

# The relationship of pain catastrophizing with postoperative patient-reported outcome measures in adults with pre-arthritic hip disease

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## ABSTRACT

The association between preoperative pain catastrophizing and postoperative patient-reported outcome measures of patients with pre-arthritic hip disease was evaluated. All patients scheduled for joint-preserving surgeries of the hip (JPSH) at our institution were approached. Patient demographics (age, sex, body mass index (BMI)), pain intensity (Numeric Pain Scale (NPS)) and pain catastrophizing (Pain Catastrophizing Scale (PCS)) were collected preoperatively. Patient function (12-Item International Hip Outcome Tool (iHot-12)) and physical and mental health (Patient-Reported Outcomes Measurement Information System (PROMIS-10) mental/physical) were collected preoperatively, three-month and one-year postoperatively. The analysis consisted of multivariate linear regression models fitted for continuous scores of outcome measures at three-month and one-year. Correlation between preoperative PCS and iHot-12 was assessed using the Pearson correlation coefficient. A total of 274 patients completed the PCS and were included in the multivariate linear regression models. Most patients were females (66.8%), mean age was 33 (SD 9), mean BMI was 26.5 (SD 5.8) and most were diagnosed with femoro-acetabular impingement (46.0%) and underwent arthroscopy (77.0%). There were statistically significant correlations between PCS and iHot-12 (preoperatively  $-0.615$ ,  $P < 0.001$ ; three-month  $-0.242$ ,  $P = 0.002$ ). Statistically significant associations were found for function (three-month PCS  $P = 0.046$ , age  $P = 0.014$ , NPS  $P = 0.043$ ; one-year BMI  $P = 0.005$ , NPS  $P = 0.014$ ), physical health (three-month BMI,  $P = 0.002$ , NPS  $P = 0.008$ ; one-year BMI  $P = 0.002$ , NPS  $P = 0.013$ ) and mental health (three-month BMI  $P = 0.047$ ; one-year BMI  $P = 0.030$ ). There is an association between function and preoperative pain catastrophizing in patients with pre-arthritic hip disease undergoing JPSH. When considering confounding variables, preoperative pain catastrophizing is associated with short-term recovery.

## INTRODUCTION

Joint-preserving surgeries of the hip (JPSH) such as hip arthroscopy, surgical hip dislocation (SHD) and peri-acetabular osteotomy (PAO) are now well-established procedures to improve the quality of life of young adults suffering from pre-arthritic hip pain and hopefully avoiding the need for joint replacement [1, 2]. JPSH are indicated for the management of conditions such as femoro-acetabular impingement (FAI), dysplasia and isolated labral tear, with most patients demonstrating improvement in levels of pain and function [1–3].

Postoperative recovery and outcomes are influenced by patient-related factors (e.g. age, preoperative function) [4, 5], but psychological factors such as preoperative pain catastrophizing have been demonstrated to play an important role in

postoperative recovery of other orthopaedic surgeries [6, 7]. Pain catastrophizing is defined as an exaggerated psychological response to a future or current painful experience influencing the ability to cope with pain [8, 9]. As a result, painful experiences are amplified and accompanied by feelings of helplessness and rumination [8, 9]. High level of pain catastrophizing has been demonstrated in some individuals with various hip conditions (e.g. dysplasia, FAI, lateral trochanteric pain syndrome, osteoarthritis, avascular necrosis), increasing physical disability [10–14]. Pain catastrophizing is also associated with longer hospital length of stay for patients undergoing total hip and knee arthroplasty [15], and poorer postoperative outcomes in patients undergoing total hip and knee arthroplasty [16–18], lumbar spine surgery [19, 20] and foot and ankle surgeries [21]. While another study demonstrated that PCSs were closely

correlated with outcomes at the time of questionnaire completion in patients who underwent lumbar spinal surgery [20].

Little is known about the impact of pain catastrophizing in patients undergoing JPSH on postoperative outcomes. The objective was to evaluate the association between preoperative pain catastrophizing and postoperative patient-reported outcome measures of patients with pre-arthritis hip disease undergoing JPSH.

