

Validity and Reliability of the Kannada Version of the Pain Catastrophising Scale in Individuals with Knee Osteoarthritis: A Cross-sectional Study

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ABSTRACT

Introduction: Pain catastrophising (PC) involves reacting to pain with an exaggeratedly negative mindset. For individuals suffering from Knee Osteoarthritis (KOA), a higher level of catastrophising correlates with more pain, restricted activity, and a diminished Quality of Life (QoL). Although, the Kannada-Pain Catastrophising Scale (K-PCS) is available in Kannada, its reliability and validity for KOA individuals have not been confirmed, so it needs to be tested specifically for this group.

Aim: To evaluate the structural validity, construct validity and reliability of the K-PCS and to determine whether it validly and reliably assesses PC in individuals diagnosed with KOA.

Materials and Methods: The present cross-sectional psychometric validation study was carried out in the Department of Physiotherapy, at JGMM Hospital and Medical Research Centre in Hubballi, Karnataka, India, from April 2026 to June 2026. The K-PCS was administered along with the Visual Analogue Scale (VAS), World Health Organisation QoL (WHOQOL-BREF), and Knee Injury and Osteoarthritis Outcome Score (KOOS). Internal consistency was evaluated using Cronbach's alpha. Test-retest reliability was assessed with the

Intraclass Correlation Coefficient (ICC) in 30 participants after seven days. Structural validity was explored using Exploratory Factor Analysis (EFA) followed by a preliminary Confirmatory Factor Analysis (CFA) of EFA derived model, while construct validity was measured using Spearman's correlation coefficient (ρ). Additionally, Composite Reliability (CR) and Average Variance Extracted (AVE) were estimated.

Results: EFA identified a two-factor model consisting of pain reflection and helplessness. A subsequent of CFA of the EFA derived model performed on the same sample, showed good apparent model fit (RMSEA=0.00, SRMR=0.039, CFI=1.00, and TLI=1.00); these findings were considered preliminary. Cronbach's α showed excellent internal consistency (0.964), with test-retest reliability evidenced by an ICC of 0.988. The K-PCS positively correlated with pain intensity (VAS; $\rho=0.813$, $p<0.001$) and negatively with knee function (KOOS; $\rho=-0.666$ to -0.787 , $p<0.001$) and QoL (WHOQOL-BREF; $\rho=-0.774$, $p<0.001$).

Conclusion: The findings provide preliminary evidence supporting the K-PCS as a valid and reliable instrument for assessing PC in Kannada-speaking individuals with KOA.

Keywords: Chronic pain, Psychometric properties, Reproducibility of Results, Surveys and Questionnaires

INTRODUCTION

The PC is a harmful mindset that involves constant negative thoughts about real or expected pain [1]. There is evidence that shows psychological factors greatly affect pain outcomes, challenging Descartes' early theories that linked pain mainly to the level of peripheral tissue injury [2]. Research from systematic reviews and meta-analyses shows that PC is a strong predictor of poor pain-related outcomes [3]. In models of fear avoidance, PC is considered a crucial element contributing to the transition of pain from the acute stage to chronicity [4]. When chronic pain is accompanied by PC, it can lead to increased disability, heightened pain levels, and reduced QoL, potentially affecting the outcomes of different treatments negatively [5].

In chronic joint disorders such as KOA, fear avoidance behaviour is seen as a factor in developing negative beliefs about pain [6,7]. Individuals with KOA who show higher levels of PC may enter a cycle where pain worsens, fear of movement increases, physical activity decreases, functional disability rises, and QoL drops, leading to poorer rehabilitation outcomes [8,9].

