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Psychometric and network analysis of kinesiophobia in Iranian surgical patients

Hamid Sharif-Nia[1,2], Erika Sivarajan Froelicher[3], Esmail Hosseinzadeh[4], Sima Hejazi[5], Reza Fatehi[6] & Poorya Nowrozi[7]✉

Kinesiophobia, the fear of movement, can significantly impede an individual's ability to engage in daily activities. This fear often stems from past traumatic experiences or witnessing others in pain, leading to an increased fear of injury. This study aimed to evaluate the psychometric properties of the Persian version of the Tampa Scale for Kinesiophobia among Iranian post-surgery patients. A methodological study conducted in 2023 involved a sample of 400 post-surgery patients selected through convenience sampling. The translated scale underwent psychometric evaluation, including network analysis, exploratory and confirmatory factor analysis for construct validity, as well as assessments for convergent and discriminant validity. Internal consistency of the scale was also assessed. The mean age of the participants was 44.38 (SD = 13.49) years and the majority of them (77.8%) were women. Exploratory factor analysis with Promax rotation identified two factors explaining 60.28% of the variance, comprising 17 items. The final model was confirmed after necessary adjustments in confirmatory factor analysis. Both convergent and discriminant validity were established, and alpha and omega coefficients of the subscales were above 0.7. The Persian version of the Tampa Scale for Kinesiophobia showed robust psychometric properties among Iranian post-surgery patients, serving as a valuable tool for evaluating and addressing kinesiophobia in this population. These findings enhance the understanding and management of kinesiophobia within the Iranian healthcare context.

Keywords Fear of movement, Kinesiophobia, Network analysis, Psychometrics, Reliability, Validity

Pain after surgery is a common experience for hospitalized patients[1]. According to the US Institute of Medicine, 80% of patients experience postoperative pain[2], and studies have shown that a wide range of surgical procedures, including both soft tissue and hard tissue surgeries, can result in postoperative pain[1,3–5]. Despite advances in understanding the mechanisms of pain generation, identifying its prevalence, and methods of managing it, inadequate pain control remains common. This can lead to consequences such as increased mortality, the development of chronic pain, impaired function, surgical recovery disturbances, and decreased quality of life[1].

One of the consequences patients may experience following pain, including postoperative pain, is kinesiophobia. Kinesiophobia is an unreasonable fear of movement and injury due to the perceived danger of pain[6] and is a psychological construct in the Fear Avoidance Model[7]. In fact, following an acute pain experience, individuals may become trapped in a cycle of disability and suffering due to emotional, cognitive, behavioral, and functional responses to pain[8]. One component of this model, movement avoidance, occurs when pain is perceived as a threat, leading to avoidance, disability, and depression[7].

Kinesiophobia affects 51 to 70 percent of chronic pain sufferers[8]. Individuals with this form of phobia tend to overreact to potential or actual threats and engage in avoidance behaviors that prevent injury or re-injury[9]. Initially, kinesiophobia was primarily associated with musculoskeletal pain and injuries, but over the years, research has been expanded to include other consequences related to kinesiophobia[10]. According to some studies, kinesiophobia can serve as a predictor of reduced quality of life, increased pain, and disability[10,11]. On

[1]Psychosomatic Research Center, Mazandaran University of Medical Sciences, Sari, Iran. [2]Department of Nursing, Amol Faculty of Nursing and Midwifery, Mazandaran University of Medical Sciences, Sari, Iran. [3]Professor Emeritus, Department of Physiological Nursing, School of Nursing, and Department of Epidemiology and Biostatistics, School of Medicine, University of California San Francisco, San Francisco, CA, USA. [4]Department of Nursing, Faculty of Medical Sciences, Gorgan Branch, Islamic Azad University, Gorgan, Iran. [5]Bojnurd School of Nursing, North Khorasan University of Medical Sciences, Bojnurd, Iran. [6]Department of Nursing, Behshahr Faculty of Nursing, Mazandaran University of Medical Sciences, Behshahr, Iran. [7]Student Research Committee, Mazandaran University of Medical Sciences, Sari, Iran. ✉email: npoorya91@gmail.com

the other hand, in other types of phobias, the patient is aware of the irrationality of their fear, but this is not the case with kinesiophobia, where the individual believes that the fear, resulting in decreased movement, is a healthy response, even though this decreased movement leads to numerous adverse effects[8]. Additionally, fear of movement and subsequently reduced mobility in surgical patients is associated with irreversible consequences such as thromboembolic events[12] and immobility that leads to poor therapeutic outcomes[13]. Therefore, accurate measurement and appropriate management of kinesiophobia are essential.

Various tools have been designed to assess fear of movement, including the Fear-Avoidance Beliefs Questionnaire (FABQ)[14], Kinesiophobia Causes Scale (KCS)[15], and Fear-Avoidance Components Scale (FACS)[16]. One of the oldest available tools for measuring this construct is The Tampa Scale for Kinesiophobia (TSK)[17]. This 17-item questionnaire was initially designed to "distinguish between non-excessive fear and phobia related to movement in patients with chronic musculoskeletal pain"[18]. It is a commonly accepted model that is comprised of two factors: somatic focus and activity avoidance. Responses options include a 5-point Likert scale ranging from 0 (completely disagree) to 4 (completely agree). Items 4, 8, 12, and 16 are reverse-scored[10]. Shortened versions of TSK, the 13, 11, 6 and 4-item versions, have also been developed[19–22].

