

A latent profile and network analysis of kinesiophobia in patients after total joint replacement

shuoni ren

zhejiang chinese medicine univeresity

Yanan Kan

The First Affiliated Hospital of Zhejiang Chinese Medical University

Yuqiu Yuan

zhejiang chinese medicine univeresity

Fuying Ye

yfy1104@126.com

The First Affiliated Hospital of Zhejiang Chinese Medical University

Research Article

Keywords: Total joint arthroplasty, Kinesiophobia, Latent profile analysis, Network analysis

Posted Date: September 29th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-10797540/v1>

License:   This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Additional Declarations: No competing interests reported.

Title : A latent profile and network analysis of kinesiophobia in patients after total joint replacement

Shuoni Ren: School of Nurinsg, Zhejiang Chinese Medical University, Hangzhou, 310053, China. renshuoni_2025@163.com

Yanan Kan: Head Nurse of the Orthopedic Research Center, The First Affiliated Hospital of Zhejiang Chinese Medical Medicine (Zhejiang Provincial Hospital of Chinese Medicine), Hangzhou, 310006, China; 277387925@qq.com

Yuqiu Yuan: School of Nurinsg, Zhejiang Chinese Medical University, Hangzhou, 310053, China; 2541017893@qq.com

Fuying Ye: Chairperson of the Trade Union, The First Affiliated Hospital of Zhejiang Chinese Medical Medicine (Zhejiang Provincial Hospital of Chinese Medicine), Hangzhou, 310006, China; yfy1104@126.com

Correspondence: Fuying Ye, Email: yfy1104@126.com

Abstract Aim Based on the system-based Model of Stress, this study aimed to classify heterogeneous subgroups of kinesiophobia in patients following total joint arthroplasty using latent profile analysis, and to identify the core symptoms within each subgroup through network analysis. Methods The present study employed a cross-sectional survey design, conducted between April 2025 and June 2026, involving 250 patients after hip or knee arthroplasty at an orthopedic center. The latent profile analysis and receiver operating characteristic curve analysis were performed to identify subgroups of kinesiophobia and to determine cutoff values. Network analysis was conducted to elucidate the interrelationships among kinesiophobia, pain intensity, pain catastrophizing, rehabilitation self-efficacy, and social support, using each scale's total score as a node. Results In 250 patients after hip or knee arthroplasty, the mean kinesiophobia score was 37.65 ± 4.45 , with a prevalence of 48.8%. Two distinct subgroups were identified: "low kinesiophobia-activity acceptance group" (73.6%) and a "high kinesiophobia-fear avoidance group" (26.4%). Binary logistic regression revealed that higher preoperative physical activity frequency (≥ 4 times/week) [OR = 7.484, $P = 0.045$], longer daily pain duration [OR = 2.723, $P = 0.010$], higher Oswestry Disability Index scores [OR = 1.278, $P < 0.001$], and negative coping style [OR = 2.142, $P = 0.002$] were independent risk factors for high Kinesiophobia, whereas higher rehabilitation self-efficacy [OR = 0.842, $P < 0.001$] was a protective factor. In the "high kinesiophobia-fear avoidance group", pain catastrophizing (PCS) emerged as the core dimension of kinesiophobia ($r_{strength}=1.424$, $r_{closeness}=1.224$, $r_{betweenness}=1.565$). Conversely, in the "low kinesiophobia-activity acceptance group", rehabilitation self-efficacy (SER) emerged as the core dimension of kinesiophobia ($r_{strength}=1.609$, $r_{closeness}=1.007$, $r_{betweenness}=1.095$). Network comparison tests revealed a statistically significant difference in network structure between the two subgroups ($M = 0.29$, $P = 0.022$), but no significant difference in global strength ($S = 3.27$, $P = 0.078$). Conclusion Patients after total joint arthroplasty display heterogeneous symptom characteristics across different latent profiles of kinesiophobia, with fundamental differences in psychological network structures between subgroups rather than in overall connectivity strength. For the high-kinesiophobia-fear avoidance subgroup, challenging and restructuring catastrophic thinking is central to reducing kinesiophobia, whereas for the low-kinesiophobia-activity acceptance subgroup, enhancing rehabilitation confidence should be regarded as a key intervention component for sustaining rehabilitation behaviors.

Keywords: Total joint arthroplasty; Kinesiophobia; Latent profile analysis; Network analysis

1 Introduction

Total joint arthroplasty (TJA), including hip and knee replacement, remains one of the primary treatments for end-stage osteoarthritis¹. Functional exercise, as an adjunctive treatment following total joint arthroplasty, has been recommended by the AAOS guidelines² to optimize outcomes and patients' quality of life. However, patients often fear that exercise may induce complications such as prosthetic joint dislocation, leading to reduced engagement and suboptimal adherence to postoperative rehabilitation. According to the fear-avoidance model³, this excessive and irrational fear of movement is defined as kinesiophobia. A recent systematic review and meta-analysis⁴ has confirmed a substantial prevalence of kinesiophobia among patients undergoing total joint arthroplasty. Previous studies have also demonstrated that kinesiophobia is closely associated with pain intensity, pain catastrophizing, rehabilitation self-efficacy, and social support, and that these factors may mediate the detrimental effects of kinesiophobia on functional recovery and disease management outcomes^{5,6}. Given its detrimental impact on outcomes, kinesiophobia in the population warrants urgent investigation.

Previous studies have used latent profile analysis (LPA) based on the Tampa Scale for Kinesiophobia (TSK) to assess the heterogeneity of kinesiophobia levels in patients after total hip arthroplasty and to distinguish the characteristics and related factors among subgroups⁷. However, these studies did not reveal that symptom interrelationships form complex network structures rather than simple linear associations, nor has such network analysis been specifically conducted in patients undergoing total joint arthroplasty. This population is of particular interest because individual background, cognition and emotion, coping style, and social support, as key components of the stress-multifactorial system, are closely intertwined and may jointly influence kinesiophobia through complex pathways. Given the multidimensional nature of kinesiophobia and the unique challenges faced by patients, adopting a comprehensive framework to investigate its influencing factors is imperative. Network analysis, as an effective tool for operationalizing this framework, can not only reveal associations among symptoms, but also identify key nodes and complex relationships among latent variables within the symptom network, offering novel targets for precise symptom management⁸.

The System-based Model of Stress(SMS) developed by QianJin Jiang⁹ posits that stress responses arise from the dynamic interaction of multiple factors across four supports: individual background, cognition and emotion, coping style, and social support. Accordingly, the aims of this study are: (1) to identify subgroups of kinesiophobia and determine cut-off values for subgroup classification; (2) to explore influencing factors based on the Multifactorial Stress System model; (3) to construct networks linking kinesiophobia subgroups with these four dimensions, identify the core dimension, and explore potential underlying mechanisms.

2 Methods

2.1 Participants and Sample Size

This study adopted a cross-sectional survey design with convenience sampling. Participants were patients after total joint arthroplasty, recruited from an orthopedic center in Hangzhou between April 2025 and July 2026. Inclusion criteria for the survey encompassed individuals who (1) underwent primary total hip or knee arthroplasty and were aged ≥ 18 years; (2) were at postoperative day 7 (range ± 2 days); (3) had intact cognitive function and sufficient language and reading ability; (4) provided written informed consent and agreed to participate voluntarily. Exclusion criteria: (1) had other musculoskeletal disorders severely affecting lower-extremity function that rendered them unable to walk; (2) had severe cardiac, pulmonary, renal, or other organic diseases or serious complications that, in the attending physician's judgment, precluded participation in rehabilitation; (3) had a diagnosed psychiatric disorder that would impede cooperation with the study protocol or rehabilitation; (4) presented any contraindication to therapeutic exercise. Sample size was determined based on the requirements of each analytical approach. For LPA, simulation studies recommend a minimum sample size of 200 to reliably detect 2-4 profiles, with each subgroup comprising at least 5% of the total sample¹⁰. For the subsequent binary logistic regression involving 22 independent variables, a minimum of 10 events per variable was required, indicating that at least 220 participants would be needed¹¹. For the network analysis conducted within each subgroup, we specified 5 nodes (kinesiophobia, pain intensity, pain catastrophizing, rehabilitation self-efficacy, and social support). The number of estimated edges in an undirected network was calculated as $[5 * \frac{5-1}{2}] = 10$, indicating parameters to be estimated. To

ensure reliability, we aimed for 3 to 5 cases per parameter, which meant that 30 to 50 cases per subgroup were necessary. Therefore, our final sample of 250 participants, with a minimum subgroup size of 64, satisfied the rigorous criteria established for thorough analysis.

2.2 Instruments

Based on the SMS, the influencing factors of kinesiophobia were categorized into four domains: individual background, cognition and emotion, coping style, and social support. The specific variables and their corresponding assessment tools are described below.

2.2.1 Individual background

Demographic and clinical data were collected using a self-designed questionnaire. The collected variables included demographic characteristics (age, sex, BMI, marital status, educational level, occupation and preoperative physical activity frequency), disease-related factors (surgical type, disease duration, number of complications, type of analgesics, and daily pain duration), and coping style-related factors (caregiver status).

