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Original Article

Analysis of the trajectory and influencing factors of kinesiophobia in elderly patients during the rehabilitation phase of limb fractures

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Abstract: Objectives: To explore the trajectory and influencing factors of kinetophobia in elderly patients with limb fracture during the rehabilitation period. Methods: In this retrospective study, we retrieved the follow-up records of 150 elderly patients with limb fractures from our hospital's electronic medical record system. We collected the demographic data and Tampa Scale for Kinesiophobia (TSK) scores of patients at postoperative day 1 (T0), 1 week (T1), 3 weeks (T2), 6 weeks (T3), and 12 weeks (T4) to track changes in kinesiophobia over time. We used Mplus 8.3 software to fit the development trajectory types of kinesiophobia based on TSK scores at time points T0 to T4 using a Latent Class Growth Model (LCGM). After selecting the best fitting model, logistic regression analysis was performed to identify the risk factors for kinesiophobia in different types. Receiver operating characteristic (ROC) curve and area under the curve (AUC) were used to compare the predictive value of relevant influencing factors for kinetophobia in elderly patients recovering from limb fracture. Results: The TSK scores decreased steadily from T0 to T4 [(46.03±7.88) at T0, (41.14±8.89) at T1, (34.61±5.64) at T2, (29.95±6.79) at T3, and (26.71±5.03) at T4], [F (4, 745) = 193.1, P < 0.001]. We identified the trajectory of changes in kinesiophobia symptoms through LCGM, gradually establishing models with 1 to 5 categories. By integrating the results of relevant fit indices, we ultimately selected the best fitting model with 2 categories. Among them, 119 patients in Class 1 (79.3%) showed a slow and continuous decline in kinesiophobia symptoms from T0 to T4, while 31 patients in Class 2 (20.7%) exhibited rapid decline followed by rebound in kinesiophobia symptoms. Logistic regression showed that older the age (OR = 1.219), per capita monthly income < 3000 yuan (OR = 12.657), numeric rating scale (NRS), patients with higher NRS (OR = 2.401) and higher self-efficacy (OR = 1.212) were more likely to be in Class 1. The ROC curve results show that the combined above indicators have a higher predictive value for the changes in fear of movement in elderly patients with lower limb fractures during the rehabilitation period (AUC = 0.934), compared to age (AUC = 0.694), per capita monthly income (AUC = 0.654), NRS score (AUC = 0.812), and self-efficacy (AUC = 0.811) as individual indicators. Conclusion: As the recovery time progresses for elderly patients with limb fractures, the overall trend of kinesiophobia scores decreases. Kinesiophobia presents with two different trajectories, with age, average monthly income, NRS score, and self-efficacy being important factors influencing the trajectory categories of kinesiophobia changes.

Keywords: Elderly patients with fracture, kinesiophobia, longitudinal study, trajectory of change

Introduction

Elderly people are prone to osteoporosis, particularly in the extremities, and they experience a reduction in muscle strength, increasing their vulnerability to fractures during daily activities [1, 2]. Fractures in the extremities usually result from external force, such as falls or impacts, or from underlying conditions that weaken the bones. Although surgical intervention is crucial, the importance of post-surgical physical rehabilitation and early functional exercises cannot be overstated, as they are essential for complete recovery. In fact, the efficacy of surgical

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treatment contributes only partially in the healing process; the remainder hinges on effective rehabilitation.

The recovery process from a fracture is often lengthy and challenging, with pre- and postoperative pain significantly affecting the patient's psychological state. This pain extends beyond physical discomfort, imposing a substantial psychological burden and frequently leading to a fear of activity, known as kinesiophobia [3]. Recent research has revealed the prevalence of kinesiophobia among orthopedic patients, especially those who have experienced intense pain and are anxious about their recovery outcomes [4]. The occurrence of kinesiophobia is influenced not just by physical pain but also by psychological state, such as fear and anxiety about the rehabilitation process [5]. These psychological barriers can hinder patient cooperation with treatment and negatively impact their mental health and overall recovery outcomes.