This questionnaire has been translated and validated in various patient populations, in patients with temporomandibular disorders[23], neck pain[24], knee surgery[25], chronic pain[26], in anterior shoulder instability[27], in patients with acute and chronic back pain[6,19,28,29], children and adolescents undergoing major surgery[30]. The questionnaire exists in the following languages: Italian, Japanese, Swedish, Turkish, Chinese, Norwegian, Spanish, Greek, and Dutch[6,10,31,32]. In Iran, the Persian version of this questionnaire has been psychometrically evaluated in populations with chronic nonspecific low-back pain (17 and 11-item versions)[19], in patients with neck pain (17-item version)[24], and in patients with low-back pain (17-item version)[29]. However, a similar study focused on the psychometric properties of this questionnaire in surgical patients was not found. Therefore, this study aimed to psychometrically evaluate (construct, convergent and discriminant validity and reliability) of the 17-item version of The Tampa Scale for Kinesiophobia questionnaire in patients undergoing surgery.

Methods

Sample size and data collection

This cross-sectional methodological study was conducted between October 2023 and February 2024. A sample of 400 Iranian adults who had undergone surgery were recrited. A minimum sample size of 200 cases has been recommended for psychometric studies[33]. This decision was made to enhance statistical power and ensure more reliable estimates, as larger samples reduce the risk of Type I and Type II errors, unstable factor structures and improve generalizability across diverse populations[34]. Furthermore, recruiting 400 participants allowed us to fulfill the requirement for two different samples necessary for assessing construct validity effectively.

The participants were chosen using a convenience sampling method, which involved selecting individuals who were readily accessible and willing to participate in the study. While this approach can introduce potential selection bias and limit generalizability, we implemented a random selection process within this convenience sample. Thus participants were randomly selected from those available at the time of data collection, which aimed to enhance the representativeness of our sample relative to the broader population of surgical patients.

The research setting consisted of hospitals affiliated with Mazandaran University of Medical Sciences that have surgical wards, located in the city of Amol, Mazandaran, Iran. To access the research sample, the researcher visited the surgical wards of selected hospitals, and patients were chosen based on the inclusion criteria. The demographic questionnaire and TSK-P were completed by the patients with the guidance of the researcher.

Inclusion and exclusion criteria

The inclusion criteria for participants in this study were as follows: participants must be at least 18 years old, able to communicate in Farsi, literate, willing to volunteer for the study, and currently hospitalized in surgical wards after a surgical procedures, including orthopedic, abdominal, or thoracic surgeries. Exclusion criteria were determined based on medical history and self-reported information collected during the initial screening process. Patients were excluded if they had:

Cognitive disorders or reduced level of consciousness: These conditions could impair the patient's ability to understand and accurately respond to the questionnaire items, compromising data validity.

Mental illnesses: Such as schizophrenia or anxiety disorders, which could independently influence fear-avoidance beliefs and responses.

Significant medical conditions: Including heart diseases (e.g., unstable angina), cerebrovascular diseases, neurological disorders, or rheumatoid arthritis, as these could directly impact physical function and pain experience.

Pregnancy or cancer: These conditions may require specialized medical management that could affect the patient's physical and psychological status.

Substance use disorders: Drug addiction or dependencies could influence pain perception, coping mechanisms, and responses on the kinesiophobia scale.

The original version of the scale

The original version of TSK was conceptualized and developed by Miller[17]. This scale has been developed to assess the components of fear of movement. It has 17 items with a Likert scale scoring based on a four-point scale from 1 to 4: (I strongly disagree = 1), (I somewhat disagree = 2), (I somewhat agree = 3), (I strongly agree = 4). The scoring of items 4, 8, 12, and 16 is reversed. The total score ranges from 17 to 68 points. Also, it should be declared that the original version of this scale was designed for adults and adolescents. Two phases were used to assess the psychometric qualities and usefulness of the "Persian version of Tampa Scale for Kinesiophobia (TSK-P)".

Translation

Subsequently, the scale was translated from English to Persian following the Gudmundsson[35] translation protocol. Two proficient English-Persian translators independently translated the TSK into Persian. An expert panel, comprised of some authors of this article and two professional translators, meticulously reviewed and amalgamated the two translations to create a Persian version of the TSK.

To validate this translation, a qualified Persian-English translator, who were not involved in the initial translation, performed a back-translation of the TSK-P into English. This back-translated version was then reviewed by our expert panel, which discussed any discrepancies and ensured that both versions maintained conceptual equivalence. The panel's involvement was crucial in refining item wording and ensuring cultural relevance for Iranian surgical patients. Finally, this revised version was approved by all members of the expert panel.

Normal distribution, outliers, and missing data

Skewness (± 3) and kurtosis (± 7) were used to individually investigate the univariate distribution of data. Also, the multivariate normality distribution was assessed by the Mardia coefficient of multivariate kurtosis (< 8). Mahalanobis d-squared ($p < 0.001$) was used to determine whether there were any multivariate outliers[36]. We employed the multiple imputation method to assess the presence of missing data[37]. The analysis confirmed that there were no missing values, indicating that all participants responded completely to the scale.

Construct validity

To test construct validity, the original dataset ($n = 400$) was randomly divided into two datasets with 200 cases each. With the first random dataset ($n = 200$), we employed Maximum Likelihood Exploratory Factor Analysis (MLEFA) with Promax rotation and Kaiser normalization. The choice of MLEFA was based on its effectiveness in estimating factor structures from continuous data, providing more reliable parameter estimates compared to other techniques such as Principal Component Analysis (PCA). MLEFA is particularly advantageous when assumptions of normality are met[38], which aligns with our dataset characteristics. Furthermore, using Promax rotation allowed us to explore potential correlations among factors, facilitating a clearer understanding of the underlying dimensions of kinesiophobia.