2.2.2 Tampa Scale of Kinesiophobia

The Tampa Scale for kinesiophobia (TSK-17) was originally developed by Miller¹² et al. and was later adapted into Chinese by Hu¹³ in 2012 for assessing kinesiophobia in patients after total joint arthroplasty. The Chinese version of the TSK comprises 17 items across two dimensions. Each item is rated on a 4-point Likert scale, with responses ranging from 1 (strongly disagree) to 4 (strongly agree), where items 4, 8, 12, and 16 are reverse-scored. Total scores range from 17 to 68, with a score >37 indicating the presence of kinesiophobia, and higher scores reflecting more severe kinesiophobia. The Chinese version of the TSK has demonstrated satisfactory psychometric properties, with a Cronbach's α coefficient of 0.778 and a test-retest reliability of 0.860¹³.

2.2.3 Visual Analogue Scale

Pain intensity was assessed using the Visual Analogue Scale (VAS)¹⁴. Patients were asked to mark a point on a straight line that best represented their pain experience, with scores ranging from 0 (no pain) to 10 (worst possible pain). Higher scores indicated greater pain intensity. The VAS has demonstrated good reliability in previous studies, with a Cronbach's α of 0.90 and a test-retest reliability of 0.922¹⁵.

2.2.4 Pain Catastrophizing Scale

Pain catastrophizing was assessed using the Pain Catastrophizing Scale (PCS), a 13-item self-report instrument originally developed by Sullivan et al¹⁶. The scale comprises three subdomains, namely rumination, magnification, and helplessness, with each item rated on a 5-point Likert scale from 0 ("not at all") to 4 ("all the time"). Total scores range from 0 to 52, with higher scores reflecting higher levels of pain catastrophizing. The Chinese version of the PCS has demonstrated sound psychometric properties in prior validation studies, showing a Cronbach's α of 0.927 and a test–retest reliability coefficient of 0.969¹⁷.

2.2.5 Rehabilitation self-efficacy

Rehabilitation self-efficacy was assessed using the Chinese version of the Self-Efficacy for Rehabilitation outcome Scale (SER), translated by Wang Haiyan et al¹⁸. The scale consists of 12 items, each rated on an 11-point Likert scale from 0 to 10, with total scores ranging from 0 to 120. Higher scores indicate higher levels of rehabilitation self-efficacy. The Cronbach's α coefficient for the Chinese version of the SER was 0.942.

2.2.6 Social Support Rating Scale

Social support was assessed using the Social Support Rating Scale (SSRS), a 10-item instrument developed by Xiao Shuiyuan¹⁹. The scale evaluates social support from three dimensions: objective support, subjective support, and utilization of support. Total scores range from 12 to 66, with higher scores indicating higher levels of social support. The Chinese version of the SSRS has demonstrated good reliability, with a Cronbach's α of 0.832²⁰.

2.2.7 Kessler Psychological Distress Scale

Psychological distress was assessed using the Kessler Psychological Distress Scale (K-10), a 10-item self-report instrument originally developed by Kessler²¹ et al. Each item is rated on a 5-point Likert scale from 1 ("none of the time") to 5 ("all of the time"), with total scores ranging from 10 to 50. Higher scores indicate more severe psychological distress. The Chinese version of the K-10 has demonstrated sound psychometric properties in prior validation studies, showing a Cronbach's α of 0.801 and a test–retest reliability coefficient of 0.969²².

2.2.8 Pain Resilience Scale

Pain resilience was assessed using the Pain Resilience Scale (PRS), a 14-item self-report measure originally developed by Slepian et al²³. Each item is rated on a 5-point Likert scale from 0 ("never") to 4 ("always"), yielding a total score ranging from 0 to 56, with higher scores indicating

greater pain resilience. The Chinese version of the PRS has been previously validated, demonstrating good internal consistency (Cronbach's $\alpha = 0.92$) and test-retest reliability (ICC = 0.81)²⁴.

2.2.9 Simplified Coping Style Questionnaire

Coping styles were assessed using the Simplified Coping Style Questionnaire (SCSQ) developed by Xie YN²⁵. The scale comprises two dimensions: positive coping (items 1 to 12, range 0–35) and negative coping (items 13 to 20, range 0–24). Each item is scored from 0 (“not used”) to 3 (“frequently used”), with higher scores indicating a greater preference for that coping style. Previous studies have reported Cronbach's α values of 0.90 and 0.75 for the two subscales, indicating satisfactory reliability²⁶.

2.2.10 DOI

Disability related to low back pain was assessed using the Oswestry Disability Index (ODI)²⁷. The scale comprises 10 items covering pain intensity, personal care, lifting, walking, sitting, standing, sleeping, sex life, social life, and travelling. Each item is scored from 0 to 5, with the total score calculated as (sum of item scores / total possible score) $\times$ 100%, yielding a range of 0–100%. Higher scores indicate greater perceived disability. Previous studies have reported Cronbach's α values ranging from 0.87 to 0.94 across different populations, indicating satisfactory reliability²⁸.

2.3 Data collection and rigor

This study was approved by the Medical Ethics Committee of the First Affiliated Hospital of Zhejiang Chinese Medical University (2025-KLS-602-01), and all participants provided written informed consent and voluntarily agreed to participate in the study. The first postoperative week constitutes a critical time window, marked by substantially elevated pain intensity, sustained high levels of kinesiophobia, and the typical initiation of early rehabilitation. Hence, kinesiophobia was specifically assessed on postoperative day 7 to characterize its early features and to inform timely clinical decision-making. Following approval from the relevant hospital departments and clinical units, face-to-face questionnaire surveys were conducted by two uniformly trained master's-level nursing students among patients who met the inclusion criteria and provided written informed consent. Demographic and clinical data were retrieved from the hospital's inpatient information system, and the remaining scales were administered on postoperative day 7 (range ± 2 days). The questionnaires were completed anonymously and independently in a face-to-face setting. For

patients who were unable to complete the questionnaire on their own, the researcher read each item aloud and recorded the responses verbatim. All questionnaires were retrieved immediately upon completion and checked for missing or incomplete items. Any omissions were filled in on the spot to ensure, to the greatest extent possible, the validity and completeness of the data. All data were double-checked by two independent researchers and then entered the database. A total of 256 questionnaires were distributed. After excluding 6 invalid responses characterized by obvious response patterns, inconsistent answers to similar items, or logical contradictions, 250 valid questionnaires were finally retained, yielding an effective response rate of 97.65%.

2.4 Data analysis

2.4.1 Latent Profile Analysis

Latent profile analysis (LPA) was performed using Mplus version 8.0, with scores of the kinesiophobia scale were entered as indicators. Models with 1 to 4 latent classes were estimated. Model selection was based on the Akaike information criterion (AIC), Bayesian information criterion (BIC), and sample-size adjusted BIC (aBIC), with lower values indicating better fit. The Lo-Mendell-Rubin adjusted likelihood ratio test (LMRT) and the bootstrapped likelihood ratio test (BLRT) were used to compare models with k versus $k-1$ classes; a significant P value (<0.05) indicated that the k -class model was superior. Classification accuracy was evaluated using entropy, with values >0.8 indicating acceptable classification. Receiver operating characteristic curve analysis was performed to determine the optimal cut-off value for the kinesiophobia scale, using the latent classes derived from LPA as the reference standard. The Youden index was employed to select the cut-off that maximized both sensitivity and specificity.

2.4.2 Statistical Analysis

SPSS version 25.0 was used for data analysis. Continuous variables were first tested for normality using the Kolmogorov–Smirnov test. Normally distributed continuous variables were expressed as mean $\pm$ standard deviation (SD), while non-normally distributed variables were presented as median (interquartile range, IQR). Categorical variables were reported as frequencies and percentages. Comparisons between subgroups were performed using the χ^2 test for categorical variables and the Mann–Whitney U test for non-normally distributed continuous variables. The Bonferroni correction was applied for post hoc pairwise comparisons. Variables with $P < 0.05$ in

univariate analyses were entered as candidates into a binary logistic regression model using forward stepwise selection.

2.4.3 Network Analysis

The selection of variables for network analysis was guided by the Stress-multifactorial system model (SMS) developed by Qianjin Jiang. Within this framework, five core variables were selected to represent key components of the stress response system: pain intensity as a disease-related stressor within the individual background dimension, pain catastrophizing (PCS) as a maladaptive cognitive appraisal within the cognition and emotion dimension, rehabilitation self-efficacy (SER) as a protective internal resource and social support (SSRS) as an external resource within the social support dimension, and kinesiophobia (TSK) as the primary stress outcome. Coping style was not included as a node in the network analysis, as preliminary analyses indicated that its inclusion did not alter the core network structure and would have unnecessarily increased model complexity; instead, it was examined as a predictor in the logistic regression analysis. As all variables were continuous, Gaussian graphical models were used to construct the networks using the R package “qgraph”(EBICglasso function)²⁹. Networks were regularized using the Least Absolute Shrinkage and Selection Operator (LASSO), guided by the Extended Bayesian Information Criterion (EBIC) model selection (gamma=0.5). The centrality indices (node strength, betweenness, and closeness) were calculated to evaluate node importance³⁰. Network stability was assessed using the R package "bootnet" with 1,000 bootstrap samples³¹. The Network Comparison Test was used to compare network structure and global strength between subgroups. Statistical significance was set at $P<0.05$.

