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# Current status and factors influencing kinesiophobia in patients with meniscus injury: a cross-sectional study



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## Abstract

**Objectives** This study aimed to examine the relationships between kinesiophobia and injury severity, balance ability, knee pain intensity, self-efficacy, and functional status in patients with meniscus injuries and to identify key predictors of kinesiophobia.

Design A single-center, prospective cross-sectional study.

**Methods** A cross-sectional study involving 123 patients diagnosed with meniscus injuries at Fujian Provincial Hospital was conducted. The knee range of motion test was used to determine limitations in knee joint mobility, whereas magnetic resonance imaging (MRI) was used to assess the severity of meniscus damage. Several validated scales were administered: the Tampa Scale of Kinesiophobia (TSK-17) to measure kinesiophobia, the visual analog scale (VAS) to assess pain intensity, the general self-efficacy scale (GSES) to evaluate self-efficacy, and the Lysholm knee score (LKS) to assess knee functional status. Additionally, balance ability was assessed using the Huber 360 Neuromuscular Control Training and Assessment System (DJO, USA). Spearman's correlation analysis was applied to explore factors associated with kinesiophobia, whereas simple linear regression analysis was used to identify its predictors.

**Results** Among the 123 participants included in the study, 60.16% were identified as experiencing kinesiophobia. Among these participants, 69.10% had grade III meniscus injuries, and 33.3% exhibited limited joint movement. The key clinical characteristics were as follows: the median VAS score was 4 (IQR 2–6), the GSES score was 22 (IQR 20–29), and the LKS score was 45 (IQR 38–55). Kinesiophobia was significantly correlated with injury severity, limited joint movement, pain intensity, self-efficacy, and other functional parameters (P < 0.05). However, no significant correlation was detected between kinesiophobia and limits of stability. Simple linear regression analysis ( $R^2$ =0.917) revealed several significant predictors of kinesiophobia, including injury severity ( $\beta$ =2.08), pain intensity ( $\beta$ =0.882), Romberg quotient (RQ) ( $\beta$ =3.239), and limited joint movement ( $\beta$ =0.868). In contrast, self-efficacy ( $\beta$ =-0.455) was negatively

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associated with kinesiophobia. Furthermore, Grade III injuries and RQ were found to be associated with markedly higher levels of kinesiophobia.

**Conclusion** Kinesiophobia is strongly associated with knee injury severity, limited joint movement, RQ, pain intensity, and self-efficacy, which are key predictors. Clinical interventions should focus on these factors to enhance rehabilitation outcomes.

Keywords Meniscus injury, Knee pain, Kinesiophobia, Psychosocial factors

#### Introduction

Meniscus injury is a prevalent musculoskeletal condition that can lead to physical dysfunction across various age groups. With the widespread adoption of arthroscopy, approximately 4 million meniscus surgeries are performed globally each year, creating significant challenges for healthcare systems [1]. The annual incidence of meniscus injuries 70 per 100,000 individuals, with a significantly greater occurrence observed in individuals over the age of 40 [2]. Furthermore, the injury rate is even more pronounced in physically active populations, such as military personnel and athletes, particularly those involved in sports such as football, basketball, gymnastics, skiing, and wrestling [3, 4]. Meniscus injuries are typically caused by either acute trauma or chronic overuse [5], both of which can impair neuromuscular function. Local inflammation in damaged tissue increases the sensitivity of peripheral sensory neurons, resulting in repeated abnormal afferent signals to the central nervous system [6]. A previous study indicated that individuals who have undergone meniscectomy and returned to sports experience elevated levels of kinesiophobia [7]. This fear of movement is also commonly observed in patients with other knee conditions, including anterior cruciate ligament reconstruction, patellofemoral pain, and knee osteoarthritis [8, 9].