To ensure that the data were suitable for factor analysis, we assessed the Kaiser–Meyer–Olkin (KMO) measure, which was found to be greater than 0.8, and conducted Bartlett's test of sphericity, which yielded a significant result ($p < 0.001$)[39]. These tests confirmed the appropriateness of our dataset for factor analysis. For factor extraction, we employed parallel analysis, a robust method that involves generating a random correlation matrices to simulate data. This technique allowed us to compare the eigenvalues obtained from our actual data with those derived from the simulated datasets. Specifically, we conducted 1000 iterations to establish a 95th percentile cutoff for eigenvalues. Factors with eigenvalues greater than this threshold were considered meaningful and retained for further analysis. This approach minimizes the risk of over-extraction by ensuring that only those factors that exceeded chance levels were included in our model[40].

Also, the Eigenvalues of more than 1, communalities of more than 0.2, and factor loadings of more than 0.3 were used for the factorability[41,42]. A communality threshold of 0.2 is generally deemed acceptable, especially in preliminary analyses, as it signifies that a factor accounts for at least 20% of the variability in an item, which is adequate for initial evaluations[43]. Likewise, a factor loading of 0.3 is commonly recognized as the minimum threshold, indicating a moderate relationship between an item and its underlying factor[44].

Eigenvalues (λ) are the sum of squared factor loadings (SSL) across all items (k) for each factor. This represents the amount of variance in each item that can be explained by the analysis. To calculate the percentage of total variance explained by the factor, the Eigenvalue is divided by the total number of items[45]. The MLEFA was performed using SPSS version 27.

The exploratory graph analysis (EGA) methods were conducted to determine the factor structure. In the field of network psychometrics, EGA is a new method that determines the number of factors underlying multivariate data. EGA generates a network plot, which is a visual guide that displays how many factors should be kept, which items cluster together, and how strongly they are related[46].

EGA offers several advantages over traditional factor analysis methods. Notably, it does not depend on rotation techniques that can produce varying results based on subjective choices. This feature allows for a more stable representation of the underlying structure. Furthermore, EGA has been demonstrated to provide comparable or superior performance in estimating dimensionality under various conditions, especially when item correlations are high or when dealing with smaller item sets[47]. The network plots produced by EGA facilitate easier interpretation by visually representing item interconnections and clustering patterns.

EGA generates a network plot, which visually displays the number of factors that are retained, based on the items that cluster together, and the strength of their relationship[47]. The estimation of EGA involves representing items as nodes, defining edges as the partial correlation between the nodes, and identifying communalities as clusters of connected nodes in multivariate data using undirected network models. EGA was estimated by applying the Graphical Least Absolute Shrinkage Optimization (GLASSO) method. This method involved the following steps[48]:

1. Identification of network nodes: The variables identified in the study as network nodes, representing the entities or concepts we wanted to analyze.
2. Construction of the network: The nodes were connected with links, representing the relationships or associations between the variables.
3. Descriptive analysis: Tools used in network science were employed to analyze the topology of the network, such as node centrality, clustering, and other measures.

4. Centrality measures: Including strength, closeness, and betweenness, were calculated to determine the importance of each node in the network.
5. Clustering analysis was performed to identify groups of nodes with similar characteristics or relationships.
6. Comparison of networks: Networks from different groups or conditions were compared to identify any significant differences in the structure and relationships between the variables[48,49].

The following centrality and clustering measures were used for the network analysis:

- Betweenness: This measure indicates the number of times a node lies on the shortest path between other nodes, revealing its role as a bridge between different parts of the network.
- Closeness: Centrality measures the average distance between a node and all other nodes in the network, indicating its ability to reach other nodes quickly.
- Strength: Centrality measures the sum of the weights of the connections of a node, indicating its overall influence in the network.
- Expected influence: This metric estimates the potential impact of a node on the network, taking into account its strength and the centrality of its neighboring nodes.
- Barabási: This centrality measure is derived from the Barabási-Albert model, which focuses on the growth and evolution of networks.
- Onnela: This centrality measure is based on the Onnela-Kim centrality, which assesses the significance of a node based on its connectivity and the connectivity of its neighbors.
- WS: The WS centrality measure, also known as the HITS algorithm, identifies nodes that serve as both authorities (highly connected to other nodes with high authority) and hubs (highly connected to other nodes with high hub scores).
- Zhang: This centrality measure is built upon the Zhang-Zhou centrality, which evaluates the importance of a node in terms of its connectivity and the centrality of its neighbors. In this study, the EGA was conducted using JASP 0.18.3.0 software.

Confirmatory factor analysis (CFA)
In the next step, the factor structure obtained from MLEFA was analyzed and confirmed by conducting (CFA based on the second random dataset (n = 200) using AMOS version 27. The following model fit indices were used to assess the model fit: Parsimony Comparative Fit Index (PCFI), Parsimony Normed Fit Index (PNFI) and Comparative Fit Index (CFI) > 0.5, Normed Fit Index (NFI), and Incremental Fit Index (IFI) was > 0.9; that of Root Mean Square Error of Approximation (RMSEA) was < 0.08; and for Minimum Discrepancy Function divided by degrees of freedom (CMIN/DF) < 3 was considered good[36,50].

