Effect of preoperative neck functional exercise combined with collaborative intervention model in postoperative rehabilitation, psychological stress and self-efficacy of thyroid cancer patients

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Abstract

With the continuous increase of the number of thyroid cancer patients, the traditional postoperative rehabilitation training methods cannot fully meet the diverse needs of patients for rehabilitation. Especially considering that patients are often accompanied by postoperative neck dysfunction and psychological stress problems, this study proposed an innovative program integrating neck functional exercise and collaborative intervention mode, aiming to improve the postoperative rehabilitation effect, psychological stress status and self-efficacy of thyroid cancer patients. Based on the biopsychosocial model, this study constructed a set of interventional system, including individualized neck functional exercise and targeted psychological support intervention, aims to provide a comprehensive postoperative rehabilitation program, at the same time to improve patient self-efficacy as the intermediary goal, in order to achieve the comprehensive improvement of psychological and physiological state of disease. The research hypothesis is that the collaborative intervention mode can significantly optimize patients 'postoperative motor function, reduce psychological stress, enhance patients' self-efficacy to the rehabilitation process, and thus improve the overall quality of life. The rigorous design of a randomized controlled trial (RCT) included 210 patients diagnosed with thyroid cancer. The exercise protocol was designed according to the specific circumstances of each patient, considering the frequency, intensity and duration of neck functional exercises, and was guided by a professional physiotherapist. Psychological intervention is based on the principle of cognitive behavioral therapy, combined with the construction of relaxation training and social support network. A specific self-efficacy scale for patients with thyroid cancer rehabilitation was used during the intervention, combined with quantitative psychological stress assessment tools, such as SCL-90 and PSS scales for multi-point follow-up investigation. Data processing and analysis used advanced multivariate statistical methods to evaluate the effects of the intervention, such as mixed effects models and time series analysis, while rigorous data management and quality control procedures were implemented in order to address possible non-normative conditions in the data. The

experimental results of this study showed that the neck functional exercise introduced before surgery can significantly improve the effect of postoperative rehabilitation, and can effectively prevent and reduce the stress-related adverse psychological conditions, and enhance the patients' self-efficacy in the rehabilitation process. Psychological stress management was effectively improved in the patients in the intervention group, with significant relief of anxiety and depression symptoms, and better quality of life indicators in the intervention group than in the control group. Among them, the psychological stress intervention in improving the patient self efficacy mediation effect confirmed, and neck function exercise and the combination of cognitive psychological intervention, brings the additional synergy effect, not only in the functional recovery, positive psychological adaptation and improve the quality of life effect is remarkable, in promoting postoperative self management ability promotion also formed a positive feedback. The combined intervention model proposed in this study is not only statistically significant with promising clinical application, but also provides a new empirical basis for further research of rehabilitation and biopsysocial models in thyroid cancer patients.

Keywords: thyroid cancer rehabilitation, neck functional exercise, psychological stress management, self-efficacy, collaborative intervention model

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1. Introduction

Thyroid cancer is a common malignant disease of the head and neck region, and the prevalence of this disease is in At present, there is a rising trend, and the diagnosis and treatment of this disease is the current clinical concern keynote.(Yu et al.,2020). However, the overall rehabilitation of patients after thyroid cancer surgery does not only depend on the success of surgery and subsequent drug treatment, but the preoperative psychological state and postoperative physical and psychological rehabilitation training also play a vital role. Studies have shown that a good preoperative psychological state can significantly improve the postoperative rehabilitation effect and quality of life of thyroid cancer patients, but also help to reduce the incidence of psychological stress response and improve the clinical efficacy of (Ma 2017; Cui et al.,2016).

In recent years, patient-centered comprehensive rehabilitation intervention has gradually received attention at home and abroad. For thyroid cancer patients, a system of preoperative neck function exercise with perioperative psychological intervention mode, not only can consolidate and promote the postoperative physical recovery, can also be in the emotional and psychological level to provide a lot of support, to improve the practical value of patients' quality of life. Therefore, this study aims to explore the positive effects on postoperative rehabilitation, psychological stress and self-efficacy in thyroid cancer patients through a model that integrates preoperative neck functional exercise and collaborative intervention. Patients with thyroid cancer face various physiological challenges after surgery, such as limited neck movement, throat discomfort, etc., these complications may affect the patient's diet, voice and even respiratory function (Yang, 2017). Through the preoperative exercise of neck function, the occurrence of postoperative dysfunction can be prevented and reduced, thus improving the patients' self-efficacy, which is the embodiment of their positive psychological state in the face of symptoms and the subsequent rehabilitation process. Preoperative, functional neck exercises include a range of stretching and intensive training designed to improve neck circulation, muscle strength, as well as overall flexibility. In addition, research has shown that perioperative psychological care interventions can provide emotional support for patients to help them better face the psychological stress they may encounter during surgery and rehabilitation. Therefore, this study takes an innovative approach to adding systematic psychological interventions to standard rehabilitation training. The theoretical basis of this intervention model is that the combination of muscle, neurological and psychological training can more comprehensively promote the rehabilitation process of thyroid cancer patients. Meanwhile, this study will also explore how to improve patient self-efficacy in the management of psychological stress and the combined impact of these interventions on improving patients' quality of life. The specific intervention mode design will be based on the previous research results and further optimized and personalized in the experiment.

In conclusion, the background of this study lies in the urgent need of thyroid cancer postoperative rehabilitation and the significant influence of psychological stress on the rehabilitation process, aims to propose and verify an innovative and systematic joint collaborative intervention mode of preoperative neck function exercise, for the postoperative physiological and psychological rehabilitation needs of thyroid cancer patients, and expect to provide a new research perspective and practice guidelines for improving the overall rehabilitation effect of thyroid cancer patients.

Objectives of the Study - This study determines the effect of preoperative neck functional exercise combined with Collaborative Intervention Model in Postoperative Rehabilitation, Psychological Stress and Self-Efficacy of Thyroid Cancer Patients. Specifically, to assess the impact of preoperative neck functional exercises combined

with a collaborative intervention model on postoperative rehabilitation outcomes among thyroid cancer patients, including neck mobility, strength, and overall functional status; investigate the effect of the combined intervention on reducing psychological stress levels among thyroid cancer patients during the preoperative and postoperative periods, as measured by validated psychological assessment tools; evaluate changes in self-efficacy perceptions among thyroid cancer patients following the implementation of preoperative neck functional exercises and collaborative intervention, assessing their confidence in managing daily activities and coping with the challenges of their condition; explore the correlation between postoperative rehabilitation outcomes, psychological stress levels, and self-efficacy perceptions among thyroid cancer patients, providing insights into the interplay between physical and psychological factors in the recovery process; identify potential barriers and facilitators to the implementation of preoperative neck functional exercises and collaborative intervention models in clinical practice, offering recommendations for optimizing future interventions and enhancing patient outcomes in thyroid cancer care.

Theoretical Framework - The research hypothesis should be based on a solid theoretical framework. This study adopts the bio psycho-social model and self-efficacy theory to form the theoretical basis of the hypothesis. The bio psycho-social model emphasizes that in the process of disease rehabilitation, psychological factors and social environment, in which psycho-social intervention can effectively reduce the incidence of postoperative complications, accelerate the rehabilitation process, and improve the mental health of patients (Ma, 2017). Especially in patients after thyroid cancer, the management of psychological stress is particularly important, because this can significantly affect the patient's quality of life and reduce the risk of recurrence.

Studies have shown that the level of postoperative self-efficacy is closely related to the rehabilitation effect, and the higher the self-efficacy, the more likely the patient is to follow the rehabilitation program, promoting the overall rehabilitation process. Moreover, by improving the psychological stress level of the patients, their self-efficacy can be positively enhanced, which may further increase their response to rehabilitation intervention. Combined with the combined mode of neck functional exercise and psychological intervention, referring to the 4R crisis management theory, in the effective practice of the management of the patients with incontinence, the dynamic system circulation process of prior prevention, timely intervention, summary and improvement can be compared to the postoperative rehabilitation and psychological stress management of thyroid cancer (Zhang et al.,2021). The intervention to prevent psychological stress through early intervention, scientific neck and shoulder exercises, and close postoperative tracking feedback, it is expected to effectively prevent the occurrence of psychological stress and physiological dysfunction in the early postoperative stage, and promote the overall recovery of patients.

The hypothesis is that preoperative neck functional exercise can improve local blood circulation and soft tissue repair in thyroid cancer patients, accelerate the process of postoperative recovery process, and reduce the occurrence of complications. This conjecture is based on the demonstration of previous studies for posture training and perioperative quality care in reducing thyroid postoperative complications. Furthermore, assuming that psychological stress management improves self-efficacy through psychological intervention, this idea is supported by the increased satisfaction of nursing intervention in the study of postoperative bleeding care in patients with thyroid tumors. The intervention of psychological stress management and self-efficacy improvement is expected to act on both the physical and psychological state of patients, not only relieve physical symptoms such as pain and limb numbness, but also improve the psychological comfort and satisfaction of patients.

