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Development and testing of the knowledge–attitudes–practices questionnaire for nurses on the perioperative pulmonary rehabilitation of patients with lung cancer

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ABSTRACT

Objective: This study aims to develop and validate a suitable scale for assessing the level of nurses' knowledge and practice of perioperative pulmonary rehabilitation.

Methods: We divided the study into two phases: scale development and validation. In Phase 1, the initial items were generated through a literature review. In Phase 2, a cross-sectional survey was conducted involving 603 thoracic nurses to evaluate the scale's validity, reliability, and difficulty and differentiation of items. Item and exploratory factor analyses were performed for item reduction. Thereafter, their validity, reliability, difficulty, and differentiation of items were assessed using Cronbach's α coefficient, retest reliability, content validity, and item response theory (IRT).

Results: The final questionnaire comprised 34 items, and exploratory factor analysis revealed 3 common dimensions with internal consistency coefficients of 0.950, 0.959, and 0.965. The overall internal consistency of the scale was 0.966, with a split-half reliability of 0.779 and a retest reliability Pearson's correlation coefficient of 0.936. The content validity of the scale was excellent (item-level content validity index = 0.875–1.000, scale-level content validity index = 0.978). The difficulty and differentiation of item response theory were all verified to a certain extent (average value = 2.391; threshold β values = −1.393–0.820).

Conclusions: The knowledge–attitudes–practices questionnaire for nurses can be used as a tool to evaluate knowledge, attitudes, and practices among nurses regarding perioperative pulmonary rehabilitation for patients with lung cancer.

Introduction

Lung cancer is a malignant tumor of the respiratory system that causes serious harm to health among people worldwide, including in China. Surgical resection is currently the most effective clinical treatment for early-stage non-small-cell lung cancer.[1] With improvements in the early screening rate for lung cancer and aging population phenomenon in China,[2] it is expected that more people will undergo surgery in the future. Although lung surgery techniques and perioperative management are constantly improving, 15%–40%[3] of postoperative pulmonary complications cause delayed postoperative discharge, high rates of admission to the intensive care unit, and patient deaths.[4] Therefore, preventing and reducing postoperative pulmonary complications are important to ensure successful surgery and accelerate recovery.

The pulmonary rehabilitation of patients with lung cancer in the perioperative period refers to a treatment program that instructs patients to perform a series of breathing and aerobic exercises to improve their cardiorespiratory endurance and physical condition,[5,6] thereby reducing postoperative pulmonary complications, promoting recovery, and improving the quality of life.[7] Perioperative pulmonary rehabilitation

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includes three continuous time periods: preoperative pulmonary prerehabilitation, postoperative (during hospitalization) pulmonary rehabilitation, and postdischarge pulmonary rehabilitation.[8] The perioperative pulmonary rehabilitation for lung cancer has more evident stages[9] and tends to the prevention and treatment of postoperative complications.[10] However, the emphasis of pulmonary rehabilitation in each stage is slightly different: for example, preoperative pulmonary rehabilitation focusses on the optimization of body function and increases the opportunity for surgical treatment, postoperative hospitalization pulmonary rehabilitation emphasizes airway management, and postdischarge pulmonary rehabilitation entails the recovery of lung function and exercise endurance in patients. All stages of pulmonary rehabilitation are beneficial to patients.[11,12]

Perioperative pulmonary rehabilitation is a crucial management strategy adopted before and shortly after surgery (during hospitalization) as well as during the process of reintegration after discharge.[9,13] In countries other than China, pulmonary rehabilitation equipment, cardiopulmonary management systems, and multidisciplinary teams are combined to develop pulmonary rehabilitation plans that are suitable for patients, and a one-to-one approach and regular evaluations are implemented.[14] For example, studies have shown with the participation of a multidisciplinary team,[15] developing a home pulmonary rehabilitation program,[16] using pulmonary rehabilitation equipment, such as a lower-limb power bicycle,[17] that patients' lung function significantly improved, and the symptoms of dyspnea decreased. The scope of research on pulmonary rehabilitation is relatively large and the scale is relatively extensive.

In Chinese mainland, it is difficult to complete perioperative pulmonary rehabilitation owing to a lack of supporting resources, technology, manpower, and operating standards. Currently, only a few large general hospitals have established perioperative pulmonary rehabilitation involving clinicians and physical therapists, and most pulmonary rehabilitation is primarily completed by clinicians with the assistance of nurses.[18] Nurses have more frequent contacts with patients before and after surgery[19] and are more suitable to undertake perioperative education and rehabilitation guidance.[20] Therefore, nurses play an increasingly important role in perioperative pulmonary rehabilitation. Nurses are indispensable evaluators, implementers, observers, and coordinators in perioperative pulmonary rehabilitation management.[21] In the practice of pulmonary rehabilitation, they should have relevant theoretical knowledge, practical skills, communication and coordination abilities, and the ability to expand their respiratory specialty. With changes in the medical model and accelerated development of rehabilitation surgery, the role of nurses in professional activities has gradually changed from that of a subordinate to that of a participant and collaborator.[22,23] Studies have shown that Knowledge, skills, attitudes, and values form the basis of effective professional activities.[24] Therefore, a pulmonary rehabilitation scale with more perioperative nursing attributes is required to provide a scientific evaluation tool for in-depth research on perioperative pulmonary rehabilitation among nurses.[25,26]

Recently, some developments of pulmonary rehabilitation questionnaires have mainly focused on chronic obstructive pulmonary disease (COPD), such as the questionnaire of medical staff's knowledge and practice on pulmonary rehabilitation of COPD patients.[25,27] However, there are differences between pulmonary rehabilitation in COPD and perioperative lung cancer; therefore, these tools cannot accurately evaluate the knowledge and practice levels of pulmonary rehabilitation nurses in perioperative lung cancer.[28,29] Hence, to enable nurses to accurately identify the key knowledge areas that need to be paid attention to in the perioperative pulmonary rehabilitation of lung cancer, this study developed and verified the reliability and validity of the questionnaire on the knowledge and practice of nurses in the perioperative pulmonary rehabilitation of lung cancer. Our results will help to accurately measure the cognitive level of nurses and provide a basis for managers to formulate targeted training strategies.