Convergent, discriminant validity
For convergent validity, composite reliability (CR) should be greater than 0.7, and Average Variance Extracted (AVE) should be greater than 0.5 for each construct. Fornell and Larcker[51] stated that for psychological constructs, if AVE is less than 0.5, but CR is more than 0.7, the convergent validity can be considered acceptable.

For discriminant validity, this study used the heterotrait-monotrait ratio (HTMT) of the correlations criterion, where the HTMT ratio between all constructs should be less than 0.85 to achieve discriminant validity[52].

Reliability
A Cronbach's alpha (α) and McDonald's omega (Ω) along with Composite Reliability (CR) and Maximum Reliability (MaxR) values exceeding 0.7, indicated satisfactory internal consistency and construct reliability for the scale[39].

Ethical approval
The Ethics Committee of Mazandaran University of Medical Sciences (Sari, Iran) approvedithis study (Ethics code: IR.MAZUMS.REC.1402.601). The participants were given a thorough explanation of the study's goals and methods, as well as assurances that their participation was entirely voluntary. Written informed consent forms for participation in the study were filled out by patients or their caregivers. All procedures adhered to the appropriate guidelines and regulations.

Results
Demographic characters
The mean age of the participants was 44.38 (SD = 13.49) years. Among the participants 192 (48%) were women and 208 (52%) were men. Most people (n = 268, 67%) had an education level lower than a diploma. In the present study, 93 participants (23.25%) reported a history of having undergone surgery. The majority of participants were married (n = 334, 83.5%), and the mean body mass index (BMI) was 26.17 (SD = 4.31).

The independent *t*-test results demonstrated that there was no significant difference in kinesiophobia scores between male (mean = 46.35, SD = 14.88) and female participants (mean = 46.45, SD = 15.34), with $p > 0.05$. Furthermore, the Pearson correlation analysis indicated no significant relationship between kinesiophobia scores and the age of participants who underwent surgery ($p > 0.05$). These results imply that demographic factors such as gender and age do not significantly impact kinesiophobia levels in this population.

MLEFA
The results of MLEFA with Promax with Kaiser Normalization rotation using the first random dataset (n = 200) extracted three factors accounting for 60.28% of the variance comprising 17 items. Moreover, the results of the

KMO (0.955) and Bartlett's test of sphericity ($p < 0.001$, chi-square = 6649.181, $df = 136$) showed the sampling was adequate and appropriate for factor analysis. The detailed results of the MLEFA are shown in Table 1. Also, the EGA is shown in Fig. 1.

Network analysis

Centrality measures:

- TSK1 has a high negative betweenness and closeness centrality, indicating its importance in connecting other variables in the network.
- TSK4 and TSK12 have high positive betweenness and closeness centrality, suggesting their strong influence and connection to other variables in the network.
- TSK17 has high negative betweenness and low closeness centrality, indicating its limited influence and connection to other variables in the network.

Clustering measures:

- TSK1 has positive Barrat and Zhang clustering measures, indicating its tendency to form clusters or communities within the network.
- TSK3 has negative Barrat and Onnela clustering measures, suggesting its low tendency to form clusters within the network.
- TSK12 has high positive Barrat and Onnela clustering measures, indicating its strong tendency to form clusters or communities within the network (Tables 2, and 3).

CFA

The CFA was conducted to confirm and validate the factor structure obtained from MLEFA using the second random dataset (n = 200). In the analysis section of the confirmatory factor analysis, correlations were drawn between the following pairs of errors to refine the model: errors 1 and 3, 4 and 7, 6 and 7, 10 and 11, 10 and 12, and 11 and 12 (Fig. 2). The results showed that the data fit the model well as evidenced by ($\chi^2(112) = 237.022$, $p < 0.001$, $\chi^2/df = 2.116$, PCFI = 0.769, PNFI = 0.783, CFI = 0.966, IFI = 0.9661, TLI = 0.959, RMSEA (90% C.I.): 0.074 [0.073, 0.086].

Convergent, discriminant validity and reliability

The results showed that AVE for factor Fear and Avoidance of Pain-Related Injuries and Perception of Pain and Physical Activity were 0.737 and 0.689 respectively, indicating good convergent validity. As for discriminant validity, the results of the HTMT ratio showed that the correlation between Fear and Avoidance of Pain-Related Injuries and Perception of Pain and Physical Activity (0.685) was lower than 0.85, demonstrating good discriminant validity for the two constructs. As for construct reliability, Cronbach's alpha, McDonald's Omega, CR, and MaxR for all constructs were greater than 0.7, demonstrating good internal consistency and construct reliability. Also, McDonald's Omega of all of the latent variables was in the acceptable range (Tables 1 and 4).