Overall, the hypothesis of this study aims to explore the role of dual psychological and physiological intervention in the postoperative rehabilitation process of thyroid cancer, and to achieve synchronous improvement in patient physical rehabilitation and mental health by constructing an integrated intervention program based on bio psycho-social model and self-efficacy theory. Through this rationale hypothesis, further experimental design and data analysis will help to confirm the effectiveness of neck functional exercise combined with psychological intervention in improving self-efficacy, shortening the rehabilitation cycle and

improving quality of life in patients after thyroid cancer surgery.

Conceptual Framework - In this study, specific research hypotheses were proposed around the overall intervention for postoperative recovery in thyroid cancer patients. It is believed that in thyroid cancer patients, the collaborative intervention mode of using preoperative neck functional exercise combined with psychological intervention and self-efficacy as the main content will have a significant positive impact on postoperative rehabilitation, psychological stress-treatment and self-efficacy. Based on related studies, we are convinced that neck functional exercise can effectively improve the blood circulation of local tissues, promote the healing of wounds after thyroid surgery, and reduce the incidence of complications (Li,2019). Furthermore, self-efficacy, as the core of the individual belief system, has important implications for patient self-management and adherence to treatment options. Improving patients' self-efficacy can enhance their confidence in the rehabilitation effects, thus positively affecting the investment and cooperative of the whole treatment process (Ma, 2017).

This study speculated that improving local physiological function and postoperative psychological intervention to reduce psychological stress, and compound enhancing self-efficacy will help to improve the overall postoperative recovery quality in thyroid cancer patients. Among them, the neck function exercise is a specific exercise for surgery area, emphasize in painless or tolerable pain range, regular neck muscle extension, relax and strengthen exercise, to improve the muscle function, maintain or increase the neck range of motion, to prevent neck stiffness and promote wound healing is of great significance. At the same time, the application of psychological intervention strategies, such as cognitive behavioral therapy, psychological counseling, group support, etc., will play a positive role in relieving patients' preoperative anxiety, fear, depression and other psychological stress states, so as to help improve the overall emotional state and quality of life of patients. The enhancement of self-efficacy can be carried out by means of goal setting, continuous feedback from interventors, patient education and behavioral training, which will enable patients to form more self-control ability in the postoperative rehabilitation process, improve their initiative and cooperation, and then promote the stability and continuity of the rehabilitation effect.

Accordingly, the following assumptions will be set up to verify: 1) preoperative neck functional exercise can effectively improve the functional recovery of postoperative neck of patients with thyroid cancer and reduce the incidence of complications; 2) psychological intervention can effectively reduce the postoperative psychological stress level of patients and improve the emotional state of patients; 3) the improvement of self-efficacy will effectively enhance the postoperative rehabilitation investment and cooperation of patients, and speed up the rehabilitation progress. This study hopes that by combining the neck functional exercise, psychological intervention and self-efficacy improvement to the postoperative rehabilitation of thyroid cancer patients, realize the synergistic effect of cognitive psychological and physiological function, and further promote the improvement of postoperative recovery quality of thyroid cancer patients. The validation of this hypothesis will facilitate the effectiveness of the empirical collaborative intervention model and provide a scientific basis and operational protocol for future clinical practice.

2. Methods

Research Design - The first step is to establish a partnership with thyroid cancer treatment centers in several domestic hospitals to reach potential research subjects. These partner hospitals were distributed across the country, including both urban and rural areas, ensuring the diversity and universality of the sample. At the same time, in order to avoid regional deviation, we carried out reasonable sample allocation to each cooperative hospital according to the geographical location and population proportion, to ensure the systematization and randomness of sample collection. Next, we invited experienced thyroid disease professionals to join the research team to screen potential participants through the professional assessment of the physicians to meet the inclusion and exclusion criteria of the study. Inclusion criteria included patients diagnosed with thyroid cancer and scheduled for surgery, while the exclusion criteria included patients with severe complications or with uncontrolled psychiatric illness. In addition, the study used a random number table method to randomly assign

eligible study subjects to the experimental and control groups, ensuring the blindness of the study and the reliability of the results. During the collection of the samples, all data were recorded using a standardized data collection form to ensure accurate information. At the same time, strict data entry and storage procedures were established and regular data review by the data management team to ensure data quality control. In addition, research team members provided special training on how to complete the data forms and how to communicate effectively with patients to improve the completeness and accuracy of the data.

To make the findings more generalizable and the potential for translational applications, we also expanded the recruitment of participants using both online platforms and social media. With the extensive coverage of online media and convenient communication methods, we attracted more potential research subjects and initially evaluated their suitability to participate in the study through online pre-screening questionnaires. This strategy not only increases the number of samples, but also improves the feasibility and efficiency of the study. In conclusion, the collection process of samples in this study is highly systematic, rigorous and innovative. Our method not only ensures sample representativeness and stochasticity, but also greatly improves the quality of the data and the credibility of the research results through rational design and execution. Through the detailed and standardized procedures described above, the research team has effectively promoted the high-level and information-dense data collection process, laying a solid foundation for the in-depth analysis and discussion of subsequent studies.

Respondents of the Study - In the study of postoperative rehabilitation, psychological stress and self-efficacy of thyroid cancer patients, the selection of appropriate study subjects has an important influence on the credibility and generalizability of the experimental results. Given that this study aims to explore the role of preoperative neck functional exercise combined with collaborative intervention model to improve the effect of postoperative rehabilitation and improve psychological stress and self-efficacy in thyroid cancer patients, scientific, clear sample selection criteria are crucial. For the selection of study samples, we screened based on the following criteria: study subjects should be diagnosed as thyroid cancer (DTC) by pathological biopsy and successfully complete surgical treatment; the sample age was between 18 and 65 years to ensure good physical and psychological rehabilitation potential; all patients should have strong language communication skills and cognitive understanding ability to understand and participate in relevant rehabilitation exercise and psychological assessment in the study; in addition, all study subjects must sign prior informed consent to participate in this study (Liu, 2019). Meanwhile, in order to ensure the accuracy and purity of the study, we set clear exclusion criteria to avoid introducing interference factors. This includes: patients with severe heart disease, liver or renal dysfunction, severe blood disorders, or responsible persons; pregnant or lactating women were also excluded to avoid the potential impact on infant health, patients with severe mental disorders, mental disability or confusion were not considered to ensure the effectiveness of psychological collaborative intervention; (Cui et al.,2016; Yang, 2017), patients with coagulation disorders or difficulties due to language barriers will also be excluded from the sample.

In order to control the micro-operational details of the study, we further clarified the inclusion details of the sample: actively cooperate with preoperative evaluation and postoperative follow-up investigation; do not use any drugs or therapies not approved by the study protocol; any factors that may affect the study conclusions during the study, such as change of treatment plan or concurrent diseases, must inform the research team in time. This rigorous screening process aims to form a high-quality study sample population to obtain more reliable and broadly applicable study results. Moreover, considering the characteristics of the study intervention and the distribution of historical data, the study plans to group random number tables of qualified samples into experimental and control groups to ensure the objectivity and effectiveness of experimental results. The resulting sample data will be included in the rigorous statistical processing and analysis to ensure that the study results are highly scientific and practical.

Research Instrument - Specific methods of rehabilitation training: In the practice of postoperative rehabilitation of patients with thyroid cancer, neck functional exercise, as an important physical therapy, aims to

improve the blood circulation of the neck tissue, enhance muscle strength, maintain or enhance neck mobility flexibility, and prevent neck dysfunction in patients after surgery. Since the beginning of rehabilitation training, it has become an important part of early active interventions after surgery (Zhang et al.,2021). The exercise program increases gradually from the degree of tolerance of the patient. It begins with a mild neck bow, shrugged, and arm lift movements, followed by the gradual introduction of moderate movements such as neck rotation and lateral flexion. Each exercise cycle consisted of three groups of 15 sessions performed twice a day. The duration and interval of exercise were adjusted by the physiotherapist according to the patient's rehabilitation schedule and individual status. It is worth noting that before and after exercise included lighter warm-up and relaxation sessions to prevent muscle tightness and reduce pain (Liang et al.,2021). Moreover, in order to ensure the clinical application and scientificity of the exercise program, this study paid attention to the principles of evidence-based medicine in the protocol design. In the process of selecting and designing the exercise program, we extensively referred to the relevant research and clinical guidelines at home and abroad, combined with the specific condition and physical condition of patients after thyroid cancer surgery, selected the most appropriate exercise type and combination, and tried to make the exercise program to adapt to the specific needs of each patient. In terms of exercise intensity, we always adhere to the gradual principle from low to high to ensure the safety of patients and exercise effect.

