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Developing a Core Stability Training Program for Patients Following Total Knee Arthroplasty, Informed by Self-efficacy Theory: A Delphi Method Study

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Abstract: ***Objective:*** *To construct a CST program for patients after TKA.* ***Materials and Methods:*** *Based on the principles of SET and following evidence, this project was constructed using the qualitative method of literature analysis and the Delphi method. The Delphi panel consisted of fifteen experts from the fields of clinical medicine, rehabilitation medicine, and nursing.* ***Results:*** *Fifteen experts were consulted and the consultation response rate was 100%; the authority coefficient for the first round was 0.89, with coefficients of variation ranging from 0.00 to 0.24, and importance ratings ranging from (3.4±0.83) to (5±0); the authority coefficient for the second round was 0.91, with coefficients of variation ranging from 0.00 to 0.23, and importance ratings ranging from (4.0±0.93) to (5 ± 0); Kendall's harmony coefficients were 0.235 and 0.245, respectively, with statistically significant differences ($p < 0.05$). The construction of SET-based CST program for post-TKA patients included 4 primary, 10 secondary and 15 tertiary indicators.* ***Conclusion:*** *The construction of SET-based CST program for postoperative TKA patients is scientific and feasible, with universal applicability, and can provide a reference basis for healthcare professionals to develop postoperative rehabilitation training for such patients.*

1. Background

As the global population ages, the prevalence of knee osteoarthritis (KOA) has increased significantly. According to the most recent statistics [1], in 2019, there were approximately 364.58 million current cases of knee osteoarthritis (KOA) worldwide, with 225.16 million cases affecting women and 29.51 million cases affecting men. In addition, 11.53 million people were disabled as a result of KOA, of which. The demographic of the patients who underwent this procedure was predominantly female, accounting for 0.9 million of the totals. Total knee arthroplasty (TKA) is regarded as an effective treatment for end-stage KOA, and it is one of the most performed surgical procedures. Data from 10 national joint registries has shown that the number of TKAs performed annually exceeds 1.5 million, with a rapid increase in recent years [2]. Although TKA has been shown to alleviate pain and improve joint function significantly, studies have also demonstrated that 10%-30% of patients still suffer from lower limb muscle strength loss, gait disorders, and impaired balance after surgery, which has a serious impact on the quality of life [3]. Consequently, the science and effectiveness of postoperative rehabilitation training have become a core issue of clinical concern.

Current rehabilitation programs following TKA predominantly concentrate on the recovery of local knee function, encompassing range of motion (ROM) training, muscle strengthening, and walking function training. However, it must be acknowledged that this knee-centered rehabilitation concept is not without its limitations. Primarily, it fails to acknowledge the pivotal role of core stability in the context of overall motor control. The core muscles, being at the center of the human power chain, have a direct impact on the transmission of power, postural control, and dynamic balance of the trunk and lower limbs [4]. Research has demonstrated that Core Stability Training (CST) can optimize the distribution of biomechanical loads in the lower limbs, reduce pressure on the knee joints, and concomitantly enhance motor coordination by augmenting proprioceptive input [5]. Secondly, the existing rehabilitation programs are characterized by a lack of standardization and systematicity. Despite the extensive utilization of CST in the management of chronic low back pain and stroke, its application in the domain of postoperative rehabilitation following TKA remains in its nascent stages. A dearth of standardized operational guidelines persists in clinical practice, compounded by a paucity of professional expertise regarding CST among healthcare professionals. This has resulted in substantial variations in the design and implementation of training programs.

The implementation of CST following TKA is associated with challenges related to patient factors. Elderly, frail, and comorbid patients often experience difficulty tolerating high-intensity training due to physiological decline. Additionally, cognitive biases, such as the belief that early activity will lead to prosthesis loosening, and low self-efficacy, can further compromise adherence to rehabilitation regimens. Research has demonstrated that, although a substantial proportion of respondents (97.7%) recognize self-efficacy as a pivotal element in treatment adherence, only a fraction (43.6%) of clinical workers systematically implement self-efficacy enhancement strategies [6]. Self-Efficacy Theory (SET) provides a theoretical framework that can be used to overcome the aforementioned bottleneck. Bandura proposed that self-efficacy, defined as an individual's confidence in accomplishing a specific behavior, is formed through four types of information sources: direct experience, vicarious experience, verbal persuasion, and physiological/emotional regulation [7, 8]. These influences impact an individual's adherence to health behaviors. In the domain of TKA

rehabilitation, extant research has demonstrated that patients who possess high levels of self-efficacy exhibit augmented training motivation and augmented functional recovery potential [9]. However, the majority of extant studies have focused on the promotion of self-efficacy in conventional rehabilitation, and there remains a lacuna in the application of SET for CST. The development of a CST program in conjunction with SET has the potential to enhance patients' pain tolerance and behavioral adherence by fostering their confidence in their training abilities, thus optimizing rehabilitation outcomes.