Kinesiophobia is a condition characterized by an irrational fear of excessive body movement or activity due to concerns about pain, injury, or reinjury. This fear often leads individuals to avoid the training and exercise essential for the recovery of knee joint function, ultimately hindering their rehabilitation [10, 11]. Following a knee injury, kinesiophobia typically worsens and is closely associated with a reduced quality of life [12]. Additionally, increased levels of kinesiophobia can delay recovery, impede the return to sports, and negatively affect muscle activity and motor strategies [13-15]. Research has indicated that in women with patellofemoral pain, kinesiophobia contributes to abnormal knee joint movement patterns [13]. A recent study suggested that kinesiophobia could influence neuromotor processes and cortical motor pain responses, thereby perpetuating pain and obstructing recovery [16]. In patients with meniscus injuries, the fear of movement is often driven primarily by an irrational psychological fear of overexertion or physical activity. This psychological fear is exacerbated by symptoms such as pain, limited joint movement, and muscle weakness, which further contributes to the development of kinesiophobia. Both psychological and physiological factors interact to form a complex barrier to physical activity in this patient population. Therefore, examining the factors associated with kinesiophobia in individuals with meniscus injuries provides a deeper understanding of their condition, which could lead to the development of personalized rehabilitation programs aimed at optimizing clinical outcomes for this group [17]. This study investigated the relationships between kinesiophobia induced by meniscus injury and injury severity, balance ability, knee pain, self-efficacy, and functional status. We hypothesized that kinesiophobia would be significantly correlated with injury severity, balance ability, knee pain, self-efficacy, and functional status. Additionally, we explored whether these factors could serve as predictors of kinesiophobia.

#### Methods

#### Study design

This was a single-center, prospective cross-sectional study conducted at Fujian Provincial Hospital from April 2023 to December 2023. This study was conducted in accordance with the Declaration of Helsinki and was approved by the Medical Ethics Committee of Fujian Provincial Hospital (No. K2023-03-041, Date of approval: March 28, 2023). This study was registered at the Chinese Clinical Trial Registry (No. ChiCTR2300073365). All patients provided written informed consent.

#### Sample size calculation

Sample size calculations were conducted using G\*Power 3.1 software (Düsseldorf, Germany) [18]. A minimum of 90 participants were required for multiple linear regression analysis with 17 potential predictors, a significance level of 0.05, a 95% confidence interval, and a medium effect size ( $F^2 = 0.15$ ). To account for potential dropouts and ensure adequate statistical power, an additional 33 participants were recruited, resulting in a final sample size of 123 participants.

#### Participants

The inclusion criteria were as follows: participants had a clinically confirmed diagnosis of unilateral meniscus injury, demonstrated clear consciousness, and possessed adequate cognitive and communication abilities to comply with the study procedures.

Exclusion criteria: pregnancy; concomitant anterior cruciate ligament injury or other ligament injuries; significant flexion contracture deformity in the injured anterior knee joint; additional musculoskeletal conditions, such as ankle sprains, hip impingement syndrome, or trunk pain (e.g., nonspecific low back pain); limb instability caused by nontraumatic factors; neurological or vestibular disorders, including stroke, Parkinson's disease, vestibular neuritis, or other conditions affecting balance; inability to stand on one leg; previous treatment for meniscus injury; or withdrawal from the study prior to completion.

#### Measurements

#### Data collection

Trained researchers communicated with eligible patients prior to the study and completed a general information questionnaire after admission. The questionnaire collected data on age, body mass index (BMI), sex, education level, and duration from injury to assessment. Subsequently, evaluations were conducted, including range of motion (ROM) testing of the affected knee joint and assessments using the Tampa Scale of Kinesiophobia (TSK-17), magnetic resonance imaging (MRI), balance ability, the visual analog scale (VAS), the general self-efficacy scale (GSES), and the Lysholm knee score (LKS). The questionnaires were collected and meticulously reviewed onsite. Patient data were gathered and organized by two researchers on the basis of electronic medical records. All the investigators held at least a bachelor's degree in medicine and received training before participating in the assessment.

#### Limited joint movement

Knee ROM was measured following American Academy of Orthopedic Surgeons (AAOS) standards [19]. In the lateral decubitus position, the patient flexed the affected knee to the maximum range, and the goniometer was positioned with the axis at the lateral femoral epicondyle, the stationary arm aligned with the femur, and the moving arm aligned with the fibula. The flexion ROM was recorded after gentle pressure was applied at the end range, with angles outside  $120-150^{\circ}$  classified as restricted flexion. For extension, the patient fully extended the knee or as far as possible, with ROM measured similarly. Patients unable to reach 0° were classified as having restricted extension ( $-10^{\circ}-0^{\circ}$  considered normal). If either flexion or extension fell outside the normal range, the joint was classified as having restricted ROM.