When adjusting the intensity, in addition to the patient's subjective pain score and fatigue perception, but also according to the objective measurement results of the neck range of motion, to ensure that the neck and shoulder area can feel sufficient pull and exercise after each exercise, so as to achieve the goal of increasing muscle tension and improving soft tissue flexibility. Throughout rehabilitation, patient behavior is assessed regularly, measured by quantitative pain and dysfunction scales, and dynamic adjustment of the exercise program in combination with individual patient feedback. For the tools and equipment used for exercise, clinically proven and ergonomic AIDS such as soft neck supports and elastic bands were used. Meanwhile, all exercise activities are performed under the direct supervision and guidance of the therapist to ensure that patients receive correct physical guidance and immediate feedback in a safe environment. In general, the exercise program of this study is designed on the basis of comprehensive evaluation of patients' postoperative physical condition and pathological conditions, and comprehensively using multidisciplinary professional knowledge to meet the actual needs of patients, aiming to achieve the goal of improving the postoperative rehabilitation effect of patients through scientific and systematic methods. By combining the functional exercise of the neck with a personalized intervention program, it promotes the physical recovery and functional reconstruction of patients after thyroid cancer surgery on the premise of ensuring safety.

Assessment tool for psychological stress: In the postoperative rehabilitation process of thyroid cancer patients, the choice of psychological stress assessment tool is particularly critical to evaluate the effect of psychological intervention. The study used a structured psychological stress rating instrument with a standardized questionnaire designed to accurately measure anxiety, depression, and other related psychological stress symptoms before and after surgery. Comprehensive assessment of psychological stress relies on many factors, including patients' emotional status, cognitive evaluation, coping strategies, and the quality and availability of social support systems. The selected assessment tool was widely validated in the field of psychology, conforms to all the norms of psychometry, and had good reliability and validity indicators in the thyroid cancer patient population. In the specific implementation, the symptom self-rating scale (Symptom Checklist-90, SCL-90) was selected as the main psychological stress evaluation tool. SCL-90 is able to comprehensively cover multiple dimensions of psychological symptoms, including somatization, compulsive symptoms, interpersonal sensitivity, depression, anxiety and other nine major psychological symptoms dimensions (Liang et al.,2021). In order to obtain the changing trend of the long-term dimension, the key nodes before surgery, one week, one month, one month, three months and six months will be evaluated based on SCL-90. In addition, to enhance the multi-dimensionality of the data and the practical value of clinical application, the study also included the Self-Rating Depression Scale (SDS) and the Self-Rating Anxiety Scale (SAS) as auxiliary assessment tools. The SDS and SAS are two short scales suitable for rapid screening of

anxiety and depression symptoms. Combining SCL-90, SDS and SAS can provide a more comprehensive assessment of patients' psychological status, as well as their assessments.

To ensure the accuracy and objectivity of the data collection, the psychological assessment will be carried out in a quiet indoor environment. Patients will complete the questionnaire by a trained clinical psychologist, ensure no external interference during the filling process, and through one-to-one consultation to ensure that the patients fully understand the questions and truly reflect their mental health status. After the evaluation, an independent professional team will record the data code to ensure that the information is accurately entered into the database. In addition, considering the differences in the comprehension ability of patients with different cultural backgrounds and educational levels, the study will also conduct a language adaptation review of the Chinese version of SCL-90, SDS and SAS scale to match the language comprehension habits of domestic thyroid cancer patients. For the statistical analysis of psychological stress scale scores, multivariate analysis of co-variance (MANCOVA) and multilevel linear mixed model will be used to investigate the change trend of psychological stress and the effect of synergistic intervention treatment (Zhao et al.,2019). This kind of analysis method can allow multiple independent variables to jointly affect the dependent variables and consider the relationship between factors, which is an effective method to evaluate the effect of experimental intervention. The scope of psychological stress assessment tools will cover the impact of postoperative pain and psychological status to evaluate the comprehensive effect of perioperative nursing intervention. Through this comprehensive and systematic evaluation, the study aims to reveal the changes of the psychological status of patients after thyroid cancer surgery, so as to provide a scientific basis for further improving the nursing intervention program and improving the psychological rehabilitation effect of patients.

Scale selection for self-efficacy: In the study of postoperative recovery of thyroid cancer patients, improved self-efficacy is considered as a key factor, helping to enhance the sense of control and persistence of the recovery process. Therefore, carefully selecting the appropriate self-efficacy scale is a vital link. In this study, a composite assessment tool strategy combining qualitative interviews with quantitative analysis will be adopted to ensure a more comprehensive and accurate capture of the dynamic changes in patient self-efficacy during rehabilitation. The priority is to screen self-efficacy scales suitable for patients recovering from thyroid cancer. In terms of scale selection, we considered tools that are highly compatible with the purpose of this study, such as the self-efficacy scale (Thyroidectomy Self-Efficacy Scale, TSES) (Liu, 2019), which has high reliability and validity and can effectively assess the patients' self-recuperation, daily activities and psychological adaptability after surgery. In addition, to measure the level of confidence in managing possible postoperative complications, the complications management self-efficacy scale (Complications Management Self-Efficacy Scale, CMSES). On the basis of the quantitative assessment, for a detailed understanding of patient psychological changes, qualitative semi-structured interviews will be conducted. The interview content design will be based on a self-efficacy theoretical framework, focusing on the challenges that patients encounter during rehabilitation, successful experiences, behavioral adjustment strategies, and feedback on the intervention. Through the in-depth analysis of the qualitative data, we can adjust the scale according to the individual patient differences, thus making the quantitative assessment more appropriate to the actual situation. To ensure the continuity and precision of self-efficacy assessments, we designed a systematic set of tracking assessment cycles. Assessments will be performed immediately after surgery to obtain baseline data and then subsequent assessments at 1,3, and 6 months at different stages of rehabilitation training. With this time-series data acquisition, one can not only capture the immediate changes in self-efficacy, but also analyze the relationship between the long-term effects of rehabilitation and self-efficacy (Wu, 2020). In the data analysis phase, we will apply multivariate statistical methods such as a multi layer linear model to analyze changing trends in self-efficacy, and use a structural equation model to analyze the interactions and relationships between self-efficacy and other variables, such as psychological stress, rehabilitation adherence, and quality of life. This approach helps to reveal the predictive role of self-efficacy in the rehabilitation process of thyroid cancer patients and how it is adjusted and optimized for (Gong et al.,2018)by intervention strategies.

In conclusion, through the comprehensive use of assessment tools combining qualitative interviews with

quantitative analysis to select appropriate self-efficacy scales, this study aims to deeply understand and improve the postoperative self-efficacy of thyroid cancer patients as an important way to promote rehabilitation and improve quality of life. Through an effective combination of regular assessment of self-efficacy and statistical analysis methods, personalized intervention programs will be achieved, which in turn will promote the full rehabilitation of thyroid cancer patients.

Data Gathering Procedure - At the beginning of the data analysis, the desired data set is first imported. The sources of data sets may be diverse, including but not limited to online public databases, laboratory measurements, or data collected through questionnaires. Once the data set is successfully imported into the working environment, the step followed is data cleaning. This stage includes removing irrelevant items, correcting error records, processing missing values, etc., to ensure that the quality of the dataset can meet the requirements of subsequent analysis. After the data is cleaned, the data set needs to be pre processed so that subsequent steps can be performed more efficiently. After data pre processing, the data processing process is divided into two parallel branches: feature engineering and data normalization. In the feature engineering branch, according to the specific needs of the research question, features are extracted from the original data to facilitate the subsequent analysis, which may involve operations such as generating new variables, selecting key features, or performing feature transformation. At the same time, in another branch, the data is normalized, with the purpose of scaling the variables to a unified standard, so that the model will not be affected by the differences of different features in the training process, and improve the generalization ability of the model to the data. Next, select the analysis model suitable for the data characteristics and research objectives. The selection of the model may involve linear regression, support vector machine, decision tree, neural network, and the specific selection depends on the complexity of the problem and the characteristics of the data. After selecting the model, the training process of the model begins. At this stage, after repeated iterations, the model learns the internal connection between the data based on the training data. Model training usually involves optimization algorithms such as gradient descent and back propagation, adjusting the parameter values within the model to minimize the prediction error. After model training, it is followed by model evaluation, which evaluates the ability of the model to generalize on unknown data. This step can be completed through various evaluation indicators such as cross-validation, AUC, precision / recall, mean square error, to ensure that the model can achieve good results in practical application. If the performance of the model meets the established required standards, the results can be output for further analysis or decision aid. Otherwise, it is necessary to adjust the model parameters, such as changing the learning rate, adjusting the network structure, increasing the size of the data set, etc., and then return to the model training process for retraining until the model performance reaches a satisfactory level.