The present study is grounded in the principles of SET and evidence-based methodologies, with the objective of formulating a CST intervention program with a focus on TKA patients. The program has the potential to serve as a valuable reference point for clinical healthcare professionals seeking to implement such training initiatives.

2. Materials and Methods

2.1 Establishment of Research Group

The team comprised a physician in rehabilitation medicine with a master's degree, an attending physician in joint surgery with a master's degree, a professor of nursing, an advanced practice nurse (master's degree), and a graduate nursing student working on her master's degree. The graduate nursing student and the advanced practice nurse were responsible for literature searching, screening, and quality assessment; the rehabilitation physician and the graduate nursing student were responsible for extracting information and drafting the initial protocol; and the professor of nursing and the attending joint surgeon were responsible for contacting the correspondence specialist. The team members collaborated to organize and analyze the results of the correspondence.

2.2 Construction of the First Draft of the Program

Literature Search

A systematic review of the literature on core stability training (CST) for patients who have undergone total knee arthroplasty (TKA) was conducted using the "6S" evidence resource pyramid model, which includes the following levels: System, Summary, Synthesis, Synthesis Study, and Study. The databases consulted for this review included BMJ Best Practice, UpToDate, the JBI Center for Evidence-Based Health Care, and the Cochrane Library.

Guidelines were gathered from several reputable sources, including the Guidelines International Collaboration (GIN), the National Institute for Health and Clinical Excellence (NICE), the Scottish Intercollegiate Guidelines Network (SIGN), the National Guidelines Library (NGC), and the Registered Nurses Association of Ontario (RNAO) in Canada. Additionally, the review utilized databases such as PubMed, Embase, Web of Science, China Knowledge, Wanfang, and the China Biomedical Literature Database. The search period began with the establishment of these databases and continued until December 31, 2024.

The search strategy employed a combination of subject-specific and free-text searches. Chinese participants used search terms such as "arthroplasty," "replacement," "knee," "total knee replacement," "knee replacement," "CST," "core training," and related phrases. For English searches, the key terms included "arthroplasty," "replacement," "knee," "core stability," "core balance," "abdomina," "core," "torso," "trunk," "exercise," "strength," "training," "rehabilitation," "total knee arthro rehabilitation," "total knee arthroplasty," and "knee replacement." These terms were entered without the use of Boolean operators. A detailed search strategy for the PubMed database is provided in Table 1.

Table 1: Search strategy of PubMed database

#1(arthroplasty, replacement, knee [MeSH Terms]) OR (arthroplasty, knee replacement [Title/Abstract]) OR (replacement arthroplasties, knee [Title/Abstract]) OR (total knee replacement [Title/Abstract]) OR (replacement, total kneel [Title/Abstract]) OR (arthroplasty, replacement, partial knee [Title/Abstract]) OR (unicompartmental knee arthroplasty [Title/Abstract])
#2("core stability" [MeSH Terms] OR "stability core" [Title/Abstract] OR "corebalance" Title/Abstract, OR "balance core" [Title/Abstract] OR "abdomina" [Title/Abstract] OR "torso" [Title/Abstract] OR "trunk" [Title/Abstract] OR "exercise" [Title/Abstract] OR "strength [Title/Abstract] OR "training" [Title/Abstract] OR "rehabilitation" [Title/Abstract])
#3 #1AND#2

Literature Inclusion and Exclusion Criteria

The inclusion criteria for the study were as follows: First, the study focused solely on patients undergoing total knee arthroplasty (TKA). Second, the content analyzed was specifically related to clinical practice guidelines for TKA patients. Third, the guidelines, evidence summaries, expert consensus, systematic evaluations, and meta-analyses had to be publicly accessible. Lastly, the language of the materials needed to be either Chinese or English.