Methods

Study design

This study comprised two phases. Phase 1 entailed questionnaire development, consisting mainly of the research topic, building a pool of items, and expert consultations. Phase 2 tested the reliability and validity of the knowledge–attitudes–practices (KAP) questionnaire for nurses on the perioperative pulmonary rehabilitation of patients with lung cancer.

Scale development

Phase 1: Developing the initial pool of items

This study is based on KAP theory that divides the transformation of human health behavior into three continuous processes: mastering basic knowledge, establishing positive beliefs, and forming healthy behavior.[30] Only when the nursing staff master the relevant knowledge of lung cancer perioperative pulmonary health and gradually identify with it and consciously pay attention to and actively and effectively implement perioperative pulmonary rehabilitation measures, can they promote the development of perioperative pulmonary rehabilitation.

The item pool was determined through an analysis of the published literature. We systematically searched the domestic and foreign databases using the subject terms 'lung cancer,' 'perioperative period,' 'pulmonary rehabilitation,' 'prerehabilitation,' and 'respiratory exercise training.' Based on the top-down approach, a search was conducted in the CNKI, Wan fang Database, VIP database, Chinese Biomedical Literature Database, PubMed, Embase, Web of Science, CINAHL, Guidelines International Net-The work, European Respiratory Society, National Guideline Clearinghouse, American Association of Cardiovascular and Pulmonary Rehabilitation, British Thoracic Society, China Guideline Clearinghouse, and so on, for systematic literature retrieval.

In total, 12,158 studies were retrieved, 4183 studies were removed, 7234 studies were further excluded after reading the title and abstract, and 120 studies were finally included and after reading the full text to exclude those with low-quality evaluations and duplications. A pool of alternative questionnaire items was developed after discussion among the members of the research group comprising one thoracic oncology surgical nursing expert (chief nurse), one expert proficient in questionnaire preparation and medical statistics, and two nursing graduate students. Related items were initially developed. The initial library of the questionnaire consisted of 54 entries with 25, 14, and 15 knowledge, attitude, and practice dimensions, respectively. Each item was scored on a 5-point Likert scale.

A total of 24 experts were consulted. A purpose-sampling method was used. The inclusion criteria for experts were the following: (1) more than five years of medical, nursing, or rehabilitation work and scientific research experience in thoracic surgery or currently engaged in perioperative pulmonary rehabilitation research in lung cancer; (2) bachelor's degree or above; (3) intermediate professional title or above; and (4) voluntary participation in the study. We asked the 24 experts to evaluate the questionnaire, which was divided into 3 parts. The first part comprised instructions for completing the form, including the research purpose, content, and importance. The second part queried the experts' basic information. The third part included the importance score and familiarity and judgment basis of experts. The questionnaires were distributed through e-mail, and experts were invited to complete the questionnaire within 15 days and return it to the researchers via e-mail. The criteria for screening items were as follows: a mean value of importance assignment of > 4 and a coefficient of variation of > 0.3. The items were screened and revised in group discussions combined with expert advice.[31]

In addition, a pilot study was conducted among 30 eligible nurses who focused on evaluating the fluency of the items. This survey was conducted to identify any difficulties experienced by patients in reading and understanding the items by asking them to rate the questionnaire.

Phase 2: Validation process

The original pool of items was validated following four main steps. Through item analysis, the questionnaire items were preliminarily screened and passed. Thereafter, the structural and content validity, psychometric evaluation, and initial reliability were assessed through exploratory factor analysis (EFA). Subsequently, the reliability was assessed using the data collected through the assessment of stability and internal consistency. Finally, item response theory (IRT) was used to test the difficulty and differentiation of items.[32,33]

Item analysis. In the item analysis process, the total scores of all the survey items were arranged in order. The top and bottom 27% of the total scores were divided into the high- and low-scoring groups, respectively. Differences in the items between the two groups were compared, and items with a composite reliability of < 3 were deleted.[31] The correlation coefficient between the items and the total score of the questionnaire was calculated, and items with a correlation coefficient < 0.4 were deleted.[31]

Content validity. Experts were enrolled using purposeful sampling from a list of 24 specialists in cancer care from 22 Class 3 Grade A specialized hospitals and 2 universities in 12 provinces and cities. There were 8 medical experts in thoracic oncology or respiratory surgery, 12 nursing experts in thoracic oncology surgery, 2 experts in the field of psychology, and 2 physical therapy experts in accelerated rehabilitation surgery. Content validity referred to the 'quantitative' agreement among panelists regarding how pertinent each item was in relation to the objective of its measurement using Likert scores (1 = completely not pertinent; 4 = completely pertinent). During this phase, some items were modified or deleted based on the validation results. Regarding content validity data analysis, the item-level content validity index and scale-level content validity index were not lower than 0.78 and 0.9,[32] respectively, indicating good content validity.

Recruitment. A multi-center, cross-sectional approach was used to collect data for psychometric evaluation, reliability, and structural validity. From September to December 2022, convenience sampling was used to select pulmonary oncology department nurses from 45 Class 3 Grade A specialized hospitals in 18 provinces and cities as research participants. Inclusion criteria were the following: (1) nurses working in thoracic surgery; (2) those who obtained the practising qualification certificate; (3) nurses with more than one year of clinical work experience; and (4) those who provided informed consent and agreed to voluntary participation in the investigation. The exclusion criteria were the following: (1) nurses currently completing advanced studies or standardized training and (2) nurses studying abroad, on maternity leave, or on sick leave during the investigation period.