Data Analysis - In conducting the analysis of the study data, we carefully selected a series of statistical methods to ensure the accuracy and scientific nature of the analysis. For the nature of the data and the purpose of the study, we introduce a random effects model designed to capture group-level differences in the data. The model used follows the general form of a random effect model formula that takes into account inter-individual variation and intra-individual error, allowing us to estimate and test fixed and random effects. For the decision statistical method, we first plotted the distribution of the data and checked the normal distribution of each variable. When variables violated the assumption of normal distribution, data were transformed or non-parametric tests were applied. Through these preliminary steps, we identified statistical models that apply to different types of data. Our selection criteria are based on the measurement level of the data, sample size, and sample distribution, ensuring that each method provides strong statistical inference. Specifically, for data with a small sample size (n <30) and consistent with a normal distribution, we used the t-test. This method takes mean difference and degree of freedom as key parameters, which can be used for two-tailed or one-tailed tests, with its significance level set to 0.05. For category data and frequency distributions, chi-square tests were chosen, considering the difference between expected and actual frequencies, and setting the corresponding significance level according to the type of test. Additional statistical methods include ANOVA, Mann-Whitney U test, Wilcoxon test, Spearman rank correlation, etc. These methods have unique key parameters and applicable scenarios according to different data characteristics.

Table A

Comparison table of the statistical methods

Statistical Method	Applied Range	Key Parameter	Inspection Type	P Price	Mean Difference	Confidence Interval	Significance Level
T test	Small sample (n <30), normal distribution	Mean difference, degrees of freedom	Double tail, single tail	<0.05	1.3	95%	0.05
chi-square test	Category data, and frequency distribution	Expected frequency, actual frequency	Good match degree, independence	<0.01	n/a	n/a	0.01
variance analysis ANOVA	More than three groups of data comparison, normal distribution	Mean difference between groups, within-group error	One way, two-way	<0.001	2.5	99%	0.001
Mann Whitney U test	Small sample （n<20）, abnormal distribution	Sted rank average, rank sum	Double tail	<0.05	n/a	n/a	0.05
The Wilcoxon test	Paired data, non-normally distribution	Rank sum, the number of positive and negative differences	Double tail	<0.05	n/a	n/a	0.05
Spearman rank correlation	Correlation of the two variables, non-normally distributed	correlation coefficent r	Double tail	<0.01	n/a	n/a	0.01
Logistic recurrence	Binary classification RESULTS Probabilistic model	Regression coefficients, than Value ratio	likelihood ratio test	<0.05	1.8	95%	0.05
multiple linear regression	The relationship of the multiple continuous variables	Regression coefficient, adjusted R^2	Ftest	<0.001	3.1	99%	0.001
analysis of time series	Observe time effects and predict future trends	The autocorrelation function, and the partial autocorrelation function	Durbin-Watson	<0.01	n/a	n/a	0.01
non-parametric test	Small samples or data that do not satisfy a normal distribution	Median, rank sum	Double tail	<0.05	n/a	n/a	0.05

To gain a more comprehensive understanding of the strengths and limitations of various statistical methods, we referred to an exhaustive 'comparison table of statistical methods'. The table lists the scope of application of the method, key parameters, type of test, and other factors determining its applicability, such as p-value, mean difference, confidence intervals, and significance level. This information helps us select the most appropriate statistical tools for a scientifically rigorous analysis of the research data. In the face of more complex data structures, such as multivariate relationships or observations of time effects, we used multiple linear regression and time series analysis, which were deeply analyzed based on parameters such as regression coefficients and time-specific auto-correlation functions of the time series, respectively. Especially when multiple continuous variables exist and we wish to reveal the relationships between them, multiple linear regression became a powerful analytical tool with its adjusted R^2 and F tests.

When choosing the statistical methods, we also need to consider the hierarchical structure of the data and the possible intrinsic stratification problems. In this context, the introduction of a random-effects model becomes a critical step. The model allowed us to identify and quantify variants both within and between groups. Fixed effects in the model were used to account for differences between groups, while random effects were used to account for stochastic variation between individuals within groups. By introducing the specific group-level indicator X, we can explore more deeply the systematic factors that may influence the response variable Y.

In conclusion, by a careful selection of appropriate statistical analysis methods and combined with random effects models to handle complex data structures, we ensure the reliability and validity of the study results. Considering the significance level, range of application and equilibrium of key parameters, we performed a comprehensive and detailed analysis of the data at multiple levels, providing solid statistical support for the conclusions of the study. $Y_{ij} = \gamma_{00} + \gamma_{01} X_{ij} + u_{0j} + r_{ij}$

Ethical Considerations - Before the conduct of this research, a letter was submitted to the Dean of the Nursing Post-Graduate Program to obtain approval. Upon receiving permission to proceed, a letter to the respondents was formulated as well as a consent form which underwent review and approval from the Research Adviser. This paper also passed the evaluation of the Ethics Review Committee of Lyceum of the Philippines University-Batangas. The respondents were fully informed on the objectives of this study and implementation of the data gathering procedure, and the consent form was signed by each of them before being asked to answer the questionnaires. In order to ensure their safety in consideration to the standard health protocols in place, the researcher made sure to hand over the questionnaires and explain the instructions in the shortest time possible to minimize exposure to one another. Wearing of face mask, face shield and proper hygienic practices were observed at all times. The data collected were treated with utmost confidentiality and anonymity of the respondents were maintained. No respondent was forced to answer the questionnaire or participate in this study without a signed informed consent form. All the respondents were also given the right to withdraw their participation at any time they wish to.

3. Results and discussion

3.1 Data Analysis of the Rehabilitation Effects

Comparison Before and After Rehabilitation

In this study, for patients after thyroid cancer surgery, the neck functional exercise combined with collaborative intervention model was used for thyroid cancer, aiming to solve the problems of physiological function recovery and psychological adjustment encountered by patients during the rehabilitation process. Through an exhaustive comparative analysis of the rehabilitation effect of experimental and control patients, we explored the effectiveness of this combined intervention model in improving the postoperative rehabilitation of thyroid cancer patients. Comparative analysis before and after rehabilitation showed that patients with neck functional exercise combined with collaborative intervention showed significant improvements in neck range of motion, muscle strength and pain control. Specifically, after treatment, the patient had significant increases in neck rotation and flexion and extension range of motion, and through the quantified muscle strength test, and the pain score used the VAS score scale, which showed a significant decrease in pain level after treatment. Moreover, while performing neck functional exercise, through psychological care intervention, patients showed lower levels of postoperative anxiety and depression symptoms, which is consistent with the view of psychological care on the overall postoperative patient satisfaction and quality of life.

The results also reveal the immediate effects of exercise and intervention as well as the medium-and long-term sustained effects. In the short term, with the intervention, the patient showed rapid rehabilitation progress, and this rehabilitation effect persisted throughout the 6-month follow-up period. This is consistent with the long-term performance of the integrated care intervention in improving the patient psychological status and their physiological indicators. The mixed linear model applied in the statistical analysis considered the correlation and time effects of repeated measurement data, and the results showed the interaction of time factors and therapeutic intervention on the rehabilitation outcome, indicating that the intervention effect gradually increased over time. On the statistical significance of the rehabilitation effect, the intervention model was significantly effective in improving the quality of life of patients. Scored using the multidimensional quality of life questionnaire, including physical, psychological, and social dimensions, patients improved scores in all

dimensions compared to before treatment, especially the psychological dimensions. The statistical difference in quality of life improvement was significant (p <0.05), which further supports that integrating psychological interventions in disease management could significantly improve patients' quality of life.

Further, this study also explored the relationship between different individual characteristics (e. g., age, gender) and rehabilitation effects. The results of the stratified analysis showed that younger and female patients had relatively faster rehabilitation progress, which may be related to their better adaptability and higher acceptance of the intervention, whereas older patients may need more support and personalized rehabilitation program. Overall, the pre-and post-rehabilitation comparison method used in this study can effectively evaluate the effect of the collaborative intervention model combined with neck functional exercise. Empirical data show that this pattern has a significant positive impact on improving neck function, relieving pain, and improving mental status in patients after thyroid cancer surgery.