The criteria for exclusion from the study included the following factors: First, the presence of duplicate studies was considered. Second, any incomplete information or unavailability of the full text was grounds for exclusion. Third, studies classified as low-quality literature were also excluded from the analysis.

Literature Screening and Quality Assessment

The quality of the guidelines was assessed using several standardized tools. The Appraisal of Guidelines for Research and Evaluation (AGREE II) was utilized to evaluate the overall quality of the guidelines. Systematic reviews were assessed using the Assessment of Multiple Systematic Reviews (AMSTAR 2). The Critical Appraisal for Summaries of Evidence (CASE) tool was employed to evaluate clinical decision-making and the summarization of evidence. Randomized controlled trials and expert consensus opinions were assessed according to the standards outlined in the 2016 edition of the JBI Centre for Evidence-Based Health Care. Three investigators independently assessed the guidelines, and a standardized percentage score was calculated for each dimension. A score above 60% on at least six dimensions was considered Grade A (highly recommended). A score between 30% and 60% on a minimum of three dimensions was

classified as Grade B (recommended), while a score below 30% on at least three dimensions was designated as Grade C (not recommended). The evaluation of other types of literature was conducted independently by two researchers, with a third researcher consulted as needed.

Development of the First Draft of the Program

Following the conclusion of the quality assessment, a team of researchers specializing in evidence-based care was tasked with the independent extraction and synthesis of evidence from the included literature. This process formed the foundation for the initial draft of the CST intervention program. In the event of disagreements arising during the extraction process, a third evidence-based researcher was appointed to arbitrate.

2.3 Delphi Method

Preparation of the Questionnaire

The expert correspondence questionnaire included the following: The first component of the study comprised a description of the questionnaire. This included the purpose of the study, the content of the questionnaire, the deadline for completion of the questionnaire, and the commitment to confidentiality. The second topic of the questionnaire pertains to the SET-based intervention program for CST in postoperative TKA patients. The importance of each entry was evaluated by the experts, with the rating increasing in importance from 1 to 5. The expert was modified according to the specific interventions outlined in the entry. Thirdly, the fundamental details of the expert should be documented, encompassing their age, gender, highest level of education, and professional designation. The fourth point pertains to the completion of two questionnaires. The first is a familiarity questionnaire, and the second is a judgment-based questionnaire. These questionnaires are to be completed by experts on the content of this research consultation.

Expert Selection Criteria

The ideal candidate will be an expert in the field of clinical orthopedic surgery, clinical nursing, and rehabilitation medicine. The position requires a bachelor's degree or higher qualification, along with at least 10 years of relevant work experience. The successful applicant will also possess in-depth knowledge of orthopedic surgery, nursing, and rehabilitation medicine.

Implementation of Delphi Method

A total of two rounds of expert consultation were conducted. In these rounds, the researcher distributed the questionnaire to the experts via email. The experts then provided their opinions and suggestions on the entries. These were collated, summarised, and analyzed by the research team. Based on the results of the first round of consultation, the questionnaire was revised and improved to form the second round of expert consultation questionnaires. After the second round of consultation, the experts' opinions were summarised. Then, improvements were made to each indicator until the experts' opinions converged. The interval between the two rounds of consultation is two weeks.

Statistical Methods

The data from the experts' meetings were organized using Excel, and the analysis was performed with the statistical software SPSS 27.0. Measurement data were described using the mean ($\bar{X}$), while the personal information of the 15 experts was summarized using frequency and percentage statistics. Count data were also presented through frequency and percentage. The motivation of the experts was assessed based on the effective recovery rate of the questionnaires and the presentation rate of expert opinions.

Degree of Authority of Experts: This is expressed using the coefficient of authority (Cr), which is the arithmetic average of the judgment coefficient (Ca) and the familiarity coefficient (Cs). The formula is $Cr = (Cs + Ca) / 2$. Cr values range from 0.35 to 1; a higher value indicates a greater degree of authority among the experts. When Cr is equal to or greater than 0.8, the experts' authority is considered high, making their opinions and suggestions more reliable.

Degree of Coordination Among Experts: This is reflected by Kendall's coordination coefficient (Kendall's W), which ranges from 0 to 1. A larger value indicates a higher degree of coordination, resulting in more reliable evaluation results, with a significance level of $\alpha = 0.05$.