Factor	Items (Q)	Factor loading	h^2	λ	% Variance	Reliability
Fear and avoidance of pain-related injuries	TSK_{11}. I wouldn't have this much pain if there weren't something potentially dangerous going on in my body	0.958	0.881	7.51	44.17	α = 0.973 Ω = 0.975
	TSK_9. I am afraid that I might injure myself accidentally	0.948	0.857			
	TSK_{10}. Simply being careful that I do not make any unnecessary movements is the safest thing I can do to prevent my pain from worsening	0.932	0.849			
	TSK_{15}. I can't do all the things normal people do because it's too easy for me to get injured	0.930	0.814			
	TSK_7. Pain always means I have injured my body	0.928	0.828			
	TSK_{13}. Pain lets me know when to stop exercising so that I don't injure myself	0.891	0.821			
	TSK_{14}. It's really not safe for a person with a condition like mine to be physically active	0.888	0.850			
	TSK_6. My accident has put my body at risk for the rest of my life	0.796	0.514			
	TSK_5. People aren't taking my medical condition seriously enough	0.794	0.644			
	TSK_3. My body is telling me I have something dangerously wrong	0.776	0.793			
	TSK_2. If I were to try to overcome it, my pain would increase	0.754	0.783			
	TSK_1. I'm afraid that I might injury myself if I exercise	0.671	0.707			
	TSK_{17}. No one should have to exercise when he/she is in pain	0.448	0.430			
Perception of pain and physical activity	TSK_{12}. Although my condition is painful, I would be better off if I were physically active	− 0.953	0.853	2.74	16.11	α = 0.896 Ω = 0.896
	TSK_{16}. Even though something is causing me a lot of pain, I don't think it's actually dangerous	− 0.800	0.632			
	TSK. My pain would probably be relieved if I were to exercise	− 0.785	0.674			
	TSK. Just because something aggravates my pain does not mean it is dangerous	− 0.779	0.580			

Table 1. The result of MLEFA on the two factors Persian version of Tampa Scale for Kinesiophobia (n = 200). h^2 Communalities, λ Eigenvalues.

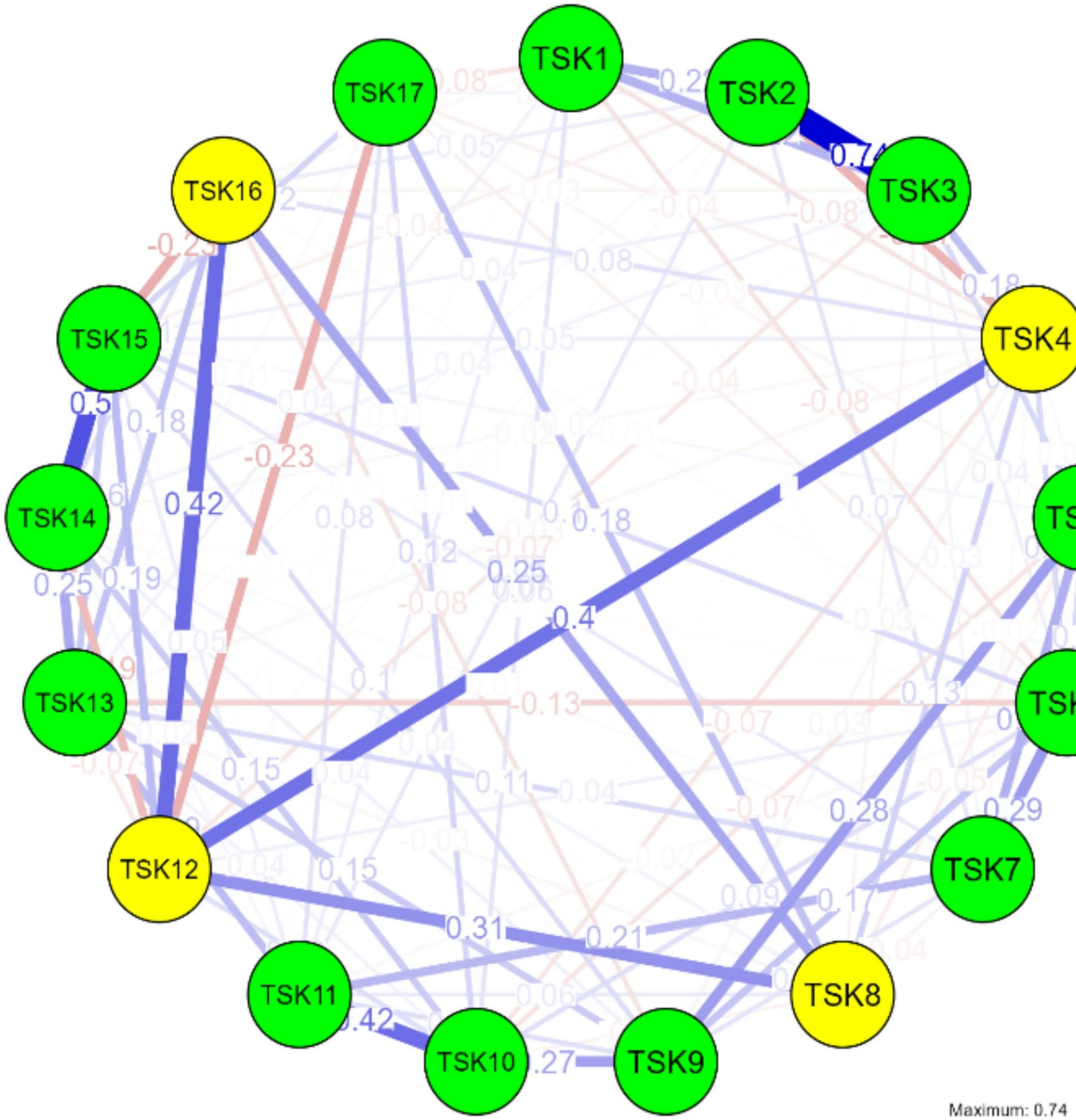

Fig. 1. Exploratory graph analysis by network analysis.

Discussion

The present study evaluated the psychometric properties of the TSK in a sample of Iranian adult surgical patients. The findings of this study indicated that the TSK demonstrated both reliability and validity.