Originally developed by Sullivan MJ et al., the PCS is still extensively used as a reliable self-assessment tool for identifying catastrophic thoughts concerning pain [10]. It examines three main aspects of PC: feeling helpless, exaggerating pain, and constantly thinking about pain. It has proven to have strong measurement qualities in

different languages and among people with musculoskeletal issues [11]. Considering India's linguistic diversity, it is crucial to develop culturally and linguistically appropriate versions of PCS to ensure accurate assessment across various regional populations. Kannada is a significant regional language spoken in Karnataka, India. Accordingly, the K-PCS was previously translated and cross-culturally adapted by Sublok PM et al., following the guidelines of Beaton DE et al., in individuals with stroke [12,13]. However, translation and cross-cultural adaptation alone do not establish the psychometric properties of an instrument for use in another clinical population. Since measurement characteristics can differ among populations, it is crucial to conduct psychometric assessments of patient-reported outcome measures within the specific population intended for use before implementing them in clinical settings or research. Considering the substantial impact of PC on pain, functionality, and rehabilitation results in individuals with KOA, it is vital to assess the psychometric attributes of the K-PCS within this group. Therefore, this study focused on examining the construct validity, structural validity, and reliability of the K-PCS in individuals with KOA.

MATERIALS AND METHODS

The present cross-sectional psychometric validation study was carried out at JGMM Hospital and Medical Research Centre in Hubballi, Karnataka, India, from April to June 2026.

The Institutional Ethics Committee of JGMM Medical College, Hubballi, provided ethical approval (reference number: JGMM/IEC/23/2026). All the study procedures are aligned with ethical standard outlined by Institutional Committee of Human Experimentation and Declaration of Helsinki 1975, updated in 2013. Before the commencement of the study, permission to use the original K-PCS was taken from the corresponding author [12]. Participants were checked for eligibility, and those who qualified gave written informed consent in Kannada before joining. For those who were not formally literate, the consent form was read aloud and explained in Kannada and informed consent was documented using a thumb impression.

Inclusion and Exclusion criteria: Eligible participants for the study were individuals aged 40 to 64 with a confirmed diagnosis of KOA, based on ACR standards or Kellgren-Lawrence grade II-III X-ray changes [14]. They must have experienced knee pain for at least three months, be literate, and provide written informed consent. Exclusions included prior knee surgery, fractures, inflammatory or systemic rheumatological diseases, neurological disorders affecting lower limb function, significant cognitive deficits, or inability to understand Kannada.

Sample size calculation: According to Hinkin's guideline, which recommends a minimum ratio of four participants per item for psychometric validation studies, the sample size was determined [15]. Since the PCS includes 13 items, at least 52 participants were necessary; however, the final number of participants was raised to 60 to account for expected dropouts.

Although the sample size meets Hinkin's recommendation of 4:1 participants per item, it falls short of the sample size recommended by COSMIN for structural validity (≥ 100) [16].

A total of 60 individuals diagnosed with KOA were recruited through purposive sampling.

Study Procedure

Following written informed consent, demographic and clinical data were documented using a standardised data collection form. All participants completed the questionnaires under the researcher's guidance. All measures were provided in Kannada. For three participants with limited literacy, interviewer-assisted administration was used. For these participants, each item was read verbatim in Kannada without explanation, interpretation, prompting, or rewording, and responses were recorded verbatim without interpretation.

For test-retest reliability, a predefined subset of 30 participants completed the K-PCS again after seven days. This interval was chosen to minimise recall bias while reducing the likelihood of clinically meaningful change in catastrophising.

Study Outcomes

- 1. Kannada version of the Pain Catastrophising Scale (K-PCS):** The K-PCS used in this study was previously translated and cross-culturally adapted by Sublok PM et al., in individuals with post-stroke shoulder pain following Beaton DE et al., guidelines. The original PCS by Sullivan MJ et al., comprises 13 items scored on a 5-point Likert scale (0=not at all to 4=all the time), with total scores ranging from 0-52; higher scores indicate greater pain catastrophising. The original scale comprises three subscales: rumination, magnification, and helplessness [10,12,13].
- 2. Visual Analogue Scale (VAS):** Pain intensity was assessed using a 10-cm horizontal VAS, anchored at 0 (no pain) and 10 (worst imaginable pain). The VAS is a valid measure of pain intensity in KOA and was included to evaluate construct validity through its expected positive association with catastrophising [17].