Degree of Concentration of Experts' Opinions: This is measured using the coefficient of variation (CV) and requires that the average score is ≥ 3.5, with a coefficient of variation ≤ 0.25. This evaluation is based on a 5-point Likert scale, where scores range from "very important" (5 points) to "very unimportant" (1 point).

3. Results

3.1 First Draft of the Program

Literature titles were imported into NoteExpress literature management software, and authors, years, and titles were used as the checking fields to remove duplicates. This process resulted in the identification of 11 valid literatures related to the CST program for postoperative patients with TKA. This literature was obtained after a thorough examination of the titles, abstracts, and full texts of the literature according to the inclusion and exclusion conditions of literature screening. The following elements were considered in the course of the review: six guidelines, three systematic evaluations, one summary of evidence, and two randomized controlled trials. The details of the literature are shown in Table 2. The first draft of the training program contained four primary indicators, 12 secondary indicators, and 13 tertiary indicators, as determined through a process of literature review and evidence extraction.

Table 2: Basic characteristics of included literature (n = 11)

Author	Source of evidence	Year of publication	Type of literature	Subject of the literature
Neal et al [10]	Up To Date	2023	guidelines	Rehabilitation of common knee injuries and diseases
O'Connor et al [11]	Up To Date	2025	guidelines	Diagnosis and treatment of anterior knee pain
Martin et al [12]	Up To Date	2025	guidelines	Indications and perioperative matters of TKA
MacDonal et al [13]	Up To Date	2025	guidelines	Strategies for preventing anterior cruciate ligament injuries
Deveza et al [14]	Up To Date	2025	guidelines	Treatment of moderate to severe knee OA
Deveza et al [15]	Up To Date	2024	guidelines	Overview of osteoarthritis management
Short et al [16]	PubMed	2025	summary of evidence	Core training exercise prescription
Rodríguez et al [17]	PubMed	2023	systematic evaluations	The impact of core stability training
Shetty et al [18]	PubMed	2024	systematic evaluations	Effects of core exercises on TKA patients
Süze et al [19]	PubMed	2025	randomized controlled trials	The effect of core exercises for remote rehabilitation on TKA patients
Qiu Yang et al [20]	CNKI	2021	randomized controlled trials	Effect of core exercise on balance in TKA patients

3.2 Results of Delphi Method

General Information of Experts

The final study involved fifteen experts from related fields who participated in two rounds of correspondence. The ages of the experts ranged from 32 to 54 years, with an average age of 41.73 years (± 6.45). Their years of experience varied from 10 to 32 years, with an average of 19.67 years (± 7.69). In terms of education, the group consisted of 2 PhD holders, 7 individuals with master's degrees, and 6 with bachelor's degrees. The distribution of professional titles was as follows: 3 senior experts, 9 associate experts, and 3 intermediate experts. The areas of specialization included 3 experts in clinical medicine, 2 in rehabilitation medicine, and 10 in clinical and orthopedic nursing.

The Degree of Motivation and Authority of Experts

A total of 15 questionnaires were distributed in the two rounds of the Delphi method, and 15 valid questionnaires were recovered, with a 100% effective recovery rate. The rate of expert opinions presented was 60% and 30%, respectively. The coefficient of expert authority (Ca), the coefficient of coordination (Cs), and the coefficient of Kendall's coordination (Cr) in the first round were 0.93, 0.85, and 0.89, respectively; and the coefficient of expert coordination (Cs), the coefficient of authority (Ca) and the coefficient of Kendall's coordination (Cr) in the second round were 0.93, 0.89 and 0.91, respectively.

Degree of Harmonization of Expert Opinions

The coefficient of variation of the Delphi method in the first round ranged from 0.00 to 0.24, with significance scores of (3.4±0.83)-(5±0); the coefficient of variation in the second round ranged from 0.00 to 0.23, with significance scores of (4.0±0.93)-(5±0); and Kendall's coordination coefficients were 0.235 and 0.245, respectively, and the differences were statistically significant ($p<0.05$).