Scholars have recognized the potential adverse impacts of kinesiophobia on patient recovery and have initiated investigations into effective coping strategies, such as Pilates intervention [6], mindfulness practice [7], and virtual walking training [8]. However, the development of kinesiophobia varies significantly among patients due to diverse physiological, psychological, and social factors. Current research on the individual variability and longitudinal patterns of this fear of movement remains insufficient, leading to an incomplete understanding of the developmental trajectories and the effectiveness of interventions. Kinesiophobia not only varies at an individual level but also exhibits group heterogeneity, indicating that different groups of patients may follow distinct paths in their disease progression [9]. The Latent Class Growth Model (LCGM), a semi-parametric statistical method, offers a highly flexible approach to explore hidden or unobserved characteristics in complex clinical scenarios. This method is used for analyzing longitudinal data to assess unknown trajectories within a population [10]. The aim of this research is to reveal the unique paths of kinesiophobia in different patients during the recovery process, providing a scientific basis for customized rehabilitation care plans, thereby enhancing the precision of interventions to meet the individualized needs of patients.

Materials and methods

Study subjects

We conducted a retrospective analysis of the medical records and telephone follow-up data of 150 elderly patients treated for limb fractures in the Nanchang Hongdu Traditional Chinese Medicine Hospital from August 2022 to August 2023. Inclusion criteria: (1) patient diagnosed with a first-time closed limb fracture [11]; (2) aged 60 years or older; and (3) with complete follow-up data. Exclusion criteria: (1) patients with open and multiple fractures; and (2) patients with diseases involving important organs such as the heart. This study was approved by the Ethics Committee of the Nanchang Hongdu Traditional Chinese Medicine Hospital.

Data collection

In this study, we obtained detailed demographic data from the hospital's medical records system, including age, gender, education level, smoking history, average monthly income, fracture location (upper limb/lower limb), and primary caregiver details.

Additionally, we also obtained measures of postoperative pain intensity and self-efficacy on the first day after surgery from follow-up records. Besides, we tracked changes in kinesiophobia using the Tampa Scale for Kinesiophobia at five time points: postoperative day 1 (T0), 1 week (T1), 3 weeks (T2), 6 weeks (T3), and 12 weeks (T4) to understand the dynamic changes in kinesiophobia among the study participants.

Research tools

Numeric rating scale (NRS) [12]: Pain intensity was assessed using NRS, which consists of a straight line with a total score ranging from 0 to 10, where 0 indicates no pain and 10 indicates unbearable pain.

Self-efficacy for exercise scale (SEE): The SEE scale, developed by Resnick et al. [13], has been adapted for the Chinese population by Lee et al. [14]. It consists of 9 items scored, each scored on a scale of 0 to 10, with a total score ranging from 0 to 90. A higher SEE score indicates higher self-efficacy.

Tampa scale for kinesiophobia (TSK) [15]: The level of kinesophobia was assessed using TSK, which consists of 17 items, each rated on a 4-point scale, ranging from "strongly disagree" (1 point) to "strongly agree" (4 points), with a total score ranging from 17 to 68. A higher TSK score indicates more severe kinesiophobia.

Statistical methods

In this study, Mplus 8.3 software was utilized to perform LCGM analysis to explore the trajectories of kinesiophobia among elderly patients during the rehabilitation phase of limb fractures. First, data cleaning was conducted to address missing values, which were imputed using the mean substitution method. Then, the data were converted from Excel format to the dat format recognizable by the Mplus software. Within Mplus, code was programmed according to the research objectives and data structure to specify the dataset, define variables, configure the model, set the analysis type, and select output options. The code was run within Mplus to initiate the LCGM analysis. Convergence status and model fit indices were checked to ensure the success operation of the model.

The goodness of fit of the model was assessed using the Akaike information criterion (AIC), Bayesian information criterion (BIC), and sample size-adjusted BIC (aBIC), where the smaller values indicate a better fit. The Entropy index was used to measure the accuracy of the latent class classification, with higher values indicating greater accuracy. An Entropy value greater than 0.8 suggests a classification accuracy of approximate 90%. To determine the most suitable model, the Lo-Mendell-Rubin (LMR) likelihood ratio test and the Bootstrapped likelihood ratio test (BLRT) were employed. A *P*-value less than 0.05 indicates suggests a statistically significant improvement in fit with additional categories.