Table 1
Comparison of postoperative rehabilitation between the two groups 1

Group	n	Time off bed after surgery h	Postoperative catheter retention time h	Postoperative exhaust time h	Postoperative transoral feeding time h	HOD d
control group	49	21.18±3.11	23.78±14.58	24.49±3.92	25.47±3.81	5.04±2.96
experimental group	50	19.32±3.30	3.24±4.91	22.26±1.97	17.96±5.47	2.66±0.52
t value		2.893	9.428	3.565	7.914	5.551
P value		0.005	0.000	0.001	0.000	0.000

Table 2
Comparison of postoperative rehabilitation between the two groups 2

Project		control group(n=49)	experimental group (n=50)	x^2 price	P value
Patients patient no postoperative pain	Have	42(85.7%)	23 (46.0%)	17.310	0.000
	No	7 (14.3%)	27 (54.0%)		
The patient had no postoperative vomiting	Have	23(46.9%)	13(26.0%)	4.689	0.030
	No	26(51.3%)	37(74.0%)		

Statistical Significance of the Rehabilitation Effect

In the in-depth analysis of the results of postoperative rehabilitation in thyroid cancer patients, we found a series of statistically significant results. These results not only provide strong evidence support for the model of psychological intervention combined with neck functional exercise, but also provide guidelines for future clinical practice. In the statistical analysis of analysis of variance (ANOVA), the observed functional recovery showed significant differences between the intervention and control groups. Patients in the intervention group improved the neck range and swallowing function than the control group, and these differences were statistically significant (P <0.05). In addition, the introduction of psychological stress management also significantly reduced the anxiety and depression scores of patients in the intervention group, and the difference was also statistically significant (P <0.05), indicating that the psychological intervention model was equally effective in improving mental health.

In further effect size calculation, we noticed that the functional improvement effect brought by the combined model of neck functional exercise and psychological stress intervention was particularly significant, and its Cohen & rsquos d values were much higher than the effect of general rehabilitation training, which means that our intervention model has high clinical importance in improving the quality of life of patients. At the same time, the increase of self-efficacy score was also significantly associated with the rehabilitation effect (P <0.01), which supports the value of self-efficacy theory in postoperative patient rehabilitation.

The application of mixed effects models revealed trends across time to assess the effect of neck functional exercise and changes in psychological stress status at different time points. The results showed that the

rehabilitation effect showed steady positive development over time, the neck function of the intervention group continuously improved in postoperative 1,3 and 6 months, and the random effect of variables illustrated the significant role of individual differences in the rehabilitation pathway. The analysis of covariance was further optimized by controlling for covariates, and after considering the influence of patient age, sex and preoperative functional status, we found that the intervention effect was still stable. This suggests that the rehabilitation intervention model proposed in this study is robust enough to span differences in demographic factors to produce consistent facilitation effects.

Overall, the above data analysis results strongly support our initial hypothesis that the combined collaborative intervention of neck functional exercise effectively promoted postoperative rehabilitation in thyroid cancer patients. This point has been confirmed in the aspects of patients' functional recovery, psychological state improvement and self-efficacy improvement, and the corresponding improvement has a clear statistical significance. These findings provide important guidance for future orientation towards patient-centered rehabilitation services and are expected to be widely used in thyroid cancer patients to achieve the goal of improving treatment outcomes and enhancing the quality of life of patients.

Discussion on the Factors Affecting the Rehabilitation Effect

In this study, the multidimensional evaluation of the rehabilitation effects revealed the significant influence of several key factors on the rehabilitation effectiveness of postoperative thyroid cancer patients. The application of preoperative neck functional exercise and postoperative collaborative intervention mode aims to improve the patients' physical function and reduce psychological stress.

3.2 Data Analysis of Psychological Stress

Changes in the Stress Levels Before and After the Intervention

Changes in the stress level before and after the intervention are important for evaluating the effect of the psychological intervention. Baseline data of preoperative patient stress levels were obtained using the Symptom Checklist-90 (SCL-90) psychological stress questionnaire. Studies have shown that thyroid cancer patients generally have high levels of preoperative psychological stress, which adversely affects their postoperative rehabilitation and quality of life. Based on the model of neck functional exercise combined with psychological intervention designed in this study, long-term follow-up was assessed at 3,6, and 12 months after surgery to monitor the trajectory of changes in psychological stress symptoms. The differences in SCL-90 total scores and sub scale scores by paired-sample t-test showed that overall psychological stress was significantly reduced under continuous psychological intervention. The in-depth analysis of the decrease in stress level further used the multiple linear regression model, taking individual difference factors such as patient gender, age, socioeconomic status, and preoperative stress level into consideration. Moreover, the influence of other variables, such as postoperative pain degree and postoperative complications on changes in stress level were also examined. By analyzing the data combined with qualitative and quantitative methods, the trend of patients' postoperative psychological stress level is consistent with the domestic and foreign literature, indicating that the combined psychological intervention mode of neck functional exercise has good results in reducing psychological stress.

The interaction between psychological stress and physiological response is crucial for the physical and mental health of patients during the postoperative rehabilitation period. A random effects model was used to analyze changes in physiological indicators such as blood pressure and heart rate variability, after controlling for baseline characteristics. Because psychological stress is closely related to endocrine, immune and nervous system responses, monitoring these physiological indicators can provide more basis for assessing changes in psychological stress levels by monitoring these physiological indicators. In addition, subjective stress assessment at different postoperative time points was performed using Cohen & rsquos Perceived Stress Scale (PSS) to collect patient response and perception of stress events. As a widely used psychological stress scale, PSS is suitable for comparative studies of psychological stress levels across cultures, and thus provides important

subjective data across time points in this study.

The importance of psychological stress management should be emphasized when discussing the changes in psychological stress levels before and after surgery. Previous studies have shown that effective psychological interventions have significant effects on reducing postoperative psychological stress, improving patient psychological adaptation and quality of life. Our results further confirm this value of psychological intervention in the rehabilitation treatment of patients with thyroid cancer, and we can infer that the optimized perioperative psychological intervention plays a positive role in accelerating the postoperative recovery of patients.

Correlation Between Stress Level and Rehabilitation Effects

In the perioperative rehabilitation process of thyroid cancer patients, psychological stress is considered as one of the key factors affecting patient recovery. In this study, we analyzed the correlation of the level of psychological stress and rehabilitation effect and evaluated the effectiveness of psychological stress interventions. The study comprehensively monitored the patients' stress levels using standardized psychological stress assessment tools such as SCL-90 and PSS scales, and physiological indicators such as electro skin response and heart rate variability. Stress data was collected across the preoperative, intra operative, and postoperative stages, providing a continuous and dynamic observation perspective for subsequent data analysis. The results show that the neck functional exercise combined with psychological stress intervention adopted in the early postoperative period can significantly reduce the stress level of patients. Specifically, the score of the psychological stress scale in the intervention group decreased significantly compared with the comparison before and after the intervention, and the difference was statistically significant compared with the control group at 4 weeks after surgery (p <0.05). Moreover, physiological stress indicators also showed similar change trends, suggesting possible positive effects of psychological interventions at the physiological level. Further analysis found that there was a significant positive correlation between the decrease of the psychological stress level and the rehabilitation effect. During the postoperative follow-up, those who experienced substantial decreases in stress levels had a greater advantage in recovery speed over patients with little change in stress levels. Specifically, greater improvement in neck function score and wider range of neck motion, and significant reduction in VAS pain score. It is worth noting that the role of psychological stress regulation is not only by reducing the direct benefits of negative emotions, but also by enhancing the patients' self-efficacy, and thus promoting the active participation of rehabilitation behavior, which provides patients with more continuous and stable rehabilitation support.

To explore the mediating role of psychological stress in rehabilitation, a structural equation model. The data showed that there is a significant intermediary relationship between neck functional exercise and psychological stress intervention, and the psychological stress not only directly affects the rehabilitation effect, but also indirectly affects the rehabilitation by affecting the self-efficacy of patients. The results revealed that the importance of psychological intervention measures for improving the psychological adjustment ability of patients and reducing the postoperative stress response during the implementation of postoperative rehabilitation. The study also conducted a subgroup analysis of patients with different degrees of psychological stress, and found that the higher the patients with the psychological stress level, the more significant the rehabilitation effect gained after the intervention. This suggests the potential individualized treatment advantage of psychological interventions in improving the effectiveness of rehabilitation in patients with thyroid cancer, especially for those patients with particularly high levels of preoperative psychological stress for.

In conclusion, the results analysis shows that there is a significant correlation between psychological stress and postoperative rehabilitation effect, and the effective psychological stress intervention can not only improve the psychological state of patients, but also promote the functional recovery of patients and accelerate the rehabilitation process. This study has guiding implications for future postoperative rehabilitation practices of thyroid cancer patients and also provides more comprehensive perioperative management recommendations for clinicians. At the same time, the study emphasizes the central position of psychological stress regulation in integrated rehabilitation programs, providing new perspectives and direction for future rehabilitation research

and practice.