- 3. Knee Injury and Osteoarthritis Outcome Score (KOOS):** The KOOS is a validated, disease-specific measure for KOA. It was included to examine the relationship between K-PCS scores and knee-related symptoms and functional status [18].
- 4. World Health Organisation Quality of Life Scale-BREF (WHOQOL-BREF):** The WHOQOL-BREF comprises 26 items assessing physical health, psychological well-being, social relationships, and environmental domains. It has demonstrated satisfactory validity and reliability in Indian clinical samples and was included to evaluate the association between catastrophising and overall QoL [19,20].

STATISTICAL ANALYSIS

Data were analysed using IBM Statistical Package for the Social Sciences (SPSS) Statistics version 27.0 (IBM Corp., Armonk, NY, USA) and R software version 4.3.1. Statistical significance was set at $p < 0.05$ (two-tailed). Continuous variables were summarised as mean $\pm$ Standard Deviation (SD), and categorical variables as frequency and percentage. Normality was assessed using the Shapiro-Wilk test and visual inspection of Q-Q plots and histograms. Internal consistency was assessed using Cronbach's alpha and corrected item-total correlations. Test-retest reliability was evaluated in 30 participants using a two-way mixed-effects ICC model for absolute agreement. Construct validity was examined using Spearman's rank correlation coefficient (ρ) between K-PCS scores and comparator measures (VAS, KOOS, WHOQOL-BREF). Correlation strength was interpreted as weak (< 0.30), moderate (0.30-0.69), and strong (≥ 0.70). Structural validity was explored using EFA with principal axis factoring and oblimin rotation (psych package, R), as latent factors of catastrophising were expected to correlate. Sampling adequacy was verified using the Kaiser-Meyer-Olkin (KMO) index and Bartlett's test of sphericity. Factor retention was based on parallel analysis, scree plot inspection, and eigenvalues > 1 . The structure matrix was reported. A subsequent CFA was performed using the lavaan package to provide a preliminary evaluation of the EFA-derived model as the CFA was conducted on the same sample used for EFA. Model fit was judged using chi-square (χ^2), Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), and Standardised Root Mean Square Residual (SRMR). Convergent validity was evaluated using standardised factor loadings, CR, and AVE. Discriminant validity was assessed using the Fornell-Larcker criterion.

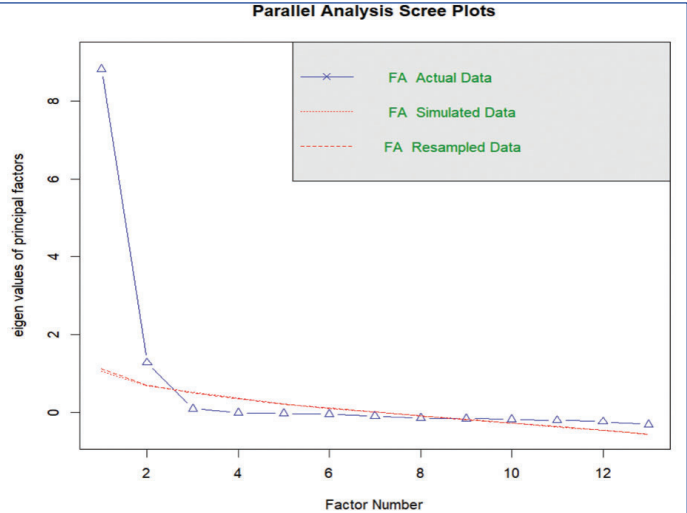
RESULTS

The mean age of the participants was 52.92 ± 7.29 . The demographic and clinical characteristics of study participants has been presented in [Table/Fig-1]. Appropriateness of EFA was supported by KMO sampling adequacy measures of 0.95 and a significant result from Bartlett's test of sphericity ($\chi^2 = 864.47$, $df = 78$, $p < 0.001$) [Table/Fig-2]. The first factor, which included PCS items 2,3,7,9,10,11,12 and 13, explained 49% of variance. The second factor comprising PCS items 1,4,5,6 and 8, accounted for 31% of variance. The structure matrix coefficient ranged from 0.505 to 0.930, with all items demonstrating strong association with the expected factors [Table/Fig-3].