Data analysis

Date analysis for EFA

This is based on the requirement that the sample size be 10–20 times the number of items, while considering a rate of 20% invalid questionnaires. As the number of questionnaire items in this study is 34, the range of sample sizes required for this study is 425–850.[34] Finally, 658 electronic questionnaires were collected, including 603 valid questionnaires, with an effective recovery rate of 91.64%. The IBM SPSS software (version 26.0) was used for the item validity and reliability analyses. We used the mirth package in R to estimate the item parameters. A P value of < 0.05 was considered statistically significant. Before EFA, the Bartlett spherical test was performed, and the Kaiser–Meyer–Olkin (KMO) value was calculated. If the χ^2 value was less than 0.05 and the KMO value was greater than 0.8, the study was considered suitable for factor analysis. Double loading meant that the loading value of two or more factors was ≥ 0.4 and that the difference was < 0.2. The cumulative variance contribution rate was $> 60\%$, indicating that the scale had good construct validity.[28]

Test–retest reliability

A sample of nurses was enrolled using a convenience and consecutive sampling approach with the same inclusion and exclusion criteria as in the previous step. A sample of 23 nurses was randomly selected and invited to retake the scale 2 weeks after their first assessment to determine the stability of the KAP questionnaire for nurses on the perioperative pulmonary rehabilitation of patients with lung cancer using the test–retest approach.

Date analysis for reliability

Cronbach's α coefficient and split-half reliability were used to evaluate the internal consistency of the scale. It is generally considered that a Cronbach's α coefficient ≥ 0.8 and a split-half reliability coefficient ≥ 0.7 indicate high reliability. Test–retest reliability was used to evaluate the stability of the measurement results of the scale; a test–retest reliability coefficient > 0.7 indicates good stability.[19,28]

Date analysis for item response theory

Because classical measurement only focuses on the whole scale and cannot comprehensively analyze the characteristics of each item, we introduce IRT in this study.[33] Notably, IRT can help explore the relationship between the abilities of respondents and their responses at the item level in more detail and can provide evaluation indicators,[32] such as the difficulty and discrimination of each item. IRT was used to further optimize this study. It is generally believed that α items with a value of $<$ 0.65 should be deleted. The β difficulty threshold was generally -3 to $+3$, and all values showed a monotonically increasing trend.[32]

Measurement

The data collected in this study comprised socio-demographic characteristics and answers to the KAP questionnaire for nurses on the perioperative pulmonary rehabilitation of patients with lung cancer. The socio-demographic characteristics were age, educational level, qualification as a respiratory nurse, whether the participant received training in pulmonary rehabilitation, knowledge of pulmonary rehabilitation, and whether the working department implements accelerated rehabilitation.

Results

Content validity and expert consultation

Of the 24 included experts aged 28–59 (43.38 ± 6.20) years, 18 had titles of senior associate or higher. In this study, 2 rounds of expert consultation were conducted; the recovery and effectiveness rates were 100.00% and 82.76%, respectively. In the first and second rounds, the opinion submission rates were 62.07% and 33.40%, respectively; the judgment basis coefficients were 0.948 and 0.954; the familiarity scores of experts were 0.748 and 0.792, the authority coefficients were 0.848 and 0.873, and the Kendall harmony coefficients were 0.226 and 0.410. After 2 rounds of expert consultation, the final questionnaire included 36 items and 3 dimensions. The content validity of the questionnaire was calculated based on the results of expert review. The item-level content validity index was 0.875–1.000, and the scale-level content validity index was 0.978, which indicated that the content validity of the questionnaire was good.

Item analysis

The composite reliability of item 36 was -3.151, which should be less than 3; the correlation coefficient of item 36 was -0.126, which should be less than 0.4. The total Cronbach's α coefficient of the scale was 0.958, and the overall Cronbach's α coefficient increased after deleting item 36. Additionally, the results of commonality and factor loading analysis showed that the commonality of item 36 was 0.048, which should be less than 0.2, and factor loading was -0.220, which should be less than 0.45,

Table 1
Sample characteristics ($N = 603$).

Characteristics		*n*	%
Age, years, mean ± SD	32.84 ± 6.70		
Gender	Male	22	3.6
	Female	581	96.4
Education background	Junior school	57	9.5
	Bachelor degree	528	87.6
	Master's degree	16	2.7
	Doctoral degree	2	0.3
Service year, years, mean ± SD	10.45 ± 7.22		
Professional title	Nurse	60	10.0
	Nurse practitioner	296	49.1
	Nurse-in-charge	222	36.8
	Associate professor of nursing	22	3.6
	Professor of nursing	3	0.5
Qualified as a respiratory nurse specialist	Yes	23	3.8
	No	580	96.2
Trained in pulmonary rehabilitation	Yes	340	56.4
	No	263	43.6
The department implements accelerated rehabilitation surgery	Yes	516	85.6
	No	87	14.4

SD, standard deviation.

indicating that the homogeneity between item 36 and other items was low. According to the results of the above-mentioned methods, item 36 was deleted.

Exploratory factorial analysis and internal consistency

In total, the average age of respondents was 32.84 ± 6.70 years (range: 22–58 years). Respondents' years of work experience ranged from 1 to 36 (10.45 ± 7.22) years, and 56.4% had received pulmonary rehabilitation training. Nurses with a respiratory specialty qualification accounted for 3.8% of the respondents (Table 1).

The χ^2 value of the Bartlett spherical test was 21,207.396 ($P < 0.001$), and the KMO value was 0.966, indicating that the questionnaire was suitable for factor analysis. Principal component analysis and the maximum variance method were used in EFA to identify three common factors, consistent with KAP theory (Fig. 1). A gravel plot showed that after the third factor, the trend gradually flattened, and the cumulative variance contribution rate was 69.674%. Item 21 comprised 2 items with a factor loading of > 0.4 that were deleted after discussion among the research team. The results of the second EFA showed that the χ^2 value of the Bartlett spherical test was 20,588.2862 ($P < 0.001$), the KMO value was 0.965, and the cumulative variance contribution rate was 69.886%. Finally, 34 items and 3 dimensions were retained. The naming of the factors was consistent with KAP theory, that is, knowledge (items K1–K14), attitudes (items A1–A6), and practices (items P1–P14). Table 2 presents the detailed EFA results.

The total Cronbach's α coefficient of the questionnaire was 0.966, and the Cronbach's α coefficient of each dimension was 0.950 to 0.965. The split-half reliability of the questionnaire was 0.779 and that of each dimension was 0.906 to 0.928. After 2 weeks, the test–retest reliability of the questionnaire was 0.926, and that of each dimension ranged from 0.823 to 0.965 (see Table 3 for details).