## MATERIALS AND METHODS

### Study design, setting and participants

This study was a consecutive cohort series. As part of a quality of care improvement initiative at our institution, all patients scheduled for elective surgery were approached to complete patient-reported outcome measures preoperatively and postoperatively. All patients diagnosed with a pre-arthritis hip condition (FAI, isolated labral tear, hip dysplasia, failed hip preservation, childhood deformity) undergoing a JPSH (arthroscopy, PAO, SHD) were eligible. This study was approved by our Institutional Ethics Review Board (20 170 533–01 H).

### Outcome measures

Patient demographics (age, sex, body mass index (BMI)), pain intensity and pain catastrophizing were collected preoperatively. Patient function and physical and mental quality of life were collected preoperatively, at three-month and one-year postoperatively.

Pain catastrophizing was assessed with the self-reported Pain Catastrophizing Scale (PCS) [8]. The PCS consists of 13 questions answered on five-point scales exploring three dimensions of pain catastrophizing (rumination, magnification, helplessness). The total score ranges from 0 to 52 with higher score indicating higher level of pain catastrophizing and a score  $\geq 30$  indicating catastrophizing [8]. The PCS demonstrates good reliability and validity properties in patients with chronic pain and healthy individuals [8, 22, 23].

Function was assessed with the patient-reported 12-Item International Hip Outcome Tool (iHot-12) [24]. The iHot-12 consists of 12 questions answered on a 100 mm visual analogue scale with higher score indicating better function. The minimal detectable change (at 90%) for the iHot-12 for adults with FAI who underwent a hip arthroscopy is 14 [25, 26]. The iHot-12 was demonstrated to be valid and reliable for a variety of hip conditions [26, 27].

Pain was assessed using a self-reported Numeric Pain Scale (NPS) consisting of one question answered on an 11-point Likert scale (0 to 10) with higher scores indicating higher pain levels [28]. The MDC (at 90%) for the NPS for patients with hip osteoarthritis is 2.7 [29]. NPS is a widely used approach to assess pain in patients with hip pathologies [30].

Health-related quality of life was assessed with the Patient-Reported Outcomes Measurement Information System (PROMIS)-10 Global Health v1.2 including Mental and Physical Health subscales [31]. The PROMIS-10 consists of 10 items for a total possible score of 20 with higher score indicating best health-related quality of life [31].

## Data analysis

Based on a medium effect size of 0.15, an alpha level of 0.05, a power of 0.80 and five predictor variables, the required sample size would be 92. Data were analysed using descriptive statistics. Representativeness of the sample included in the analyses was determined using chi-squared test for dichotomic variables

Table I. Main Characteristics of Participants (n = 274)

Characteristics	Mean (SD)			
Age	33 (9)			
Female	183 (66.8)			
BMI*	26.5 (5.8)			
Diagnosis	Preoperatively (n, %)	Three-month (n, %)	One-year (n, %)	
FAI	126 (46.0)	67 (40.9)	56 (41.5)	
Isolated labral tear	72 (26.3)	47 (28.7)	32 (23.7)	
Dysplasia	57 (20.8)	40 (24.39)	36 (26.7)	
Failed hip preservation	18 (6.6)	9 (5.5)	10 (7.4)	
Childhood deformity	1 (0.4)	1 (0.6)	1 (0.7)	
Procedure				
Arthroscopy	211 (77.0)	121 (73.8)	97 (71.9)	
PAO	57 (20.8)	39 (23.8)	35 (25.9)	
SHD	86 (2.2)	4 (2.4)	3 (2.2)	

Femoro-acetabular impingement (FAI), peri-acetabular osteotomy (PAO), surgical hip dislocation (SHD).