After determining the optimal model, intergroup differences were examined using univariate analysis (χ^2 test or *t*-test). Variables with statistical significance in the univariate analysis were then included in logistic regression analysis to identify factors influencing kinesiophobia trajectory categories. A one-way analysis of variance was used to compare the differences in TSK scores across the time points from T0 to T4. Receiver operating characteristic (ROC) curves and the area under the curve (AUC) were applied to assess the predictive performance of the screened factors for kinesiophobia in elderly patients with lower limb fractures during the rehabilitation period. A *p*-value less than 0.05 is considered indicative of statistically significant differences.

Results

Basic information

This study involved 150 elderly patients who were in the recovery period after limb fractures. The cohort consisted of 90 females and 60 males with an average age of (74.21±5.41) years. The majority of the patients (n = 101) had an educational level of junior high school or below. The average monthly income was mostly concentrated below 3000 RMB (n = 71), followed by 3000 to 5000 RMB (n = 47), and a minority of patients had an income exceeding 5000 RMB (n = 32). A significant number of participants (n = 93) reported previous falls. The fracture site was evenly distributed in the lower limbs (n = 77) and the upper limbs (n = 73). In terms of caregivers, family members were the main caregivers (n = 78), followed by nursing workers (n = 57), and the remaining 15 patients were taken care of by other caregivers. Pain assessment showed that the patients had an average NRS score of (6.75±1.53) points, indicating a relatively high level of pain. In addition, the average self-efficacy score of the patients was (50.11±6.21), suggesting a moderate level of confidence in their ability to recover. Details are shown in **Table 1**.

TSK scores across T0 to T4 in elderly patients recovering from limb fracture

The TSK scores showed an overall downward trend across the five time points, T0 to T4, in the elderly patients during the rehabilitation period for limb fracture. A repeated analysis of variance confirmed significant differences in TSK scores across 5 time points ($P < 0.001$), are shown in **Figure 1** and **Table 2**.

Correlation of TSK scores across T0 to T4 in elderly patients recovering from limb fracture

T1 was positively correlated with T2, and T2 was positively correlated with T3 ($r = 0.662$, 0.657, $P < 0.01$), as shown in **Table 3**.

Table 1. Basic information of patients

Variables		n	%
Age (years)		74.21±5.41	
Sex	Man	60	40.00
	Woman	90	60.00
Education	Junior high school and below	101	67.33
	Above junior middle school	49	32.67
Per capita monthly income (Yuan)	< 3000	71	47.33
	3000-5000	47	31.33
	> 5000	32	21.33
Fall history	Yes	93	62.00
	No	57	38.00
Fracture site	Upper limb	73	48.67
	Lower limbs	77	51.33
Primary caregiver	Nursing workers	57	38.00
	Family member	78	52.00
	Other	15	10.00
NRS (score)		6.75±1.53	
Self-efficacy (score)		50.11±6.21	

Note: NRS, Numeric Rating Scale.

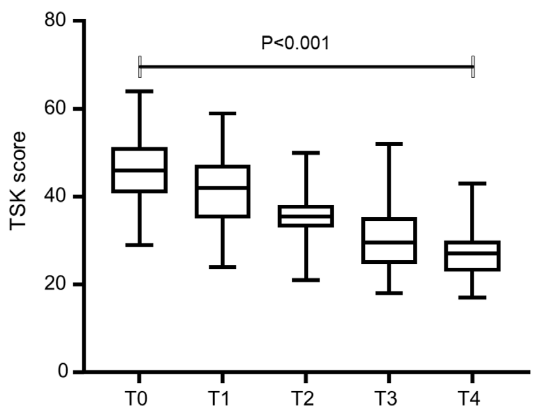

Figure 1. TSK scores at T0-T4 time points. Notes: TSK, Tampa Scale for Kinesiophobia; T0-T4, post-operative day 1 (T0), 1 week (T1), 3 weeks (T2), 6 weeks (T3), and 12 weeks (T4).