#### Fear of movement

The TSK-17 was used to assess patients' fear of movement. The scale consists of 17 items, each rated on a 4-point Likert scale ranging from 1 to 4. The total score ranges from 17 to 68, with a score > 37 indicating the presence of kinesiophobia in the patient [20].

#### Meniscus damage

MRI was performed using a Siemens 3.0 T scanner with T1- and T2-weighted sequences in the axial, coronal, and sagittal planes. An experienced radiologist evaluated the meniscus condition on the basis of standardized grading criteria: (1) Degree of damage: Grade I, punctate or small patchy high-signal intensity within the meniscus; Grade II, linear high-signal intensity not extending to the meniscal surface; Grade III, linear high-signal intensity reaching the superior or inferior surface [21].

#### **Balance** ability

The Huber 360 neuromuscular control training and evaluation system (DJO, USA), which was used to assess balance ability in participants, has been validated in previous studies [22, 23]. A fixed frame was installed on the platform, and the participants stood barefoot with the inner edges of their feet against the sides of the frame, with their arms hanging naturally at their sides. They were instructed to maintain an upright posture, with their head and chest raised and eyes facing forward, following system prompts to complete the test. Prior to the assessment, a single familiarization session was conducted to ensure that the participants understood how to use the equipment and perform the test correctly, minimizing performance variability due to unfamiliarity with the procedure and enhancing the reliability of the assessment.

The testing protocol involved several tasks performed sequentially: standing with one's eyes open for 50 s, standing with one's eyes closed for 50 s, standing on one's foot with one's eyes open for 30 s, and shifting the center of gravity (COG) in response to directional arrows displayed on a screen. Movements were made in eight randomized directions (forward, backward, left, right, and diagonal), with participants returning to the center between directions. The tests were conducted by experienced therapists, and the following key parameters were measured to evaluate balance control: (1) balance ability: track length (LNG), which represents the total COG sway path length, where longer paths indicate poorer COG control; the Statokinesigram area (SSKG), which reflects the range of COG sway, with larger areas suggesting more severe balance impairments; sway velocity (speed), where higher velocities indicate faster, less controlled COG movements; the Romberg quotient (RQ), which is the ratio of SSKG under eyes-closed to eyes-open conditions, indicating the compensatory role of vision in balance; and limits of stability (LOS), which reflects the ability to shift the COG while maintaining postural stability. These metrics provide a comprehensive assessment of balance control and postural stability.

#### Pain intensity

Pain intensity in patients with meniscus injury was assessed using the VAS. The scale ranges from 0 to 10, where 0 indicates no pain, 1–3 represents mild pain, 4–6 indicates moderate pain, 7–9 corresponds to severe pain, and 10 signifies intense pain. A higher score reflects greater pain intensity in the patient [24].

#### Self-efficacy

The GSES was used to assess patients' self-efficacy. It consists of 10 items, each rated on a 4-point scale ranging from 1 to 4. The total score ranges from 1040, with higher scores indicating greater self-efficacy in the patient [25].

#### Knee functional status

Knee function status was assessed using the LKS, which includes 8 items: limp, support, locking, pain, instability, swelling, stair climbing, and squatting. The total score ranges from 0 to 100, with higher scores indicating better knee function [26].