Summary of Expert Opinions and Modifications

Following a comprehensive review of the available expert opinions, screening criteria, and statistical results, the team made the following adjustments to the program indicators:

First Round of Expert Consultation:

The secondary indicator, "Share relevant educational materials", was deleted and incorporated into indicator 1.1.1. It is imperative to demonstrate the correct training techniques (e.g. diaphragmatic breathing, seated torso rotation, heel raises, standing leg swings) to patients, while also informing them of the training timing, frequency, and precautions. Furthermore, it is essential to distribute educational materials related to TKA surgery and training. The secondary indicator, entitled "Share strategies for overcoming difficulties", has been removed and incorporated into indicator 4.1.1. Patients' pain symptoms must be assessed before training, they are instructed on how to manage pain during training, and they are provided with coping strategies for when pain occurs. The item entitled "Bridging Exercise" was revised from the first round to "Seated Torso Rotation".

The following two tertiary indicators have been added:

"2.2.2: The implementation of regular follow-up via WeChat or telephone calls is imperative to assess patient training completion and adherence, and to provide guidance, encouragement, and reinforcement of established positive behaviors.

As stated in section 4.2.3, the responsibility for conducting scheduled follow-ups after patient discharge falls upon healthcare providers. The purpose of these follow-ups is to ascertain the post-discharge needs of patients and to determine their rehabilitation status.

The wording of all secondary indicators was revised to explicitly state the subject or agent acting (e.g., "Patient mastery of correct CST methods," "Jointly setting training goals by nurses and patients").

Second Round of Expert Consultation

An alteration has been made to one item (2.1.1). It is asserted that clinicians at intermediate levels or above provide patients with regular positive counseling. The emphasis placed on the benefits of appropriate training for improving knee joint

function and balance is also highlighted. This revision incorporated a stipulation about the professional caliber of clinicians who furnish counseling services.

A framework for the implementation of interventions was added, incorporating the theoretical underpinnings, the intervention's content, the intervention's temporal parameters, its frequency, and the requisite precautions.

The finalized CST program, grounded in Self-Efficacy Theory (SET), encompasses four primary indicators, ten secondary indicators, and fifteen tertiary indicators, as delineated in Table 3. The clinical intervention implementation framework is outlined in Table 4.

Table 3: CST scheme based on SET

Norm	Importance Score ($\bar{x}\pm s$)	Coefficient of Variation (CV)	Perfect Score (%)
1 Direct experience (capacity building)	5±0	0	100
1.1 Patients master the correct core stability training (hereinafter referred to as "training") method	5±0	0	100
1.1.1 Demonstrate the correct training posture (abdominal breathing, sitting rotation, heel raise, standing back leg swing) to patients, inform them of the timing and frequency of training and precautions, and distribute educational materials related to TKA surgery and training	4.8±0.41	0.09	80
1.2 The nurse and patient set training goals together	4.4±0.51	0.12	40
1.2.1 According to the actual situation of the patient, set feasible stage training goals together with the patient (such as abdominal breathing on the day of operation, sitting post rotation on the second day after operation, etc)	4.07±0.7	0.17	26.67
1.3 Patient supervision and feedback	4.73±0.46	0.1	73.33
1.3.1 Medical staff accompany and guide patients to fill in the Core Stability Training Log at the end of each training session, so as to review the training experience	4.8±0.41	0.09	80
1.4 Patients review their training experience	4±0.93	0.23	40
1.4.1 Deepen the impression of successful experiences by reviewing training experiences	4.67±0.49	0.1	66.67
2. Verbal persuasion (medical guidance)	4.87±0.35	0.07	86.67
2.1 Benefits of positive counseling training for medical staff to patients	4.8±0.41	0.09	80
2.1.1 Doctors and nurses with intermediate or above professional titles should regularly give positive advice to patients, emphasizing the benefits of appropriate training for improving knee function and balance ability	4.87±0.35	0.07	86.67
2.2 The medical staff affirmed the progress of the patients	4.13±0.83	0.2	40
2.2.1 Provide timely feedback and encouragement to patients who insist on achieving their goals	4.67±0.49	0.1	66.67
2.2.2 Regularly communicate with patients via wechat or follow up their training completion and training log filling, and give guidance and encouragement to strengthen the good behavior they have established	4.2±0.86	0.21	46.67
3. Alternative experience (peer education)	4.93±0.26	0.05	93.33
3.1 Medical staff share successful cases	4.13±0.92	0.22	46.67
3.1.1 Explain to patients the successful cases of patients undergoing TKA who improve knee function and balance through training	4.2±0.86	0.21	46.67
3.1.2 Sort out and summarize the feelings and experiences of patients' feedback, and share them regularly in the wechat group	4.13±0.52	0.12	20
3.2 Medical staff organize peer communication among patients	4.13±0.92	0.22	46.67
3.2.1 Organize face-to-face sharing and communication among patients in the same period to promote mutual support among patients	4±0.76	0.19	26.67
4. Physiological and emotional state (boosting confidence)	4.8±0.41	0.09	80
4.1 Symptom assessment education	4.2±0.77	0.18	40
4.1.1 Assess the patient's pain symptoms before training, inform the patient how to overcome the influence of pain in training and how to deal with the pain when it occurs	4.67±0.49	0.1	66.67
4.2.2 Evaluate whether the patient has postoperative complications such as bleeding, venous thrombosis and infection, pay attention to the patient's emotional state after complications, and provide health education and psychological care for corresponding symptoms	4.2±0.68	0.16	33.33
4.2 Social support	4.73±0.46	0.1	73.33
4.2.1 Encourage family members to have more emotional communication with patients, and affirm and recognize the ideas of patients	4±0.93	0.23	40
4.2.2 Mobilize family members to actively participate in the patient training program, and give oral praise or reward for the patient's progress in time	4.4±0.51	0.12	40
4.2.3 Doctors and nurses regularly follow up patients to understand their discharge needs and rehabilitation status after discharge	4.73±0.46	0.1	73.33