Analysis of potential categories of kinetophobia in elderly patients recovering from limb fracture

The study utilized Latent Class Growth Modeling (LCGM) to analyze the TSK scores at five time points (T0 to T4) among 150 patients. Models ranging from 1 to 5 categories were sequentially developed. As the number of categories in the model increased, the values of AIC, BIC, and BIC decreased. **Table 4** shows that compared to other models, Model 5 had smaller information criterion values, but the LMRT corresponding *P*-value was greater than 0.05, indicating no statistical difference. Finally, considering the results of the comprehensive fit indices, Model 2 was selected as the best-fitting model.

Using Model 2, a trajectory graph was plotted with TSK scores on the vertical axis and time points T0 to T4 on the horizontal axis, depicting kinesiophobia trajectories based on two categories (**Figure 2**). Class 1, with a total of 119 patients (79.3%), exhibited continuous decline in kinesiophobia symptoms during the tracking process, named the "Continuous-Decline group". Class 2, consisting of 31 patients (20.7%), showed rapid decline followed by rebound in kinesiophobia symptoms throughout the tracking process, named the "Decline-Rebound group".

Single factor analysis of kinetophobia in elderly patients recovering from limb fracture

Based on the fitting results of LCGM, the development trajectory of kinesiophobia in elderly fracture patients during the recovery period can be divided into two subgroups (Class 1 and Class 2). The results of the single-factor analysis show that there were statistically significant differences (all $P < 0.05$) in age, gender, educa-

Table 2. Comparison of TSK scores among the 5 time points in elderly patients recovering from limb fracture analyzed by repeated measurement of variance

Source of Variation	*SS*	*df*	*MS*	*F* (DFn, DFd)	*P*-value
Between Groups	37711	4	9428	193.1	< 0.001
Within Groups	36380	745	48.83		
Error	74092	749			

Notes: TSK, Tampa Scale for Kinesiophobia; ANOVA, one-way analysis of variance.

Table 3. Correlation among TSK scores at T0-T4 time points in elderly patients recovering from limb fracture (*r* value)

Time	T0	T1	T2	T3
T0	1.000			
T1	0.032	1.000		
T2	0.136	0.662**	1.000	
T3	0.105	0.125	0.657**	1.000
T4	-0.089	-0.140	-0.066	0.060

Notes: TSK, Tampa Scale for Kinesiophobia; T0-T4, post-operative day 1 (T0), 1 week (T1), 3 weeks (T2), 6 weeks (T3), and 12 weeks (T4); $^{**}P < 0.01$.

tion level, monthly income per capita, history of falls, NRS scores, and self-efficacy between the two classes of kinesiophobia trajectories in elderly fracture patients during the recovery period, as shown in **Table 5**.

A multifactorial analysis of the factors affecting kinesiophobia trajectories in elderly fracture patients during rehabilitation period

Using the results of the latent class analysis as the dependent variable (with Class 2 as the reference), logistic regression analysis was conducted with seven statistically significant variables from the univariate analysis as independent variables. The analysis showed that older age (*OR* = 1.219), a monthly per capita income of less than 3000 RMB (*OR* = 12.657), higher NRS scores (*OR* = 2.401), and higher self-efficacy (*OR* = 1.212) were more likely to belong to Class 1 (**Table 6**).

Construction and verification of prediction model

Based on the results of the logistic regression, we derived a predictive model equation: logit(p) = -30.620 + 0.198 × age + 2.538 × per capita monthly income (coded as 2 for ≤ 3000 RMB, 1 for 3000-5000 RMB, 0 for > 5000 RMB) + 0.876 × NRS score + 0.193 × self-efficacy.

The ROC curve analysis (**Figure 3**) indicates that the combined evaluation have a high predictive value for the trajectory Class 1 of kinesiophobia in elderly limb fracture patients during the recovery period (AUC = 0.934), which is higher than that of individual indicators such as age (AUC = 0.694), per capita monthly income (AUC = 0.654), NRS score (AUC = 0.812), and self-efficacy (AUC = 0.811).