Cultural factors significantly influence the concept of kinesiophobia in patients who have undergone surgery. Kinesiophobia, defined as an irrational fear of movement due to concerns about pain or re-injury, can be shaped by various cultural beliefs and societal norms that dictate how individuals perceive pain, recovery, and physical activity.

In many cultures, including Iranian culture, beliefs about fate and spirituality can affect how individuals interpret pain and recovery. For instance, Iranian patients may view their experiences with pain as a spiritual test of faith, which can lead to a stoic approach to suffering and a reluctance to express vulnerability. This perspective may contribute to a higher tolerance for pain but could also exacerbate kinesiophobia if patients fear that movement might jeopardize their spiritual or physical well-being[45].

Cultural norms regarding independence and self-reliance can further complicate the experience of kinesiophobia. In societies where there is a stigma associated with appearing weak or dependent on others, patients may be less likely to seek help or express fears related to their recovery[53]. This can lead to increased

Variable	Network			
	Betweenness	Closeness	Strength	Expected influence
TSK1	−0.917	−2.104	−1.565	−1.605
TSK2	−0.051	−0.472	0.413	0.336
TSK3	−0.267	−0.662	0.683	1.392
TSK4	2.113	1.309	0.497	−0.988
TSK5	−0.267	−1.064	−1.448	−0.743
TSK6	−0.267	−0.294	−0.341	−0.525
TSK7	−0.592	−0.958	−0.695	0.569
TSK8	−0.917	−0.724	−0.634	−0.168
TSK9	0.166	−0.182	−0.201	0.870
TSK10	0.598	0.323	0.379	0.745
TSK11	−0.592	−0.273	−0.233	1.213
TSK12	2.655	1.750	2.472	0.234
TSK13	0.057	0.641	0.176	0.131
TSK14	−0.484	0.933	0.122	0.307
TSK15	−0.592	0.939	1.180	0.910
TSK16	0.274	1.031	0.450	−0.375
TSK17	−0.917	−0.191	−1.256	−2.302

Table 2. Centrality measures per variable.

Variable	Network			
	Barrat	Onnela	WS	Zhang
TSK1	1.216	−0.965	0.969	2.153
TSK2	1.305	0.338	1.495	0.292
TSK3	−1.483	−1.054	−0.136	0.054
TSK4	−0.262	−0.408	−0.983	0.446
TSK5	−0.486	−0.353	0.050	−0.679
TSK6	−0.018	−0.679	−0.347	−0.898
TSK7	−0.575	−1.017	−1.045	−1.084
TSK8	−1.359	−0.212	−1.133	1.597
TSK9	0.272	1.830	1.495	−0.533
TSK10	−1.425	−0.076	−0.607	−1.443
TSK11	−0.827	−0.647	−1.483	−1.296
TSK12	1.297	2.542	1.145	−0.128
TSK13	0.289	−0.460	−0.157	−0.080
TSK14	1.717	0.297	1.583	0.667
TSK15	0.069	0.866	−0.506	−0.151
TSK16	0.678	0.602	0.269	1.236
TSK17	−0.409	−0.603	−0.607	−0.153

Table 3. Clustering measures per variable.

anxiety about movement and a greater likelihood of developing kinesiophobia as patients avoid activities that they perceive might expose them to judgment.

The interplay between cultural context and psychosocial factors such as anxiety, depression, and social support is crucial in understanding kinesiophobia. Cultural perceptions of mental health can affect how individuals express these emotions and seek help. In cultures where mental health problems are stigmatized, individuals may be less likely to acknowledge their fears or seek psychological support, thereby exacerbating kinesiophobia[54].

The relationship between demographic factors such as gender and age with kinesiophobia in surgical patients is complex and has been explored in various studies[55]. In our research, we found no significant differences in kinesiophobia scores between male and female participants, nor was there a correlation with age. This finding is consistent with the work of Aleksić et al.[55], which highlighted that while older age and female sex are often associated with higher levels of kinesiophobia, their influence can vary significantly across different populations and contexts. Specifically, they noted that factors such as lower education levels and negative coping styles may play a more critical role in predicting kinesiophobia than age or gender alone[56]. Additionally, a study by Silva et al.[57] found that kinesiophobia levels did not significantly differ between genders in elderly females with chronic