Item response theory analysis

The discrimination of each item on the questionnaire under the classical test theory (CTT) framework was between 0.601 and 0.910, so there was no need to delete any items. The difficulty level of all items in the questionnaire ranged from 0.701 to 0.908, and the overall score ranged from 4 to 5. The CTT results indicated that the overall quality of the questionnaire was good. Table 4 presents the results of the corresponding CTT measurement indicators for each item.

Table 5 presents the estimation results for the item parameters according to the graded response model in IRT. On calculating the discrimination parameters of items 1 to 34, the average value obtained was 2.391, and all items were greater than 0.65; the α value indicates that all items on the questionnaire have good discrimination. Additionally, the threshold values on the scale ranged from −1.393 to 0.820, within the range of −3 to +3; however, the threshold β values of some items were missing. Considering the characteristics of content β_4 of the items and the fact that the items reached the standard in the CTT framework, these items were retained.

Fig. 2 shows the item character curve for each item. Ideally, the first curve (corresponding to a score of 1 on the questionnaire item selected in this study) should be monotonically decreasing; in other words, as the ability level of the respondent increases, the probability of scoring 1 will gradually decrease. The fifth curve (5-point value) should be

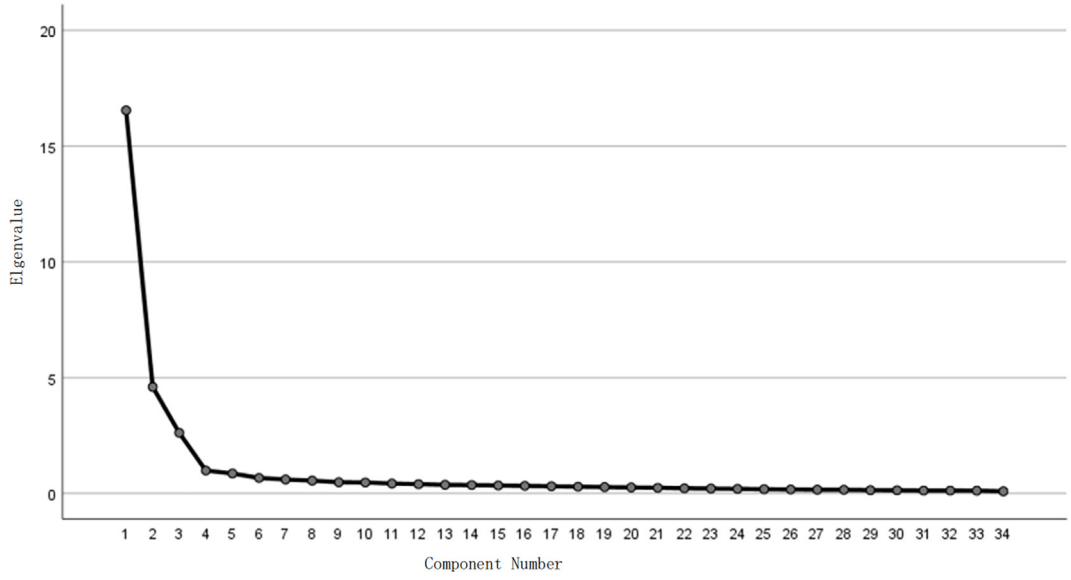

Fig. 1. Questionnaire on nurses' knowledge, attitudes, and practices regarding lung cancer perioperative pulmonary rehabilitation: Lithotripsy chart showing the results of exploratory factor analysis.

Table 2
Exploratory factor analysis of knowledge, attitudes, and practices questionnaire ($N = 603$).

Items	Behavior	Knowledge	Attitude
P1. I will tell lung cancer patients undergoing a surgery the correct method to judge whether the exercise program is appropriate or aggressive.	0.825	0.291	0.142
P2. I will give timely nutritional guidance to lung cancer patients undergoing a surgery and having nutritional risks.	0.823	0.215	0.282
P3. I will provide smoking cessation information to the patients who have difficulty quitting smoking before lung cancer surgery.	0.810	0.233	0.201
P4. I will formulate a pulmonary rehabilitation plan according to the age, physical function and exercise ability of lung cancer patients undergoing a surgery.	0.790	0.295	0.168
P5. I will evaluate the implementation process and results of the pulmonary rehabilitation program for lung cancer patients undergoing a surgery.	0.784	0.299	0.176
P6. I wwill inform the purpose and method of home pulmonary rehabilitation for lung cancer patients discharged from hospital.	0.772	0.213	0.281
P7. I will understand the real experience of pulmonary rehabilitation of lung cancer patients at various stages of the perioperative period.	0.770	0.309	0.119
P8. I will provide a health education on the perioperative pulmonary rehabilitation for lung cancer patients in a way that they can easily understand.	0.769	0.177	0.363
P9. I will promptly assess the postoperative pain level of lung cancer patients and treat symptoms accordingly.	0.760	0.170	0.383
P10. I will guide lung cancer patients undergoing a surgery with COPD to use drug inhalation devices correctly.	0.760	0.290	0.227
P11. I will take various measures in time to prevent sputum retention in patients.	0.752	0.220	0.353
P12. I will instruct patients to do at least 5 deep-breathing exercises every hour after they wake up from surgery.	0.736	0.303	0.136
P13. I will instruct patients to use incentive/threshold pressure load breathing trainer correctly.	0.735	0.261	0.140
P14. I will guide lung cancer patients to go to the ground as soon as possible after surgery.	0.647	0.131	0.429
K1. I know the applicable population of inspiratory muscle training.	0.214	0.831	0.040
K2. I know the criteria for judging the interruption of exercise training for lung cancer patients in the perioperative period.	0.181	0.821	0.051
K3. I know what is the main inspiratory muscle of the human body and its important function.	0.193	0.796	0.061
K4. I know the clinical significance of forced expiratory volume in first second and diffusing capacity of carbon monoxide.	0.154	0.793	0.045
K5. I know how to calculate target heart rate for aerobic exercise.	0.143	0.789	0.063
K6. I know the types of inhaled drugs commonly used by lung cancer patients undergoing surgery combined with COPD.	0.179	0.775	0.118
K7. I know that the form, intensity, duration, frequency, progression, and expected results of exercise training at each stage of lung cancer perioperative period should be different.	0.209	0.768	0.168
K8. I know the primary methods for assessing a patient's exercise capacity.	0.238	0.733	0.208
K9. I know the best time to take protein powder after exercise training.	0.250	0.732	0.043
K10. I know that mild anxiety and depression symptoms in lung cancer patients undergoing a surgery can be improved through pulmonary rehabilitation.	0.296	0.703	0.078
K11. I know the commonly used smoking cessation methods before lung cancer surgery.	0.300	0.701	0.104
K12. I know the content of the preoperative multimodal prerehabilitation program.	0.254	0.667	0.217
K13. I know the purpose and main methods of sports training.	0.243	0.633	0.363
K14. I know that the best time to quit smoking before lung cancer surgery is still unclear.	0.168	0.605	0.177
A1. I believe that the active participation of the patients and their families will promote the pulmonary rehabilitation of the lung cancer patients undergoing a surgery.	0.270	0.113	0.883
A2. I believe that information related to perioperative pulmonary rehabilitation should be shared among the multidisciplinary groups involved.	0.273	0.132	0.883
A3. I think nurses should know more about perioperative pulmonary rehabilitation.	0.296	0.128	0.855
A4. I think the implementation of perioperative pulmonary rehabilitation for lung cancer patients will enhance my sense of professional value.	0.266	0.142	0.848
A5. I believe that following guidelines/consensus guidelines for perioperative pulmonary rehabilitation will facilitate pulmonary rehabilitation.	0.291	0.192	0.831
A6. I think that collaboration between physicians, nurses, and physical therapists will improve pulmonary rehabilitation in lung cancer patients undergoing a surgery.	0.304	0.167	0.793
Value of characteristic	9.418	8.717	5.626
Variance contribution rate	27.701	25.638	16.547
Cumulative variance contribution rate	27.701	53.339	69.886