Table 4: Implementation process of CST program interventions based on SET

Theory evidence	Content of the intervention	Intervention time	Else
Direct experience	1. Knowledge related to disease and core stability training (hereinafter referred to as "training"): ① Knowledge related to disease includes: purpose of surgery, preoperative preparation, postoperative rehabilitation. ② Knowledge related to training includes: detailed explanation of the advantages of training and its positive effect on rehabilitation.	1-3 days before surgery	Training Exercises: 1. Abdominal Breathing: Lie flat on your back with your knees bent, and place both hands on your abdomen. Inhale slowly through your nose, allowing your abdomen to rise and expand outward as much as possible. Then exhale slowly through your mouth, gradually contracting your abdomen. 2. Seated Rotation: Sit with your hands hanging naturally at your sides. Slowly turn your upper body to one side, holding the position for 2-3 seconds at the maximum point, then slowly return to the starting position and switch to the other side. 3. Heel Raise: Stand with your feet shoulder-width apart, knees slightly bent, and slowly raise your heels before lowering
	2. Demonstrate the correct training method to the patient and inform the patient of the precautions for training.		
	2. Demonstrate the correct training method to the patient and inform the patient of the precautions for training.		
Verbal persuasion	4. Patients were positively advised to emphasize the benefits of appropriate core training for improving knee function and balance ability.		

	5.Invite patients and their families to enter the wechat group.		them. 4. Standing Backward Leg Swing: Stand with your feet together, hold onto a fixed object, and swing one leg straight back, pausing at the highest point for 1-2 seconds.
Alternative experience	6.Tell the patient 1~2 success stories		
Direct experience	1. Issue the Core Stability Training Log, teach patients how to use the log, and instruct patients to fill in the log truthfully before and after training.	Postoperative 1-2 weeks	Training frequency: 1. Abdominal breathing: 3-5 sets per day, with 10-15 breaths per set. 2. Seated rotation: 3-5 sets per day, with 8-10 rotations per set. 3. Calf raises: 4-6 sets per day, with 15-20 repetitions per set. 4. Standing leg swings: 4-6 sets per day, with 15-20 repetitions per set. Train at least 5 days a week, with each exercise lasting about 5 minutes, and the total training time should be around 20 minutes.
	2. After the patient returned to the ward, he/she would conduct progressive training according to the actual situation and phased goals. Once severe pain, vertigo, palpitation, dyspnea and other uncomfortable symptoms occurred during the training, he/she would immediately stop the training and rest.		
	3. Take the patient through their training experience to deepen their impression of successful experiences.		
Physiological and emotional states	4. Inform the patient of the possible pain degree and duration after surgery; apply cold to the knee joint within 72 hours after surgery, and use analgesic drugs on time according to doctor's advice.		
	5. Evaluate whether the patient has postoperative complications such as bleeding, venous thrombosis and infection, pay attention to the patient's emotional state after complications, and provide health education and psychological care for corresponding symptoms.		
Alternative experience	6.The organization organizes face-to-face sharing and communication among patients, including feelings before and after training, strategies to overcome difficulties, how to persist in completing goals, etc., to promote mutual support among patients.		
Verbal persuasion	7. Encourage patients who have achieved their goals and recorded their logs by using motivational language such as "You did a great job!" and "You can do it!". Reiterate the benefits of sticking to CST and emphasize the precautions during training.		
Physiological and emotional states	1. After training, patients should check in and upload training photos (report whether any adverse events occurred) in the wechat group every week. Those who do not check in will be contacted by the principal investigator to ask for reasons in time and give relevant help and guidance.	One month after discharge	Training Precautions: 1. Before the intervention begins, confirm the patient's information to assess their current condition and provide appropriate training strategies for different stages. 2. During the intervention, each patient will be accompanied by a caregiver throughout the process to ensure safety. During the first two days of training in the hospital, nurses will monitor the patient's heart rate and blood oxygen saturation using a pulse oximeter, closely observing for any exercise-related injuries and adjusting the intensity as needed based on the patient's subjective feelings. 3. Before discharge, provide additional guidance to both the caregiver and the patient to ensure they understand the training methods, maintain the continuity of the intervention, and that the caregiver provides one-on-one supervision during the patient's exercises to ensure their safety.
	2. Inform the family to accompany the patient to exercise as much as possible, communicate with the patient more emotionally, affirm the patient's ideas; mobilize the family to encourage the patient to share the joy of completing the training goal, and enhance the positive emotions of the patient.		
Alternative experience	3.Summarize the feelings and experiences of patients' feedback, and share them regularly in the wechat group.		
Verbal persuasion	4.Regular wechat communication or telephone follow-up was conducted to check the completion of training and the filling of training logs, and guidance and encouragement were given to strengthen the good behaviors that had been established.		