3 Results

3.1 Participant characteristics

The study population consisted of 96 males and 154 females. The median kinesiophobia score was 36.0(34.0,42.0), and the prevalence of kinesiophobia was 48.8%.Participants' characteristics are reported in Table 1.

3.2 Analysis of the latent profile and characteristics of Kinesiophobia in total joint arthroplasty

As the number of classes increased from 1 to 4, AIC, BIC, and aBIC progressively decreased, indicating improved model fit. The BLRT was significant for all class solutions, whereas the LMR test was significant for the 2-, 3-, and 4-class models ($P > 0.05$). Entropy values were 0.76 for the 2-class model, 0.54 for the 3-class model, and 0.62 for the 4-class model. Although the BLRT favored more classes, the 2-class model yielded the highest entropy, providing the best classification accuracy. After comprehensively considering the advantages of subgroup classification accuracy, the necessity of establishing a cut-off value for kinesiophobia, and the importance of parsimoniousness and interpretability, we selected the two-class model as the optimal one. Table 2 shows all fit indices for LPA with 1–4 classes.

The latent profile analysis (LPA) divided the sample into two distinct subgroups, with profile patterns across TSK-17 items shown in Fig. 1. Class 1 ($n = 184$, 73.6%) had a median total TSK-17 score of 35.0 (34.0, 38.0) and lower mean scores than Class 2 on 16 items (differences: 0.19–0.70), and was characterized by acceptance of physical activity and absence of avoidance behavior and was named the “low kinesiophobia-activity acceptance group”. In contrast, Class 2 ($n = 66$, 26.4%) had a median total TSK-17 score of 44.0 (42.0, 45.0) and significantly higher scores on most items, and exhibited pronounced fear-avoidance beliefs and excessive somatic focus, leading to its designation as the “high kinesiophobia-fear avoidance group”. The scores on TSK_7 were similar between the two groups (2.41 vs. 2.40). The median kinesiophobia scores differed significantly between the two subgroups (*Mann-Whitney Z* = -11.656, $P < 0.01$), confirming the distinctiveness of the classification.

3.3 Heterogeneity of characteristics and kinesiophobia between different subgroups

Univariate analyses were performed to examine differences between the two kinesiophobia subgroups across variables. As presented in Table 1, the two groups differed significantly in caregiver status, frequency of physical activity, and pain intensity (all $P < 0.05$). Furthermore, statistically significant differences were also observed between the two groups in disease duration, daily pain duration, pain catastrophizing, psychological distress, Oswestry Disability Index, coping style, social support, and rehabilitation self-efficacy (all $P < 0.05$) (Table 1).

3.4 Influencing factor of kinesiophobia

A binary logistic regression model was constructed with kinesiophobia subgroup (Class 1 = low-kinesiophobia-activity acceptance group, Class 2 = high-kinesiophobia-fear avoidance group) as the dependent variable. Variables with $P < 0.05$ in univariate analysis were entered as candidates into the regression model using the enter method, with age and sex forced into the model as clinically important covariates. Multicollinearity was assessed using variance inflation factor (VIF), and all VIF values were < 5 , indicating no significant collinearity. Table 3 presents the variables entered into the binary logistic regression model based on univariate screening. The results are reported across four conceptual dimensions: (1) Individual factors: Higher preoperative physical activity frequency (≥ 4 times per week) was associated with increased risk [OR = 7.484, 95% CI: 0.955–58.634, $P = 0.045$], whereas a frequency of 1–3 times per week did not significantly differ from the reference group [OR = 1.345, $P = 0.723$]. Longer daily pain duration [OR = 2.723, 95% CI: 1.268–5.850, $P = 0.01$] and higher Oswestry Disability Index scores [OR = 1.278, 95% CI: 1.091–1.496, $P < 0.01$] were independently associated with increased risk. Pain intensity ≥ 4 score [OR = 1.946, $P = 0.446$], disease duration [OR = 1.005, $P = 0.937$] did not independently predict kinesiophobia. (2) Cognitive and emotional factors: Neither pain catastrophizing [OR = 1.048, 95% CI: 0.925–1.188, $P = 0.459$] nor psychological distress [OR = 0.885, 95% CI: 0.714–1.097, $P = 0.265$] independently predicted kinesiophobia. (3) Coping Style: Negative coping style emerged as a significant risk factor for kinesiophobia [OR = 2.142, 95% CI: 1.303–3.522, $P < 0.01$], whereas positive coping style showed no independent association [OR = 0.903, 95% CI: 0.728–1.120, $P = 0.354$]. (4) Social Support: Professional caregiver status was identified as a risk factor for kinesiophobia [OR = 40.876, 95% CI: 1.013–1.502, $P = 0.045$], whereas care by children [OR = 0.444, $P = 0.462$] or other relatives [OR = 0.388, $P = 0.247$] showed no significant association compared with spousal care. Higher rehabilitation self-efficacy was identified as a protective factor against kinesiophobia [OR = 0.842, 95% CI: 0.776–0.913, $P < 0.01$], whereas social support showed no independent association with kinesiophobia [OR = 1.109, 95% CI: 0.964–1.276, $P = 0.149$]. The Hosmer-Lemeshow test indicated good model fit ($\chi^2 = 1.017$, $df = 8$, $P = 0.989$). The area under the ROC curve (AUC) was 0.986 (95% CI: 0.975–0.997), demonstrating excellent discriminatory ability. To facilitate clinical screening, ROC analysis was performed to determine the optimal cut-off value of the total TSK score for identifying patients with high kinesiophobia, using the LPA-derived subgroups as the reference standard. The AUC for the total TSK score in discriminating high

kinesiophobia was 0.982 (95% CI: 0.975–0.997). Based on the maximum Youden index, the optimal cut-off value was 38.5, yielding a sensitivity of 97.0% and a specificity of 98.4%. Since the scale scores are integers, a total TSK score of ≥ 39 was defined as high kinesiophobia.

3.5 Networks of difference kinesiophobia subgroups

3.5.1 Network structure

Fig. 2A presents the network structure for the “low kinesiophobia-activity acceptance” subgroup. In this network, rehabilitation self-efficacy (SER) showed the strongest connection with social support (SSRS) ($r = 0.16$), followed by pain catastrophizing (PCS) with SER ($r = 0.13$), PCS with TSK ($r = 0.05$), and PCS with SSRS ($r = 0.03$). Weak negative correlations were observed between SSRS and TSK ($r = -0.01$), SSRS and VAS ($r = -0.07$), and SER and TSK ($r = -0.02$). Fig. 2B presents the network structure for the “high kinesiophobia-fear avoidance” subgroup. In this network, pain catastrophizing (PCS) showed the strongest connection with SER ($r = 0.21$), followed by PCS with VAS ($r = 0.10$), PCS with SSRS ($r = 0.06$), PCS with TSK ($r = 0.04$), and VAS with TSK ($r = 0.06$). A weak negative correlation was observed between SSRS and TSK ($r = -0.07$).

3.5.2 Centrality analysis

Fig. 3 displays the centrality indices for both subgroups. In the low kinesiophobia-activity acceptance group, the top three nodes in terms of strength were rehabilitation self-efficacy ($r_{strength} = 1.609$), social support ($r_{strength} = 1.452$), and pain catastrophizing ($r_{strength} = 1.238$); the top three nodes in terms of closeness were rehabilitation self-efficacy ($r_{closeness} = 1.007$), social support ($r_{closeness} = 0.876$), and pain catastrophizing ($r_{closeness} = 0.754$); and the top three nodes in terms of betweenness were rehabilitation self-efficacy ($r_{betweenness} = 1.095$), social support ($r_{betweenness} = 0.832$), and pain catastrophizing ($r_{betweenness} = 0.621$). Taken together, rehabilitation self-efficacy ranked consistently high across all three centrality indices and exhibited the highest strength, and was therefore identified as the most central node in this network. In the high kinesiophobia-fear avoidance group, the top three nodes in terms of strength were pain catastrophizing ($r_{strength} = 1.424$), rehabilitation self-efficacy ($r_{strength} = 1.135$), and pain intensity ($r_{strength} = 0.976$); the top three nodes in terms of closeness were pain catastrophizing ($r_{closeness} = 1.224$), rehabilitation self-efficacy ($r_{closeness} = 1.018$), and pain intensity ($r_{closeness} = 0.892$); and the top three nodes in terms of betweenness were pain catastrophizing ($r_{betweenness} = 1.565$), rehabilitation self-efficacy ($r_{betweenness} =$

1.121), and pain intensity ($r_{\text{betweenness}} = 0.876$). Accordingly, pain catastrophizing was identified as the most central node in this network (Fig. 3).

3.5.3 Network stability and invariance testing

The case-dropping subset bootstrap demonstrated good stability for all three centrality indices. The stability coefficients for strength in the low- and high-kinesiophobia groups were 0.78 and 0.68, respectively; those for closeness were 0.68 and 0.60, respectively; and those for betweenness were 0.60 and 0.52, respectively (Fig. 4), suggesting good stability for strength and acceptable stability for closeness and betweenness. Network invariance testing revealed a statistically significant difference in network structure between the two subgroups ($P = 0.022$), but no significant difference in global strength ($P = 0.078$), indicating that the two subgroups differed in network structure rather than overall connectivity strength (Fig. 5).