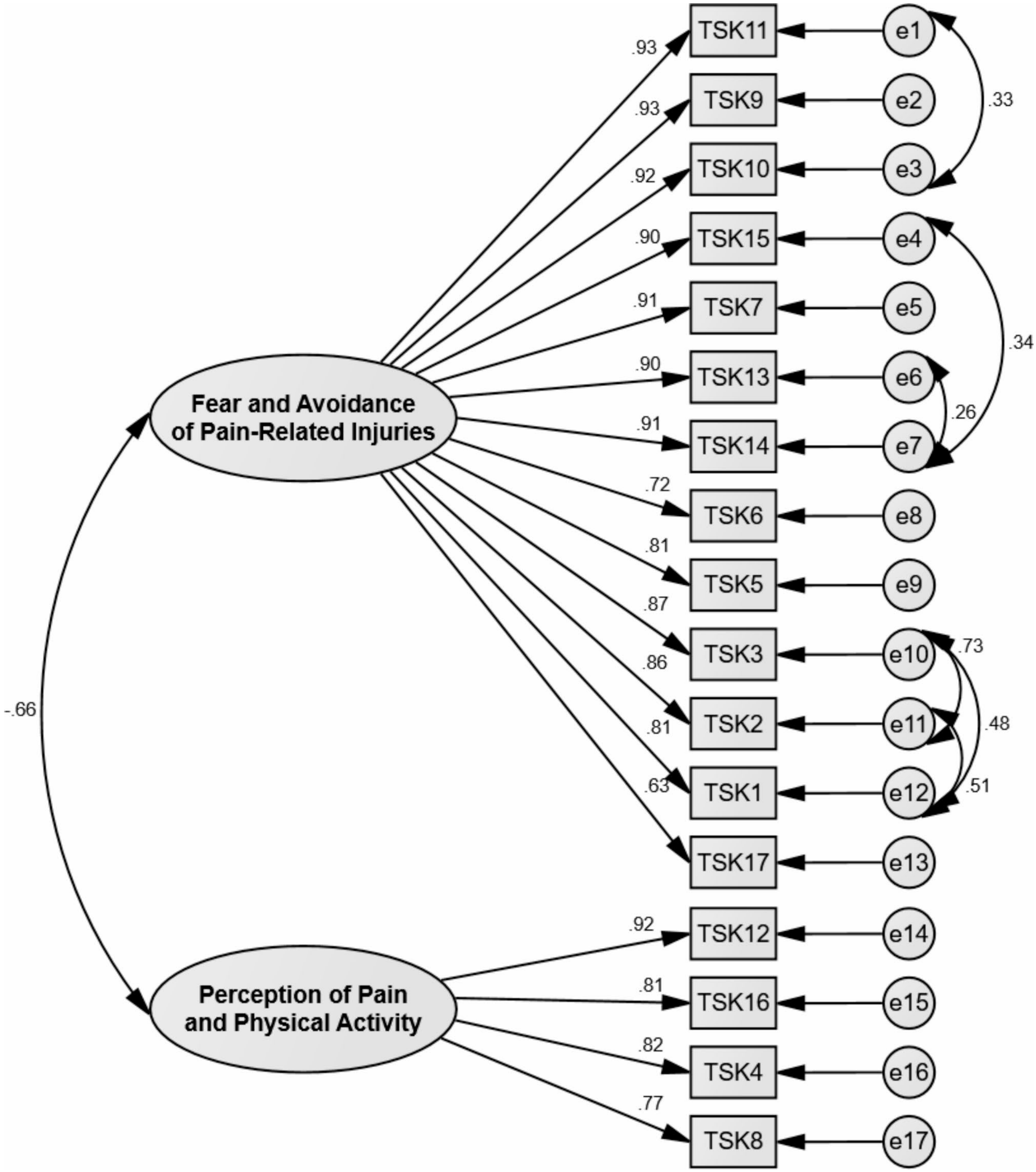

Fig. 2. The results of the CFA and factor loadings.

Factors	CR	MaxR	AVE
Fear and avoidance of pain-related injuries	0.973	0.980	0.737
Perception of pain and physical activity	0.898	0.914	0.689

Table 4. The results of the convergent validity and construct reliability (n = 200).

musculoskeletal pain, suggesting that sociocultural factors might influence these experiences. Furthermore, Higuchi et al.[56] emphasized that while older adults may experience higher kinesiophobia due to declining cognitive and physical abilities, this does not uniformly apply to all surgical populations. These findings indicate that while age and gender are commonly considered risk factors for kinesiophobia, their impact may not be as pronounced in out surgical contexts, necessitating further investigation into how these demographic variables interact with psychological factors influencing kinesiophobia.

The results of the EFA revealed that the Persian version of the TSK consisted of two factors and exhibited adequate stability in assessing kinesiophobia in postoperative patients. This 17-item scale with two factors accounted for 60.28% of the total variance in kinesiophobia among Iranian surgical patients.

It is noteworthy that the TSK has been translated into various languages and utilized with participants presenting diverse medical conditions. Consequently, studies conducted in different countries have identified 2 or 3-factor structures, as well as 5-factor structures, in different versions, with varying levels of explained variances for this scale[31,58,59]. Gómez-Pérez et al., in the results of their initial factor analysis on the 17-item scale, found factor loadings below 0.3 for the reverse-scored items (items 4, 8, 12, and 16) and subsequently removed these items[31]. The results of the study by Houben et al., also showed that the reverse-scored items had weak inter-item correlations and, in the initial factor analysis, did not load together with other items on the same factor. Instead, they grouped together in a separate factor. As a result, they also removed these four items and conducted factor analysis using the 13-item version[60]. Similarly, Jafari et al., in their item analysis on Persian-version of the scale, achieved a better Cronbach's alpha for the entire scale by removing these four items. As a result, they excluded these items in further analyses and examined the 13-item version[29]. However, in the present study, these four items were retained as they demonstrated acceptable factor analysis results. These discrepancies underscore the influence of cultural context and patient characteristics on the psychometric evaluation of the TSK. Consistent with prior research, the current study's findings support the notion that the TSK possesses satisfactory psychometric properties.

The internal consistency analysis of the TSK yielded satisfactory results. Notably, the utilization of McDonald's Omega in this study is advantageous as it is independent of sample size and the number of items[61]. The results of Askary-Ashtiani el al. study on the Persian version of the scale indicated a Cronbach's alpha in the range of 0.77 to 0.78[24]. This level of alpha is lower than the Cronbach's alpha obtained in the present study. In another study conducted on the Persian version of this scale, Jafari et al.'s study[29], the overall Cronbach's alpha for the 17-item version was 0.796. By removing 4 items, these researchers achieved a higher overall alpha of 0.831. In contrast, in the present study, both factors had an overall alpha higher than 0.8 with all 17 items included.