Discussion

As age increases, many elderly individuals encounter reduced mobility, weakened strength, and decreased bone quality. Consequently, even a mild slip or minor bump can easily result in fractures [16]. For these patients, the primary treatment goal is to promote disease recovery. However, restoring physical function to its pre-fracture state presents a significant rehabilitation challenge. Rehabilitation differs from treatment as it emphasizes preventing issues such as muscle atrophy, soft tissue contractures, and joint stiffness on the basis of treatment. The core method of rehabilitation is functional exercise, which not only strengthens muscle power but also help patients to recover or compensate for lost functions by unlocking their potential capabilities. In the past, most scholars focused on the physical outcome indicators or predictive factors for movement rehabilitation in fracture patients [17, 18]. However, the role of psychological factors in movement rehabilitation may be even more critical than physical outcome indicators [3, 19]. Jakobsson et al. [20] found a significant association between kinesiophobia and prolonged sitting behavior postoperatively, suggesting that kinesiophobia may lead to reduced activity in patients, increasing the risk of prolonged sitting. It also highlights the negative impact of kinesiophobia on the patient's rehabilitation process, including muscle atrophy, joint stiffness, and delayed functional recovery.

We found that elderly patients in the rehabilitation period after limb fracture exhibited the highest level of kinesophobia on the first day

Table 4. LCGM fitting for kinetophobia in elderly patients recovering from limb fractures

Models	AIC	BIC	aBIC	Entropy	*P*		Group size
					LMRT	BLRT	
1	4995.676	5025.783	4994.135	--	--	--	150
2	4835.934	4884.104	4833.467	0.954	< 0.001	< 0.001	119/31
3	4775.939	4842.173	4772.547	0.914	0.064	< 0.001	32/97/21
4	4736.402	4820.700	4732.085	0.865	0.336	< 0.001	31/37/25/57
5	4719.745	4822.106	4714.503	0.899	0.101	< 0.001	27/31/54/35/3

Notes: LCGM, Latent Class Growth Model; AIC, Akaike information criterion; BIC, Bayesian information criterion; aBIC, sample size-adjusted BIC; LMRT, Lo-Mendell-Rubin test; BLRT, Bootstrapped likely-hood ratio test.

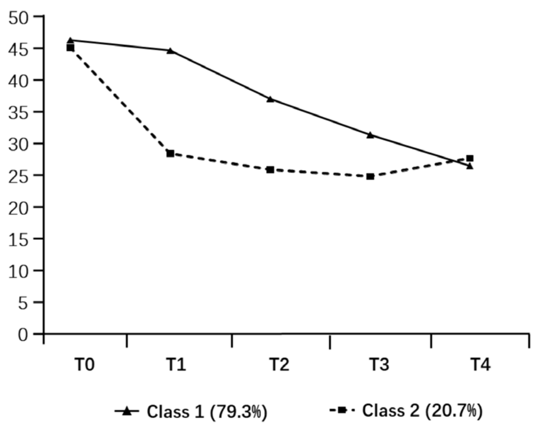

Figure 2. Chart of trajectories of kinesophobia in elderly patients with limb fracture during rehabilitation period. Notes: T0-T4, postoperative day 1 (T0), 1 week (T1), 3 weeks (T2), 6 weeks (T3), and 12 weeks (T4); Class 1, Continuous-Decline group; Class 2, Decline-Rebound group.