Variables	Values
Age (years)	52.92 $\pm$ 7.29
BMI (kg/m ²)	28.07 $\pm$ 3.44
Pain duration (months)	41.28 $\pm$ 24.15
Gender-Female	36 (60.0%)
Gender-Male	24 (40.0%)
Bilateral involvement	26 (43.3%)
Right involvement	19 (31.7%)
Left involvement	15 (25.0%)
K-L Grade II	30 (50.0%)
K-L Grade III	30 (50.0%)

PCS Total	29.07±13.79
VAS	5.23±2.25
KOOS Pain	55.70±19.98
KOOS Symptoms	64.75±14.41
KOOS ADL	59.94±16.80
KOOS Sport/Rec	50.00±21.42
KOOS QoL	53.33±20.51
WHOQOL-BREF Total	60.90±8.77

[Table/Fig-1]: Demographic and clinical characteristics of study participants (N=60).
*Continuous variables presented as mean±SD; categorical variables presented as n (%).
BMI-Body mass index; K-L-Kellgren-lawrence; K-PCS-Kannada pain catastrophising scale; VAS-Visual Analogue Scale; KOOS-Knee Injury and Osteoarthritis Outcome Score; ADL-Activities of Daily Living; Sport/Rec-Sport and Recreation; WHOQOL-BREF-World health organisation quality of life-brief



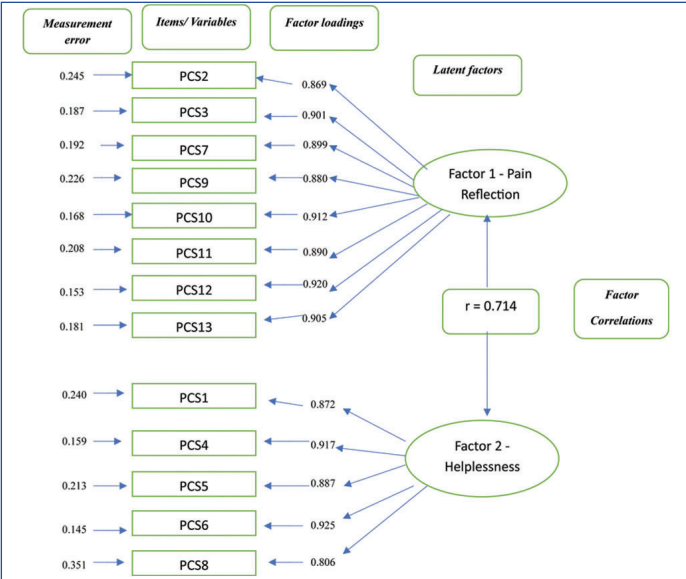
[Table/Fig-2]: Parallel analysis scree plot supporting the two-factor structure of Kannada Pain Catastrophising Scale (K-PCS).
*The scree plot compares observed eigenvalues with simulated eigenvalues obtained through parallel analysis. Two factors were retained because their observed eigenvalues exceeded the corresponding simulated eigenvalues

Item No.	Original PCS Subscale [10]	Brief description (original PCS paraphrased)	Structure coefficient Factor 1 (Pain Reflection)	Structure coefficient Factor 2 (Helplessness)
13	Magnification	Fear that something serious could occur	0.915	0.523
10	Rumination	Focusing on the intensity of pain	0.915	0.598
3	Helplessness	Feeling that improvement will never occur	0.901	0.623
9	Rumination	Unable to stop thinking	0.880	0.594
7	Magnification	Dwelling on painful experiences	0.897	0.644
2	Helplessness	Feeling unable to continue	0.868	0.608
11	Rumination	Wishing for the pain to end	0.887	0.644
12	Helplessness	Feeling there is nothing that can help	0.916	0.698
6	Magnification	Concern that the pain may worsen	0.638	0.930
1	Helplessness	Uncertainty about whether the pain will subside	0.569	0.867
8	Rumination	Desire for the pain to disappear	0.505	0.806
4	Helplessness	Perceiving the pain as unbearable	0.675	0.919