#### Statistical analysis

Statistical analyses were conducted using IBM SPSS Statistics version 26.0. The normality of the variables was assessed with the Shapiro-Wilk test. Continuous variables that followed a normal distribution are presented as the means ± standard deviations (SDs), whereas nonnormally distributed variables are expressed as the medians with interquartile ranges (IQRs). Categorical variables are reported as the frequencies (n) and proportions (%). Spearman's correlation analysis was performed to examine the relationships between kinesiophobia and its potential influencing factors. The correlation coefficients were interpreted as follows: coefficients of 0.2 or less indicated weak correlations, coefficients between 0.3 and 0.5 indicated moderate correlations, coefficients between 0.6 and 0.7 represented moderate to strong correlations, and coefficients of 0.8 or higher signified strong correlations [27]. Furthermore, multivariable linear regression analysis was used to derive unstandardized regression coefficients ( $\beta$ ). The predictive power of each final model was assessed by calculating the R-squared (R<sup>2</sup>) value, which indicates the percentage of variance explained. This analysis aimed to determine whether injury severity, limited joint movement, RQ, pain intensity and self-efficacy were significant predictors of kinesiophobia.

#### Results

#### **Participant characteristics**

Intotal, 158 potential patients were initially contacted; however, 15 patients were unable to visit the hospital for the examination due to business commitments. Additionally, 20 patients did not meet the inclusion criteria and were therefore excluded from the study (Fig. 1).

Table 1 presents the baseline characteristics of the study participants. The median age was 53 years (IQR: 44–61), and the mean BMI was  $24.84\pm3.09$  kg/m<sup>2</sup>, with a range from 18.37 to 31.25 kg/m<sup>2</sup>. Among the participants, 74 (60.2%) were female, and 30 (24.39%) had attained a college degree or higher. The median duration between injury and assessment was 9 weeks (IQR: 2–16). Additionally, 85 (69.10%) patients had Grade III injuries, and 41 (33.3%) had restricted joint mobility.

Over 60% of the participants (60.16%) were found to experience kinesiophobia. The clinical characteristics of the subjects are presented in Table 2, which includes the TSK-17 scores, VAS scores, GESE scores, and Lysholm knee scores. The median TSK-17 score was 41 (range: 32–46), indicating a moderate level of kinesiophobia. For pain assessment, the median VAS score was 4 (IQR: 2–6). The GESE score, which reflects the general evaluation of knee function, had a median value of 22 (IQR: 20–29). Finally, the Lysholm knee score, which reflects knee-specific function and symptoms, had a median of 45 (IQR: 38–55).

Table 3 presents the balance ability of the participants under various conditions. When standing on the platform with both feet and eyes open, the mean LNG was 690.72 ± 143.97 mm, with a range of 408.01–1120.33 mm. The median SSKG value (IQR) was 316.29 (212.85-430.74) mm<sup>2</sup>, and the mean speed was  $13.82 \pm 2.88$  mm/s, with a range of 8.16-22.41 mm/s. In contrast, when standing with both feet and eyes closed, the median LNG value (IQR) was 987.89 (837.10-1142.83) mm, whereas the median SSKG value (IOR) was 532.63 (395.11-634.32) mm<sup>2</sup>. The median speed (IQR) was 19.76 (16.74–22.86) mm/s. For the affected leg with eyes open, the median LNG value (IQR) was 1533.58 (1265.21-1869.26) mm, and the median SSKG value (IQR) was 788.94 (537.08-1048.52) mm<sup>2</sup>. The average LOS was 56697.00 ± 24536.13, with a range of 12966.22-114683.20. Additionally, the median RQ value (IQR) was 1.53 (1.17–2.40).

# Spearman's correlation analysis of factors related to kinesiophobia

Spearman correlation analysis revealed several significant relationships, as summarized in Table 4. Kinesiophobia was significantly positively correlated with injury severity, limited joint movement, the RQ, the VAS score, the GSES score, track length, the statokinesigram area, speed with eyes closed, speed of the affected foot with eyes



Fig. 1 Recruitment flow chart

 Table 1
 Baseline characteristics of the study participants

(n = 123)		
Variables	Value	
Age(years), median (IQR)	53(44–61)	
BMI(kg/m <sup>2</sup> ),mean (SD)	$24.84\pm3.09$	
Sex		
Male, (n/%)	49(39.80)	
Female, ( <i>n</i> /%)	74(60.20)	
Highest level of education		
Primary, ( <i>n</i> /%)	36(29.27)	
Secondary, (n/%)	28(22.76)	
Senior, ( <i>n</i> /%)	29(23.58)	
Junior college, ( <i>n</i> /%)	19(15.45)	
Bachelor's degree or above, (n/%)	11(8.94)	
The duration from injury to assessment(month)median	9(2–16)	
(IQR)		
Damage degree		
< III degree, (n/%)	38(30.90)	
III degree, (n/%)	85(69.10)	
Limited joint movement		
unrestricted, (n/%)	82(66.7)	
limitation, (n/%)	41(33.3)	
BMI, body mass index		