Table II. Outcome measures mean at the different follow-ups

Outcome measures	Mean (SD) or n (%)
Preoperative PCS	23.2 (12)
Number (%) with score $\geq 30$	87 (31.8)
Preoperative NPS	6.3 (2.1)
iHot-12	
Preoperative	33 (18.5)
PCS $\geq 30$	21 (13.3)
PCS < 30	38 (18.1)
3 months postoperative	51 (25.1)
PCS $\geq 30$	43 (23.6)
PCS < 30	54 (23.8)
1 year postoperative	58.9 (27.4)
PCS $\geq 30$	52 (30.3)
PCS < 30	59 (25.7)
PROMIS mental	
Preoperative	12 (3.5)
3 months postoperative	12.9 (3.3)
1 year postoperative	12.9 (3.5)
PROMIS physical	
Preoperative	12.1 (2.8)
3 months postoperative	13.5 (2.6)
1 year postoperative	13.8 (2.9)

Numeric Pain Scale (NPS) Pain Catastrophizing Scale (PCS).

\*iHot-12 (preoperative n = 279, 3 months n = 206, one year n = 141), PCS n = 274, PROMIS physical/mental (preoperative n = 292, 3 months n = 209, one-year n = 148), Numeric Pain Scale (preoperative n = 274).

RESULTS

and independent t-test for continuous variables. Differences for iHot-12 and PCS between diagnoses and between procedures at were tested at each assessment period using ANOVAs. Correlation between preoperative PCS and iHot-12 was assessed using the Pearson correlation coefficient. Multivariate linear regression models were fitted for continuous scores of three-month and one-year postoperative iHot-12, PROMIS physical and PROMIS mental as dependent variables. Independent variables were preoperative pain catastrophizing, NPS, age, sex and BMI. Multicollinearity of independent variables was assessed with  $r > 0.90$  indicating collinearity [32]. Statistical significance was set at alpha 0.05 using two-tailed tests. Analyses were performed using SAS v9.4 (SAS Institute Inc., Cary, North Caroline, USA).

From January 2018 to January 2021, a total of 380 patients underwent JPSH at our centre and 274 completed the PCS (72%), the mean score was 23.2 (SD 12), and 31.8% had a PCS  $\geq 30$  (Tables I, II, Fig. 1). No statistically significant demographic differences were found between patients who completed the PCS and non-respondents (age  $P = 0.15$ , sex  $P = 0.18$ , BMI  $P = 0.20$ ). Of the 274 patients who completed the PCS, most were diagnosed with FAI (46.0%), underwent arthroscopy (77.0%) and 66.8% were females, with a mean age of 33 years (SD 9) and a mean BMI of 26.5 (SD 5.8) (Table I). In total, 164 and 135 patients were included in the three-month and one-year iHot-12 regressions respectively, and 166 and 98 in the PROMIS physical and mental health regressions. The distribution of diagnosis and