5	Helplessness	Feeling unable to tolerate the pain	0.645	0.884
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[Table/Fig-3]: Exploratory Factor Analysis (EFA): Structure matrix of the Kannada Pain Catastrophising Scale (K-PCS) [10].
*Extraction method Principal axis factoring with oblimin rotation; Values shown are structure matrix coefficients (item-factor correlations) obtained from the oblique rotation; Bold values indicate the primary factor for each item

Following the identification of the factor structure through EFA, a subsequent evaluation was conducted using CFA on the same sample as a preliminary assessment [Table/Fig-4]. The two-factor model best matched the data, with statistics showing $\chi^2=63.90$, $df=64$, $CFI=1.00$, $TLI=1.00$, $SRMR=0.039$, and $RMSEA=0.00$. In contrast, the one-factor and initial three-factor models did not fit well [Table/Fig-5]. As the EFA and CFA were conducted on the same participants, these CFA findings should be interpreted as preliminary rather than as independent confirmation of the factor structure.



[Table/Fig-4]: Confirmatory Factor Analysis (CFA) path diagram of the final two-factor model of the Kannada Pain Catastrophising Scale (K-PCS).
*The diagram presents standardised factor loadings, measurement errors, and the correlation between the latent factors of the two-factor K-PCS model

Model	χ^2	df	CFI	TLI	RMSEA	SRMR	Interpretation
Model 1	225.21	65	0.819	0.783	0.203	0.114	Poor fit
Model 2	219.62	62	0.822	0.776	0.206	0.109	Poor fit
Model 3	63.90	64	1.000	1.000	0.000	0.039	Good apparent fit; preliminary CFA

[Table/Fig-5]: Comparison of Confirmatory Factor Analysis (CFA) goodness-of-fit indices for competing K-PCS measurement models.
* χ^2 , Chi-square statistic; df, Degrees of freedom; CFI Comparative Fit Index; TLI: Tucker-Lewis Index; RMSEA, Root Mean Square Error of Approximation; SRMR: Standardised Root Mean Square Residual; Model 1 represents the one-factor model; Model 2 represents the original three-factor model proposed by Sullivan MJL et al. [10]; Model 3 represents the two-factor model identified in the present study

The K-PCS demonstrated excellent internal consistency, with the pain reflection subscale achieving a Cronbach's alpha of 0.970, the helplessness subscale reaching 0.950, and the entire scale scoring 0.964 [Table/Fig-6]. The corrected item-total correlations ranged from 0.641 to 0.894. When individual items are removed, Cronbach's alpha ranged between 0.959-0.965, demonstrating exclusion of any single item does not significantly alter the scale's internal consistency [Table/Fig-7].

Scale	No. of Items	Cronbach's α
Pain Reflection	8	0.970
Helplessness	5	0.950
Total K-PCS	13	0.964

[Table/Fig-6]: Internal consistency of the Kannada Pain Catastrophising Scale (K-PCS).
*K-PCS: Kannada Pain Catastrophising Scale

The CR values for pain reflection and helplessness were found to be 0.971 and 0.946, respectively [Table/Fig-8].

Item	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
PCS1	0.707	0.964
PCS2	0.824	0.961
PCS3	0.852	0.960
PCS4	0.805	0.961
PCS5	0.771	0.962
PCS6	0.781	0.962
PCS7	0.859	0.960
PCS8	0.641	0.965
PCS9	0.825	0.961
PCS10	0.849	0.960
PCS11	0.852	0.960
PCS12	0.894	0.959
PCS13	0.811	0.961

[Table/Fig-7]: Item-level internal consistency statistics of the Kannada Pain Catastrophising Scale (K-PCS).

*K-PCS: Kannada pain catastrophising scale; Overall Cronbach's alpha=0.964

Construct	CR	AVE	√AVE
Pain Reflection	0.971	0.806	0.898
Helplessness	0.946	0.778	0.882

[Table/Fig-8]: Composite Reliability (CR), convergent and discriminant validity of the two-factor Kannada Pain Catastrophising Scale (K-PCS) (n=60).