4 Discussion

The present study is the first to employ latent profile analysis (LPA) to identify two distinct subgroups of kinesiophobia among 250 patients undergoing total joint arthroplasty and to establish an optimal cut-off value for identifying patients with high levels of kinesiophobia. Additionally, guided by the System-based Model, this study investigated the factors influencing kinesiophobia. On this basis, network analyses were further constructed to examine the relationships between kinesiophobia and pain intensity, pain catastrophizing, rehabilitation self-efficacy, and social support. This integrated approach enabled us to identify subgroup-specific core dimensions and to elucidate the distinct network architectures underlying the two subgroups.

4.1 Clinical implication of subgroup identification

The study identified two distinct subgroups of kinesiophobia among patients undergoing total joint arthroplasty: a "low kinesiophobia-activity acceptance group" (73.6%) and a "high kinesiophobia-fear avoidance group" (26.4%). We further applied ROC analysis anchored to the LPA-derived subgroups and established an optimal cut-off value of 39 for identifying patients with high-level kinesiophobia. Based on this cut-off, 26.4% of patients in our cohort were classified as having high-level kinesiophobia. Previous studies typically used a cut-off of 37 to identify kinesiophobia regardless of severity, whereas our threshold of 39 specifically identifies patients

with high-level kinesiophobia. The importance of such identification is underscored by the well-documented negative impact of kinesiophobia on postoperative recovery. Accumulating evidence has demonstrated that kinesiophobia contributes to muscle weakness and delayed joint recovery, ultimately attenuating the health benefits conferred by arthroplasty^{32,33}, and this association is further supported by our finding that the high kinesiophobia-fear avoidance group exhibited significantly greater functional impairment. These findings underscore the importance of early identification and targeted intervention for kinesiophobia in perioperative care. Given the high prevalence of kinesiophobia and its detrimental impact on functional outcomes, routine screening using the proposed 39-point cut-off to identify patients with high-level kinesiophobia may represent a practical strategy to optimize recovery and preserve the long-term benefits of total joint arthroplasty.

We observed that patients in the "high-kinesiophobia-fear avoidance group" scored higher on most TSK-17 items, reflecting pronounced fear-avoidance beliefs regarding functional exercise and heightened vigilance to physical discomfort, whereas those in the "low-kinesiophobia-activity acceptance group" demonstrated greater acceptance of physical activity and an absence of overt avoidance behaviors. Notably, both subgroups showed comparable scores on the item "pain means tissue damage," suggesting that pain cognition may play a more critical role than kinesiophobia severity in shaping patients' interpretation of somatic signals. This pattern can be understood through the stress-multifactorial system model⁹. According to this model, when individuals perceive painful experiences, fear of exercise and maladaptive pain beliefs interact with physiological and psychological stressors, reinforcing counterproductive responses that impede recovery, irrespective of kinesiophobia severity. Our findings align with previous reports emphasizing the pivotal role of pain cognition in postoperative recovery, underscoring that pain is commonly misattributed to ongoing tissue damage rather than recognized as a normative phenomenon during recovery^{34,35}.

4.2 The core dimension of kinesiophobia in subgroups

Network comparison tests revealed significant differences in network structure between the two kinesiophobia subgroups, but no significant difference in global strength. This dissociation suggests that the distinction between the two groups arises not from the overall density of intervariable connections, but rather from differential patterns of connectivity, implying that kinesiophobia may be sustained by distinct core drivers across severity levels. In the high-fear

avoidance subgroup, pain catastrophizing emerged as the central network node, exhibiting weak correlations with pain intensity and social support but a moderate negative correlation with rehabilitation self-efficacy. The System-based model provides a theoretical framework for interpreting the positive association between kinesiophobia and pain catastrophizing. According to this model, when pain is perceived as a threatening stimulus, catastrophic cognitive appraisals amplify harm perception and increase vigilance toward somatic sensations, thereby reinforcing fear-avoidance beliefs and perpetuating kinesiophobia. Previous studies have similarly established pain catastrophizing as a critical amplifier in the cognitive appraisal process, leading to overestimation of injury risk and subsequent avoidance behaviors³⁶. In the present network, the influence of catastrophizing operated primarily through undermining rehabilitation confidence, rather than through its connections with pain severity or external support. Consequently, interventions targeting pain catastrophizing may offer the greatest benefit in reducing kinesiophobia among high-risk patients, particularly when integrated with strategies that bolster rehabilitation self-efficacy. Based on these findings, for the high fear-avoidance subgroup, cognitive restructuring techniques derived from cognitive behavioral therapy are recommended to modify catastrophic pain interpretations. The present study identified rehabilitation self-efficacy as the core node sustaining positive behavioral patterns in the low-kinesiophobia activity acceptance subgroup. Its moderate correlation with pain catastrophizing, coupled with weak associations with other factors, suggests that self-efficacy may function as a relatively independent psychological resource. The clinical relevance of this resource is supported by previous studies, which have confirmed a link between self-efficacy and rehabilitation engagement and functional outcomes following total joint arthroplasty³⁷. A review demonstrated that rehabilitation self-efficacy serves as a crucial predictor of future kinesiophobia, indicating that an individual's level of self-efficacy in the early stages may effectively predict the potential challenges they might encounter later when outcomes fall short of expectations³⁸. Clinical interventions for this subgroup should not be oriented merely toward fear reduction, but toward strengthening patients' rehabilitation confidence through mastery experiences and skills training. Clinical efforts should focus on standardized rehabilitation assessment and precise guidance, with regular follow-up visits to dynamically monitor changes in kinesiophobia and adjust rehabilitation plans in a timely manner.

Notably, the connection between SER and PCS consistently represented the strongest edge in both networks, suggesting that the interplay between rehabilitation self-efficacy and pain catastrophizing constitutes a core cognitive conflict underlying kinesiophobia, regardless of subgroup membership. Thus, when examining the network architecture of kinesiophobia, a notable pattern emerged: the dynamic balance between these two cognitive forces, rather than the presence of either alone, critically shapes the trajectory of fear-avoidance behaviors and may determine whether patients remain trapped in fear avoidance or sustain active rehabilitation. This finding aligns with longitudinal evidence from Slepian et al.³⁹, who demonstrated that the predictive power of the fear-avoidance model is enhanced when both pain-related vulnerability (catastrophizing) and protective resources (self-efficacy) are considered simultaneously.

4.3 The core influencing factor of the subgroup

According to Jiang's System-based model⁹, kinesiophobia can be conceptualized as a stress response arising from the dynamic interaction of multiple systemic factors. Guided by this framework, we examined potential contributors to kinesiophobia across four interrelated domains. Preoperative physical activity frequency (≥ 4 times per week) was associated with an increased risk of postoperative kinesiophobia. This association may be conceptualized as follows: patients with regular preoperative physical activity accumulate negative experiences during activity, which progressively reinforce avoidance responses and ultimately culminate in a stress response pattern characterized by activity avoidance. In contrast, patients with lower preoperative activity frequency, lacking such negative experiences, tend to be more compliant with professional rehabilitation guidance postoperatively. These findings suggest that, for patients with high preoperative activity frequency, preoperative psychological education interventions targeting activity-related expectations should be explored as a potential strategy to reduce the risk of kinesiophobia. Disease duration was not independently associated with kinesiophobia, suggesting that the time elapsed from symptom onset to surgery is not a critical determinant of kinesiophobia development. Rather, kinesiophobia appears to be driven more by daily pain exposure and functional limitations. This finding helps to explain why daily pain duration, which is a measure of cumulative pain exposure, emerged as a significant predictor of kinesiophobia, as prolonged pain exposure may reinforce the belief that "activity is dangerous" through repeated conditioning⁴⁰. Notably, pain intensity, as a single-timepoint measure, did not reach statistical significance after adjusting for other variables.

Although this finding differs from the results of some previous studies, the discrepancy may be attributable to the inability of a single-timepoint pain intensity assessment to capture the temporal pattern of pain exposure⁴¹. These findings suggest that the core drivers of kinesiophobia are not pain intensity per se, but rather the cumulative frequency of pain experiences and the degree of functional limitation, which remained an independent risk factor in the regression model. A possible mechanism is that repeated difficulties in basic activities may lead patients to perceive their physical condition as too weak for rehabilitation training, thereby reinforcing fear-avoidant behaviors⁴².