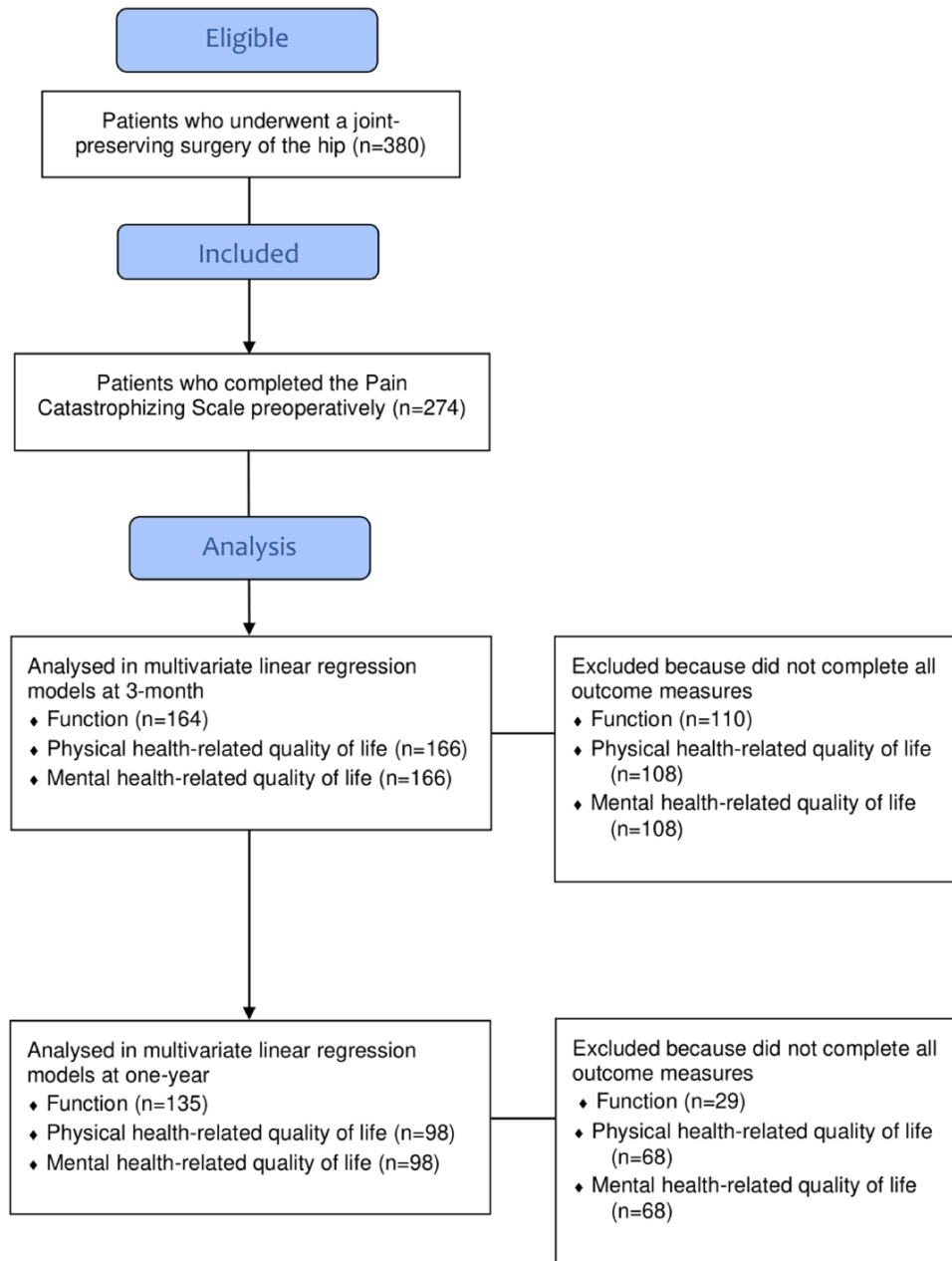


Fig. 1. Flow of participants.

procedure was similar across assessment periods (Table I). There were no statistical differences for iHot-12 and PCS between diagnoses and between procedures at each assessment period, except between procedures at three-month for iHot-12 ( $P = 0.03$ ). Statistical differences in preoperative iHot-12 ( $P = 0.04$ ) and NPS ( $P = 0.02$ ) were found between participants included and not included in the three-month regression models, but these differences were under the minimal detectable change (MDC) (means of 31 and 36 for iHot-12, and 7 and 6 for NPS respectively). There were no statistical differences between participants included and not included in the one-year regression models.

There was a statistically significant moderate correlation between preoperative PCS and preoperative iHot-12 ( $-0.615$ ,  $P < 0.001$ ). The mean iHot-12 scores for participants with preoperative PCS  $\geq 30$  versus  $< 30$  were, respectively, 21 (SD 13.3) versus 38 (SD 18.1) preoperatively, 43 (SD 23.6) versus 54 (23.8) at three-month and 52 (30.3) versus 59 (25.7) at one-year (Table I). The MDC for iHot-12 was exceeded by 55.4% of participants at three-month and 94.1% at one-year. No multicollinearity was found between variables in all multiple regressions. Multivariate linear regression revealed statistically significant associations between preoperative PCS and three-month iHot-12 ( $P = 0.046$ ), age ( $P = 0.014$ ) and NPS ( $P = 0.043$ ) (Table III). The correlation between preoperative PCS and three-month iHot-12 was  $-0.242$  ( $P = 0.002$ ). The multivariate association between preoperative PCS and one-year iHot-12 was no longer statistically significant ( $P = 0.927$ ), but

statistically significant multivariate associations were found between one-year iHot-12 and BMI ( $P = 0.006$ ) and NPS ( $P = 0.040$ ).