*CR: Composite Reliability; AVE: Average Variance Extracted; √AVE: Square root of the Average Variance Extracted; CR values ≥0.70 indicate acceptable internal consistency; AVE values ≥0.50 indicate adequate convergent validity

The total K-PCS score demonstrated ICC of 0.988 with 95% of confidence interval spanning from 0.975 to 0.994 [Table/Fig-9]. The Bland-Altman plot supported strong test-retest reliability, showing a mean difference of -0.03 and 95% limits of agreement between -4.32 and 4.26, with majority of observations lying within these limits of agreement [Table/Fig-10].

Scale	ICC (95% CI)	SEM	MDC95	Mean Difference	95% Limits of Agreement	p-value
Pain Reflection	0.981 (0.962-0.991)	1.043	2.891	-0.07	-2.93 to 2.80	<0.001
Helplessness	0.974 (0.946-0.988)	1.037	2.874	0.10	-2.83 to 3.03	<0.001
Total K-PCS	0.988 (0.975-0.994)	1.511	4.188	-0.03	-4.32 to 4.26	<0.001

[Table/Fig-9]: Test-retest reliability of the Kannada Pain Catastrophising Scale (K-PCS) and Subscales (n=30).

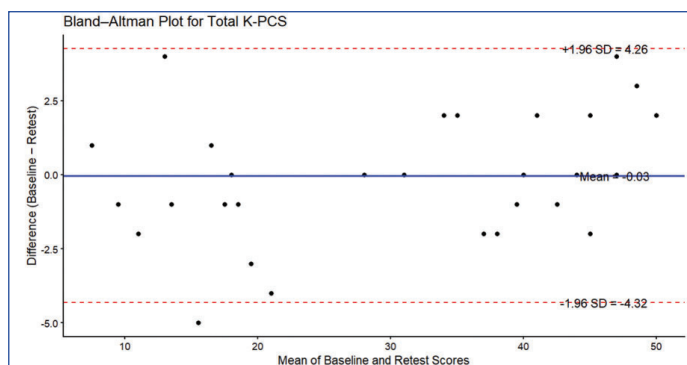
*ICC: Intraclass Correlation Coefficient; CI: Confidence Interval; SEM: Standard error of measurement; MDC95: Minimal detectable change at the 95% confidence level; Higher ICC values indicate greater stability of repeated measurements

Spearman's rank correlation between K-PCS total score and all outcome measures is detailed in [Table/Fig-11].

DISCUSSION

The present study evaluated the psychometric properties of the K-PCS in individuals with KOA. Overall, the findings support excellent internal consistency, high test-retest reliability, and sound construct, convergent, and discriminant validity, with preliminary evidence supporting the identified two-factor structure.

The Kannada version was previously translated and validated by Sublok PM et al., in individuals with chronic shoulder pain after stroke, where the original three-factor structure was retained.



[Table/Fig-10]: Bland-Altman plot showing agreement between baseline and 7-day retest K-PCS total scores (n=30).

*The solid horizontal line represents the mean difference between baseline and retest scores, whereas the dashed lines represent the 95% limits of agreement

Outcome Measure	Spearman's ρ	Strength of Correlation	p-value
VAS	0.813	Very strong positive	<0.001
KOOS Pain	-0.787	Very strong negative	<0.001
KOOS Symptoms	-0.666	Strong negative	<0.001
KOOS ADL	-0.772	Very strong negative	<0.001
KOOS Sport/Rec	-0.772	Very strong negative	<0.001
KOOS QoL	-0.782	Very strong negative	<0.001
WHOQOL-BREF Total	-0.774	Very strong negative	<0.001

[Table/Fig-11]: Construct validity of the Kannada Pain Catastrophising Scale (K-PCS) assessed using Spearman's rank correlation coefficients (n=60).

*VAS, Visual Analogue Scale; KOOS, Knee Injury and Osteoarthritis Outcome Score; ADL, Activities of Daily Living; Sport/Rec, Sport and Recreation; WHOQOL-BREF, World Health Organisation Quality of Life-Brief

However, factor structure can vary across clinical populations because pain experience is shaped by the underlying disease. Post-stroke pain is often associated with neurological damage, altered sensorimotor processing, and central mechanisms, whereas KOA is predominantly characterised by chronic nociceptive pain, progressive joint degeneration, movement-evoked pain, fear of movement, and functional limitation. Re-evaluation of the K-PCS in KOA was therefore warranted [12].