Cognitive and emotional responses determine individuals' initial perception of threat. In the present study, neither pain catastrophizing nor psychological distress independently predicted kinesiophobia, a finding that differs from previous research positioning these two variables as core components of the fear-avoidance model. However, it is possible that pain catastrophizing, characterized by rumination, magnification, and helplessness, may interact with rehabilitation self-efficacy to shift patients toward avoidance-oriented behavioral responses. This suggests that the interplay between catastrophic interpretations of functional exercise and rehabilitation self-efficacy may indirectly contribute to kinesiophobia, a hypothesis that warrants further investigation through formal mediation or interaction analyses. Similarly, psychological distress did not independently predict kinesiophobia. This may be because psychological distress reflects the behavioral consequences rather than the causes of kinesiophobia. Alternatively, as suggested by previous research, psychological distress may share overlapping variance with other variables in the model⁴³. However, these explanations remain speculative, and future studies are warranted to conduct mediation analyses to examine the potential mediating role of passive coping in the relationship between pain catastrophizing and kinesiophobia, as well as to explore the bidirectional relationship between psychological distress and kinesiophobia. These findings further suggest that, although pain catastrophizing occupies a central position in the fear-avoidance model and exhibits a relatively strong network association with kinesiophobia, it did not independently predict kinesiophobia in the regression analysis. This apparently paradoxical result suggests that the effect of pain catastrophizing on kinesiophobia may not be direct, but rather indirectly transmitted through behavioral pathways such as passive coping. Therefore, although cognitive and emotional factors undoubtedly warrant attention in clinical assessment, our findings emphasize the importance of

directly targeting avoidance behaviors rather than focusing solely on cognitive interventions in the management of kinesiophobia.

Social support is commonly regarded as a key factor in modulating individuals' cognitive appraisal of stressors and their subsequent coping responses. In this context, higher rehabilitation self-efficacy emerged as a protective factor against kinesiophobia, reflected in patients' greater confidence in their own abilities. This confidence enables them to actively adhere to functional exercise and promotes behavioral engagement rather than avoidance. Moreover, self-efficacy is clinically modifiable, and future interventions may consider enhancing patients' psychological status through mastery experiences, verbal persuasion, and emotional management. In contrast, social support did not independently predict kinesiophobia. This may be attributable to the fact that social support in the present study primarily reflected the availability of support (e.g., sources such as family and friends), rather than the quality of support. Notably, compared with patients who received care from their spouses, those who received care from professional caregivers exhibited a higher risk of postoperative kinesiophobia, whereas patients cared for by their children or other relatives did not show a statistically significant difference in kinesiophobia risk. A possible explanation for this difference is that patients residing in institutional care settings, despite receiving more professional support, may lack the emotional support and secure attachment provided by family members⁴⁴. However, merely having access to support sources may be insufficient to reduce the risk of kinesiophobia. What appears to be more critical is whether the emotional security and sustained encouragement embedded in support can effectively facilitate patients' attempts at safe activity, rather than merely providing physical assistance. This distinction between "having support" and "having high-quality support" may determine whether patients can transform external support into confidence in their own rehabilitation abilities. It may also fail to translate into protective factors if patients adopt passive help-seeking rather than active coping strategies. This finding is consistent with previous research suggesting that the quality of emotional bonding and sense of security is more important than the source of support itself⁴⁵. Future studies are warranted to further investigate the specific mechanisms through which social support quality contributes to the development and maintenance of kinesiophobia.

4.4 Limitations

There are certain limitations to be noted. Firstly, the convenience sampling method was adopted solely within the orthopedics and traumatology center of a single tertiary hospital in Zhejiang Province. The limited geographic scope and inadequate population representativeness may compromise the generalizability of the findings. Future studies should employ multilevel cluster sampling with larger sample sizes across diverse cultural settings to further validate the external validity of the conclusions drawn from this research. Second, the cross-sectional design of this study precludes the establishment of causal relationships between kinesiophobia and its influencing factors. Longitudinal studies incorporating key indicators such as coping styles, pain exposure, and rehabilitation self-efficacy are warranted to elucidate the temporal trajectories of these associations. Future research is recommended to focus on the core variables within these indicators, which may inform the development of targeted therapeutic strategies and contribute to a deeper understanding of the mechanisms underlying the role of kinesiophobia in rehabilitation outcomes following hip and knee arthroplasty. Third, the reliance on self-reported data should be acknowledged when interpreting the findings. Given this limitation, future qualitative or mixed-methods studies are warranted to explore the practical difficulties faced by patients with high levels of kinesiophobia following total hip arthroplasty, which may inform the development of more ecologically valid intervention strategies in clinical practice.

5 Conclusions

This study identified heterogeneity in kinesiophobia among patients undergoing total joint arthroplasty through latent profile analysis. Network analysis further revealed that, although no significant differences were observed in network structure between the two subgroups, the identification of core symptoms elucidated the key drivers of kinesiophobia specific to each subgroup: pain catastrophizing emerged as the core symptom in the “high-kinesiophobia-fear avoidance group”, whereas rehabilitation self-efficacy served as the core symptom in the “low-kinesiophobia-fear avoidance group”. These findings suggest that the distinction between subgroups may arise from differences in connectivity patterns among variables, and that the interplay between pain catastrophizing and rehabilitation self-efficacy may constitute a core cognitive conflict underlying kinesiophobia across subgroups. Moreover, factors such as rehabilitation self-efficacy

and negative coping styles were identified as independent influencing factors of kinesiophobia. These findings provide a basis for implementing core symptom-based precision management of kinesiophobia in clinical practice, which may contribute to reducing kinesiophobia levels in patients after total joint arthroplasty.

Reference:

1. I U. Surgical Treatments for Osteoarthritis. *Eur J Rheumatol* 2024. p. S41-S47.
2. Hannon CP, Delanois RE, Nandi S, Fillingham Y. American Academy of Orthopaedic Surgeons Clinical Practice Guideline Summary Management of Osteoarthritis of the Hip. *J Am Acad Orthop Surg*. Oct 15 2024;32(20):e1027-e1034. doi:10.5435/jaaos-d-24-00420
3. Vlaeyen JWS, Linton SJ. Fear-avoidance and its consequences in chronic musculoskeletal pain: a state of the art. *Pain*. Apr 2000;85(3):317-332. doi:10.1016/s0304-3959(99)00242-0
4. Li XQ GH, Xu XT, Ding LF. Risk factors for kinesiophobia in patients after total hip and knee arthroplasty: A meta-analysis. *China Journal of Convalescent Medicine*. 2024;33(6):49-53.
5. Zhou Y, Gao W, Gao S, Guo X, Liu M, Cao C. Pain Catastrophizing, Kinesiophobia and Exercise Adherence in Patients After Total Knee Arthroplasty: The Mediating Role of Exercise Self-Efficacy. *J Pain Res*. 2023;16:3993-4004. doi:10.2147/jpr.S432106
6. Du X, Shao Y, Xue J, Kong J. Prevalence and influencing factors of kinesiophobia after total knee arthroplasty: a systematic review and meta-analysis. *J Orthop Surg Res*. Apr 1 2025;20(1):332. doi:10.1186/s13018-025-05752-w
7. Zhang L ZZ, Zhang CL, Fu J. Latent profile analysis and influencing factors of early postoperative kinesiophobia in elderly patients undergoing total hip arthroplasty. *Chin J Mod Nurs*. 2024;30(29):4002-4008.
8. Epskamp S, Borsboom D, Fried EI. Estimating psychological networks and their accuracy: A tutorial paper. *Behav Res Methods*. Feb 2018;50(1):195-212. doi:10.3758/s13428-017-0862-1
9. J Q. *Systemic model of psychological stress: collected works on medical psychology and psychosomatic medicine*. Scientific and Technical Documentation Press; 2024.
10. Nylund KL, Asparouhov T, Muthén BO. Deciding on the Number of Classes in Latent Class Analysis and Growth Mixture Modeling: A Monte Carlo Simulation Study. *Structural Equation Modeling A Multidisciplinary Journal*. 2007;14(4):535-569.
11. Peduzzi P, Concato J, Kemper E, Holford TR, Feinstein AR. A simulation study of the number of events per variable in logistic regression analysis. 1996;49(12):0-1379.
12. Miller RP, Kori SH, Todd DD. The Tampa Scale: a Measure of Kinisophobia. *The Clinical Journal of Pain*. 1991;7:51.
13. W H. *Cultural Adaptation of the Simplified Chinese Versions of the Tampa Scale for*

Kinesiophobia and the Fear-Avoidance Beliefs Questionnaire and Their Application in Degenerative Low Back and Leg Pain. 硕士. Second Military Medical University; 2012. https://kns.cnki.net/kcms2/article/abstract?v=R4S5WDEiKcvS3aQKTsyVzkyqyNt4UCI1BrGr557tO7xdBA0USYH8iGAle3X7GI4IjpFSo511fwSXd_zZxJOH_xArj2mDZFhsrhJLS4KZSPG4YomLI_Q073reQnjbyuMi5mmmxEUZ7w9ltVV80EMA4O6eGiKk8IKrBqMr_MEE9GKVzKsfeHySc9Nd78uF2kKQO&uniplatform=NZKPT&language=CHS

14. Lena O, Todri J. A cross-cultural adaptation study on the validity and test-retest reliability of pain assessment tools in Albanian older adults with low back pain. *Geriatr Nurs*. Jan 2026;67:103723. doi:10.1016/j.gerinurse.2025.103723

15. Badia X, Monserrat S, Roset M, Herdman M. Feasibility, validity and test-retest reliability of scaling methods for health states: the visual analogue scale and the time trade-off. *Qual Life Res*. Jun 1999;8(4):303-10. doi:10.1023/a:1008952423122

16. Sullivan, Michael, J., et al. The Pain Catastrophizing Scale: Development and validation. *Psychological Assessment*. 1995;

17. Yap JC, Lau J, Chen PP, et al. Validation of the Chinese Pain Catastrophizing Scale (HK-PCS) in patients with chronic pain. *Pain Med*. Mar 2008;9(2):186-95. doi:10.1111/j.1526-4637.2007.00307.x

18. Wang HY XY, Hu SL. Reliability and validity of the Chinese version of the Rehabilitation Self-Efficacy Scale. *Chinese Journal of Modern Nursing*. 2014;20(3):268-270.