Multivariate linear regression revealed no association between preoperative PCS and PROMIS physical health at three-month and one-year ( $P = 0.092$ ,  $P = 0.708$ ). There were statistically significant associations between three-month PROMIS physical health and BMI ( $P = 0.002$ ) and NPS ( $P = 0.008$ ) (Table IV). Statistically significant multivariate association was also found between one-year PROMIS physical health and BMI ( $P = 0.002$ ) and NPS ( $P = 0.013$ ).

Multivariate linear regression revealed no association between preoperative PCS and PROMIS mental health at three-month and one-year ( $P = 0.517$ ,  $P = 0.184$ ). There were statistically significant associations between three-month and one-year PROMIS mental health and BMI ( $P = 0.047$ ,  $P = 0.032$  respectively) (Table V).

## DISCUSSION

There is growing evidence that preoperative pain catastrophizing can be an important element influencing postoperative recovery and function in patients undergoing orthopaedic surgeries [6, 7, 10, 11]. Our study demonstrated that a considerable number of patients with pre-arthritis hip condition undergoing various JPSH have significant levels of preoperative pain catastrophizing that is associated with worse three-month postoperative functional outcomes. Furthermore, consistent with experts'

Table III. Multivariate linear regression models for function (iHot-12)

Model	Independent variable	Regression coefficient ( $\beta$ )	Standard error	95% confidence interval	P value
3 months ( $n = 164$ )	PCS	-0.35	0.18	-0.70, -0.01	0.046
	Age	-0.54	0.22	-0.98, -0.11	0.014
	Female	-1.19	4.09	-9.28, 6.89	0.771
	BMI	0.19	0.38	-0.56, 0.94	0.613
	Preoperative NPS	-2.09	1.02	-4.10, -0.07	0.043
1 year ( $n = 135$ )	PCS	-0.02	0.22	-0.45, 0.41	0.927
	Age	-0.38	0.27	-0.93, 0.16	0.163
	Female	-5.13	5.23	-15.47, 5.21	0.328
	BMI	-1.28	0.46	-2.18, -0.37	0.006
	Preoperative NPS	-2.50	1.21	-4.89, -0.11	0.040

Body mass index (BMI), femoro-acetabular impingement (FAI), Numeric Pain Scale (NPS), Pain Catastrophizing Scale (PCS).

Table IV. Multivariate linear regression models for physical health-related quality of life (PROMIS physical health)

Model	Independent variable	Regression coefficient ( $\beta$ )	Standard error	95% confidence interval	P value
3 months ( $n = 166$ )	PCS	-0.03	0.02	-0.07, 0.01	0.092
	Age	0.002	0.02	-0.04, 0.05	0.930
	Female	0.41	0.43	-0.45, 1.26	0.348
	BMI	-0.13	0.04	-0.21, -0.05	0.002
	Preoperative NPS	-0.29	0.11	-0.50, -0.08	0.008
1 year ( $n = 98$ )	PCS	-0.01	0.03	-0.07, 0.04	0.708
	Age	-0.03	0.03	-0.09, 0.04	0.367
	Female	-0.47	0.72	-1.90, 0.964	0.518
	BMI	-0.20	0.06	-0.32, -0.08	0.002
	Preoperative NPS	-0.39	0.15	-0.68, -0.09	0.011

Body mass index (BMI), femoro-acetabular impingement (FAI), Numeric Pain Scale (NPS), Pain Catastrophizing Scale (PCS).