COPD, chronic obstructive pulmonary disease.

monotonically increasing, that is, with an improvement in the respondent's ability level, the probability of scoring 5 points will gradually increase.[29,30] The second to fourth curves (scores ranging from 2 to 4) of the item should conform to a normal distribution. As shown in Fig. 2, most items met this criterion, indicating that all items could well distinguish between respondents with different ability levels.

Discussion

This scale is an excellent tool for assessing the level of knowledge and practice of pulmonary rehabilitation nurses during the perioperative period for lung cancer. In this study, we used a variety of methods to verify whether our KAP questionnaire had the appropriate psychometric properties. The test–retest reliability coefficient was 0.936 and that of each dimension was between 0.823 and 0.965. The overall Cronbach's α coefficient of the questionnaire was 0.966 and that of each dimension was between 0.950 and 0.965; both were > 0.800. The split-half reliability of the questionnaire was 0.779 and that of each dimension was between 0.906 and 0.948; both were > 0.700.[31,32] These results showed that the questionnaire had reliable stability and internal consistency. The cumulative variance contribution rate was 69.886%, indicating that the questionnaire had good structural validity.

Table 3
Reliability measurement results for each dimension of the knowledge, attitudes, and practices questionnaire ($N = 603$).

Dimension	Cronbach's α coefficient was calculated	Split-half reliability	Test–retest reliability
Knowledge	0.950	0.906	0.965
Attitude	0.959	0.948	0.823
Behavior	0.965	0.928	0.858
Total scale	0.966	0.779	0.936

Table 4
Item discrimination parameters and difficulty parameter estimation.

Items	Degree of discrimination	Difficulty
Item P1	0.854	0.841
Item P2	0.871	0.862
Item P3	0.837	0.855
Item P4	0.827	0.848
Item P5	0.823	0.838
Item P6	0.822	0.878
Item P7	0.797	0.842
Item P8	0.832	0.872
Item P9	0.828	0.878
Item P10	0.819	0.843
Item P11	0.827	0.877
Item P12	0.767	0.834
Item P13	0.752	0.822
Item P14	0.717	0.903
Item K1	0.821	0.717
Item K2	0.802	0.710
Item K3	0.779	0.730
Item K4	0.761	0.701
Item K5	0.757	0.706
Item K6	0.764	0.741
Item K7	0.776	0.768
Item K8	0.756	0.792
Item K9	0.730	0.719
Item K10	0.722	0.759
Item K11	0.727	0.789
Item K12	0.698	0.787
Item K13	0.685	0.823
Item K14	0.601	0.788
Item A1	0.897	0.908
Item A2	0.910	0.898
Item A3	0.878	0.898
Item A4	0.864	0.895
Item A5	0.874	0.892
Item A6	0.811	0.902

The results based on IRT showed that the degree of discrimination in the questionnaire was between 1.035 and 5.067, with an average value of 2.391. According to Baker's standard that the degree of discrimination should be greater than 0.65, the questionnaire items had a relatively good degree of discrimination.[35] Only a few items had partially missing difficulty threshold β, and respondents had no choice of extremely low values.[36] This might be related to the fact that respondents were all thoracic surgery nurses with relevant work experience, and low-value options were not consistent with the actual situations of these nurses. In future research, the expression of these options can be improved. This finding may also be related to the insufficiently large sample size. The case of extremely low values, representing an extreme situation with a low frequency of occurrence, was not present when the sample was recruited; however, this does not mean that these low values do not exist. Therefore, it is necessary to expand the sample size and conduct multi-center, large-sample research in the future.

The KAP questionnaire for nurses on pulmonary rehabilitation during the perioperative period among patients with lung cancer is a highly scientific tool. Measuring perioperative pulmonary rehabilitation knowledge is important for those working in the field of thoracic surgery

Table 5
Item discrimination parameters and difficulty parameter estimation.