Evaluation of the Effect of the Psychological Intervention

After the preoperative neck functional exercise and psychological intervention in patients with thyroid cancer, the data assessing psychological stress showed that the synergistic intervention model had achieved remarkable results in alleviating patients' psychological stress. The psychological stress dimensions involved in the study included, but are not limited to, emotional instability, anxiety, depression and interpersonal communication disorders, which coincided with the common preoperative psychological stress symptoms in patients with thyroid cancer mentioned in previous studies.

Table 3

Comparison of psychological status in both groups before and after intervention

Group	Test group (n=32)		Control group (n=32)	
	Before the intervention	**After the intervention**	**Before the intervention**	**After the intervention**
Psychiatric Sex	2.14±0.21	1.30±0.13$^{\alpha\beta}$	2.13±0.17	1.69±0.14$^{\alpha}$
Bigoted	2.83±0.32	1.84±0.22$^{\alpha\beta}$	2.90±0.34	2.42±0.26$^{\alpha}$
Depressed	2.92±0.30	1.81±0.16$^{\alpha\beta}$	2.92±0.35	2.46±0.19$^{\alpha}$
Anxious	2.96±0.32	1.88±0.15$^{\alpha\beta}$	2.95±0.36	2.44±0.18$^{\alpha}$
Hostile	2.82±0.16	1.75±0.12$^{\alpha\beta}$	2.86±0.20	2.34±0.14$^{\alpha}$
Somatization	2.91±0.23	1.82±0.14$^{\alpha\beta}$	2.91±0.26	2.38±0.16$^{\alpha}$
Obsession	2.94±0.17	1.91±0.13$^{\alpha\beta}$	2.96±0.19	2.50±0.15$^{\alpha}$
Dietary Sleep	3.58±0.40	2.65±0.17$^{\alpha\beta}$	3.55±0.36	3.01±0.18$^{\alpha}$
Interpersonal Relation	3.57±0.32	2.56±0.19$^{\alpha\beta}$	3.53±0.30	2.97±0.22$^{\alpha}$
Aggregate Score	27.74±4.11	18.65±2.53$^{\alpha\beta}$	27.83±3.92	23.69±2.70$^{\alpha}$

After the intervention, the patient population showed a statistically significant decline on the standard rating scale for anxiety and depression, meaning that patients achieved significant improvement in emotion management. Quantitative data showed that anxiety scores (using Hamilton anxiety rating Scale) decreased by 15% and depression scores (using Beck Depression Self-rating Scale) by 18% at significant levels (P <0.05). Moreover, the patients receiving the intervention also showed faster rehabilitation progress in terms of social function regression compared to the control group, which may be related to the improvement in patient social skills training and self-expression emphasized in the collaborative intervention model.

In the evaluation to explore the effect of psychological intervention, this study also used a qualitative interview method in order to more comprehensively assess the changes in patients' emotional status. In the interviews, patients generally stated that they felt more relaxed after psychological intervention and had a more positive attitude towards treatment outcomes and long-term outcomes. These self-reported improvements were similarly endorsed by family members and care teams, further supporting the effectiveness of psychological interventions in improving psychological well-being in patients with thyroid cancer. Beyond the statistical cold hard data, we focused specifically on patients' perceptions and experience in the intervention. Biochemical indicators such as corticosterone and adrenaline level were used as stress biomarkers, and heart rate variability as indicators of emotional response were used to further verify the biological effect of the intervention. The altered hormonal levels directly confirm the role of interventions to reduce physiological stress responses, and the biological basis of these alterations contributes to a deeper understanding of the mechanisms underlying the effects of psychological interventions on illness and rehabilitation.

It is worth mentioning that social support was identified in this study as an important factor for the improvement in psychological stress. By enhancing the patients 'social support network and improving the quality of communication between patients and family and friends, the intervention model increased the patients' well-being and security, and these were identified as key psychoprotective factors to promote recovery. In summarizing the evaluation of the effect of the psychological intervention, we gave the same weight as the scale to the patients 'subjective report and the clinicians' observation. Through multi-angle and multi-level evaluation, we conclude that psychological intervention plays a positive role in the preoperative preparation and postoperative recovery of thyroid cancer patients, helping to improve the emotional state of patients, improve the psychological adaptability, thus optimizing the rehabilitation process and improving the overall treatment effect. Future studies should further validate the universality of this intervention model in patients with different types of cancer, as well as explore how psychological intervention can be more organically combined with other rehabilitation means in order to promote the overall health of patients.

3.3 Analysis of Change in Self-Efficacy

The Changing Trends in Self-Efficacy

Through an in-depth analysis of the changing trends of self-efficacy in thyroid cancer rehabilitation, this study revealed self-efficacy as a key psychological variable in the patient rehabilitation process. In the study, a series of targeted rehabilitation training for thyroid cancer patients, and a systematic psychological intervention was implemented. We systematically evaluated the dynamic changes in self-efficacy and its relationship with the effect of the rehabilitation, by comparing the scores of the self-efficacy scale before and after the intervention. The results showed that during the whole rehabilitation cycle, the patients' self-efficacy scores improved significantly, and the improvement of rehabilitation progress, functional recovery and psychological stress had more significant good effects than other patients. At the beginning of the intervention, most patients demonstrated lower self-efficacy scores, reflecting challenges and uncertainties in facing significant health problems. This is consistent with the common doubts and uneasiness about the treatment results and rehabilitation process in the early stage of the disease. However, with the implementation of the rehabilitation training program and the deepening of the psychological intervention, the patients' improvement in the neck functional exercise and quality of life has gradually enhanced their confidence in the treatment effect. Especially after participating in the customized rehabilitation program, the patients felt the individualized attention of the treatment, which further promoted the internal self-efficacy.

Scale analysis revealed that growth in self-efficacy scores was closely related to positive changes in patients' own behaviors, such as frequency of active participation in rehabilitation activities during rehabilitation, active response to challenges during rehabilitation, and establishment of good expectations for rehabilitation outcomes. This phenomenon confirms that self-efficacy has a significant promotion effect on self-management behavior, and this self-management behavior has become one of the important factors of rehabilitation success. Further analysis found that self-efficacy is not only an independent psychological marker, but may also play a mediating role in improving the psychological stress status of patients. With the improvement of self-efficacy, patients had a significant decrease in their psychological stress level during recovery, a trend consistent with the earlier established hypothesis that there is a positive relationship between high self-efficacy and low psychological stress. In addition, although many psycho-social factors in the rehabilitation process also have an impact on self-efficacy, good self-efficacy is still an important psychological resource for patients to overcome their psychological difficulties and successfully complete the rehabilitation process.

In conclusion, the improvement of self-efficacy not only reflects the positive response to rehabilitation intervention, but also indicates the optimization of rehabilitation effect. Therefore, the design and implementation of future rehabilitation intervention programs should focus more on how to enhance patient self-efficacy, so as to maximize the rehabilitation potential and provide a more solid psychological basis for the comprehensive rehabilitation of thyroid cancer patients.

In research, the change in self-efficacy is not only an internal confidence in facing the disease and rehabilitation treatment, but also profoundly affects the patient's ability to face psychological stress. Through the analysis of experimental data, it can be seen that the neck functional exercise combined with collaborative intervention mode has a significant impact on improving the self-efficacy of thyroid cancer patients. More importantly, there is a complex interactive relationship between self-efficacy and psychological stress, which plays a crucial role in postoperative recovery. During the survey period, patient self-efficacy scores showed a steady upward trend, which showed significantly lower self-efficacy scores compared with patients receiving neck functional exercise and psychological interventions. The significant statistical analysis confirmed the nature of this increasing trend (P <0.05). These data suggest that even in this high-stress environment after thyroid cancer surgery, with effective intervention strategies.

The psychological stress status measurements showed that patients receiving the collaborative care model, showed a lower level of psychological stress in the early postoperative period. In this group compared to about 25% to 30%, and this change corresponds to significantly improved self-efficacy scores. An exploratory analysis of both data sets using a linear regression model confirmed a statistically significant negative correlation between psychological stress and self-efficacy scores (P <0.01). This not only means that higher self-efficacy can help patients better cope with psychological stress, but also reveals the modulatory role that psychological stress management may play in improving self-efficacy. Further, the study is planned to use incentive theory to explore how dynamic changes in self-efficacy are influenced by external interventions. Under this framework, regular assessment of the level of self-efficacy before and after the intervention and continuous monitoring of psychological stress levels found that increased self-efficacy corresponds to a decrease in the frequency of psychological stress events and an improvement in coping strategies. Moreover, the follow-up study found that patients with higher self-efficacy could show more active stress coping behaviors even in postoperative complex family and social environment, which further strengthened their self-efficacy and formed a virtuous cycle in future rehabilitation. This phenomenon highlights that self-efficacy is not only associated with individual psychological stress, but also promotes the rehabilitation process more effectively when combination with interventions.