#### Table 2 Clinical characteristics of the participants

Variables	Value
TSK-17(17–68),median (IQR)	41(32–46)
VAS(0–10),median (IQR)	4(2-6)
GSES(10–40),median (IQR)	22(20–29)
LKS(0-100),median (IQR)	45(38–55)

TSK-17, Tampa Scale for Kinesiophobia-17; VAS, visual analog scale; GES, general self-efficacy scale; LKS, Lysholm knee score

open, the Lysholm score, and the duration from injury to assessment. However, no significant correlation was detected between kinesiophobia and the length of hospital stay (LOS).

#### Multifactor analysis of factors related to kinesiophobia among patients with meniscus injuries

The results of the simple linear regression analysis, presented in Table 5, yielded an R<sup>2</sup> value of 0.917. This finding indicated that the independent variables in the model (injury severity, limited joint movement, RQ, VAS score and GSES score) predicted 91.7% of the variance in kinesiophobia. The overall model fit was deemed satisfactory, as evidenced by an F value less than 0.05. Moreover, the variance inflation factor (VIF) was found to be less than

Variables	Value
Both side leg with eyes opening	
LNG(mm), mean (SD)	$690.72 \pm 143.97$
SSKG(mm <sup>2</sup> ), median (IQR)	316.29(212.85-430.74)
Speed(mms), mean (SD)	$13.82 \pm 2.88$
Both side leg with eyes closed	
LNG(mm), median (IQR)	987.89(837.10-1142.83)
SSKG(mm <sup>2</sup> ), median (IQR)	532.63(395.11-634.32)
Speed(mms), median (IQR)	19.76(16.74–22.86)
Affected side leg with eyes open	
LNG(mm), median (IQR)	1533.58(1265.21-1869.26)
SSKG(mm <sup>2</sup> ), median (IQR)	788.94(537.08-1048.52)
LOS, mean (SD)	$56697.00 \pm 24536.13$
RQ, median (IQR)	1.53(1.17–2.40)

LNG, tracklength; SSKG, statokinesigram area; LOS, Limits of Stability; RQ: Romberg Quotient

Table 4	Bivariate correla	ation analysis	of factors	related to
kinesiopl	nobia			

Variables	R/Z	Р
Damage degree	-7.515	< 0.001
Limited joint movement	-3.804	< 0.001
VAS	0.836	< 0.001
GSES	-0.855	< 0.001
LKS	-0.583	< 0.001
The duration from injury to assessment	-0.231	0.01
Both sides legs with eyes opening		
LNG	-0.419	< 0.001
SSKG	-0.471	< 0.001
Speed	-0.420	< 0.001
Both sides legs with eyes closed		
LNG	0.264	0.003
SSKG	0.529	< 0.001
Speed	0.271	0.002
Affected side leg with eyes open		
LNG	0.397	< 0.001
SSKG	0.614	< 0.001
LOS	-0.148	0.102
RQ	0.895	< 0.001

VAS, visual analog scale; GSES, general self-efficacy scale; SSKG, statokinesigram area; LKS, Lysholm knee score; LNG, tracklength; LOS, Limits of stability; RQ: Romberg Quotient

#### **Table 5** TSK-17 multiple linear regression (n = 123)

5, and the tolerance exceeded 0.20, confirming that there was no multicollinearity present in the model.

Specifically, the incidence of kinesiophobia in patients with Grade III injuries was approximately 2.080 units higher than that reported in patients with injuries below Grade III. Furthermore, for patients with meniscus injuries, those exhibiting restricted joint movement had a kinesiophobia score that was 0.868 units higher than that of patients with unrestricted joint movement. Additionally, each one-unit increase in the RQ and VAS scores was associated with increases in kinesiophobia of 3.239 and 0.882 units, respectively. In contrast, a one-unit increase in self-efficacy was linked to a decrease of 0.455 units in kinesiophobia.