Items	Degree of discrimination parameter	Difficulty-level parameters			
	α	β_1	β_2	β_3	β_4
Item P1	2.734	−1.054	−0.537	0.016	–
Item P2	3.524	−1.429	−1.106	−0.622	−0.055
Item P3	2.605	−1.542	−1.102	−0.594	−0.044
Item P4	2.404	−1.111	−0.605	0.029	–
Item P5	2.376	−1.478	−1.042	−0.559	0.035
Item P6	2.622	−1.296	−0.642	−0.154	–
Item P7	2.014	−1.692	−1.125	−0.599	0.041
Item P8	2.711	−1.284	−0.677	−0.083	–
Item P9	2.659	−1.329	−0.684	−0.122	–
Item P10	2.298	−1.490	−1.146	−0.568	0.028
Item P11	2.602	−1.330	−0.679	−0.114	–
Item P12	1.833	−1.540	−1.114	−0.558	0.038
Item P13	1.813	−1.449	−0.996	−0.535	0.073
Item P14	2.016	−1.423	−0.810	−0.254	–
Item K1	2.450	−1.186	−0.613	−0.214	0.644
Item K2	2.149	−1.229	−0.601	−0.188	0.668
Item K3	2.162	−1.250	−0.672	−0.274	0.672
Item K4	1.789	−1.372	−0.610	−0.164	0.820
Item K5	1.786	−1.251	−0.594	−0.171	0.635
Item K6	1.893	−1.394	−0.768	−0.311	0.679
Item K7	1.959	−1.684	−0.899	−0.421	0.571
Item K8	1.815	−1.925	−0.982	−0.542	0.470
Item K9	1.519	−1.379	−0.746	−0.182	0.667
Item K10	1.528	−1.757	−0.927	−0.384	0.632
Item K11	1.555	−2.058	−0.978	−0.531	0.461
Item K12	1.444	−1.903	−1.037	−0.565	0.548
Item K13	1.458	−1.792	−1.259	−0.747	0.357
Item K14	1.035	−2.324	−1.371	−0.553	0.591
Item A1	4.940	−1.523	−1.390	−1.095	−0.166
Item A2	5.067	−1.517	−1.393	−0.980	−0.090
Item A3	3.608	−1.390	−1.310	−0.995	−0.114
Item A4	3.118	−1.486	−1.365	−0.970	−0.095
Item A5	3.178	−1.587	−0.976	−0.047	–
Item A6	2.617	−1.745	−1.021	−0.124	–

nursing. The present questionnaire was developed by referring to the relevant literature and consulting thoracic surgery experts from hospitals and universities in many locations across China, and it was based on KAP theory.[36,37] The team members have rich research experience in the field, and the team was comprehensive and extensive, representing the development level of thoracic surgery in Mainland China. This rendered the questionnaire items highly relevant to both theory and practice.

In addition to basic knowledge and skills, the survey addresses physical activity, nutrition, and psychology. Moreover, the roles of nurses before, during, and after lung cancer surgery and during pulmonary rehabilitation at home after discharge are considered. Therefore, our questionnaire can be used to comprehensively evaluate the functional literacy levels of nurses in Mainland China regarding perioperative pulmonary rehabilitation, thereby addressing the lack of such tools. In the future, the results of this questionnaire can be used to analyze current problems among nurses in pulmonary rehabilitation for patients with lung cancer during the perioperative period to improve corresponding measures, formulate targeted training programs, and promote the improvement of nurses' professional knowledge, attitudes, and practices regarding pulmonary rehabilitation. In addition, our testing revealed that the questionnaire could be completed within an average of 10–15 min, affirming its practicality and feasibility in real-world settings.

Limitations

The indicators of the scale used to measure the level of knowledge and practice of pulmonary rehabilitation nurses in the perioperative period for lung cancer were found to be generally satisfactory. However, this study has some limitations. First, owing to the lack of gold standards, we did not test the criterion validity. Second, due to geographical

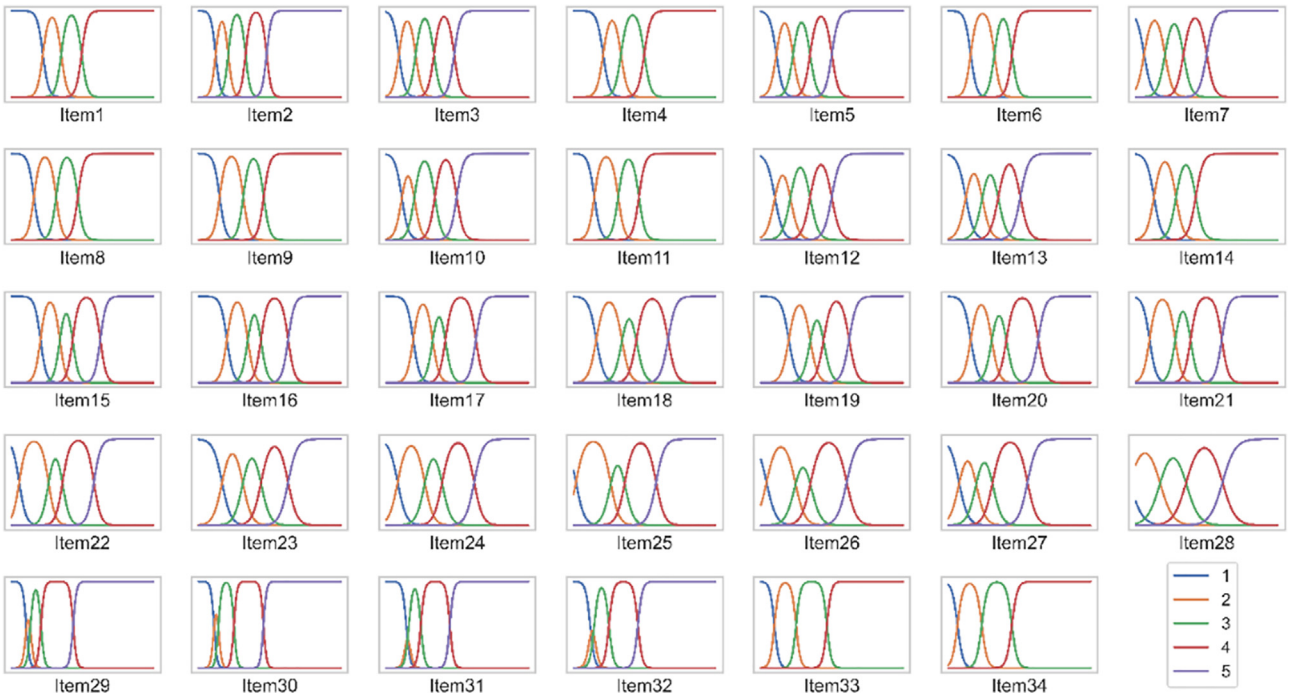

Fig. 2. Characteristic curves of items 1 to 34.

constraints and a limited sample size, EFA was not conducted in this study. Large-sample verification and further optimization are required. Third, in IRT, a few items have low differentiation, but they are retained in consideration of the completeness of the questionnaire content and other statistical results. However, there is still potential and room for revision and refinement of this tool in future research.