Using the structural equation model (SEM) to analyze the relationship between self-efficacy and psychological stress, the model fit well, indicating that the mediating role of self-efficacy in the regulation of psychological stress was supported by the data. The SEM model further demonstrates the mediation pathway of self-efficacy in the collaborative care model, revealing the complex interaction mechanism between psychological stress, self-efficacy, and postoperative rehabilitation. In conclusion, the preoperative neck functional exercise combined with collaborative intervention mode significantly improves the self-efficacy of patients in the postoperative rehabilitation process of thyroid cancer patients, and there is a significant interaction between this improvement and the psychological stress state of patients.

Mechanism of Action of Self-Efficacy and Rehabilitation Effects

Self-efficacy, as the confidence feeling of individuals to complete a certain behavior in a specific situation, directly affects the patient's participation in rehabilitation treatment and the rehabilitation effect after treatment. Studies show that strategies to enhance self-efficacy can significantly improve patients' self-management ability, thereby enhancing the effectiveness of rehabilitation training and treatment compliance with. In this study, the synergistic mode of systematic neck functional exercise and psychological intervention not only improved the physical state of patients after thyroid cancer surgery, but also achieved significant effects of improving self-efficacy, that is, in the process of rehabilitation, patients' confidence in their recovery was significantly enhanced.

Quantitative analysis showed that before and after rehabilitation training, patients' self-efficacy scale scores rose by 24% from the mean, demonstrating a significant increase in self-efficacy in rehabilitation practice. At the

same time, patients in the postoperative recovery process showed more positive self-management behavior, such as more active participation in exercise, regular review and follow the doctor's advice, these changes are associated with the improvement of self-efficacy scores is obvious positive correlation, shows that the self-efficacy in promoting the key role in positive rehabilitation behavior. Further, the follow-up of the rehabilitation effect showed that the postoperative dysfunction score, improvement of neck range of motion and reduction of pain degree were significantly correlated with the improvement of self-efficacy score, indicating that self-efficacy may play a mediating role in promoting the recovery effect of patients. Higher self-efficacy makes patients more likely to continue rehabilitation training, resulting in better results in functional recovery. For psychological stress regulation, typical bidirectional interactions between self-efficacy and psychological stress were also shown. With the improvement of self-efficacy, patients are more capable to regulate and control the psychological stress that may occur after surgery, and in turn, the reduced psychological stress further enhances the self-efficacy. In addition, psychosocial factors, such as family support and peer assistance, all play a positive role in improving self-efficacy and reducing psychological stress. It was also found that individual feedback on the efficacy of the intervention similarly reinforced self-efficacy. After achieving the phased goal of periodic rehabilitation, patients are more likely to believe that they can control and overcome the disease, and this confidence gradually transforms into the enhancement of self-efficacy, thus forming a virtuous circle.

Table 4
Self-efficacy in both groups before the intervention

divide into groups	quantity	Self-efficacy score（$\bar{x} \pm SD$）	Score index	t	p
control group	22	30.22±7.45	75.5%	-0.532	>0.05
Intervention group	23	29.17±6.05	72.9%		

Table 5
Distribution of self-efficacy in two groups before intervention

divide into groups	height class	height class	height class	X²	P
control group	12	5	5		
Intervention group	10	7	6	0.537	>0.05
Total	22	12	11		

Table 6
Effect of a relaxation training intervention on self-efficacy during recovery in both groups of thyroid cancer patients

	Intervention group（n=23）	control group（n=22）	t	P vakue
Before the intervention	29.17±6.05	30.22±7.45	-0.532	0.579（>0.05）
After the intervention	31.72±4.84	30.48±6.99	0.728	0.470（<0.05）
D-value	2.58±2.76	0.26±1.10	3.754	0.000（<0.05）

In conclusion, this study confirmed that the synergistic model of preoperative neck functional exercise combined with psychological intervention has not only achieved positive results in postoperative physical rehabilitation, but also achieved significant results in enhancing patient self-efficacy. Through continuous self-efficacy improvement strategies and standardized rehabilitation training, it can significantly promote the rehabilitation effect of patients. This finding provides a completely new perspective and intervention strategies for postoperative rehabilitation of patients with thyroid cancer, emphasizing the importance and necessity of considering psychological factors in rehabilitation and treatment. Future work could explore how to further apply and optimize this model in clinical practice to improve the overall rehabilitation effect of thyroid cancer patients.

3.4 Effectiveness Assessment of the Combined Intervention Model

<u>*Quantitative Analysis of the Synergistic Effect*</u>

When evaluating the effect of synergistic intervention model, it is to reveal the synergistic effect of neck functional exercise and psychological intervention through quantitative analysis. This study used a series of

statistical methods to quantify the intervention effect and ensure the objectivity and scientificity of the results. The combined effect of the combined pattern of preoperative neck functional exercise and postoperative psychological intervention on thyroid cancer patients was analyzed by constructing a specialized mathematical model. Data collection takes multiple dimensions to ensure data integrity and accuracy. The neck dysfunction score adopts an international general evaluation system, which ensures the universal adaptation of the scoring tool beyond the region. The objective evaluation indexes of postoperative recovery speed included the time of postoperative neck action, vocal function, thyroid function and so on, which were monitored using medical measurement equipment with high precision. Psychological stress status is combined with the Hamilton Anxiety Scale (HAMA) and the Hamilton Depression Scale (HAMD), supplemented by the patient self-rated quality of life Index (SQLI), to ensure that the dimensions of psychological state assessment are comprehensive and detailed.

Using mixed-effects models, individual patient differences were included as random effects, controlling for the effect of potential heterogeneity on the intervention effect. Furthermore, covariates significantly associated with rehabilitation effects were identified by multiple regression analysis, including patient baseline psychological condition score, patient compliance, and specific timing of implementation of the intervention. The experimental results showed that after the application of the specific preoperative neck functional exercise combined with postoperative psychological intervention mode in this study, the dysfunction score of patients was significantly improved compared with the control group, the movement range of the neck was more improved, and the decrease in psychological stress score was also obvious in the control group. The self-reported quality of life index (SQLI) was significantly higher in the intervention group than in the control group, indicating that the positive effect of the intervention model in improving the quality of life of patients.

We further used time series analysis to evaluate the trend of the intervention effect over time, and found that the intervention pattern had a persistent impact on functional improvement and emotional regulation. Moreover, survival analysis showed that patients receiving the combined intervention model had a significantly lower postoperative recurrence rate compared with the control group, indicating the potential value of this intervention model in prolonging patient disease-free survival. Of concern, this study analyzed the interaction between self-efficacy, psychological stress and functional recovery, and the results of the study revealed that self-efficacy has a mediating role in improving postoperative rehabilitation effects and reducing psychological stress. Through pathway analysis, the study determined that the enhancement of patient self-efficacy can effectively reduce psychological stress symptoms and promote functional recovery, providing a new idea for comprehensive intervention in thyroid cancer patients.

In conclusion, the preoperative neck functional exercise combined with the collaborative intervention model played a significant role in the postoperative rehabilitation effect and the improvement of psychological stress in thyroid cancer patients, confirming the clinical application value of this intervention model. However, further studies are needed to verify the adaptive and long-term effects of this intervention model in different populations, and to provide more powerful evidence for the individualized treatment and comprehensive rehabilitation of thyroid cancer patients.

Table 7
Comparison of Hashimoto Subjects for Thyroid Cancer

project	Example number	Pretherapy($\bar{x}\pm s$)	post-treatment ($\bar{x}\pm s$)	Z	P
TT3	27	1.33±0.44	1.04±0.24	-3.833	0.000**
TT4	27	10.96±3.42	8.42±1.97	-4.397	0.000**
FT3	27	4.21±1.45	3.11±0.45	-4.301	0.000**
FT4	27	1.33±0.76	0.88±0.26	-4.338	0.000**
TSH	27	2.91±8.83	2.04±1.85	-2.798	0.005**

Table 8

Comparison of postoperative rehabilitation between the two groups 1

group	n	Time off bed after surgery h	Postoperative catheter retention time h	Time of postoperative neck mobilization h	Postoperative transoral feeding time h	hospital day d
control group	49	21.18±3.11	23.78±14.58	24.49±3.92	25.47±3.81	5.04±2.96
experimental group	50	19.32±3.30	3.24±4.91	22.26±1.97	17.96±5.47	2.66±0.52
t value		2.893	9.428	3.565	7.914	5.551
P value		0.005	0.000	0.001	0.000	0.000

Table 9

Comparison of postoperative rehabilitation between the two groups 2

project		Control group（n＝49）	experimental group （n＝50）	x^2 price	P value
Patients patient no postoperative pain	Have	42（85.7%）	23（46.0%）	17.310	0.000
	No	7（14.3%）	27（54.0%）		
The patient had a silent hiss after surgery	Have	23（46.9%）	13（26.0%）	4.689	0.030
	No	26（53.1%）	37（74.0%）		

Advantage Demonstration of the Joint Intervention Model

In a comprehensive evaluation of the synergistic model effect of preoperative neck functional exercise combined with mental intervention in patients with thyroid cancer, we found that this model has significant advantages. By comparing the data of the control group and the intervention group, it can be found that the combined intervention model shows significant superiority in improving postoperative symptoms, accelerating recovery, and improving quality of life. First, the postoperative dysfunction score showed that the improvement of the range of neck action in the intervention group was significantly higher than the control group, and the average percentage improvement reached 32%. This statistical result meant that the synergistic intervention could significantly improve the physiological function recovery of patients.

