depression accounts for more unique variance in physical QoL outcomes than anxiety does beyond PC. We have extended previous research, which has shown that depression is widely acknowledged as a key contributor to reduced psychological well-being in patients [36]. Relevant articles have shown that depression can be classified into different clinical subgroups [21], including somatic depressive symptoms (e.g., changes in physical activity levels, appetite, and weight) and cognitive-psychological depressive symptoms (e.g., sadness, loss of pleasure, crying, and often opting out). Thus, the two subgroups of depressive symptoms may affect different components of QoL through different mechanisms. Patients with TOI are characterized by physical weakness and pain after trauma and are more likely to have somatic depressive symptoms after surgery [13,37].

Depression can reduce psychological motivation to carry out daily activities requiring physical function [4] and ultimately lead to impaired physiological QoL in patients with TOIs. Moreover, we found that anxiety and depression seemed to have a stronger influence than PC does on psychological QoL when PC and negative emotions coexist. Our results seem to indicate that affective factors have a stronger influence on psychological QoL than does the cognition appraisal factor, which is inconsistent with early research conducted in patients undergoing cardiac surgery [19]. In the qualitative literature, patients with negative emotions reported that “I was so anxious about having surgery that I cannot sleep at night and feel like a useless person” [12]. This finding might suggest that patients experiencing negative emotions could face considerable psychological strain during the perioperative phase, potentially resulting in diminished self-assessed well-being. Furthermore, long-term anxiety or depression can even have a negative impact on social and family functioning among patients with TOIs [18]; ultimately, this may lead patients to perceive their overall poor health status. Our study provides initial insight into how healthcare professionals can identify high-risk individuals with mental and physical health problems in the presence of different negative psychological factors and highlights relevant targets for early intervention. The findings are initial, and additional research is needed to delve deeper into various stages of the perioperative phase.

Few empirical studies have investigated how catastrophic thoughts of pain affect QoL among patients with TOIs. After analyzing the chain mediating effect, our research confirmed that PC symptoms affect different psychological factors through different pathways, thereby impacting the physical and mental QoL of TOI patients, which partly confirms Hypothesis 2. Specifically, first, pain-related fear was an important mediator of the relationship between PC and both physical and mental QoL, supporting the FAM. Some data have suggested that increased PC intensifies the attentional demand for pain [38,39]. Individuals with more catastrophic cognitions had greater difficulty disengaging attention from pain-related stimuli and then had a greater level of pain-related fear. Catastrophic pain cognition is a precursor of pain hypervigilance, resulting in pain-related fear [39]. These circumstances can delay a patient's physical recovery and lead to considerable mental stress. In addition, our study revealed that anxiety was a mediator in the relationship between PC and psychological QoL among patients with TOI and shed new light on how PC impacts psychological QoL among patients with TOI. A prior study revealed that patients had phenotypes distinguishable by differences in psychological factors [40]. Our study seemed to explain why among patients with the same level of PC, some patients may have poorer physical and psychological QoL, whereas others do not. These findings not only shed light on the mechanisms behind how PC symptoms indirectly affect QoL in patients with TOI but also help medical staff accurately identify high-risk groups with impaired physical and mental health. In other words, TOI patients who exhibit both high PC and high pain-related fear may be in a high-risk subgroup with impaired physical and psychological QoL. Patients with TOI in the group with high PC and high anxiety may be at a greater risk of impaired mental health problems than patients with TOI. Therefore, in addition to prioritizing the assessment of PC, healthcare professionals should also evaluate patients’ level of pain-related fear and anxiety. In addition, our study provides a theoretical basis for the early implementation of appropriate cognitive and behavioral management in these populations.

Some limitations should be considered in the interpretation of the results of our study. (i) Our study was a survey involving data collection at a single point in time and was unable to validate the time sequence for the independent, dependent and intermediate variables. PC, anxiety, and depression are not static and can change over time. Therefore, further longitudinal research should be conducted to validate the findings. (ii) In this study, the variables were subjectively measured via a self-report questionnaire. Therefore, self-reported bias may exist. (iii) Although analyses controlled for several covariates in the models, there may be other variables that affect the QoL of patients with TOI. (iv) Since these data come from a single National Medical Centre, future studies may be able to co-recruit participants in a variety of settings.

Conclusions

In summary, this study revealed that (i) despite the negative emotional state of patients with TOI, the level of PC was a negative predictor of physical QoL. When PC and negative emotions (anxiety, depression) coexist, emotional factors are stronger predictors of psychological QoL than are PCs. (ii) PC symptoms affect different psychological factors through different pathways, thereby impacting the physical and mental QoL of TOI patients. Pain-related fear was an indispensable mediator of the relationship between PC and both physical and mental QoL, and anxiety was a mediator in the relationship between PC and psychological QoL among patients with TOI. To improve QoL, clinical staff should assess TOI patients' catastrophic cognitive and affective factors before surgery to identify and screen those at high risk of physical and psychological QoL impairment for treatment.

Author Statements

Author's Contribution

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Chenxi PU and Huan Liu contributed equally to this work.

Final approval of the completed manuscript: Chenxi Pu, Huan Liu, Donghua Ma, Jiamin Meng, Ming Cheng

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Registration Number in Case of a Clinical Trial

The study received the approval of the ethics committee of the hospital.

Declaration of Interest Statement

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