19. SY X. Theoretical basis and research application of the Social Support Rating Scale. *J Clin Psychiatry*. 1994;4(2):3.

20. Liu JW LF, Lian YL. Reliability and validity of the Social Support Rating Scale. *J Xinjiang Med Univ*. 2008;(1):3.

21. Kessler RC, Andrews G, Colpe LJ, et al. Short screening scales to monitor population prevalences and trends in non-specific psychological distress. *Psychological Medicine*. 2002;32(6):959-976. doi:10.1017/S0033291702006074

22. Zhou CC CJ, Wang T. Reliability and validity of the Chinese version of the Kessler 10 Psychological Distress Scale. *Chin J Clin Psychol*. 2008;16(6):3.

23. Slepian PM, Ankawi B, Himawan LK, France CR. Development and Initial Validation of the Pain Resilience Scale. *J Pain*. Apr 2016;17(4):462-72. doi:10.1016/j.jpain.2015.12.010

24. He SL, Wang JH, Ji P. Validation of the Pain Resilience Scale in Chinese-speaking patients with temporomandibular disorders pain. *J Oral Rehabil*. Mar 2018;45(3):191-197. doi:10.1111/joor.12591

25. YN X. A preliminary study on the reliability and validity of the Simplified Coping Style Questionnaire. *Chin J Clin Psychol*. 1998;6(2):2.

26. Liu PP HM, Xing WL, Zhang GQ. Reliability and validity of the Simplified Coping Style Questionnaire in female patients with urinary incontinence. *Xinjiang Medical Journal*. 2024;54(4):415-419+426.

27. Fairbank JC, Pynsent PB. The Oswestry Disability Index. *Spine (Phila Pa 1976)*. Nov 15 2000;25(22):2940-52; discussion 2952. doi:10.1097/00007632-200011150-00017

28. Koivunen K, Widbom-Kolhanen S, Pernaa K, Arokoski J, Saltychev M. Reliability and validity of Oswestry Disability Index among patients undergoing lumbar spinal surgery. *BMC Surg*. Jan 3 2024;24(1):13. doi:10.1186/s12893-023-02307-w

29. Epskamp S, Cramer AOJ, Waldorp LJ, Schmittmann VD, Borsboom D. qgraph: Network Visualizations of Relationships in Psychometric Data. *Journal of Statistical Software*. 05/24 2012;48(4):1 - 18. doi:10.18637/jss.v048.i04
30. Robinaugh DJ, Millner AJ, McNally RJ. Identifying Highly Influential Nodes in the Complicated Grief Network. *J Abnorm Psychol*. 2016;125(6):747-757.
31. Epskamp S, Borsboom D, Fried EI. Estimating Psychological Networks and their Accuracy : A tutorial paper. *Springer US*. 2018;(1)
32. Doury-Panchout F, Metivier JC, Fouquet B. Kinesiophobia negatively influences recovery of joint function following total knee arthroplasty. *Eur J Phys Rehabil Med*. Apr 2015;51(2):155-61.
33. Bakırhan S, Ünver B, Elibol N, Karatosun V. Fear of movement and other associated factors in older patients with total knee arthroplasty. *Ir J Med Sci*. Oct 2023;192(5):2217-2222. doi:10.1007/s11845-022-03214-4
34. Kinoshita T, Kutsuna T, Watamori K, et al. Pain catastrophizing immediately after surgery predicts postoperative patient satisfaction one year after total knee arthroplasty. *Bone Jt Open*. Nov 13 2025;6(11):1457-1465. doi:10.1302/2633-1462.611.Bjo-2025-0076.R2
35. Sergiooris A, Verbrugghe J, Bonnechère B, et al. Inter-individual differences in early post-operative pain, cognitions, and emotions after total hip arthroplasty: A longitudinal cohort study. *Clin Rehabil*. Jun 2025;39(6):784-795. doi:10.1177/02692155251333537
36. Rogers AH, Farris SG. A meta-analysis of the associations of elements of the fear-avoidance model of chronic pain with negative affect, depression, anxiety, pain-related disability and pain intensity. *Eur J Pain*. Sep 2022;26(8):1611-1635. doi:10.1002/ejp.1994
37. Magklara E, Burton CR, Morrison V. Does self-efficacy influence recovery and well-being in osteoarthritis patients undergoing joint replacement? A systematic review. *Clin Rehabil*. Sep 2014;28(9):835-46. doi:10.1177/0269215514527843
38. Zhu WJ JD, Ji HJ, Wang YQ, Lu XQ. Relationship between rehabilitation self-efficacy and kinesiophobia in patients with lower extremity traumatic fractures: A longitudinal study based on a cross-lagged model. *Journal of Southeast University (Medical Sciences Edition)*. 2025;44(6):879-888.
39. Slepian PM, Ankawi B, France CR. Longitudinal Analysis Supports a Fear-Avoidance Model That Incorporates Pain Resilience Alongside Pain Catastrophizing. *Ann Behav Med*. Apr 20 2020;54(5):335-345. doi:10.1093/abm/kaz051
40. Sanson N, Hach S, Moran R, Mason J. Behavioural activation and inhibition systems in relation to pain intensity and duration in a sample of people experiencing chronic musculoskeletal pain. *Musculoskelet Sci Pract*. Jun 2020;47:102129. doi:10.1016/j.msksp.2020.102129
41. Stone AA, Broderick JE, Kaell AT. Single momentary assessments are not reliable outcomes for clinical trials. *Contemp Clin Trials*. Sep 2010;31(5):466-72. doi:10.1016/j.cct.2010.05.006
42. Zale EL, Lange KL, Fields SA, Ditre JW. The relation between pain-related fear and disability: a meta-analysis. *J Pain*. Oct 2013;14(10):1019-30. doi:10.1016/j.jpain.2013.05.005
43. Burri A, Ogata S, Rice D, Williams F. Pain catastrophizing, neuroticism, fear of pain,

and anxiety: Defining the genetic and environmental factors in a sample of female twins. *PLoS One*. 2018;13(3):e0194562. doi:10.1371/journal.pone.0194562

44. Assaf N, Bazzi H, Ghanem K, Saasouh W. Optimizing surgical outcomes through increased familial support in the perioperative period. Perspective. *Frontiers in Anesthesiology*. 2025;Volume 4 - 2025

45. Nasika IN, Wiart C, Bonvarlet AS, Guillaume J, Yavchitz A, Tereno S. Attachment patterns, self-compassion, and coping strategies in patients with chronic pain. *Pain Rep*. Sep 2023;8(5):e1087. doi:10.1097/pr9.0000000000001087

Ethics approval and consent to participate

This study was conducted in accordance with the principles of the Declaration of Helsinki. The protocol was approved by the Medical Ethics Committee of the First Affiliated Hospital of Zhejiang Chinese Medical University (Approval No. 2025-KLS-602-01), and written informed consent was obtained from all participants prior to their enrolment.

Consent for publication

Not applicable.

Availability of data and materials

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Competing interests

The authors declare that they have no competing interests.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Authors' contributions

Shuoni Ren¹: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing – original draft.

Yanan Kan²: Methodology, Resources, Validation, Writing – review & editing.

Yuqiu Yuan¹: Data curation, Formal analysis, Software, Visualization, Writing – review & editing.