In the present study, the two-factor model demonstrated good apparent fit compared to the one-factor and original three-factor models. While Sullivan MJ et al. conceptualised PC as three correlated dimensions such as rumination, magnification, and helplessness, the cross-cultural validations have reported inconsistent latent structures [10]. The Korean, German, Italian, Chinese, and Hindi versions supported the three-factor structure, whereas Nepali, Arabic, Turkish, Swedish, and Bengali versions identified a two-factor solution [21-30]. The present findings add to the growing evidence that the dimensionality of PC is influenced by cultural and clinical factors rather than being universal. The two-factor solution identified here is clinically interpretable for KOA. Factor 1, labelled pain reflection, comprised items 2, 3, 7, 9, 10, 11, 12, and 13, reflecting persistent attention to pain, repetitive negative thinking, worry, and exaggerated appraisal of pain. These items originate from the original rumination, magnification, and helplessness domains, suggesting that individuals with KOA may not differentiate these cognitive processes but experience them as a broader pattern of sustained cognitive engagement with pain. Factor 2, labelled helplessness, comprised items 1, 4, 5, 6, and 8, reflecting perceived inability to cope, emotional surrender, fear of worsening, and diminished confidence in pain control. This distinction is clinically plausible, as repeated pain during weight-bearing, functional decline, and fear of progression may promote hypervigilance toward pain while simultaneously fostering a sense of loss of control.

The K-PCS demonstrated excellent reliability. Cronbach's alpha for the total scale (0.964) and subscales (pain reflection 0.970;

helplessness 0.950) exceeded the recommended threshold for patient-reported outcome measures and was comparable to or higher than values reported in previous validations. Although $\alpha > 0.95$ may suggest item redundancy, corrected item-total correlations (0.641-0.894) were high and α remained stable after deletion of any single item (0.959-0.965), indicating that items contribute meaningfully without being redundant. Test-retest reliability over seven days was excellent (ICC=0.974-0.988), and Bland-Altman analysis showed negligible systematic bias with narrow limits of agreement, supporting temporal stability.

Construct validity was supported by hypothesised associations. Higher K-PCS scores correlated strongly and positively with pain intensity and strongly and negatively with all KOOS subscales and WHOQOL-BREF total score. These findings are consistent with fear-avoidance models, in which catastrophic interpretation of pain leads to fear of movement, activity avoidance, deconditioning, and functional decline, and extends to psychological and social domains of QoL [4,9]. Furthermore, the two-factor model demonstrated good convergent validity (CR>0.90, AVE>0.50 for both factors) and discriminant validity, as the square root of AVE for each factor exceeded the inter-factor correlation (0.714).

From a clinical perspective, routine assessment of PC using the K-PCS may facilitate early identification of patients at risk for persistent pain, functional limitation, fear of movement, and poor QoL. This allows timely implementation of psychologically informed interventions, including cognitive-behavioural strategies, pain neuroscience education, and individualised exercise programs targeting maladaptive pain cognitions.

Limitation(s)

First, although the sample meets Hinkin's recommendation of 4:1 participants per item, it falls short of the sample size recommended by COSMIN for structural validity (≥ 100). A larger sample would enhance the stability and generalisability of the factor structure. Second, EFA and CFA were performed on the same dataset because an independent validation sample was not available. This approach increases the risk of overfitting; therefore, the CFA findings should be interpreted as preliminary and require confirmation in an independent, adequately powered sample. Third, although only three participants required interviewer-assisted administration with standardised verbatim reading, interviewer bias cannot be fully excluded.

CONCLUSION(S)

The present study demonstrates how K-PCS is relevant for individuals with KOA and presents evidence that highlights challenges faced by the clinical population. The identified two-factor structure suggests that PC in KOA is characterised by complementary dimensions of pain reflection and helplessness. The availability of a validated Kannada instrument may facilitate early identification of maladaptive pain-related cognitions and support psychologically informed assessment, treatment planning, and future research in Kannada-speaking individuals with KOA.

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