4. Discussion

4.1 SET-based Protocol for CST in Patients Who Have Undergone TKA is Scientific and Feasible

In the domain of rehabilitation medicine, the development of a CST program grounded in SET holds considerable promise for the post-operative rehabilitation of TKA. The SET paradigm emphasizes an individual's beliefs concerning their capacity to execute particular behaviors [21]. These beliefs exert a substantial influence on the patient's active engagement and adherence during the postoperative rehabilitation process [22]. Postoperative patients who have undergone TKA frequently experience symptoms of anxiety and self-doubt. These symptoms are often attributable to postoperative pain, functional limitations, and uncertainty regarding the rehabilitation process. Consequently, these symptoms can affect their adherence to rehabilitation and their motivation to engage in training. The SET-based CST program has been shown to systematically enhance patients' self-efficacy by providing direct experience, alternative experience, verbal persuasion, and regulation of physiological and emotional states. The accumulation of direct experience allows patients to increase their confidence through repeated practice during training. Alternative experience provides patients with an indirect experience of success by observing the success of peer cases, thereby reducing their anxiety. Verbal persuasion reinforces patients' positive perceptions of their abilities through positive feedback and encouragement from healthcare professionals. The regulation of physiological and emotional states helps patients to overcome their pain and fear and to maintain a positive state of mind. The regulation of physiological and emotional states has been shown to help patients overcome pain and fear and maintain a positive mindset.

The combined effect of these measures has been shown to stimulate patients' intrinsic motivation and encourage more active participation in rehabilitation training, thus significantly improving the rehabilitation outcome. CST, as the core content of the rehabilitation program, is scientifically based on targeting the dysfunction of core muscles in patients following knee arthroplasty. The core muscles, being at the center of the human body's power chain, play a crucial role in the effective transmission of lower limb power, the precise control of body posture, and the maintenance of dynamic

balance [23]. By enhancing core stability, patients are able to improve the biomechanical load distribution of the knee joint and reduce knee joint stress, as well as optimize motor coordination and reduce the risk of re-injury by strengthening proprioceptive inputs [24]. Consequently, the SET-based CST program, which integrates psychological interventions with physiological training, offers a comprehensive and effective approach to supporting the rehabilitation of patients following TKA.