Fuying Ye³: Conceptualization, Project administration, Supervision

Acknowledgements

The authors thank the patients for their valuable assistance in contribution

**Table 1 Differences in participant characteristics between “low-kinesiphobia activity acceptance “and
“high-kinesiophobia-fear avoidance group” (N=250)**

Variables	Total sample(n=250) n(%) or Median(P25,P75)	Class1(n=184,73.6%) , n(%)or Median(P25,P75)	Class1(n=66,26.4 %), n(%)or Median(P25,P75)	χ^2/Z	P
Age (years)					
<65	87 (34.8)	66 (75.9)	21 (24.1)	$\chi^2=0.617$	0.735
65~80	126 (50.4)	90 (71.4)	36 (28.6)		
>80	37 (14.8)	28 (75.7)	9 (24.3)		
Sex					
Male	96(38.4)	73 (76.0)	23(24.0)	$\chi^2=0.478$	0.489
Female	154(61.6)	111(72.1)	154(27.9)		
BMI (kg/m²)					
<18.5	9(3.6)	5(55.6)	4(44.4)	$\chi^2=2.748$	0.429
≥18.5 and <25	123(49.2)	94(76.4)	29(23.6)		
≥25	107(42.8)	76(71.0)	31(29.0)		
Bed rest	11(4.4)	9(81.8)	2(18.2)		
Marital status					
Married	208(83.2)	149(71.6)	59(28.3)	$\chi^2=2.509$	0.259
Single	11(4.4)	10(90.9)	1(9.1)		
Divorced/Widowed	31(12.4)	25(80.6)	6(19.3)		
Educational level					
Primary school or below	117(46.8)	81(69.3)	36(30.7)	$\chi^2=2.683$	0.261
Junior or senior high school	114(45.6)	87(76.4)	27(23.6)		
College degree or above	19(7.6)	16(84.3)	3(15.7)		
Occupation					
Worker/Farmer	16(6.4)	13(81.3)	3(18.7)	$\chi^2=1.323$	0.731
Clerk/Staff	20(8.0)	16(80.0)	4(20.0)		

Retired	143(57.2)	102(71.3)	41(28.6)		
Other	71(28.4)	53(74.6)	18(25.3)		
Caregiver status					
Spouse	146 (58.4)	115(78.8)	31(21.2)	$\chi^2=19.177$	<0.01
Children	39 (15.6)	27(69.2)	12(30.8)		
Other relatives as caregiver	49 (19.6)	38(77.6)	11(22.4)		
Professional caregiver	16(6.4)	4(25.0)	12(75.0)		
Surgical type					
Knee arthroplasty	118 (47.2)	81 (68.6)	37 (31.4)	$\chi^2=2.825$	0.093
Hip arthroplasty	132 (52.8)	103(78.0)	132(22.0)		
Preoperative physical activity frequency					
Never	88(35.2)	74(84.1)	14(15.9)	$\chi^2=42.44$	<0.01
1~3 times per week	118(47.2)	96(81.4)	22(18.6)		
≥4 times per week	44(17.6)	14(31.8)	30(68.2)		
Types of analgesics					
<2 types	67 (26.8)	47 (70.1)	20 (29.9)	$\chi^2=2.525$	0.277
≥2 and <4 types	171 (68.4)	130 (76.0)	41 (24.0)		
≥4 types and above	12 (4.8)	7 (3.8)	5 (41.7)		
Number of complications					
None	82 (32.8)	57(69.5)	25(30.5)	$\chi^2=1.119$	0.571
1 ~ 2 points	154 (61.6)	116(75.3)	38(24.7)		
≥3 points	14(5.6)	11(78.6)	3(4.5)		
Pain intensity					
0~3 score	200 (80.0)	157(78.5)	43(21.5)	$\chi^2=12.35$	<0.01
≥4score	50 (20.0)	27(54.0)	23(46.0)		
Disease duration(years)					
	4.60 (1.50,10.42)	3.30 (0.60, 8.85)	7.80 (4.42, 12.42)	$Z=-5.00$	<0.01

Daily pain duration (hours)	2.0(2.0,3.0)	2.0(2.0,3.0)	3.0(2.0,5.0)	Z=-5.895	<0.01
Pain catastrophizing	37.0(33.0,41.0)	36.0(33.0,41.0)	38.0(35.0,42.0)	Z=-2.21	0.027
Psychological distress	46.0 (42.0, 50.0)	47.0 (44.0, 51.0)	42.0 (39.0, 46.0)	Z=8-5.1	<0.01
Pain resilience	48.0 (44.0, 51.0)	47.0(44.0,51.0)	48.0(45.0,52.25)	Z=-0.954	0.340
Oswestry Disability	56.0(50.0,62.0)	54.0(48.0,60.0)	62.0(58.0,66.0)	Z=-7.141	<0.01
Coping Style					
Positive coping	32.0(29.0,34.0)	32.0(29.0,35.0)	31.0(29.0,35.0)	Z=-2.42	0.015
Negative coping	18.0(17.0,20.0)	18.0 (16.0,19.0)	20.0(19.0,21.0)	Z=-6.20	<0.01
Social support	39.0(36.0,42.0)	39.0(35.0,41.0)	41.0(37.0,41.0)	Z=-3.12	<0.01
Rehabilitation self-efficacy	89.0(74.0,103.0)	99.0(86.0,105.0)	69.0(64.0,76.25)	Z=-10.225	<0.01
kinesiophobia	36.0(34.0,42.0)	35.0(34.0,38.0)	44.0(42.0,45.0)	Z=-11.656	<0.01

Note: BMI,body mass index;** $P<0.05$

Table2 Fit indices for 4 model using latent profile analysis(N=250)

Profile	AIC	BIC	aBIC	Entropy	LMR (P)	BLRT (P)	Class Probability
1	10890.99	11010.71	10902.93	1.00	-	NA	1
2	10864.17	11047.29	8909.643	0.76	<0.001	0.01	0.736/0.264
3	10866.02	11112.52	8841.641	0.54	0.022	0.37	0.412/0.276/0.312
4	10871.92	11181.81	8813.606	0.62	0.058	0.60	0.408/0.312/0.144/0.136

AIC: Akaike Information Criterion, BIC: Bayesian Information Criterion, aBIC: adjusted Bayesian Information Criterion, LMR: Lo-

Mendell-Rubin likelihood ratio test, BLRT: Bootstrap likelihood ratio test.

Table 3 Factors associated with identified kinesiophobia latent classes

Variables	β	SE	Wald χ^2	OR(95%CI)	P
-----------	---------	----	---------------	-----------	---

Careprovider status					
Spouse	Ref				
Children	-0.812	1.105	0.541	0.444 (0.051-3.868)	0.462
Other relatives as caregiver	-0.946	0.818	1.340	0.388 (0.078-1.928)	0.247
Professional caregiver	3.711	1.893	3.841	40.876 (1.013-1.502)	0.045
Preoperative physical activity frequency					
Never	Ref				
1~3 times per week	0.296	0.836	0.126	1.345 (0.261-6.923)	0.723
≥4 times per week	2.013	1.050	3.673	7.484 (0.955-58.634)	0.045
Pain intensity					
0~3 score	Ref				
≥4score	0.666	0.873	0.582	1.946 (0.352-10.771)	0.446
Disease duration(years)	0.005	0.060	0.006	1.005 (0.894-1.129)	0.937
Daily pain duration (hours)	1.002	0.390	6.596	2.723 (1.268-5.850)	0.010
Pain catastrophizing	0.047	0.064	0.548	1.048(0.925-1.188)	0.459
Psychological distress	-0.122	0.109	1.245	0.885(0.714-1.097)	0.265
Oswestry Disability	0.245	0.081	9.278	1.278(1.091-1.496)	<0.01
Coping Style					
Positive coping	-0.102	0.110	0.858	0.903(0.728-1.120)	0.354
Negative coping	0.762	0.254	9.029	2.142(1.303-3.5221)	<0.01
Social support	0.103	0.072	2.078	1.109(0.964-1.276)	0.149
Rehabilitation self-efficacy	-0.172	0.042	17.199	0.842(0.776-0.913)	<0.01

* $P < 0.1$

Note. OR = odds ratio; CI = confidence interval; VIF = variance inflation factor. Class 1=low-kinesiophobia-activity acceptance group (coded as 0); Class 2 = high-kinesiophobia-fear avoidance group (coded as 1). All VIF values were < 5, indicating no significant multicollinearity.

Fig.1. Distribution of the estimated mean scores for social isolation in the 3-class LPA model