Conclusions

This study successfully developed and validated a KAP questionnaire for nurses on the perioperative pulmonary rehabilitation of patients with lung cancer. The questionnaire has good reliability and validity. In future research, it will be important to further verify the accuracy of the model developed in this study, explore the relevant factors influencing KAP levels among nurses regarding perioperative pulmonary rehabilitation for patients with lung cancer, and improve nurses' specialist competence in perioperative pulmonary rehabilitation.

CRediT author contribution statement

Xue Wu: Writing – Original draft, Writing – Revised draft preparation, and Data curation; Xinyue Liang: Investigation, Formal analysis, Data Curation; Yan Li: Methodology, Writing – Review and editing; Ruishuang Zheng: Methodology, Writing – Review and editing. All authors had full access to all the data in the study, and the corresponding author had final responsibility for the decision to submit for publication. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted. Data and other materials are available upon request from the corresponding authors.

Ethics statement

The study protocol was approved by the Research Ethics Committee of Tianjin Medical University Cancer Institute and Hospital (IRB No. bc2022182). All enrolled nurses were informed about the aim and methodology of the study, and informed consent was obtained from them. Enrolled nurses were informed of the confidentiality of their responses.

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Declaration of competing interests

All authors have no conflicts of interest to declare. The last author, Dr. Ruishuang Zheng, is a member of the editorial board of the *Asia-Pacific Journal of Oncology Nursing*. The article underwent the journal's standard review procedures, with peer review conducted independently of Dr. Zheng and their research groups.

Data availability statement

The data that support the findings of this study are available from the corresponding author, Yan Li, upon reasonable request. The data are not publicly available due to their containing information that could compromise the privacy of research participants.

Declaration of Generative AI and AI-assisted technologies in the writing process

No AI tools/services were used during the preparation of this work.

References

1. Peddle CJ, Jones LW, Eves ND, et al. Effects of presurgical exercise training on quality of life in patients undergoing lung resection for suspected malignancy: a pilot study. *Cancer Nurs*. 2009;32:158–165. https://doi.org/10.1097/NCC.0b013e3181982ca1.
2. Li W, Zhang LH, Gong XQ, et al. Analysis of the frontier and hotspot of screening technology for early lung cancer based on bibliometrics. *Chin J Clin Thorac Cardiovasc Surg*. 2022;29:1478–1484. https://kns.cnki.net/kcms/detail/51.1492.R.20220902.1654.004.html.
3. Brioude G, Gust L, Thomas PA, et al. Complications postopératites des exérèsees pulmonarias [Postoperative complications after major lung resection]. *Rev Mal Respir*. 2019;36:720–737. https://doi.org/10.1016/j.rmr.2018.09.004.
4. Yang J, Xia Y, Yang Y, et al. Risk factors for major adverse events of video-assisted thoracic surgery lobectomy for lung cancer. *Int J Med Sci*. 2014:863–869. https://doi.org/10.7150/ijms.8912.