after surgery (T0), with a mean score of (46.03±7.88). Meanwhile, we found that kinesiophobia symptoms showed an overall decreasing trend over the following 12 weeks. Additionally, there was a positive correlation between postoperative week 1 (T1) and postoperative week 3 (T2), as well as between T2 and postoperative week 6 (T3). This indicates a strong synchronous change in trend in patients' TSK scores from T1 to T3. However, as time progresses, this decline weakens, suggesting a need for further research to explore the underlying reasons and implications. We identified two trajectories of kinesiophobia symptom changes using LCGM: the "Continuous-Decline" (79.3%) and the "Decline-Rebound group" (20.7%). This indicates heterogeneous developmental trajectories of kinesiophobia in elderly patients during the rehabilitation period. While some patients' kinesiophobia may gradually recover to lower levels, a small portion experiences rapid decline followed by rebound in kinesiophobia symptoms during the early stages of rehabilitation. This suggests that these patients may face certain challenges or difficulties during the recovery process, warranting special attention and intervention. Rehabilitation professionals can help alleviate kinesiophobia through methods such as remote rehabilitation programs, cognitive-behavioral therapy, relaxation techniques, and virtual walking training [7, 8, 21]. Further identification of predictive factors for heterogeneous developmental trajectories provided a basis for the formulation of precise intervention strategies.

We found that age and monthly per capita income are factors influencing the classification of kinesiophobia trajectory changes in elderly patients during the recovery period of limb fractures. Older patients with lower monthly per capita income are more likely to belong to the "Continuous-Decline group". Wang Z et al. [22] conducted a latent feature analysis and found that kinesiophobia can be categorized into three distinct types: low fear type (C1), moderate fear type (C2), and high fear type (C3). In their study, elderly patients were classified as C3, while female patients and those with a normal BMI were classified as C1; patients with a normal BMI and those who were overweight were classified as C2. This suggests that the levels and trajectories of kinesiophobia in different populations may be influenced by various factors. This provides valuable insights for understanding the heterogeneity of kinesiophobia trajectories in elderly patients with limb fractures. Elderly patients often receive more rehabilitation education and support, which help them understand the importance and necessity of rehabilitation, thus reducing their fear of movement. Phelps

Table 5. A univariate analysis of the factors affecting trajectory of kinesiophobia during rehabilitation in elderly patients with extremity fractures

Variables		Class 1 (n = 119)	Class 2 (n = 31)	χ^2/t value	*P* value
Age (years)		75.03±5.24	71.06±4.93	3.802	< 0.001
Sex	Man	54 (45.38)	6 (19.35)	6.940	0.008
	Woman	65 (54.62)	25 (80.65)		
Education	Junior high school and below	86 (72.27)	15 (48.39)	6.377	0.012
	Above junior middle school	33 (27.73)	16 (51.61)		
Per capita monthly income (Yuan)	< 3000	63 (52.94)	8 (25.81)	8.172	0.017
	3000-5000	35 (29.41)	12 (38.71)		
	> 5000	21 (17.65)	11 (35.48)		
Fall history	Yes	80 (67.23)	13 (41.94)	6.677	0.010
	No	39 (32.77)	18 (58.06)		
Fracture site	Upper limb	57 (47.90)	16 (51.61)	0.136	0.713
	Lower limbs	62 (52.10)	15 (48.39)		
Primary caregiver	Nursing workers	42 (35.29)	15 (48.39)	1.875	0.392
	Family member	65 (54.62)	13 (41.94)		
	Other	12 (10.08)	3 (9.68)		
NRS score		7.12±1.32	5.32±1.47	6.601	< 0.001
Self-efficacy		51.34±6.01	45.29±4.42	5.271	< 0.001

Notes: Class 1, Continuous-Decline group; Class 2, Decline-Rebound group; NRS, Numeric Rating Scale.

Table 6. A multifactorial analysis of the factors affecting trajectory of kinesiophobia in elderly patients with extremity fractures during rehabilitation

Variables	*β*	*S.E.*	Wald χ^2 value	*P* value	*OR* [95% *CI*]
Age (years)	0.198	0.073	7.330	0.007	1.219 [1.056, 1.408]
Per capita monthly income (> 5000 yuan as reference)					
3000-5000 Yuan	1.349	0.811	2.765	0.096	3.854 [0.786, 18.905]
< 3000 Yuan	2.538	0.895	8.039	0.005	12.657 [2.189, 73.191]
NRS score	0.876	0.262	11.209	0.001	2.401 [1.438, 4.008]
Self-efficacy	0.193	0.056	11.690	0.001	1.212 [1.086, 1.354]
Constant	-30.620	6.896	19.717	< 0.001	--

Note: NRS, Numeric Rating Scale.