**Table V. Multivariate linear regression models for mental health-related quality of life (PROMIS mental health)**

Model	Independent variable	Regression coefficient ( $\beta$ )	Standard error	95% confidence interval	P value
3 months ( $n = 166$ )	PCS	-0.02	0.02	-0.06, 0.03	0.517
	Age	0.02	0.03	-0.04, 0.08	0.441
	Female	1.08	0.57	-0.04, 2.20	0.058
	BMI	-0.11	0.05	-0.21, -0.001	0.047
	Preoperative NPS	-0.25	0.14	-0.53, 0.03	0.082
1 year ( $n = 98$ )	PCS	-0.05	0.04	-0.12, 0.02	0.184
	Age	0.01	0.04	-0.07, 0.09	0.828
	Female	0.56	0.92	-1.26, 2.38	0.544
	BMI	-0.17	0.08	-0.32, -0.01	0.032
	Preoperative NPS	-0.11	0.19	-0.49, 0.27	0.567

Body mass index (BMI), femoro-acetabular impingement (FAI), Numeric Pain Scale (NPS), Pain Catastrophizing Scale (PCS).

recommendations, our study has investigated this association using both disease-specific (iHot-12) and generic (PROMIS-10) patient-reported outcome measures as they provide important complementary information (functional impact versus general health status) [33–35].

Pain catastrophizing was associated with preoperative and three-month function for adults with a pre-arthritis hip condition (FAI, isolated labral tear, hip dysplasia, failed hip preservation, childhood deformity) undergoing a JPSH (arthroscopy, PAO, SHD). When considering confounding variables, pain catastrophizing was associated with three-month postoperative function, but the association was no longer statistically significant at one-year. A study in patients undergoing hip arthroscopy for FAI demonstrated that one-year postoperative PCSs were statistically different for those achieving minimal clinically important difference in outcomes at one-year compared to those who did not achieve it, but also a lack of significant relationship between preoperative PCSs and one-year outcomes [36]. Bearing in mind that our study included various pre-arthritis hip conditions and JHPS, it appears the preoperative PCS is only associated with short-term outcomes, while long-term postoperative changes in PCS influence long-term postoperative outcomes. Clinicians should consider these findings to inform their clinical practice, especially when counselling patients during the recovery period, managing postoperative expectations, deciding on further interventions and managing pain medications. Specifically, clinicians could refer patients with high PCS to preoperative and/or postoperative rehabilitation to decrease pain catastrophizing levels and in turn, optimize functional levels [37–39].

There was no association between pain catastrophizing and PROMIS physical and mental health at any time point. As PROMIS is a generic health-related outcome measure, pain catastrophizing does not seem to influence health in general [33, 35]. Pain intensity and BMI were consistently found to be associated with three-month and one-year postoperative function and physical/mental health. These findings are consistent with a systematic review of 38 studies and a scoping review of 101 studies of outcomes predictors for hip arthroscopy revealing that BMI and symptoms severity, including pain level, are predictors of postoperative outcomes [4, 40].

These findings should be considered in light of limitations. First, this study followed patients for only one year; therefore, findings might not reflect long-term outcomes. Second, patients were recruited in one institution, but across multiple orthopaedic surgeons. Third, this study investigated the association between PCS and postoperative patient-reported outcome measures in a variable patient population (various pre-arthritis hip diseases undergoing a variety of JHPS). However, it was not possible to conduct subgroup analyses to investigate the association between PCS and the different hip diagnosis and procedures because of the sample size. However, the distribution of diagnosis and procedures was similar across assessment periods. Fourth, these findings should be weighed within the context of the limited follow-up rate. Nonetheless, the follow-up rate in this study is similar to other prospective cohort studies with this population [41–44] and international prospective registries collecting patient-reported outcome measures [45].

## CONCLUSION

Our study demonstrated an association between preoperative function and preoperative pain catastrophizing in patients with various pre-arthritis hip disease (FAI, isolated labral tear, hip dysplasia, failed hip preservation, childhood deformity) undergoing different JPSH (arthroscopy, PAO, SHD). More importantly, preoperative pain catastrophizing was only associated with three-month postoperative function, which can help surgeons counsel the patients with regard to their recovery.

## DATA AVAILABILITY

Data will be shared upon reasonable request to the corresponding author.

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### CONFLICT OF INTEREST STATEMENT

None declared.

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