#### Discussion

The results of this study indicate that kinesiophobia is positively correlated with injury severity, limited joint movement, RQ, and VAS scores, suggesting that as the degree of knee joint injury, joint movement limitations, RQ, and pain scores increase, the level of psychological fear also intensifies. Kinesiophobia is negatively correlated with self-efficacy, indicating that patients with lower self-efficacy experience higher levels of psychological fear. Moreover, injury severity, joint movement limitations, RQ, the VAS score, and the GSES score are significant predictors of kinesiophobia in patients.

In this study, individuals with meniscus injuries presented kinesiophobia, as measured by the TSK-17. A significant correlation was found between the degree of meniscus injury and the level of kinesiophobia. Additionally, the severity of meniscus injury was a positive predictor of kinesiophobia, indicating that more severe injuries were associated with higher levels of kinesiophobia. When the meniscus is damaged, its protective function is compromised, leading to reduced joint stability and an increased risk of secondary cartilage damage, which worsens the condition [28, 29]. A study reported that more severe meniscus injuries are linked to a greater likelihood of developing clinical symptoms [30]. For injuries below Grade III, the clinical symptoms are typically minimal and are often limited to localized edema or mild

Model	Unstandardized Coefficients		Standardized Coefficients		95.0% Confidence Interval		Collinearity Statistics		
	В	Std. error	Beta	Т	Sig.	Lower bound	Upper bound	Tolerance	Variance inflation factor
(Constant)	39.934	2.678		14.911	0.000	34.630	45.238		
Damage degree	2.080	0.609	0.130	3.415	0.001	0.874	3.287	0.471	2.123
Limited joint movement	0.868	0.432	0.055	2.011	0.047	0.013	1.724	0.900	1.111
RQ	3.239	0.403	0.361	8.038	0.000	2.441	4.037	0.337	2.969
VAS score	0.882	0.195	0.242	4.512	0.000	0.495	1.269	0.236	4.240
GSES score	-0.455	0.080	-0.308	-5.69	0.000	-0.614	-0.297	0.231	4.322

Dependent variable: TSK score. RQ, Romberg Quotient; VAS, Visual Analog Scale; GSES, General Self-Efficacy Scale

pain, which may not significantly impact participation in physical activities. However, when the injury reaches Grade III or higher, the tear becomes more severe, potentially affecting joint movement. In such cases, pain may occur during walking, or the injury may be accompanied by joint locking, knee snapping, or quadriceps atrophy, leading to restricted movement, abnormal gait, or even falls while walking [31]. Patients with severe meniscus injuries are more likely to develop a fear of movement to avoid pain or further injury. A similar study [32] also suggested that kinesiophobia is associated with knee joint pain, flexion, and overall function. Therefore, individuals with meniscus injuries should seek early diagnosis and treatment, gain a clear understanding of the extent of their injury, and follow medical advice to prevent further deterioration.

In this study, a significant correlation was found between RQ and kinesiophobia. Specifically, RQ was identified as a positive predictor of kinesiophobia in patients with meniscus injuries, meaning that higher RQ values were associated with higher levels of kinesiophobia. The RQ represents the ratio of static balance measured under eyes-closed conditions to that under eyes-open conditions [33]. A larger RQ value indicates a greater reliance on vision for maintaining static balance. When vision is controlled for and only proprioception and vestibular input remain, neuromuscular control becomes less effective in regulating static balance [34]. Balance is defined as the ability to maintain, achieve, or restore one's position through postural adjustments [35], which depend on several factors, including biomechanical elements, spatial orientation, action strategies, dynamic control abilities, and sensory strategies [36–40]. Among these, sensory strategies, particularly those involving proprioceptive input, play crucial roles in postural control and cognitive processing [41, 42]. Proprioception, which refers to the detection of muscle contraction and joint position, provides essential feedback to the brain's neurons for analyzing motor behavior. Consequently, proprioception is fundamental for maintaining body posture stability [43, 44]. Research has shown that mechanoreceptors in the anterior and posterior regions of the meniscus are involved in detecting proprioceptive signals, playing a critical role in the sensory feedback mechanism of the knee joint and its position regulation during movement [45]. Following a meniscus injury, impairments in proprioception reduce the ability to sense knee movement and select appropriate sensory inputs, weakening or even eliminating a patient's perception of knee joint position, direction, and speed. This impairment contributes to the development of kinesiophobia. Similar studies have demonstrated a strong association between kinesiophobia and knee stability [46, 47]. Therefore, it is crucial for patients with meniscus injuries to gain an accurate understanding of their condition at an early stage, seek prompt medical evaluation, and follow medical recommendations to prevent the injury from worsening.