5. Batchelor TJP, Ras burn NJ, Abdelnour-Berchtold E, et al. Guidelines for enhanced recovery after lung surgery: recommendations of the enhanced recovery after surgery (ERAS®) society and the European Society of thoracic Surgeons (ESTS). *Eur J Cardio Thorac Surg Off J Eur Assoc Cardio Thorac Surg*. 2019;55:91–115. https://doi.org/10.1093/ejects/ezy301.
6. Karmacharya RM, Shakya R, Singh AK, et al. Recovery pattern in different surgical approaches on thoracic enhanced recovery based fourteen-step protocol in patients undergoing cardio-thoracic surgery at university hospital of Nepal. *Kathmandu Univ Med J*. 2020;18:181–185. https://pubmed.ncbi.nlm.nih.gov/33594027.
7. Hu XL, Yang D. Research progress of optimal perioperative management for patients with lung cancer and chronic obstructive pulmonary disease (COPD). *Fudan Univ J Med Sci*. 2019;46:267. https://doi.org/10.3969/j.issn.1672-8467.
8. Spruit MA, Singh SJ, Garvey C, et al. An official American Thoracic Society/European Respiratory Society statement: key concepts and advances in pulmonary rehabilitation. *Am J Respir Crit Care Med*. 2013;188:e13–e64. https://doi.org/10.1164/rccm.201309-1634ST.
9. Cavalheri V, Granger CL. Exercise training as part of lung cancer therapy. *Respirology*. 2020;25:80–87. https://doi.org/10.1111/resp.13869.
10. Shen Chunhui, Che Guowei. Status and progress of pulmonary rehabilitation in perioperative patients with lung cancer. *Chin J Rehabil Med*. 2011;26:686–689. https://doi.org/10.3969/j.issn.1001-1242.2011.07.023.
11. Taskin H, Telli Atalay O, Yunus G, et al. Postoperative respiratory muscle training in addition to chest physiotherapy after pulmonary resection: a randomized controlled study. *Physiother Theory Pract*. 2020;36:378–385. https://doi.org/10.1080/09593985.2018.1488189.
12. Fujimoto S, Nakayama T. Effect of combination of pre-and postoperative pulmonary rehabilitation on onset of postoperative pneumonia: a retrospective cohort study based on data from the diagnosis procedure combination database in Japan. *Int J Clin Oncol*. 2019;24:211–221. https://doi.org/10.1007/s10147-018-1343-y.
13. Nelson G, Bakkum-Gamez J, Kalogeria E, et al. Guidelines for perioperative care in gynecologic/oncology: enhanced Recovery after Surgery (ERAS) Society recommendations-2019 update. *Int J Gynecol Cancer Off J Int Gynecol Cancer Soc*. 2019;29:651–668. https://doi.org/10.1136/ijgc-2019-000356.
14. Hou XJ, Fu R, Dai JH, et al. Visual analysis of research hotspots and frontiers of remote lung rehabilitation. *J Nurs*. 2022;17:17–22. https://link.cnki.net/doi/10.16460/j.issn1008-9969.2022.17.017.
15. Divisi D, Di Francesco C, Di Leonardo G, et al. Preoperative pulmonary rehabilitation in patients with lung cancer and chronic obstructive pulmonary disease. *Eur J Cardio Thorac Surg Off J Eur Assoc Cardio Thorac Surg*. 2013;43:293–296. https://doi.org/10.1093/ejcts/ezs257.
16. Pehlivan E, Balcı A, Kılıç L. Can functional inoperability in lung cancer patients be changed by pulmonary rehabilitation? *Turk gouges kelp damar ceramist derigs*. 2019;27:212–218. https://doi.org/10.5606/tgkdc.dergisi.2019.16474.
17. Marhic A, Dakhil B, Pantafive G, et al. Long-term survival following lung surgery for cancer in high-risk patients after perioperative pulmonary rehabilitation. *Interact Cardiovasc Thorac Surg*. 2019;28:235–239. https://doi.org/10.1093/icvts/ivy225.
18. Pang WY, Zhang YX, Li JJ, et al. Construction and application of nurse-led respiratory care team in pulmonary rehabilitation of critically ill patients. *Chin Nurs Manag*. 2019;19:657–661. https://doi.org/10.3969/j.issn.1672-1756.2019.05.004.
19. Granger CL, Denehy L, Remedios L, et al. Barriers to translation of physical activity into the lung cancer model of care. a qualitative study of clinicians' perspectives. *Ann Am Thorac Soc*. 2016;13:2215–2222. https://doi.org/10.1513/AnnalsATS.201607-540OC.
20. White J, Dixon S. Nurse led Patient Education Programmed for patients undergoing a lung resection for primary lung cancer. *J Thorac Dis*. 2015;7:S131–S137. https://doi.org/10.3978/j.issn.2072-1439.2015.03.11.
21. Li Y, Yan C, Li J, et al. A nurse-driven enhanced recovery after surgery (ERAS) nursing program for geriatric patients following lung surgery. *Thoracic cancer*. 2020;11:1105–1113. https://doi.org/10.1111/1759-7714.13372.
22. Luo Y, Yang XM, Xu XP, et al. Construction and validation of core competency evaluation index system for respiratory specialty nurses. *J Nurs Sci*. 2018;33:53–57. https://doi.org/10.3870/j.issn.1001-4152.2018.23.053.
23. Zhao WF, Cao WX, Wang HX. Research progress of medical care integration model. *Chin General Pract Nurs*. 2017;15:4130–4133. https://doi.org/10.3969/j.issn.1674-4748.2017.33.012.
24. Benson-Soros JJT, Li Nursing. Promoting student participation and learning in the observational clinical setting. *Teach Learn Nurs*. 2006;1:43–46. https://doi.org/10.1016/j.teln.2006.06.003.
25. Wang C, Wang QF, Zeng YH, et al. Analysis of knowledge, attitude and practice status quo of pulmonary rehabilitation among nurses in respiratory department. *Chin J Mod Nurs*. 2019;25:875–879. https://doi.org/10.3760/cma.j.issn.1674-2907.2019.07.019.
26. Du WJ, Wang JJ, Zhang G, et al. Study on the cognitive and training needs of 403 nursing staff in a third-class hospital of a military on pulmonary rehabilitation. *South China J Prev Med*. 2021;47:1076–1079. https://doi.org/10.12183/j.scjpm.2021.1076.
27. Sun Q, Sun BP, Wei LP. Investigation on knowledge, letter and practice of pulmonary rehabilitation among medical staff in Zhengzhou Hospital. *South China J Prevent Med*. 2021;47:1483–1485. https://doi.org/10.12183/j.scjpm.2021.1483.
28. Wu ZZ, Zhang R, Chang Y, et al. Current status and influencing factors of knowledge-attitudes-practice about pulmonary rehabilitation among respiratory nurses in tertiary medical institution of Ningxia. *J Ningxia Med Univ*. 2021;43:423–428. https://doi.org/10.16050/j.cnki.issn1674-6309.2021.04.019.
29. Chen AL, Tang WF, Xu L, et al. Analysis of the current situation and influencing factors of knowledge, attitude, and practice of pre-habilitation among medical staff in department of thoracic surgery. *China Med Herald*. 2022;19:192–196.
30. Cleary A, Dowling M. Knowledge and attitudes of mental health professionals in Ireland to the concept of recovery in mental health: a questionnaire survey. *J Psychiatr Ment Health Nurs*. 2009;16:539–545. https://doi.org/10.1111/j.1365-2850.2009.01411.x.
31. Li Z. *Nursing Research Methods*. People's Medical Publishing House; 2012.
32. Wu ML. *Questionnaire Statistical Analysis Practice: SPSS Operation and Application*. Chongqing: Chongqing University Press; 2010:158–296.
33. Wang MC, Liu T. *Handbook of Quantitative Research in Psychology and Behavior*. Chongqing University Press; 2023.
34. Etikan I, Bab tope O. A basic approach in sampling methodology and sample size calculation. *Med Life Clin*. 2019;1:1006.
35. Luo ZS. *Basis of Item Response Theory*. Beijing: Beijing Normal University Press; 2012.
36. Baker FB, Kim SHJLT. *Item Response Theory: Parameter Estimation Techniques*. 2nd ed.; 2023-04-01 [EB/OL] https://www.routledge.com/Item-Response-Theory-Parameter-EstimationTechniques-Second-Edition/Baker-Kim/p/book/9780824758257.
37. Feng X, Luo H, Liu M, et al. Development and validation of knowledge, attitude and practice questionnaire for pediatric nurses to prevent central venous device-related thrombosis in hospitalized children. *Nurse Educ Pract*. 2023;71:103694. https://doi.org/10.1016/j.nepr.2023.10369.