4.2 SET-based Protocol for CST in Patients Who Have Undergone TKA is Operable and Applicable

In this study, a CST programme based on SET was constructed in order to provide a new strategy for the postoperative rehabilitation of TKA. This strategy emphasises the individual's belief in their ability to perform specific behaviours, and combines with SET to promote the rehabilitation of the patient in all aspects. In this study, the patients' physiological indexes and subjective and objective environments after surgery were firstly assessed. Based on the patients' knee function, muscle strength and balance, clear and feasible training goals in stages were set in consultation with the patients and their families. The initial goal is to focus on core muscle activation and basic balance training. The mid-term goal is to gradually introduce coordination and stability training. The long-term goal is to focus on functional recovery and the prevention of secondary injuries. For instance, patients must attain a specific level of knee mobility and muscle strength before progressing to the subsequent stage of training. In order to optimise the external environment for achieving the goals, the study encouraged family members to accompany the patients, provide emotional support and supervise the training, and introduced a peer-sharing mechanism, organising regular exchanges of training experiences and results to enhance patients' confidence and motivation. Furthermore, the study incorporated patient feedback through group meetings to make adjustments to the training programme in accordance with its efficacy, patients' sentiments, and rehabilitation progress. This approach was undertaken to ensure the adaptability and effectiveness of the programme.

In this study, we integrated supervision and feedback into the entire rehabilitation process and developed a comprehensive training logbook. In this logbook, patients and their families documented their training experiences, emotions, and outcomes. This approach aimed to enhance patients' self-management awareness and their perception of rehabilitation. It was on this basis that a progressive training programme was designed with the aim of improving walking drive and upper extremity coordination ability. In order to ensure the continued efficacy of the programme, group meetings were held on a regular basis for the purpose of making adjustments. In summary, the programme effectively guarantees the continuity and feasibility of CST after TKA through the following measures: goal negotiation and formulation, optimisation of external support, and process supervision and feedback. Furthermore, the programme provides strong support for patient rehabilitation.

4.3 Limitations and Outlook

Despite the rigorous design and implementation of this study during the program's development, two limitations remain. Firstly, the validation of the program is dependent on a small sample of experts and extant literature and is lacking in support from a large sample of long-term clinical data. This hinders the program's ability to comprehensively assess the long-term effects and potential risks. Furthermore, the extrapolation of the effects to different regions, ethnicities, and medical environments of the patient population may be biased. Secondly, the implementation details of the program must be adaptable to the individual differences of patients and medical resources. The variability in medical standards, facilities, and patient compliance among different institutions affects the universality and operability of the program. This necessitates additional time and effort to make personalized modifications and improvements in practical application.

In the future, there is a need for multicentre, large-sample, randomized controlled trials to track and validate the long-term effects of the protocol. Such studies would also investigate the potential effects on patients' knee function, balance, pain management, quality of life, and other dimensions, as well as the dynamic changes of the effects in different phases. The objective of such studies would be to further optimize the details of the protocol and to accumulate high-quality, evidence-based medical evidence. This, in turn, would enhance the scientific validity and credibility of the protocol.

On the other hand, interdisciplinary collaborative research needs to be strengthened, and multidisciplinary experts in sports medicine, psychology, biomechanics, and other disciplines should be united to comprehensively and deeply explore the intrinsic mechanism and interaction between CST and self-efficacy enhancement from a biopsychosocial medical model, to inject new vitality into the theoretical foundation of the program and expand its clinical application and promotion prospects. With the rapid development of digital medical technology, innovative technological means such as remote rehabilitation monitoring and artificial intelligence-assisted assessment can be actively explored to improve the precision and convenience of the program implementation, enhance patient participation and compliance, and promote the field of post-knee replacement rehabilitation towards a new era of intelligence and personalization.

5. Conclusion

The present study proposed a set-based CST for postoperative TKA patients, constructed through a systematic literature search and two rounds of Delphi expert correspondence. The protocol has a reliable evidence base, good scientific validity, and generalisability, and is of guiding significance in clinical practice for carrying out postoperative rehabilitation management and improving multidimensional rehabilitation care outcomes in this cohort of patients.

5.1 Ethical/Copyright Corrections

This study was conducted in accordance with the Helsinki Declaration. The research protocol was approved by the Institutional Review Board of Youjiang Medical University

for Nationalities on May 8, 2025 (ethical approval number: 2024110709), and all participants signed written informed consent.

5.2 Disclosure

The authors declare no conflicts of interest in this work.

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Developing a core stability training program for patients following total knee arthroplasty, informed by self-efficacy theory: A Delphi Method Study

ETHICS APPROVED

The research protocol was approved by the Institutional Review Board of Youjiang Medical University for Nationalities on May 8, 2025 (ethical approval number: 2024110709).

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