The findings of this study indicated that higher levels of pain were predictive of higher levels of kinesiophobia. Similar results have been reported in studies of other knee joint conditions [48, 49]. A patient's fear of movement can be viewed as a coping strategy, potentially aimed at reducing knee joint pain. Pain is a subjective experience that involves both a physiological response and a complex perceptual process [50]. The perception and processing of pain involve multiple regions of the brain, including the prefrontal cortex, cingulate cortex, and amygdala, all of which contribute to both the sensory experience of pain and its emotional processing. As a result, external somatosensory inputs and internal motivational, affective, and cognitive processing may interact during the adaptive regulation of pain [51]. Previous studies have shown that pain intensity is correlated with pain catastrophizing, a phenomenon in which patients experience negative cognitive and emotional responses [52, 53]. This altered state of attention and expectation can intensify their emotional reactions to pain. Additionally, the tendency to catastrophize pain is linked to a higher incidence of chronic pain and muscle dysfunction [54]. According to the fear-avoidance model [55], catastrophic thinking following a pain episode leads to heightened kinesiophobia and increased sensitivity to pain. This creates a protective response in which patients adopt a negative coping strategy, often avoiding activities or movements that could trigger pain. Consequently, patients with higher pain levels may struggle to engage in regular rehabilitation exercises, resulting in increased kinesiophobia.

Some researchers have suggested that long-term fear of movement can lead to muscle fatigue and disuse atrophy, creating a vicious cycle that impairs functional performance [6, 16]. The results of this study revealed a moderate positive correlation between kinesiophobia and knee joint function scores. Patients with meniscus injuries may exhibit fear-avoidance behavior due to painful stimuli and reduced muscle strength, both of which can negatively impact lower limb functional performance. In a previous systematic review [56], Rethman proposed similar findings, stating that higher levels of kinesiophobia were associated with poorer functional performance. Furthermore, Smith reported that exercise therapy performed despite pain had certain benefits over exercises performed without pain [57]. This suggests that healthcare providers should promptly assess patients' pain levels and implement appropriate interventions, particularly for those experiencing higher pain levels. By doing so, patients can gain a clearer understanding of the relationship between pain and exercise, alleviate their psychological distress, and engage in exercises within acceptable pain thresholds. Such an approach may help maximize the recovery of knee joint function.

A significant correlation between self-efficacy and kinesiophobia was found in this study, highlighting the considerable influence of self-confidence on the development of kinesiophobia. Self-efficacy was identified as a negative predictive factor for kinesiophobia in patients with meniscus injuries, suggesting that higher levels of self-efficacy are associated with lower levels of kinesiophobia [58]. Previous studies have also identified selfefficacy as one of the key psychosocial factors influencing meniscus injury rehabilitation [48, 59]. Self-efficacy refers to an individual's confidence in their own abilities [60] and plays a crucial role in both the development of and response to kinesiophobia. Patients with low self-efficacy often fear that exercising will worsen pain or other physical symptoms, which can lead to feelings of helplessness and frustration. This, in turn, can intensify the avoidance of physical activity, resulting in poor adherence to early rehabilitation exercises and subsequently affecting treatment outcomes [61]. Ericsson reported that enhancing self-efficacy could help patients confront the stress associated with exercise-related fears in a positive and proactive manner [59]. Furthermore, increasing self-efficacy can aid patients in managing physical pain and emotional stress and facilitate the adoption of proactive coping strategies, such as participation in activities and functional exercises [62]. Similar findings were reported by Eliza in a study on musculoskeletal trauma [63]. Additionally, patients with high self-efficacy tend to demonstrate better compliance with treatment and achieve improved recovery outcomes. Therefore, healthcare professionals should implement interventions aimed at enhancing self-efficacy, such as educating patients on cognitive and behavioral pain management strategies through manuals and video tutorials and supporting them in mastering these techniques [64]. Assisting patients with low self-efficacy in building confidence to overcome their fear of exercise is essential, as this can encourage more active participation in pain management through exercise [65].