EE et al. [23] also acknowledged this. Additionally, elderly patients may have accumulated more life experience and coping strategies, enabling them to adapt to the rehabilitation process more quickly. The older generation upholds the concept of thrift and household management, possibly being more eager to regain self-sufficiency quickly, reduce family burdens, and this drive may lead them to be more proactive during the rehabilitation process.

Örücü Atar M et al. [19] found that the prevalence of kinesiophobia in patients with traumatic lower limb amputation was 40.4%, and it was associated with factors such as age, gender, pain intensity, and psychological state (such as depression and anxiety). In the study by Tiaho Y et al. [24], pain intensity was correlated with kinesiophobia, and pain management and psychological support were found to be crucial in reducing kinesiophobia and improving the rehabilitation process for patients. In our study, the NRS score on the first postoperative day was another factor affecting the classification of kinesiophobia trajectory in elderly patients during the rehabilitation period after fracture. Higher NRS scores are more likely to belong to the Class 1 "Continuous-Decline group". During the early stages of post-fracture rehabilitation, patients may experience pain, swelling, bruising, and functional

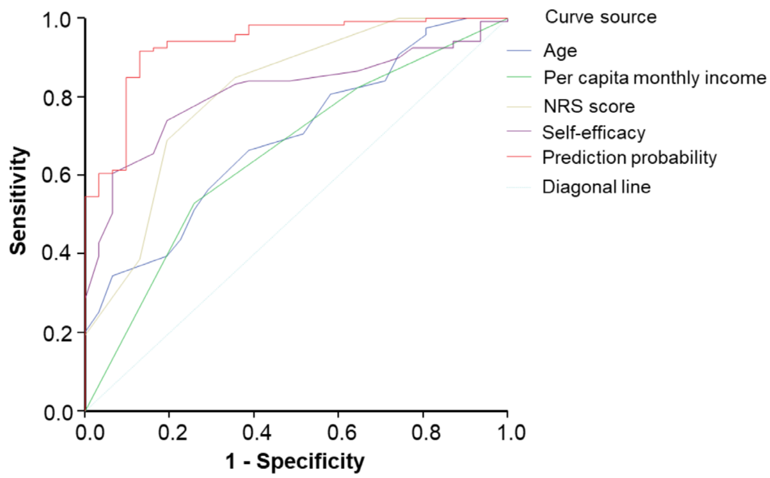

Figure 3. Various prediction models for the kinesiophobia trajectory in elderly patients with limb fracture during rehabilitation analyzed by Receiver operating characteristic curve.

impairments, as well as deformity and abnormal movements in the injured limb. During rehabilitation, the medical team tends to pay more attention to patients with higher NRS scores, including providing more effective pain management strategies. This may involve medication, physical therapy, or other non-pharmacological therapies to alleviate pain and reduce the patients' kinesiophobia [25, 26]. Additionally, patients with higher pain scores may receive more support from family and friends, and this social support may help them maintain a positive attitude during the rehabilitation process, thereby reducing kinesiophobia. Therefore, our study emphasizes that even though some patients may experience significant pain at the beginning of rehabilitation and may have higher levels of kinesiophobia as a result, their levels of kinesiophobia tend to gradually decrease over time, demonstrating a positive trend in recovery. In a study by Goudie et al. [27], lower NRS scores at post-operative 6 months in patients with distal radius fractures were associated with lower levels of kinesiophobia. Unfortunately, we only analyzed NRS scores on the first day postoperatively, and future research should continue to investigate whether there is a subgroup of patients who have negative psychological reactions to pain and how best to identify and intervene in order to help these patients.