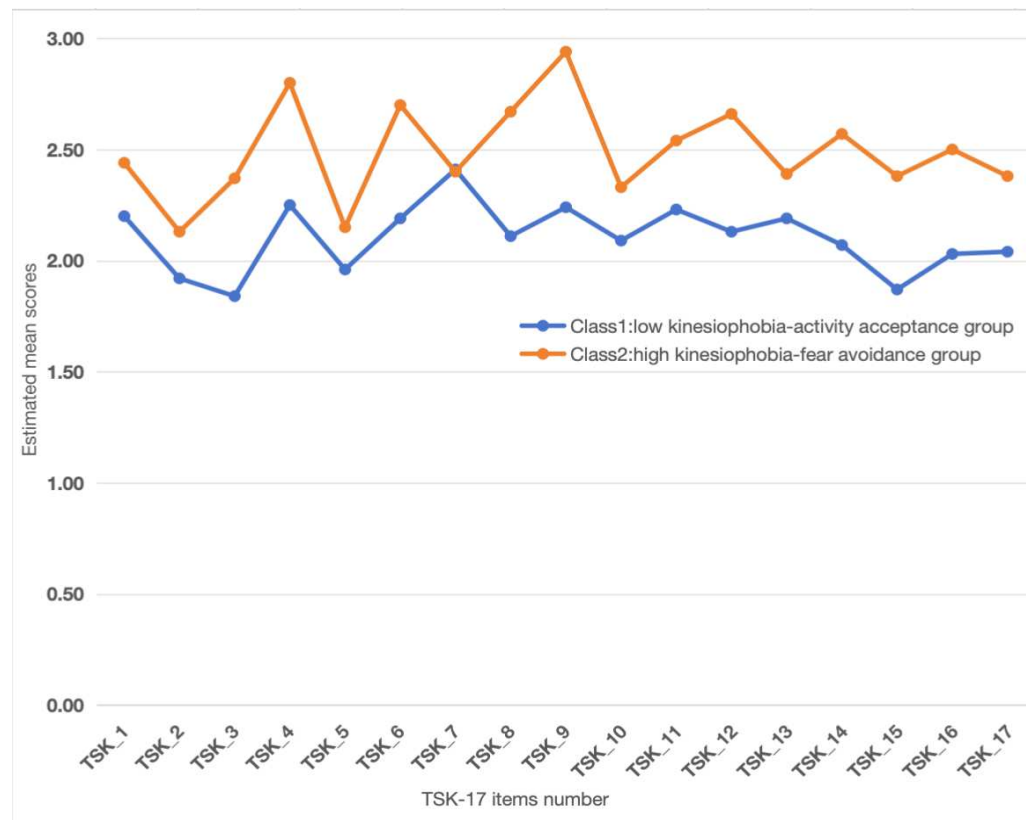
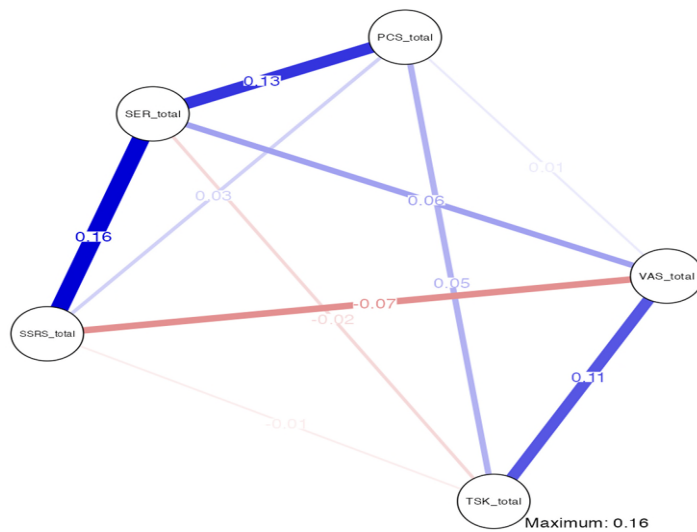
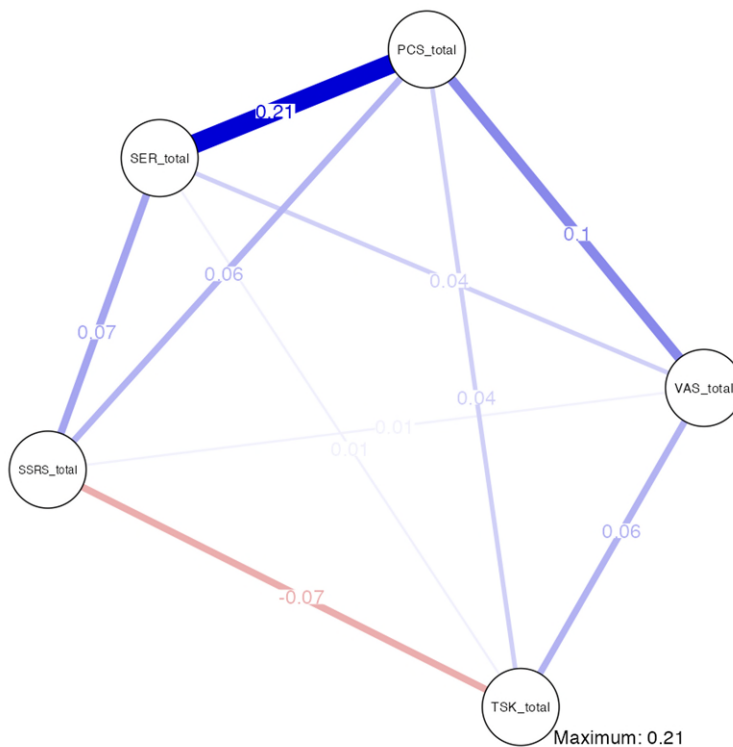


Fig.2 Network diagrams in the three different subgroups of kinesiophobia among patients after total joint arthroplasty.(a)Network diagram in the“low- kinesiophobia-activity acceptance group”;(b)Network diagram in the “high- kiensiophobia-fear avoidance group”;



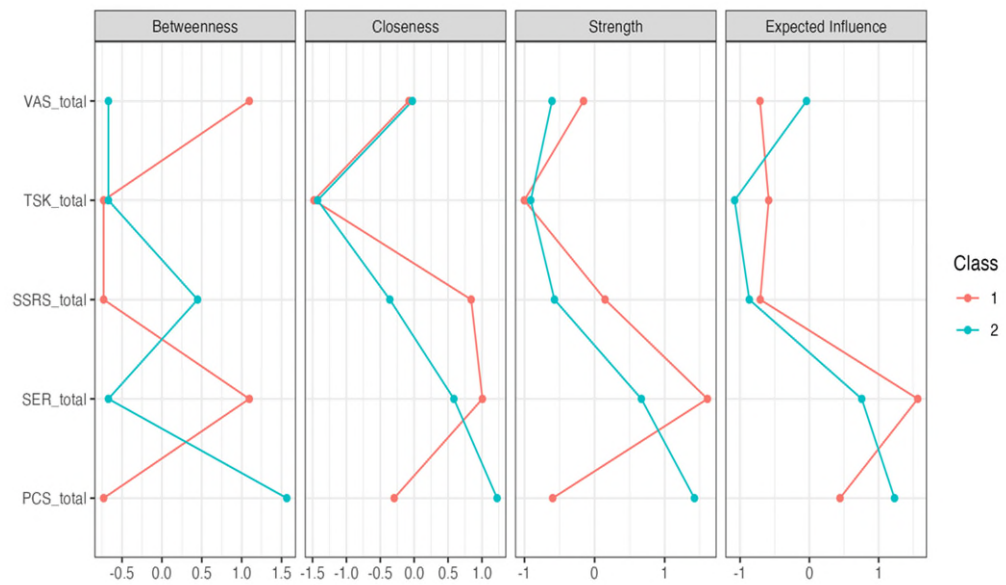
(a) Network diagram in the“low- kinesiophobia-activity acceptance group”



(b) Network diagram in the “high- kiensiophobia-fear avoidance group”

Note: The thickness of the edge represents the strength of the correlation(thicker edges indicate stronger association(blue for positive correlations and red dashed lines for negative correlations)).

Fig. 3. Node centrality plot of the networks in the two different subgroups of kinesiophobia among patients undergoing total joint arthroplasty



Note: VAS, pain intensity; PCS, pain catastrophizing; SER, rehabilitation self-efficacy; SSRS, social support; TSK, kinesiophobia

Fig4. Stability of centrality indices for the two kinesiphobia subgroups

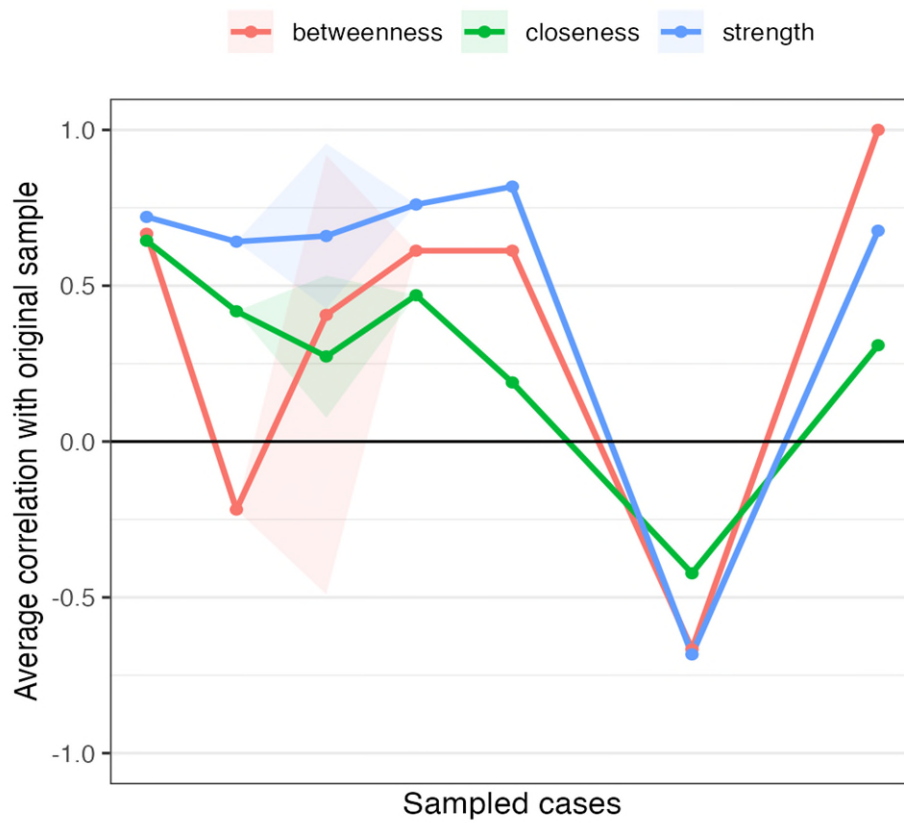


Fig5. Network invariance test between the two kinesiphobia subgroups.