#### Limitations

This study has several limitations that warrant attention. First, the cross-sectional design, while providing valuable insights into correlations, limited the ability to establish causal relationships. Longitudinal or experimental studies are needed to explore the directionality and causality of these associations. Second, the reliance on self-reported measures for pain intensity, self-efficacy, and kinesiophobia may have introduced biases due to variations in individual perceptions and emotional states. Third, the study did not account for other potentially significant clinical or biomechanical variables, such as preinjury activity levels, psychological conditions, or specific rehabilitation protocols. Additionally, the lack of detailed classification of meniscus damage (e.g., medial vs. lateral, anterior vs. posterior) may have masked important differences in how injury subtypes influence kinesiophobia. The focus on a single hospital also limits the generalizability of the findings, and a multicenter study with a more diverse sample is recommended. Moreover, the analysis of balance ability was limited, with insufficient exploration of specific deficits and their interaction with kinesiophobia. Socioeconomic and cultural factors, which significantly influence rehabilitation adherence and psychological responses, were also not considered. Finally, confounding variables, such as prior injuries or pharmacological interventions, were not controlled for, potentially impacting the observed relationships. Future research should adopt longitudinal designs; integrate objective measures; and consider additional clinical, demographic, and psychosocial variables to increase the robustness and applicability of the findings.

#### Conclusion

This study demonstrated that kinesiophobia was significantly associated with knee injury severity, limited joint mobility, RQ, pain intensity, and self-efficacy, with these factors identified as key predictors. Patients with more severe injuries, greater joint mobility restrictions, and higher RQ and pain intensity exhibited higher levels of kinesiophobia, while higher self-efficacy was associated with reduced kinesiophobia. These findings underscore the multifaceted nature of kinesiophobia, driven by an interplay of physical and psychological factors, and highlight the importance of addressing these factors in clinical practice. The implications for clinical management are significant. Early identification and targeted interventions for kinesiophobia could mitigate its impact on rehabilitation outcomes. Clinicians should integrate strategies to enhance self-efficacy, address pain management proactively, and promote joint mobility and stability through tailored rehabilitation programs. Such approaches not only prevent the progression of kinesiophobia but also facilitate adherence to rehabilitation protocols, optimize recovery, and improve patients' functional outcomes.

#### Supplementary Information

The online version contains supplementary material available at https://doi.or g/10.1186/s13018-025-05498-5.

Supplementary Material 1 Supplementary Material 2

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Not applicable.

#### Author contributions

All authors contributed to the study conception and design. Manuscript draft, Material preparation, data collection and analysis were performed by F.Q. T., PX.and C. J. Analysis and interpretation of data were done by X.H. K., D.B. H. and Y.L. D. Critical revision of manuscript was conducted by Z.H. L., S.Z. W. All authors read and approved the final manuscript.

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#### Data availability

No datasets were generated or analysed during the current study.

#### Declarations

#### Ethics approval and consent to participate

The research was conducted in accordance with the ethical guidelines set forth by the journal and received prior approval from the Fujian Provincial Hospital Ethics Committee (K2023-03-041). The manuscript has been reviewed and approved by all coauthors and complies with the journal's co-authorship guidelines. The study adhered to the principles of the World Medical Association's Declaration of Helsinki and its Code of Ethics, and informed consent was obtained from all participants involved in the research.

#### **Consent for publication**

Not applicable.

#### **Competing interests**

The authors declare no competing interests.

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