The self-efficacy theory, first proposed by American psychologist Bandura A [28] in 1977, reflects an individual's confidence in their ability to complete a specific activity and is negatively correlated with the level of kinesiophobia. Solimeo SL et al. [29] suggested that self-efficacy has predictive power in the health behaviors of older adults, including fall prevention and kinesiophobia. Our study shows that individuals with higher self-efficacy are more likely to belong to Class 1, the "Continuous-Decline group". It may be that individuals with high self-efficacy are less easily discouraged, when facing threatening stimuli such as pain, they put in more effort to overcome it, viewing it as a challenge to be accepted rather than a threat to avoid [30]. Therefore, patients with high self-efficacy are more likely to engage in promoting health behaviors, enabling them to actively continue with rehabilitation training and exercise.

Analysis and mining of clinical data is an extremely important aspect of the medical field, as it helps doctors extract useful information from complex data, thereby making more accurate diagnoses and treatment decisions. For elderly patients in the recovery period after limb fractures, the emergence of kinesiophobia (fear of movement) can significantly affect the recovery process and quality of life of elderly fracture patients. Given the multitude of factors that can influence changes in kinesiophobia, which may interact and affect each other, constructing a model capable of predicting these symptom changes is particularly important. However, there is a current lack of exploration into predictive models for the trajectory of kinesiophobia changes in elderly patients during the recovery period after limb fractures, both domestically and internationally. Our study addresses this gap by constructing a predictive model based on logistic regression results. The ROC results show that the combination of age, per capita monthly income, NRS score, and self-efficacy has a high predictive value for the trajectory of kinesiophobia changes in elderly patients during the recovery period after limb fractures (AUC =

0.934). Pain, a physiological factor, may affect a patient's sense of self-efficacy, a psychological factor, which in turn can influence the development of kinesiophobia. Economic status may affect a patient's ability to access psychological support and rehabilitation resources, both of which are related to the development of kinesiophobia. Future research can further explore the interactions between these factors and how multidisciplinary collaboration can be used to more effectively prevent and treat kinesiophobia.

This study successfully identified two trajectories of kinesophobia in elderly patients during the recovery period of limb fractures through longitudinal observation: Class 1 "Continuous-Decline group" and Class 2 "Decline-Rebound group", along with the relevant influencing factors. Our research findings have important implications for clinical practice:

(1) Screening and Assessment: Regular screening for fear of movement in patients at different stages of rehabilitation, followed by personalized assessments based on individual patient characteristics such as age, economic status, pain levels, and self-efficacy.

(2) Personalized Treatment Plans: Recognizing the two different trajectories of kinesophobia enables clinicians to design more personalized rehabilitation plans for patients. For example, patients in the "Decline-Rebound group" may require more frequent follow-ups and enhanced psychological support, incorporating interdisciplinary approaches such as physical therapy, psychological therapy, and medication to provide comprehensive rehabilitation support and prevent symptom relapse.

(3) Economic and Social Support: Our research indicates a correlation between average monthly income and the trajectory of kinesophobia, highlighting the need for social and economic support mechanisms such as financial assistance or rehabilitation subsidies for low-income patients to reduce their economic burden.

(4) Psychological Support and Intervention: Providing psychological counseling services can help patients deal with kinesophobia and other psychological issues. Techniques such as cognitive-behavioral therapy can help patients change negative thinking patterns and reduce kinesophobia symptoms.

(5) Self-Efficacy Enhancement: Enhancing patients' self-efficacy through education, encouraging participation in decision-making, and providing positive feedback are helpful to creating a supportive environment where patients feel supported and empowered.

Conclusion

By reviewing the follow-up data, we tracked the trajectory of kinesophobia in elderly patients recovering from limb fractures, and identified two potential categories: "Continuous-Decline group" and the "Decline-Rebound group". The study demonstrates that there are differences in the trajectory of kinesiophobia symptoms in elderly patients during the recovery period of limb fractures. Age, monthly average income, NRS score, and self-efficacy are important factors influencing the trajectory categories of kinesiophobia changes in elderly patients. This provides a reference basis for subsequent interventions. However, this study has limitations as it is retrospective and the sample selection is relatively narrow, leading to insufficient sample representation. To address these limitations, multicenter studies can be conducted in the future.

Disclosure of conflict of interest

None.

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