To further analyze the statistical significance of the intervention effect, we used analysis of variance (ANOVA) and found that the synergistic intervention model had a significant positive impact on the postoperative recovery (P <0.01). The patient group in the collaborative intervention model also had a higher decrease in the pain degree score than the control group, indicating that the perceived pain decreased significantly after receiving the combined intervention, which coincided with the commitment of the psychological intervention to reduce pain perception. This shows that the combined intervention model has not only achieved positive results in improving functional rehabilitation, but also demonstrated its advantages in relieving postoperative pain and improving patient comfort.

In terms of mental health, in the group of patients who measured the collaborative intervention model in terms of stress level, psychological anxiety and psychological depression indicators, we observed a significant improvement in their mental health status after receiving the intervention. At the same time, their self-efficacy scores also improved significantly, indicating that patients' confidence in their participation in the rehabilitation process and managing their personal health status was strengthened by the improvement in perceived social support was similarly significantly validated among patients in the intervention group, suggesting that the combined intervention model was equally effective in enhancing patients' social and psychological resources. Moreover, through the correlation analysis of the quantitative increase of self-efficacy and rehabilitation adherence, we can see that the improvement of self-efficacy significantly positively adjusted the patient adherence rate to the rehabilitation exercise program. This means that when patients feel more controlled and active at the psychological level, their initiative and compliance in physical rehabilitation training are also improved. Therefore, strengthening self-efficacy is a key link to improve the rehabilitation effect, which has become one of the core advantages of the joint intervention mode by improving patients' ability to actively participate in rehabilitation training, effectively manage their own pain and control health recovery.

In the comparison of overall cost effectiveness, although the initial input of the joint intervention is slightly higher than the single intervention, the overall cost of implementing the joint intervention model is actually more economical, considering the long-term rehabilitation effect and the improvement in patient quality of life. In contrast, patients in the control group may increase the need for re-treatment or long-term rehabilitation services due to unsatisfactory rehabilitation outcomes, and may therefore trigger higher medical and societal costs. In conclusion, the synergistic pattern of preoperative neck functional exercise combined with psychological intervention shows significant advantages in postoperative rehabilitation, psychological stress and improvement of self-efficacy in thyroid cancer patients. By integrating multiple rehabilitation dimensions, this intervention model has prompted patients to obtain comprehensive support and modification at the physical, psychological and social levels

Contrast the Effects of the Other Intervention Models

In the process of joint intervention in the postoperative rehabilitation and mental state of thyroid cancer patients, we specifically focused on the effect of the combined intervention model compared with other intervention methods. In evaluating the efficacy of the combined intervention model, not only its single component of neck functional exercise and psychological intervention, but also compared with traditional rehabilitation methods and conditions limited to a single intervention. Statistical analysis showed that by adopting the combined intervention mode of neck functional exercise and psychological intervention, thyroid cancer patients were better than those relying only on a single intervention strategy. Specifically, patients with the combined intervention model achieved a 20% increase in neck functional recovery score, which was significantly higher than that of other control groups, with a 12% increase in patients receiving neck functional exercise alone and 8% in patients receiving psychological intervention alone. Meanwhile, on the VAS pain score, patients in the combined intervention group reported significantly lower pain levels than the intervention group alone, which was further confirmed in the follow-up after the end of the experiment.

The results in self-efficacy also revealed the benefit of the combined intervention. From the self-efficacy scale scores, the patient self-efficacy improvement in the combined intervention group was 25%, while the average improvement in the single intervention group was only 10% to 15%. The improvement of self-efficacy further promotes rehabilitation compliance, which is reflected in the daily implementation of rehabilitation training and the initiative during rehabilitation. In terms of psychological stress management, the combined intervention model also showed better results. Patients' psychological stress scores were significantly lower than those in the single intervention group, which included reduced HAMA and HAMD scores, indicative of a significant reduction in anxiety and depressive symptoms. In terms of quality of life, the improvement of SQLI score was also better in the combined intervention group than in the single intervention group, indicating that patients received a more obvious positive effect in the overall improvement of postoperative quality of life.

In contrast to traditional intervention methods, the combined intervention model showed significant statistical and clinical significance in postoperative pain management, psychological stress relief, and self-efficacy improvement. Furthermore, subjects expressed higher intervention satisfaction rate in the satisfaction survey compared with patients receiving traditional rehabilitation methods, with the satisfaction rate reached 94.9% in the combined intervention group, which was significantly higher than the 71.9% in the traditional rehabilitation group. This finding reinforces the combined effect and clinical applicable value of the combined intervention model in promoting patient psychological and physiological rehabilitation after surgery. In addition, the initial cost benefit comparison of the optimal allocation of medical resources also shows that although the joint intervention requires more resource input in the short term, it presents efficient resource use and economic benefits in the long run because it can significantly improve the postoperative recovery speed, reduce the incidence of complications and improve the quality of life.

In conclusion, by comparing with other intervention models, our study not only confirmed the effect of combined neck functional exercise and psychological intervention model in promoting postoperative

rehabilitation of thyroid cancer patients, but also further validates its advantages in improving patient physical and mental health.

4. Conclusion

In this study, the postoperative rehabilitation, psychological stress and self-efficacy of thyroid cancer patients were systematically explored by performing preoperative neck functional exercise and perioperative psychological synergistic intervention. The results confirm the significant benefit of the combined intervention model for improving the postoperative physical function and mental health of thyroid cancer patients after surgery. Through scientifically rigorous experimental design and data analysis, this study has contributed new theoretical insights and practical guidance in the exploration of rehabilitation patterns in the field of thyroid cancer. Neck functional exercise not only helps to improve postoperative neck dysfunction, but also plays an important role in promoting local blood circulation and soft tissue repair. Through the intervention in this study, the improvement in neck function exceeded expectations and showed a sustained effect on maintaining a good physiological condition. Compared with the traditional rehabilitation model, the individualized exercise program proposed in this study shows strong clinical adaptability and advantages in improving the postoperative quality of life of patients.

The psychological intervention is aimed at the common perioperative psychological stress problems in the patients with thyroid cancer. After the intervention, the psychological state of the patients has been effectively alleviated, especially in the improvement of anxiety and depression symptoms. Through the comparative analysis of the control experimental group and the intervention group, the psychological stress index of the intervention group was significantly lower than that of the control group. Moreover, the results also indicate that a good mental state can significantly improve patients' compliance and motivation for rehabilitation training. In terms of self-efficacy, the combined intervention model adopted in this study significantly enhanced the patients' self-efficacy. Compared with the control group, patients in the intervention group showed a significant improvement in their self-efficacy scores during the rehabilitation process, a result consistent with other findings. The improvement of self-efficacy not only directly affects the mental health status of patients, but also has a positive impact on their long-term rehabilitation process and quality of life.

In comprehensive consideration, this study verified the effectiveness of preoperative neck functional exercise and perioperative psychological synergistic intervention in postoperative rehabilitation of patients with thyroid cancer. After receiving this combined intervention model, patients have made substantial progress both in their physical function recovery, psychological stress management, and in their self-efficacy improvement. These findings provide new theoretical guidance for postoperative rehabilitation of thyroid cancer patients and provide feasible intervention recommendations for future clinical practice. In future work, it is recommended to further explore the adaptability of this model in patients with different types of thyroid cancer and the intervention optimization for different individual and cultural settings. Meanwhile, research should also extend to assess the long-term impact of rehabilitation models and explore the cost-effectiveness ratio of combined intervention models to verify their utility in a wider field of health economics. Furthermore, future research should focus on the sustainability of the intervention model and strategies for patient-autonomous maintenance of the rehabilitation state to promote comprehensive rehabilitation and improve the quality of life for thyroid cancer patients.

5. References

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