The first factors identified in the scale pertain to Fear and Avoidance of Pain-Related Injuries. It is well-established that fear and avoidance beliefs are closely linked to the perception of pain, particularly in cases of chronic pain[62]. Anticipation of severe pain often results in heightened vigilance and monitoring of pain sensations, potentially rendering even mild pain intolerable[63]. Items associated with this factor suggest that patients' perceptions regarding postoperative pain may lead them to restrict their activities, thereby increasing the risk of postoperative immobility complications. Consequently, healthcare professionals should prioritize pain management in the immediate postoperative period and provide patients with appropriate guidance on postoperative activity levels to mitigate such risks.

The second factor, namely Perception of Pain and Physical Activity, highlights the significance of pain perception as a defensive mechanism signaling potential harm to tissues and hazardous conditions[64].

The items associated with this factor underscores the importance of proper perception of pain post-surgery in facilitating effective planning for physical activity in patients. Consequently, pre-surgical interviews conducted by nurses can offer insights into patients' anticipated pain perceptions post-surgery, enabling the reinforcement of positive attitudes toward pain. Moreover, addressing negative perceptions can be achieved through educational interventions, aiding patients in maintaining their physical activity levels following surgery.

The correlations drawn between the errors of items 10 and 11, 14 and 15, 13 and 14, as well as 1 and 2, and 1 and 3 in the TSK were instrumental in refining the confirmatory factor analysis model. These specific error correlations suggest that certain items may share common variance beyond what is accounted for by the underlying constructs of the scale. This finding aligns with the theoretical framework of kinesiophobia, which posits that fears related to movement and potential injury can manifest in interconnected ways among various items on the TSK. By addressing these correlations, we enhance the scale's construct validity and ensure a more accurate representation of the psychological dimensions of kinesiophobia in surgical patients. This refinement is crucial for improving the assessment's sensitivity to detect fear-related behaviors that may hinder rehabilitation outcomes.

In the modification of CFA, the interpretation of error measurement correlations is critical for understanding the underlying structure of the data. When specific items in a measurement model exhibit correlated errors, it suggests that these items share variance that is not accounted for by the latent constructs being measured. This shared variance may arise from common contextual factors, similar wording, or other systematic influences affecting responses[65].

Including these error correlations in the CFA model can enhance its fit by acknowledging these additional relationships, thereby improving the model's overall explanatory power. However, it also indicates potential redundancy among items, which could complicate the interpretation of the constructs. Ultimately, recognizing and addressing correlated errors helps refine the measurement model, leading to more accurate assessments of the psychological dimensions being studied, such as kinesiophobia in surgical patients[66].

The study's findings also indicate that the items within this scale demonstrate robust convergent and divergent validity. Items that reflect a particular construct should converge or share a high proportion of variance in common, known as convergent validity, while discriminant validity refers to the degree to which a construct is genuinely different from other constructs[36].

Furthermore, the internal consistency coefficients of the scales dimensions reveal that the items within each factor exhibited strong internal correlations, elucidating and measuring a broader concept effectively. In essence, the items within each dimension sufficiently capture and assess a specific concept.

Conclusion

The Persian version of the TSK demonstrated acceptable construct validity and reliability. The scale is comprised of two factors encompassing 17 items, collectively explaining 60.28% of the total variance of kinesiophobia observed in post-surgery patients. This instrument holds potential utility for healthcare professionals, including doctors and nurses, in the identification of kinesiophobia among pre-surgical patients. By utilizing the TSK scale, healthcare providers can effectively educate patients before the surgery to mitigate fear, thereby reducing the risk of immobility-related complications post-surgery. It is recommended that future studies evaluate other psychometric properties of the Persian version of the scale in Persian-speaking populations.

Limitations

The lack of evaluation of other psychometric properties, such as test–retest reliability and responsiveness of the scale, is also considered another limitation of this research. The utilization of a four-point scale in the TSK restricts respondents' ability to convey neutral opinions, potentially biasing the data towards either agreement or disagreement. This constrained-choice format may fail to fully grasp the subtleties of participants' fear of movement, thereby impacting the accuracy of the results and their applicability to wider demographics. Subsequent research endeavors could enhance their methodology by implementing an odd-numbered scale to accommodate a neutral response alternative.

Clinical implications

Enhanced pre-operative management

The findings of the study offer valuable insights for healthcare professionals in identifying and effectively managing kinesiophobia in patients by preparing then for surgery. By addressing this fear of movement, healthcare providers can potentially reduce complications and enhance the overall recovery process.

Optimized rehabilitation programs

The study emphasizes the significance strategies to kinesiophobia into post-operative rehabilitation programs. By doing so, patients can experience improvements in their functional capacity and overall quality of life.

Tailoring interventions

By pinpointing specific factors and indicators associated with kinesiophobia, healthcare professionals can develop targeted interventions tailored to each patient's needs. For instance, implementing pre-operative inspiratory muscle training can effectively address kinesiophobia and lead to better outcomes for patients undergoing surgery.

Data availability

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

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Author contributions
Performance of data gathering: Poorya Nowrozi; Planning and supervision of the work: Hamid Sharif-Nia; Performance of the analysis: Hamid Sharif-Nia; Manuscript draft: Reza Fatehi, Sima Hejazi, and Esmail Hosseinzadeh; and comment on the final manuscript: Erika Sivarajan Froelicher and All authors.

Declarations

Competing interests
The authors declare no competing interests.

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Correspondence and requests for materials should be addressed to P.N.